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CONTENT

FACTORS INFLUENCING CLIMATE CHANGE ADAPTATION STRATEGIES AMONG ARABLE CROP FARMERS IN OSUN STATE, NIGERIA

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Abstract

This study assessed the determinants of the strategies adopted by the arable crop farmers in coping with climate change in Osun state, Nigeria. A multistage sampling technique was used to select 120 arable crop farmers as samples for the study. Data for the study were collected with a structured interview schedule. Data were analysed with descriptive and inferential statistical tools; frequency distributions, means, standard deviation, percentages, and Pearson's Product Moment Correlation (PPMC). Descriptive results reveal that most (87.5%) of the sampled farmers were male, and married (63.00%). The average age, household size, and years of formal education were 53.6 years, 10.15 persons, and 5.20 years respectively. Perceived significant variables influencing climate change were fluctuating rainfall patterns and extreme temperature with weighted mean scores (WMS) of 4.55 and 4.47 respectively. The major climate change adaptation strategy and constraint to adaptation were late or early planting, and unavailability of capital with WMS scores of 4.54 and 2.80 respectively. Significant factors influencing climate change adaptation strategies were age, household size, years of formal education, and farming experience. The study concluded that farmers were aware of the effects of climate change and have adopted coping strategies, especially planting their crops early or late in line with emerging rainfall patterns. Thus, extension services must be tailored towards awareness and adoption of improved agronomy practices and planting materials, especially early maturing and drought-resistant varieties of crops that would mitigate climate change effects on crop productivity. Also, farmers should be encouraged to insure their crops against failure due to the effects of climate change.

Key words: *arable crop farmers, climate change, adaptation strategies*

INTRODUCTION

The thirteenth sustainable development goal is centered on climate action. Changing climate is of serious concern globally to farmers, especially in tropical Africa [15]. It is the primary determinant of agricultural productivity among rural households in Africa [8]. Evidence abounds that climate change has impacted adversely on agricultural output, and there is a need to arrest this critical situation. Farmers in Sub-Saharan have a higher vulnerability to climate change than their counterparts in other parts of the globe.

According to [20] climate change has come to stay posing a severe threat to the development of agriculture and other non-farm activities. However, the vulnerability is higher in agricultural production relative to other sectors of the economy. The two basic factors that triggered climate change are bio-geography and human anthropogenic activities. Apart from the inherent climatic factors, external natural factors outside the climate system such as volcanic eruptions, the intensity of solar radiation, and the earth's rotation around the sun have impacted the climate on a short-term basis [7]. According to Intergovernmental Panel on Climate Change (IPCC) report, the United Nations Framework Convention on Climate Change (UNFCCC), defined climate change as alterations in climatic elements induced by direct or indirect human activities(anthropogenic) resulting in global atmospheric changes and climatic variability observable over compared periods of time.

According to [4] relevant research has shown that Africa's vulnerability to climate change is attributed to poor or badly implemented agricultural policies and programmes, low adoption of improved technology, abject poverty extreme weather conditions, and social and economic challenges.

Climate changes have negatively impacted people and their means of livelihood and the ecosystem. These have constituted a serious developmental challenge globally, especially for the vulnerable poor in developing economies [12]. Adaptation or agronomy practices and farm strategies are already in place [5].

In order to meet the continuously growing food demand of the populace in Nigeria, there is a need to modify food production and systems in order to mitigate the increasing effects of climate change. Evidence abounds that there are significant changes in farming technologies and systems in response to climate change effects in the region [1].

In recent times, sub-Sahara Africa is the center of focus on the probable impacts of climate change on agricultural production, economic growth, and sustainable all-around economic growth. This can be attributed to persistent drought induced by surging temperatures and a significant reduction in the amount of rainfall. Indicators of changing climate in the region include; a significant reduction in soil moisture resulting in declining soil quality, crop resilience, prolonged growing seasons, persistent rise in sea levels, decline in yields of crops and animals, prolonged farm drought, and weed resurgence among others [18]. This has negatively affected agriculture; the mainstay of the African economies. The situation is exacerbated by adjoining factors such as abject poverty, inequality in land distribution, inadequate access to capital and technology, dilapidated public infrastructure such as road networks, and inadequate research and extension.

A few researchers studied the factors influencing the adoption of climate change mitigation measures and concluded that the main ones are: "age of the farmer, farming experience, tenancy status, farm size, years of education, extension contact, income, access to credit and membership of farmers' association" [11, 19].

Climate change has recently attracted global attention as an emerging threat to sustainable global development affecting all the sectors of the world economy. The continuous global increase in greenhouse emissions has triggered higher climate change impacts. Emissions from agricultural production have contributed significantly to climate change ranking third behind emissions from energy consumption and chlorofluorocarbon. production and contributing about 15% of the total anthropogenic greenhouse gases emission.

This study, therefore, attempted to describe the socio-economic characteristics of the arable crop farmers, examine farmers' perceived effects of climate change, examine the level of use of adaptation strategies, and constraints limiting the use of adaptation strategies among the arable crop farmers in the study area.

Hypothesis of the study

There is no significant relationship between selected socio-economic characteristics of the arable crop farmers and their climate change adaptation strategies

MATERIALS AND METHODS

The study was conducted in the Ife-Ijesha Agricultural Zone of Osun State, Nigeria. The zone shares a boundary in the North with Kwara State, Ekiti and Ondo States in the South, and Ogun and Oyo States in the West.

Important cities and towns in the Ife-Ijesha zone include the ancient kingdom capitals of

Ile-Ife, Ilesha, and Ijebu-Jesha. Osun State occupies a land mass of approximately 14,875 square kilometers which was taken out of the old Oyo state on the 27th of August, 1999.

Data were collected on information relevant to the study from the sampled arable crop farmers using a well-structured interview schedule. A multistage sampling procedure was used for selecting the respondents. Based on Osun State Agricultural Development Programme (OSSADEP) delineation, Ife/Ijesha Agricultural zone consists of ten Local Government Areas which are equivalent to ten blocks. The first stage of sampling involved the purposive selection of four (4) Local government areas (Ife North, Oriade, Ife East, and Atakumosa East) from the ten (10) local government areas present in the zone as a result of the preponderance of farming activities in the area. The second stage involved random sampling of three (3) rural communities from the selected local government areas based on field experience. Ultimately, ten (10) arable crop farmers were selected from the communities using a random sampling technique to make a total of 120 arable crop farmers as a representative sample for the study. The collected data were analysed with both descriptive and inferential statistical tools.

RESULTS AND DISCUSSIONS

The result in Table 1 shows that the age of 85.00% of the arable crop farmers' age ranged between 41-70 years, with a mean of 53.67 years, implying that the sampled farmers were adults, and mature enough to perceive the effects of climate change on arable crop production, and the ability to mitigate and adapt to the effects in order to improve their crop output in the study area.

This finding corroborates with that of [3] that older and more experienced farmers have the ability and capability to cope with the adverse effects of climate change relative to the younger and inexperienced farmers.

The majority (87.5%) of the respondents were males while only (12.5%) were females.

This corroborates [17] that the implication of males' greater proportion may be that productivity is expected to be higher because males have a tendency to be more labour efficient.

Furthermore, larger percentages (63.3%) of them were married. This is in line with the findings of [16] who reported that married people tend to be responsible for the needs of their family at all times.

The household size reveals that the majority (77.3%) of them had between 3 and 5 persons and the mean household size is 5 persons. This finding agrees with that of [3] that households with large members tend to be more efficient than households with small members in coping with the delirious effects of climate change on crop production.

Furthermore, the mean years of formal education are 10.45 years, implying that the sampled farmers are literate enough to perceive the effects of climate change. This corroborates [3] who postulated that the acquisition of formal education may enhance adaptation strategies against the effects of climate change. Farming is the primary occupation of most (71.4%) of the sampled arable crop farmers.

Also, 40. 00% of the arable crop farmers had between 21 and 30 years of experience in arable crop production. The mean years of production experience was 25.6±11.98 years. This result is in tandem with that of [6] which stated that a good farming experience could help farmers in making good decisions and choices in their crop production process hence, has a positive implication for crop productivity.

A larger proportion (40.0%) of the farmers had between 4.5 and 6.5 acres while the mean farm size was 6.39 acres.

However, putting more land into cultivation may not really translate into increased productivity, especially when farmers have to face climate change outcomes.

This conforms with [10] that the likelihood to adapt to climate change increases with an increase in farm size.

In addition, most (89.20%) of the arable crop farmers sourced their capital from cooperative societies.

Table 1. Distribution of the respondents according to their socio-economic characteristics (n=120)

	Frequency	Percentage	Mean
Age			
21	3	2.5	53.6±10.15
31-40	4	3.3	
41-50	57	47.5	
51-60	17	14.2	
61-70	28	23.3	
Above 70	11	9.2	
Gender			
Male	105	87.5	
Female	15	12.5	
Marital status			
Single	16	13.3	
Married	76	63.3	
Widowed	9	7.5	
Separated and divorced	19	15.9	
Household size			
3-5	85	77.3	4.80±2.045
6-9	22	20.0	
Above 9	3	2.7	
Years of education			
0	30	25.0	10.45±5.226
1-6	7	5.8	
7-12	45	37.5	
Above 12	38	31.7	
Primary occupation			
Farming	85	71.4	
Trading	5	4.2	
Artisan	28	23.5	
Civil servant	2	1.7	
Years of farming experience			
1-10	12	10.0	25.6±11.98
11-20	33	27.5	
21-30	48	40.0	
31-40	10	8.3	
Above 41	17	14.2	
Farm size (acres)			
0.5-2.5	1	0.8	6.39±4.57
2.5-4.5	32	26.7	
4.5-6.5	48	40.0	
6.5-8.5	24	20.0	
8.5-10.5	10	8.3	
Above 10.5	5	4.2	
Source of capital			
Personal savings	91	75.8	
Cooperative association	107	89.2	
Family and friends	32	26.7	
Annual income(₦'000)			
1-500	53	44.2	125,327.7 ± 113,244.1
501-1,000	23	19.2	
1,001-1,500	8	6.7	
1,501-2,000	5	4.2	
2,001-2,500	14	11.7	
2,501-3,000	5	4.2	
Above 3,000	12	10.0	

Source: Field survey, 2021.

Lastly, data in the table shows that some (44.2%) of the sampled arable crop farmers had an income of between ₦1,000 and ₦500,000 while 19.2% of them had an income of between ₦501 and ₦1,000 while 11.7% of them had between ₦2,001,000 and ₦2,500,000.

The mean annual income of the respondents is N125,327.70, implying that the farmers' farm income may be sufficient to meet their significant farm needs.

Perceived effects of climate change

The perceptions of the sampled arable crop farmers on climate change are presented in Table 2. Results in the Table shows that farmers perceived inconsistent rainfall pattern (WMS=4.55), extreme temperature (WMS =4.47), and late onset of rainfall as the major causes of climate change in the study area. This is in conformity with [9] who observed negative global effects of climate trends on wheat and maize yields in many regions. The result also shows that reduced rainfall (WMS = 3.82) and long dry season (WMS = 3.70) were considerably major effects.

Table 2. Distribution of respondents according to their perceived effects of climate change

Perception	WMS	RANK
Non consistent rainfall pattern	4.55	1st
Extremes in temperature	4.47	2nd
Rainfall starts late	4.37	3rd
Reduced rainfall	3.82	4th
Long dry season	3.70	5th
High intensity rainfall	1.91	6th

Source: Field survey, 2021.
WMS= Weighted Mean Score

[2] lend credence adding that delay in rainfall commencement and high temperatures result in stunted growth and eventual death of some young plants. This is in accordance with [13] who stated that significant effects of climate change are manifested in the form of more erratic and decreased volume of rainfall, protracted drought, and surge in ambient temperature.

Climate change adaptation strategies used by the respondents

Table 3 presents the arable crop farmers' distribution according to their level of use of adaptation strategies. Using the weighted mean score (WMS), in ranking various strategies in order of importance reveals that following rainfall patterns, planting their crops early or late, embracing mixed copping, and use of good cultural practices scored the highest WMS score of 4, 54, 4.43 and 4.39 respectively. In consonance with [14], the main adaptation strategies of arable crop farmers include a change in crop types, planting short-season varieties, changing planting dates, and crop diversification. Furthermore, planting cover crops, wetland farming, pests and disease-resistant cropping, and use of proper drainage channels had a WMS score of 2.95, 2.74, 2.68, and 2.15 respectively and these were the least used adaptation strategies among the farmers in the study area. In addition, the use of cover crops, farming on wetlands, planting of disease and drought resistance varieties of crops (WMS = 1.93), shifting cultivation (WMS = 1.90), irrigation of farmland (WMS = 1.73), cultivation on floodplains and valleys (WMS = 1.68) and alley farming (WMS = 1.34) were 2.74, 2.68 and 2.15, respectively were in low usage as adaptation strategies among the arable crop farmers in the study area. The result further showed that drought tolerant crop varieties (WMS = 1.93), shifting cultivation (WMS = 1.90), irrigation of farmland (WMS = 1.73), cultivation on floodplains and valleys (WMS = 1.68) and alley farming (WMS = 1.34) were ranked least of all the adaptation strategies.

Table 3. Distribution of arable crop farmers according to their adaptation strategies

Adaptation strategies	Very High	High	Moderate	Low	Very low	WMS	Rank
Targeting rainfall to plant, leading to either early or late planting	89(74.2)	19(15.8)	5(4.2)	2(1.7)	5(4.2)	4.54	1st
Good cultural practices	78(65.0)	22(18.3)	12(10.0)	5(4.2)	3(4.2)	4.39	2nd
Mixed species cropping	77(64.2)	32(26.7)	1(0.8)	6.(5.0)	4(3.3)	4.43	3rd
Farming of several varieties	15(12.5)	44(36.7)	35(29.2)	21(17.5)	5(4.2)	3.35	4th
Planting cover crops	10(8.3)	17(14.2)	61(50.8)	22(18.3)	10(8.3)	2.95	5th
Wetland/Fadama farming	5(4.2)	10(8.3)	66(55.0)	27(22.5)	12(10.0)	2.74	6th
Pest and diseases resistant crop	6(5.0)	10(8.3)	60(50.0)	28(23.3)	16(13.3)	2.68	7th
Construction of proper drainage channels	4(3.3)	4(3.3)	26(21.7)	59(49.2)	27(22.5)	2.15	8th
Drought tolerant crop varieties	2(1.7)	8(6.7)	12(10.0)	56(46.7)	42(35.0)	1.93	9th
Shifting cultivation	3(2.5)	5(4.2)	20(16.7)	42(35.0)	50(41.7)	1.90	10th
Irrigation of farmland	5(4.2)	4(3.3)	1(0.8)	54(45.0)	56(46.7)	1.73	11th
Cultivation on floodplains and valleys	4(3.3)	2(1.7)	6(5.0)	48(40.0)	60(50.0)	1.68	12th
Alley farming	2(1.7)	2(1.7)	1(0.8)	25(20.8)	90(75.0)	1.34	13th

Source: Field survey, 2021.

Constraints to the use of adaptation strategies

Table 4 presents the distribution of the respondents according to constraints limiting the use of adaptation strategies among the farmers. Ranking first is inadequate access/capital unavailability with WMS score of 2.80, following this, the second and third-ranking are unavailability of subsidies on planting materials, and unavailability of required production inputs with WMS scores of 2.79 and 2.56 respectively. These results are in line with that of [14] who reported that. inadequate access/unavailability of capital and unavailability of the required production inputs are the major factors limiting adaptation strategies among farmers in the study area. The least severe constraints to adaptation strategies in the study area are a low level of awareness of climate change variability, irregularities of extension services, gross time consumption, and poor access to climate change information with a WMS score of 1.98, 1.70, 1.68, and 1.55 respectively.

Low awareness level of climate change variability (WMS = 1.98), irregularity of extension services (WMS = 1.70), gross time consumption (WMS = 1.68) and poor access to information on climate change (WMS = 1.55) were the least severe constraints to the use of adaptation strategies.

Table 4. Distribution of arable crop farmers according to constraints to the use of adaptation strategies

Constraints	Very severe	Severe	Mild	WMS	Rank
Capital unavailability	103(85.8)	10(8.3)	7(5.8)	2.80	1st
No subsidies of planting materials	102(85.0)	11(9.2)	7(5.8)	2.79	2nd
Inadequate required production input	75(62.5)	38(31.7)	7(5.8)	2.56	3rd
Low awareness level of climate change variability	28(23.3)	62(51.7)	30(25.0)	1.98	4th
Irregularity of extension services	30(25.0)	25(20.8)	65(54.2)	1.70	5th
Gross time consumption	11(9.2)	60(50.0)	49(40.8)	1.68	6th
Poor access to information on climate change	3(2.5)	60(50.0)	57(47.5)	1.55	7th

Source: Field survey, 2021.

Results of simple linear regression analysis: The results of regression analysis used to determine the significant factors influencing adaptation strategies utilised in the study area are shown in Table 5.

Table 5. Simple linear regression analysis showing selected socio-economic factors influencing adaptation strategies employed

Variables	Coefficient(β)	Std. Error	t value	Significance
(Constant)	38.757	3.462	11.195	0.000
Age	-0.087	0.061	-1.420	0.170
Farming experience	-0.023	0.058	-0.393	0.698
Farm size	0.227	0.084	2.707	0.013**
IGA	0.001	0.000	3.501	0.002***
Years of education	0.157	0.080	1.962	0.062*

N.B: *** Significant at 1% and ** Significant at 5% *Significant at 10%
R^2=0.689, Adjusted R^2=0.519, F value=9.765
Source: Data Analysis, 2021.

Table 5 shows that the adjusted R-squared is 0.52 and the F-value (9.765) is statistically significant at a 10% level, implying that the model fitted the data for the study and that the independent variables explain about 52.00% variation in the dependent variable.

The farm size coefficient has a negative value and is statistically significant at a 5% level, indicating that the variable is negatively related to the adaptation strategies utilised by the sampled farmers in the study area.

The coefficients of years of formal education and income-generating activities (IGAs) are positive and significant at 1% and 10% levels of significance respectively, showing that these variables are positive determinants of adaptation strategies utilized by the sampled farmers in the study area.

Test of hypothesis

Table 6 shows the summary of the Pearson product correlation matrix establishing the association between arable crop farmers selected socio-economic characteristics and strategies adopted by the farmers to cope with the effects of climate change.

Results in the Table show that age (r=-0.397, p=0.000) and farm size (r=0.395, p=0.000) ae negatively related to farmers' adaptation strategies. These implies that aged farmers and farmers with large farm size may not be able to cope with effects of climate change, while farmers with moderate farm size may cope effectively with the effects of climate change.

However, farmers with large household size, higher years of formal education, and farming experience may cope effectively with climate change effects.

Table 6. Pearson product correlation matrix showing the relationship between selected socio- economic characteristics of the arable crop farmers and climate adaptation strategies

Variable	Coefficient	Sig	Decision
Age	-0.397	0.000**	S
Household size	0.257	0.005**	S
Years of education	0.215	0.018*	S
Farming experience	0.299	0.000**	S
Farm size	-0.395	0.000**	S

Source: Data analysis, 2021.
**Significant at 1%, *Significant at 5%

CONCLUSIONS

It was concluded that farmers were aware of the manifestations of climate change. They never planted their crops sequentially rather; they always planted most of their crops at the onset of raining season. Adaptation measures such as planting of crops more adaptable to new climate situation; application of irrigation; planting early maturing varieties; planting drought resistant varieties; planting pests and diseases resistance varieties were commonly in practice among the sampled farmers. Capital unavailability and no subsidy of planting materials constrained the use of adaptation strategies, alternating seasons for cropping and farm insurance were least adopted byarable crop farmers in the study area. Adaptation strategies were influenced by socio-economic characteristics of the farmers.

From the study findings, the following recommendations were made:

(i)Intensification of extension services especially campaigns on adoption of improved agronomic practices; planting of early maturing and drought resistance varieties that would help farmers to mitigate the effects of climate change.

(ii)Extension education to encourage farmers to insure their farms against crop failures due to climate change should be intensified among the farmers.

(iii) Farmers should have access to credit facilities and other farm inputs that will cushion them against climate change effects in the study area and

(iv) Subsidy on planting materials and required production inputs should be provided by government and agricultural stakeholders, to encourage proper and increase use of adaptation strategies.

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NATURAL HONEY: A STUDY ABOUT ROMANIAN POTENTIAL TO DEVELOP ITS PRODUCTION AND EXPORTS ON INTERNATIONAL MARKETS

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Abstract

The study aims to evaluate Romanian potential to develop its natural honey production and exports on European and world markets, based on Romanian honey appreciated quality and its attractive price. The research method is based on a quantitative approach and use time data series related with Romanian honey production and trade. The conclusions underline a positive trend of the honey production in Romania, related with an increase of bee families and a development of the beekeeping sector especially in the West Region of Development.

Key words: *honey, production potential, trade, Romania*

INTRODUCTION

The stories of the bee and honey bee products followed the humanity during centuries. Recent studies reveal spectacular issues related to the lives of bees and beekeepers as well as honey and bee products.

While is well known that bees are social insects, it might be surprising the studies that show their democratic decisions in choosing their next nest site, based on a face-to-face consensus-seeking assembly [16].

The beekeepers are helped by the researches related with the threats to the health and wellbeing of honey bee, as those targeted to understand the morphology, epidemiology, pathogenesis and the transmission of the honey bee viruses [2], or related with honey bee nutrition [8, 9] and necessity for supplementary feeding [9].

Some studies connected these aspects and studied the feedbacks that nutrition had on honey bee state of health [4].

While many studies are focused on the negative effects of pesticides on honey [11], more studies are related with the extensive colony losses of honey bee at world level and their various causes [15]. That is why the EU issued a programme for sustainable beekeeping [5].

Not so many studies are related with the economic aspects of the honey bee commercialisation on the markets. Several studies are searching for consumer`s preferences for locally produced honey [3, 13], the needs for marketing cooperation and for honey business strategy [17] or role of honey bees in generating incomes in farms and their role as an input in enhancing crops productivity. Even fewer studies are related with the international trade with honey and honey products. But these studies are related rather with the impacts of honey safety and quality standards on honey trade [1, 18].

In a recent book dedicated to honey analyse [14] the authors detailed the evolution of the honey sector in Romania, Serbia and Italy, proposing the indicator of Average Annual Growth Rate, which was used to compare the evolution of trade balance in the analysed period in these countries.

Their results pointed Romania as an important exporter of honey, having a net trade balance, with an average yearly growth rate of more than 50% in the period of ten years included in their research.

In this context, the paper aimed to analyze the evolution of the honey bee production in Romania and its international trade with honey.

MATERIALS AND METHODS

The research related with production was conducted at the regional and national level, and within EU and World context.

For this study, based on the honey production we calculated statistical indicators as: the mean, the standard deviation, the coefficient of variation, the annual growth rate, and specific trade indicators as: trade balance, export and import prices.

The data were provided of Romanian National Institute of Statistics and the main provider of trade data, International Trade Centre.

A SWOT analysis was also made to show which are the strengths, weaknesses, opportunities and threats in honey production and trade.

RESULTS AND DISCUSSIONS

Evolution of production

The production of honey bee in Romania increased from 23,062 tons in 2012 to 30,831 tons in 2021 (Figure 1).

During this decade, the average production was 26,304 tons, recording an annual growth rate of 3.28%.

While The Region South West Oltenia had the biggest honey production in 2021, and recorded also the highest average production from 2012 to 2021, the North West Region recorded the highest annual growth rate, of 5.5%, with an increase of production by 61% from 2012 to 2021 (Table 1).

Table 1. The evolution of the honey production in Romania between 2012 and 2021 by region (tons)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Romania	23,062	26,678	18,040	27,893	21,202	30,177	29,162	25,269	30,724	30,831
North West	2,910	3,117	2,291	3,568	2,821	4,031	4,249	3,263	4,345	4,710
Centre	3,354	3,958	2,533	4,269	3,117	3,829	3,493	3,408	3,877	3,839
North East	3,368	3,433	2,711	4,081	3,188	3,917	3,880	3,691	4,342	4,589
South East	2,922	3,130	2,246	3,271	2,232	5,201	4,724	4,333	5,652	5,134
South Muntenia	3,395	4,152	2,688	4,058	3,116	4,049	3,962	3,078	3,556	3,858
Bucharest - Ilfov	219	379	171	277	193	261	344	314	328	238
South West Oltenia	3,797	4,491	2,718	4,657	3,809	5,299	5,387	4,712	5,278	5,488
West	3,097	4,018	2,682	3,712	2,726	3,590	3,124	2,470	3,346	2,975

Source: INSSE data base [12].

The highest variability of production in the analysed period was recorded in the Bucharest – Ilfov Region and the West Region was the only region with negative annual growth rate between 2012 and 2021 (Table 2).

Table 2. Indicators calculated in relation to the evolution of the honey production in Romania by region for the period 2012-2021

	Mean	St. Dev.	Coef. of variation	Annual growth rate (%)	2021/2012
Romania	26,304	4,369	0.17	3.28	+33.69
North West	3,531	781	0.22	5.50	+61.86
Centre	3,568	498	0.14	1.51	+14.46
North East	3,720	562	0.15	3.50	+36.25
South East	3,885	1,274	0.33	1.43	+75.70
South Muntenia	3,591	505	0.14	1.43	+13.64
Bucharest - Ilfov	272	68	0.25	0.93	+ 8.68
South West Oltenia	4,564	893	0.20	4.18	+ 44.54
West	3,174	493	0.16	-0.45	-3.94

Source: own calculation based on INSSE data base [12].

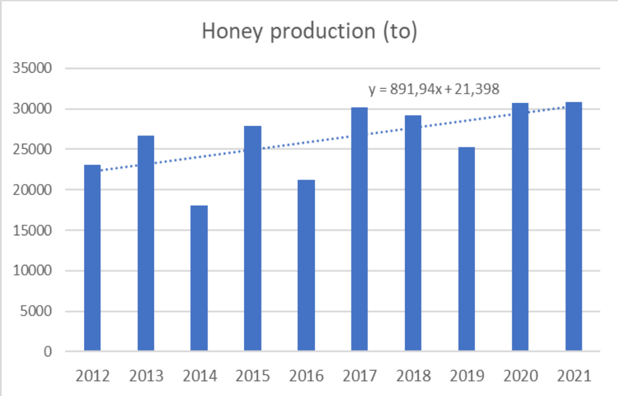

Fig. 1. Honey production in Romania
Source: INSSE data base [12].

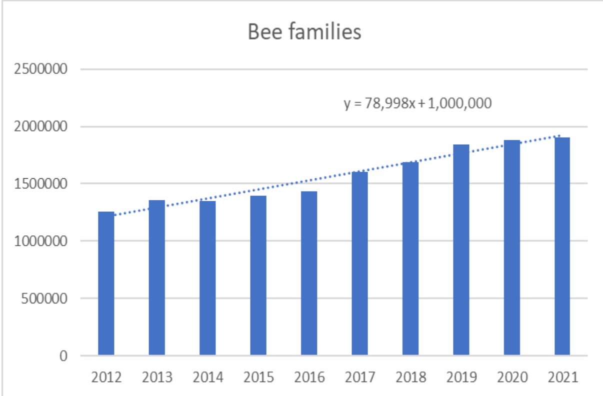

Fig. 2. Bee families in Romania
Source: INSSE data base [12].

Evolution of bee families

Despite overall decline of the number of pollinators in the EU, due to climate change effects, pollution and biodiversity loss [5], the number of bee families in Romania increased from 1.2 million in 2012 to 1.9 million in 2021, corresponding to an annual growth rate of 4.74%.

As calculated in average for this period, at national level were recorded about 1.5 million of bee hives. In 2021 the South East Region was in top with the number of bee families, with around 0.33 million, followed by the North East Region with 0.31 million of bee families (Table 3).

Table 3. The evolution of the bee families in Romania by region between 2012 and 2021 (thousands)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Romania	1,254	1,354	1,350	1,392	1,437	1,602	1,689	1,843	1,879	1,903
North West	162	170	174	171	184	209	230	294	308	312
Centre	188	195	191	202	203	204	211	223	225	226
North East	170	195	193	198	199	215	219	238	248	252
South East	141	138	136	138	147	252	282	323	333	337
South Muntenia	185	192	194	197	215	227	228	249	265	263
Bucharest - Ilfov	18	18	13	13	14	14	16	16	15	11
South West Oltenia	218	270	275	298	294	312	324	311	290	291
West	168	172	171	172	177	165	176	186	191	206

Source: INSSE data base [12].

Table 4. Indicators calculated in relation with the evolution of the bee families in Romania by region for the period 2012-2021

	Mean (thousands)	St. Dev. (thousands)	Coef. of variation	Annual growth rate (%)	2021/2012
Romania	1,570	244	0.16	4.74	+51.76
North West	221	61	0.28	7.55	+92.54
Centre	207	13	0.07	2.04	+19.96
North East	213	26	0.12	4.43	+47.71
South East	223	90	0.41	3.97	+139.16
South Muntenia	221	29	0.13	3.97	+41.96
Bucharest - Ilfov	15	2	0.14	-5.07	-37.36
South West Oltenia	288	29	0.10	3.28	+33.68
West	178	12	0.07	2.34	+23.09

Source: own calculation based on INSSE data base [12].

The North West Region has recorded the highest annual growth rate of 7.5% for the bee family's population, while the Bucharest Ilfov Region confirmed the loss of production conditions that generated a negative annual growth rate, of around -5%. The bee

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population from the South East Region showed the highest variability between 2012 and 2021. In the Bucharest – Ilfov Region of Development, a region that had seen great changes and interactions between the urban and rural environment, with a huge development of urban areas, the beekeeping occupation will be hardly to find in the next decades.

In the Table 4 were presented the main statistical indicators, calculated in relation with the evolution of the bee hives in Romania for the period 2012-2021.

SWOT Analysis

A SWOT analysis of the honey bee sector in Romania in the EU context [6] underline, from the authors point of view, the next aspects:

Strengths:

1. Tradition doubled by passion;
2. The climate is favourable for bee production in most part of the country;
3. All the Romanian beekeepers that have above 150 hives units are part of producer's organisations;
4. Romania is situated in top 3 of EU countries as regarding the number of hives and the total quantity of produced honey, and both indicators have a positive trend;
5. The average cost per kg of honey produced is one among the smallest from EU;
6. The Romanian export possibilities are attractive even within EU, where the trade balance with honey is negative;
7. The beekeeping sector is supported by the Romanian Apiculture Program, financed by the European Union (50%) and the member states (50%) and the funds allocated are related with the number of beehives.

Weaknesses:

1. The reduced size of the beekeepers from Romania, compared with the situation from the main honey bee producers from EU and the negative trend of them in the recent years;
2. Small number of the beekeepers with significant hive families;
3. Low average yield in kg of honey per beehive and per year, related with other EU producers;
4. Low internal consumption of honey bee per capita, far below EU average;
5. Low average price of honey per kg in the site of production and very low average price of honey in bulk at wholesalers;
6. Only few producers can manage to have beekeeping as an essential source of income.

Opportunities:

1. There are many potential seasonal spots at the national level where the beekeepers can develop their production;
2. The possibility of the beekeepers to access the NAP in the areas as: technical assistance, combating of beehive invaders and diseases, transhumance rationalisation or hives restocking;
3. The increasing use of honey bee in medicine, related with the healing effects, which increase the demand for honey bee;
4. Trading of the Romanian honey bee on the international markets, at superior price level.
5. Diversification of the product range;
6. Developing of the new brands or why not, of a National Honey Brand;
7. The use of the concept and the advantages of the mountain products for the producers located in the mountain areas;
8. Enhancing online sales in the beekeepers' options on the market.

Threats:

1. Low incomes from the beekeeping activity discouraged many of the newcomers to the sector and the attraction of accessing EU funds is annihilated by the limited possibilities in developing their business;
2. The aging of the traditional beekeepers and the lack of descendants interested in the following of beekeeping tradition;
3. The high level of pesticides that threats the beehives and the high frequency of the invaders and diseases within the beehives;
4. Limited access to the distribution channels for many beekeepers;
5. Changes in land use might affect in time the opportunities for beekeepers in developing their activities and can increases the transhumance costs;
6. Imported quantities of honey in the EU from Ukraine and China;

Similar remarks in SWOT analysis in honey production and trade were made by [7];

Romania was a net exporter for honey in the analysed period, even if it can be seen that in

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2022 it was exported 6,864 tons of honey, comparative with 9,748 tons in 2012 (Table 5).

Table 5. Trade balance for honey in Romania (tons)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Exported quantity	11,460	12,649	11,116	10,863	10,371	12,249	10,509	10,497	13,185	11,941	12,183
Imported quantity	1,712	2,967	2,577	2,450	3,388	3,630	3,013	2,373	5,906	5,226	5,319
Trade balance	9,748	9,682	8,539	8,413	6,983	8,619	7,496	8,124	7,279	6,715	6,864

Source: ITC data base [10].

The Romanian trade balance for honey bee was in consequence positive in the last decade, and with a higher sold at the beginning of the analysed period when the imported quantities were smaller. In 2022, Romania exported honey bee worth 52,384 thousand $ and imported honey bee worth 14,680 thousand $. In 2021 was recorded the highest net positive balance, of 58,800 thousand $. The export of Romanian honey bee in the non-EU countries ad more value to the trade balance, but the options in this moment are limited to a small number of countries (Table 6).

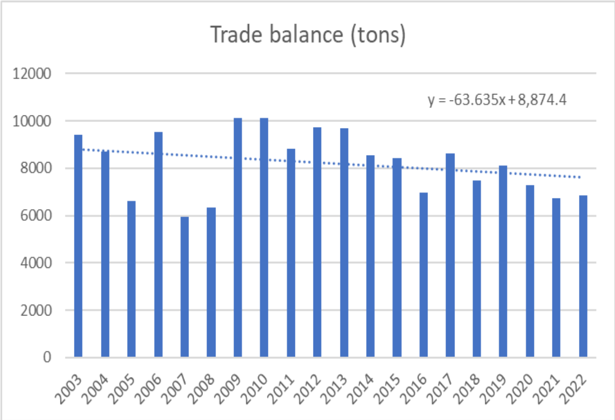

Fig. 3. Trade balance in Romania for honey (tons)
Source: ITC data base [10].

Table 6. Trade balance for honey in Romania (US Dollar thousand)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Export value	44,593	54,572	53,919	46,020	41,492	52,138	49,288	42,359	48,995	58,880	52,384
Import value	5,144	5,546	8,302	6,183	8,992	10,560	11,388	8,706	16,616	16,027	14,680
Trade balance	39,449	49,026	45,617	39,837	32,500	41,578	37,900	33,653	32,379	42,853	37,704

Source: ITC data base [10].

In quantitative terms, the Romanian exports of honey bee were above 10,000 to in every year of the analysed period, with a record of 13,185 to exported in 2020. The imported quantities started to increase in the last years, with the highest quantities recorded in 2020, of 5,906 to. Germany is the main destination of the Romanian exports of honey, with over 4.5 thousand to exported in 2019, followed by Italy and Poland. From non-EU countries, the main destination of honey bee exports was Japan, followed by the former member of EU, United Kingdom (Figure 5).

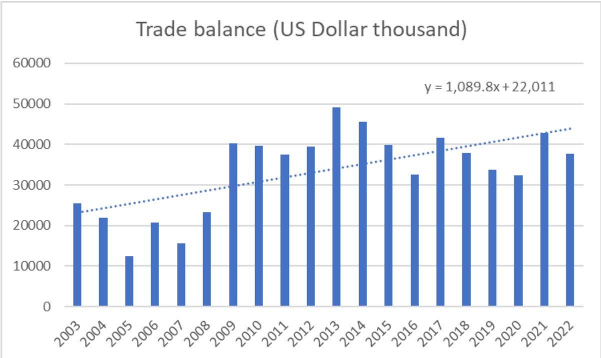

Fig. 4. Trade balance in Romania for honey (US Dollar thousand)
Source: ITC data base [10].

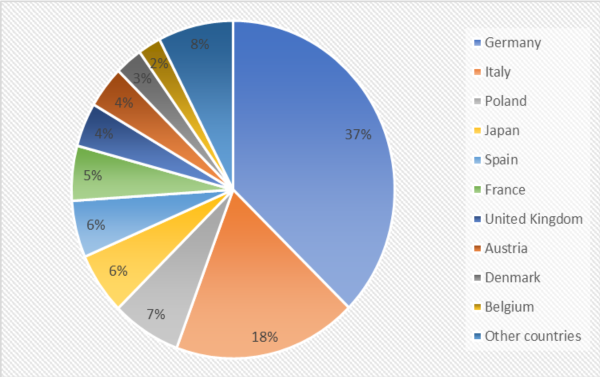

Fig. 5. Top importing markets for honey exported by Romania in 2022 (tons)
Source: ITC data base [10].

The honey bee sector in Romania can mainly be supported by attractive prices on the national and international markets.
The internal price of honey bee is not attractive both for buyers and sellers.

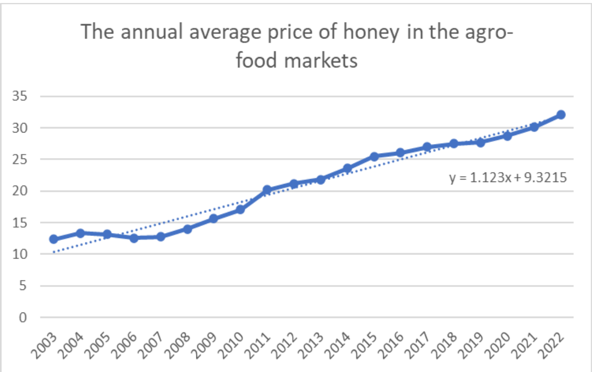

Fig. 6. The annual average price of honey in the agro-food markets in Romania (lei/kg)
Source: INSSE data base [12].

While for the first category the price is too low, for the second category the price is a restriction for most part of the consumers, which had average or rather low incomes.
The price of the honey bee in Romania was in 2022 around 5 - 6 euro/kg, but the positive trend of honey price on agro-food markets was not an advantage for the producers, which faced also higher production costs (Fig. 6).
The export prices were not in the advantage of the Romanian producers that wanted to sell their products on the EU and non-EU markets. The highest export price was recorded in 2021, of 4,931 $/to, but the evolution of export prices is quite unpredictable from one year to another, correlated with the honey bee production variations from Romania and abroad. The only benefit of exports was the sale of large bulk quantities.

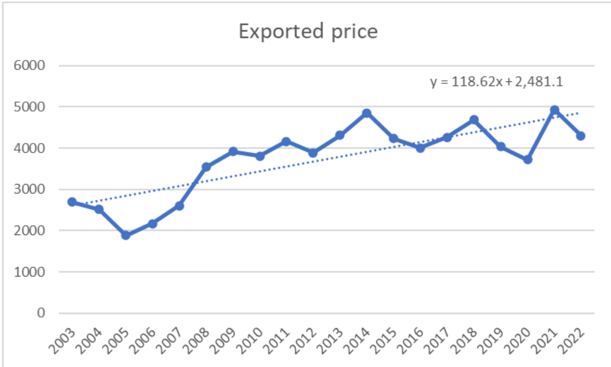

Fig. 7. Exported price for honey ($/tons)
Source: ITC data base [10].

In terms of import prices, as it is shown in Figure 8, the smallest price was in 2013, of 1,869 $/to and the highest in 2018, of 3,780 $/to. In 2022, Romania imported honey with 2,760 $/to.

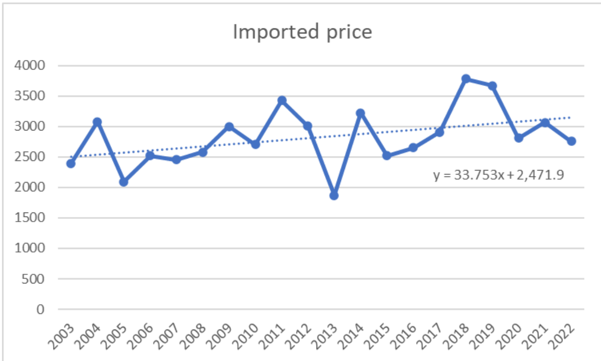

Fig. 8. Imported price for honey ($/tons)
Source: ITC data base [10].

CONCLUSIONS

Still traditional in Romania, which is an important producer of honey bee from EU, large quantities of honey bee are sell by producers directly, outside official markets.
The price of the honey bee in Romania does not ensure a decent living from the beekeeping activity alone, and the exports prices are also very low, which is also a week of the sector. Creating a national brand for honey bee might be a solution in promoting beekeeping activities, and in increasing of export prices. The sector which is strongly related with the health of the population due to honey properties should be more supported by Romanian state, and the activity of

beekeeper should get better recognition and support. Studies about honey consumption and promoting of honey consumption should be targeted at least for the young population. The large-scale use of bee products in pharmacy could also be the subject of some studies and cooperation solutions between beekeepers and the pharmaceutical sector should be found and supported through government support measures.

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THE RELATIONSHIP BETWEEN DOMESTIC AGRICULTURAL INVESTMENTS AND ECONOMIC GROWTH IN GHANA

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Abstract

We investigated the contribution to economic growth emerging from Ghana's investment intodomestic agriculture. To this effect, time series data spanning 1965 to 2020 was used. For data analysis, stationarity was achieved using Augmented Dicky-Fuller and Phillips-Perron test; the ARDL bounds approach adopted for cointegration; finally, the Error Correction Model and Granger causality test were used for determining the long-run and short-run causal effects. From the results, in both long-run and short-run, the nation's domestic agricultural investment was not a positive contributor to economic growth. Positive contribution to economic growth was from investment in other sectors (industrial and service sectors) and trade openness index. Moreover, government expenditure index contributed negativelyto economic growth. In the short-run, unidirectional causality was from economic growth to government expenditure index, other sector investments to economic growth, and economic growth to trade openness index. In this study, we strongly advocate for considerable government domestic investment into the agricultural sector besides other sector investments, and further relaxing trade policies since it is the only surety to achieving the government's two-fold agenda of zero tolerance for hunger and poverty while simultaneously increasing agriculture's contribution to economic growth with partial dependence on donor funds.

Key words**:** *agricultural growth, domestic investment, economic growth, granger causality*

INTRODUCTION

Governments' domestic agricultural investmentsplay a crucial role when determining the prevailing food security situations in developing economies [30]. Decision to eliminate hunger and poverty in most African countries by implementing sustainable agricultural policies aligns positively with the United Nation's Sustainable Development Goals [18]. The inappropriate budgetary allocation among the various economic sectors has slowed sustainable development in Africa. Globally, agriculture is perceived to be a major player in economic transformation [17]. According to Aneani et al. [3], the sector in Ghana, employs approximately one-third of the working labor force, contributes almost 64% of foreign exchange earnings. Despite the sector's progress, rural farmers still live in a deplorable state. Moreover, the majority are operating on a smallholder basis with the lack of farming inputs and practicing rain-fed agriculture as a means of survival [4]. How this sector promotes economic welfare in its entirety remains unsolved. Early literature in low-income countries on agriculture's contribution to economic growth tries to clarify these issues [15, 27, 29]. Inherent problems such as ineffective agricultural policies, use of traditional farming methods, and low capital investment have propelled others to challenge the assertion that agriculture always promotes economic growth [14, 22].

A vast literature exists on the economic impacts of domestic agriculture investments, while others concentrated on the impact of governments' investment on other sectors. These results differ because fiscal policies and economic situations differ in these countries.

The significant impacts of domestic agriculture investments on agricultural growth and poverty reduction in the long-run exists for countries such as China, and India [13], and African countries such as Zambia, Kenya, Tunisia, and Congo [1, 6].

Best to our knowledge, Ghana lacks empirical study on how domestic agricultural investment promotes economic growth. This study establishes whether domestic investment into agriculture sector in the face of other sector investments, trade openness, and government expenditure enhances economic growth. This study contributes to existing literature by providing an operational framework on budget allocation particularly to the actors in the agricultural sector.

MATERIALS AND METHODS

Data Sources

Secondary data (annual time series from 1965-2020)from Bank of Ghana and Ministry of Food and Agriculture was used. Economic growth was taken as gross domestic product (GDP) in Ghana cedis (GH₵), government's domestic investment into the agricultural sector in GH₵, and government's investment into the industrial and service sectors referred to as other sector investments in GH₵. Trade openness index (%) calculated by summing trade flows (imports and exports) in goods and services and dividing them by GDP was also considered. Finally, general government expenditure index (%) representing a function of total government expenditure comprising of other expenses besides those incurred from investments into the major economic sectors.

Empirical Strategy

Since dataset is an annual time series type, we first performed a stationarity test using the Phillips-Perron (PP) and the Augmented Dicky Fuller (ADF) tests. Secondly, after specifying the autoregressive distributed lag model (ARDL), with reference to a set of information criteria such as final prediction error (FPE), Schwarz information criterion (SC), Hannah-Quinn criterion (HQ), and Akaike criterion (AC), the optimum lag lengths were determined for each variable. The bounds test was used in the third stage to determine the existence of any cointegration relationship. Where cointegration relationship exists, causality must be inferred from these two models (long-run and short-run). Fourthly, long-run model was estimated by an error correction model instead of the vectors error correction model (VECM) due to the presence of one cointegrating relationship. The fifth stage involved a pair wise Granger causality test for the short-run causal effects. Finally, the robustness and credibility of the models were checked by sets of diagnostic tests such as Breusch-Pagan-Godfrey, Harvey, Glejser, Jarque-Bera, and ARCH.

Unit Root Test

The study used the ADF test per the specification of Dickey & Fuller [9], Dickey et al. [10], Elliott et al. [12], and the PP test following Philips &Perron [26]. The test equation is specified as follows:

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \cdots + \beta_i Y_{t-i} + \varepsilon_t \quad (1)$$

where:

Y_t is the time series data on gross domestic product growth to be tested. β_0 and β_1 represents intercepts and the coefficient of interest involving the unit root test ε_t is the error term, β_2, β_3 ... β_i are the augmented lagged difference parameters of Y_t, indicating the i[th] order of autoregressive processes. The null hypothesis to be tested in the unit root analysis is specified as:

$H_0: \beta = 0$, presence of unit root (non-stationary)

$H_1: \beta \neq 0$, no unit root (stationary)

ARDL Bounds Cointegration Test

After performing a stationary test, the series is likely to be integrated of I (0) - level stationary, I (1) - stationary after first difference, and integrated of different orders, thus I (0) and I (1) series. Once stationarity is achieved among the series, a cointegration test is necessary to establish the long-run relationship and short-run dynamics among the variables. Depending on the order of integration, these two cointegration tests; Engle-Granger cointegration and the Johansen cointegration are best suited for I (0), or I (1) series. The third approach to cointegration, used here, is the bounds cointegration test convenient for a combination of I (0) and I (1) orders. A major advantage of the bounds test as revealed by Pesaranet al. [24, 25] is that it produces unbiased long-run estimates.

The generalized ARDL (p, q) model is specified as:

$$Y_t = \gamma_{0i} + \sum_{i=1}^{p} \delta_i Y_{t-i} + \sum_{i=1}^{q} \beta_i X_{t-i} + \varepsilon_t \qquad (2)$$

where:
Y_t is a vector and the variables in (X_t) are allowed to be purely $I(0)$ or $I(1)$; β and δ are coefficients; γ is a constant; i = 1, …, k; p, q are optimal lag orders for dependent and independent variables; ε_{it} is the error terms (independent or serially uncorrelated). To perform the bounds test for cointegration, the conditional ARDL (p, q_1, q_2, q_3, q_4) model with 5 variables is specified as:

$$\begin{aligned}\Delta \mathrm{lngdp_t} = {} & a_{01} + b_{11}\mathrm{lngdp_{t-i}} + b_{21}\mathrm{lnasiv_{t-i}} + b_{31}\mathrm{lnosiv_{t-i}} + b_{41}\mathrm{lngvexp_{t-i}} + b_{51}\mathrm{lntop_{t-i}} \\ & + \sum_{i=1}^{p} a_{1i}\,\Delta \mathrm{lngdp_{t-i}} + \sum_{i=1}^{q} a_{2i}\,\Delta \mathrm{lnasiv_{t-i}} + \sum_{i=1}^{q} a_{3i}\,\Delta \mathrm{lnosiv_{t-i}} \\ & + \sum_{i=1}^{q} a_{4i}\,\Delta \mathrm{lngvexp_{t-i}} + \sum_{i=1}^{q} a_{5i}\,\Delta \mathrm{lntop_{t-i}} + \varepsilon_{1t} \qquad (3)\end{aligned}$$

$$\begin{aligned}\Delta \mathrm{lnasiv_t} = {} & a_{02} + b_{12}\mathrm{lngdp_{t-i}} + b_{22}\mathrm{lnasiv_{t-i}} + b_{32}\mathrm{lnosiv_{t-i}} + b_{42}\mathrm{lngvexp_{t-i}} + b_{52}\mathrm{lntop_{t-i}} \\ & + \sum_{i=1}^{p} a_{1i}\,\Delta \mathrm{lnasiv_{t-i}} + \sum_{i=1}^{q} a_{2i}\,\Delta \mathrm{lngdp_{t-i}} + \sum_{i=1}^{q} a_{3i}\,\Delta \mathrm{lnosiv_{t-i}} \\ & + \sum_{i=1}^{q} a_{4i}\,\Delta \mathrm{lngvexp_{t-i}} + \sum_{i=1}^{q} a_{5i}\,\Delta \mathrm{lntop_{t-i}} + \varepsilon_{2t} \qquad (4)\end{aligned}$$

$$\begin{aligned}\Delta \mathrm{lngvexp_t} = {} & a_{03} + b_{13}\mathrm{lngdp_{t-i}} + b_{23}\mathrm{lnasiv_{t-i}} + b_{33}\mathrm{lnosiv_{t-i}} + b_{43}\mathrm{lngvexp_{t-i}} + b_{53}\mathrm{lntop_{t-i}} \\ & + \sum_{i=1}^{p} a_{1i}\,\Delta \mathrm{lngvexp_{t-i}} + \sum_{i=1}^{q} a_{2i}\,\Delta \mathrm{lnasiv_{t-i}} + \sum_{i=1}^{q} a_{3i}\,\Delta \mathrm{lngdp_{t-i}} \\ & + \sum_{i=1}^{q} a_{4i}\,\Delta \mathrm{lnosiv_{t-i}} + \sum_{i=1}^{q} a_{5i}\,\Delta \mathrm{lntop_{t-i}} + \varepsilon_{3t} \qquad (5)\end{aligned}$$

$$\begin{aligned}\Delta \mathrm{lntop_t} = {} & a_{04} + b_{14}\mathrm{lngdp_{t-i}} + b_{24}\mathrm{lnasiv_{t-i}} + b_{34}\mathrm{lnosiv_{t-i}} + b_{44}\mathrm{lngvexp_{t-i}} + b_{54}\mathrm{lntop_{t-i}} \\ & + \sum_{i=1}^{p} a_{1i}\,\Delta \mathrm{lntop_{t-i}} + \sum_{i=1}^{q} a_{2i}\,\Delta \mathrm{lnasiv_{t-i}} + \sum_{i=1}^{q} a_{3i}\,\Delta \mathrm{lngdp_{t-i}} \\ & + \sum_{i=1}^{q} a_{4i}\,\Delta \mathrm{lnosiv_{t-i}} + \sum_{i=1}^{q} a_{5i}\,\Delta \mathrm{lngvexp_{t-i}} + \varepsilon_{4t} \qquad (6)\end{aligned}$$

$$\begin{aligned}\Delta \mathrm{lnosiv_t} = {} & a_{05} + b_{15}\mathrm{lngdp_{t-i}} + b_{25}\mathrm{lnasiv_{t-i}} + b_{35}\mathrm{lnosiv_{t-i}} + b_{45}\mathrm{lngvexp_{t-i}} + b_{55}\mathrm{lntop_{t-i}} \\ & + \sum_{i=1}^{p} a_{1i}\,\Delta \mathrm{lnosiv_{t-i}} + \sum_{i=1}^{q} a_{2i}\,\Delta \mathrm{lnasiv_{t-i}} + \sum_{i=1}^{q} a_{3i}\,\Delta \mathrm{lngdp_{t-i}} \\ & + \sum_{i=1}^{q} a_{4i}\,\Delta \mathrm{lngvexp_{t-i}} + \sum_{i=1}^{q} a_{5i}\,\Delta \mathrm{lntop_{t-i}} + \varepsilon_{5t} \qquad (7)\end{aligned}$$

where the natural log of each variable is defined as follows: Ingdp for Gross domestic product, Inasiv for agriculture sector investments, Ingvexp for government expenditure index, Inosiv and Intop for other sectors investments and trade openness index. Δ and ε_t are the difference operator and error terms respectively. After selecting the appropriate lag lengths for each dependent variable, thus 1, 3, 1, 4, 2 per the order of equations (3) to (7), we proceeded with the bounds test. The hypothesis for the bounds test is specified as:

$$H_0 : b_{1i} = b_{2i} = b_{3i} = b_{4i} = b_{5i} = 0$$

$$H_1 : b_{1i} \neq b_{2i} \neq b_{3i} \neq b_{4i} \neq b_{5i} \neq 0$$

where:
i=1,2,3,4,5
The null hypothesis stipulates that the coefficients of the long-run equations are all equal to zero implying no cointegration among the variables in the selected model, and vice versa for the alternative hypothesis. If the null hypothesis is accepted, only a short-run model is specified. The bounds test depends on the joint F- statistics which is compared to the critical values of the *I* (0) or *I* (1) bound preferable at a 5% significance level. When the F-value is greater than the upper bound *I* (1) critical values then cointegration exists, and otherwise, if it is less than the lower bound, *I* (0) critical values. The test is inconclusive if the F-value lies between the *I* (0) and *I* (1) critical bounds.

The Long-Run Error Correction Model (ECM)

The outcome of the bounds cointegration test (presented in the results section) indicated one cointegration relationship when gross domestic product was the dependent variable. Similar to the study of Narayan & Smyth [19] and Odhiambo [20], the short-run dynamic parameters associated with the long-run estimate were obtained by estimating an ECM instead of VECM due to the presence of only onecointegration equation. The coefficient of the lagged error correction-term is expected to bear a negative sign to justify the use of the bounds test and the existence of long-term equilibrium. The *t*-statistics on the explanatory variables in the error correction model indicates the short-run causal effects. Similar to the study of Ohen et al. [21], a parsimonious and more reliable result was achieved by eliminating insignificant lags from the over-parameterized model.
The long-run model and the error correction model (ECM) are specified as:

$$\text{lngdp}_t = a_0 + \sum_{i=1}^{p} a_{1i}\,\text{lngdp}_{t-i} + \sum_{i=1}^{q} a_{2i}\,\text{lnasiv}_{t-i} + \sum_{i=1}^{q} a_{3i}\,\text{lnosiv}_{t-i} + \sum_{i=1}^{q} a_{4i}\,\text{lngvexp}_{t-i} + \sum_{i=1}^{q} a_{5i}\,\text{lntop}_{t-i} + \varepsilon_t \quad (8)$$

$$\Delta\text{lngdp}_t = a_0 + \sum_{i=1}^{p} a_{1i}\,\Delta\text{lngdp}_{t-i} + \sum_{i=1}^{q} a_{2i}\,\Delta\text{lnasiv}_{t-i} + \sum_{i=1}^{q} a_{3i}\,\Delta\text{lnosiv}_{t-i} + \sum_{i=1}^{q} a_{4i}\,\Delta\text{lngvexp}_{t-i} + \sum_{i=1}^{q} a_{5i}\,\Delta\text{lntop}_{t-i} + \lambda ECT_{t-1} + g\varepsilon_t \quad (9)$$

where:
$\lambda = (1 - \sum_{i=1}^{p} \delta_i)$, speed of adjustment parameter with a negative sign
$ECT = (\text{lngdp}_{t-i} - \theta X_t)$, error term; the extracted residuals from the regression of the long-run equation
$\theta = \frac{\sum_{i=0}^{q} \beta_i}{\alpha}$, is the long-run parameter
$a_{1i}, a_{2i}, a_{3i}, a_{4i}, a_{5i}$ are the short-run dynamic coefficients. All the rest are previously defined.

The Pairwise Granger Causality Test and Robustness Analysis

Although cointegration generally indicates the presence of causality, at least in one direction, the true direction of causality may be lacking among the variables. The direction of causality, in this case, can be detected through the ECM by using the *t*-statistics of the regressors. Also, short-run causal effects can be obtained through the *F*-statistics from either the pairwise Granger causality test or the Walds test. The hypothesis underpinning the pairwise Granger causality is expressed as:

H_0 : no Granger causality

H_1 : the null hypothesis is not true

The decision criteria is to reject the null hypothesis if the probability value of the *F*-statistics is ≤ 0.05, and vice versa.

RESULTS AND DISCUSSIONS

Descriptive Analysis

From Table 1 which portrays descriptive statistics, the average gross domestic product (GPD) for the period under consideration was ₵ 34,205.20 billion (approximately $ 6.38 billion at a current exchange rate of 1$ to ₵6.36, where ₵ represents Ghana Cedis) with a standard deviation of 516.43. In the year 2020, nominal GDP for Ghana stands at $ 66.75 billion while per capita GDP is $ 2,266, against $ 62.54 billion and $ 2,032 for the year 2019. Average agriculture sector investments representing total domestic agriculture sector expenditure by the government was ₵126.01 million with possible outliners represented by minimum and maximum of 6.43 and 497 respectively. The government expenditure index was 18.34%, trade openness index was 55.27%, and finally, average investment in the two major sectors (industry and service) was ₵1,088 billion.

Table 1. Descriptive statistics

Variable*	Mean	Std. Dev.	Min.	Max.
Gross domestic product (GDP)	34,205.20	516.43	16.60	312,550.23
Agriculture sector investments (ASIV)	126.01	138.32	6.43	497.32
Government expenditure index (GVEXP)	18.34	3.33	11.84	30.53
Trade openness index (TOP)	55.27	27.28	6.32	86·02
Other sector investments (OSIV)	1,088.70	185.98	47.23	5,789.34

*GDP and OSIV in billion cedis, ASIV in million cedis, GVEXP and TOP in %.

Source: Authors’ calculation based on national data.

Stationarity Test

Table 2 indicates stationarity test results using constant and trend specifications. Only government expenditure index gained stationarity at levels *I*(0). Hence, the null hypothesis that the series have unit roots and non-stationary at levels was accepted. However, the data series gained stationarity after their first difference. Since all the variables exhibit stationarity, cointegration relationship existing among them can be established using the appropriate test. The bounds cointegration test is used instead of the Johansen test which is strictly designed for *I*(0) or *I* (1) order of integration.

Table 2. Results of unit root test

Variables	ADF		PP	
	Level	First difference	Level	First difference
Gross domestic product (InGDP)	-2.631	-6.449***	-2.563	-6.525***
Agricultural sector investments (InASIV)	-2.469	-3.697**	-2.112	-7.453***
Government expenditure index (InGVEXP)	-5.273***	-7.307	-5.273***	-19.424
Trade openness index (InTOP)	-2.311	-5.483***	-2.098	-5.265***
Other sectors investments (InOSIV)	-2.062	-7.318***	-2.062	-7.331***

***, ** and *denotes significance levels at 1%, 5%, and 10% respectively. The critical values are -4.140, -3.512 and -3.376 for significance levels at 1%, 5%, and 10% respectively.

Source: Authors’ calculation based on national data.

Bounds Cointegration Analysis

The unit roots test results revealed a combination of both level and first difference stationarity. The bounds test was used for determining the level of relationship between variables when each is used as a dependent variable. Table 3 indicates the results. With lag lengths mentioned previously, equations 3, 4, 5, 6, and 7, were estimate 5.27, 2.26, 2.55, 1.37 and 2.30 were obtained as the F-statistics. A long-run relationship exists among the variables because *In*GDP in equation (3) with F-value of 5.27was higher than upper-bound critical value of 4.01 at 5% level.

Table 3. Results of bounds cointegration test (lags: 1, 3, 1, 4, 2)

Variables	AIC Lags	F-stat.	Outcome	Estimation
InGDP	1	5.27	cointegration	ECM (error correction model)
InASIV	3	2.56	no cointegration	ARDL (short-run model)
InGVEXP	1	2.55	no cointegration	ARDL (short-run model)
InTOP	4	1.37	no cointegration	ARDL (short-run model)
InOSIV	2	2.30	no cointegration	ARDL (short-run model)
Lower-bound critical value at 5%	2.86			
Upper-bound critical value at 5%	4.01			

Source: Authors' calculation based on national data.

The ARDL Long-Run Estimates and Error Correction Model

The Long-Run Model

Results are indicated in Table 4 below. Long-run growth in the economy was determined by investments into the industrial and services sectors. Government spending as well as transparency in trade were also among the determinants. Government's monetary allocation to the agricultural sector was not a predictor of economic growth for the study period.

At 5%, a negative (-0.349) impact on economic growth emerged from Government expenditure index. As opposed to government expenditure index, the coefficient of trade openness index was positive and significant at 1%. At a 10% significant level, government's investment into other sectors was positive and a possible determinant of economic growth. Agricultural sector investments although recorded a positive coefficient of 0.027 did not significantly influence economic growth in this study.

Table 4. ARDL approach for the estimated long-run coefficients

Variable	Coef.	Std. Error	t-stat.
Constant	-1.042	0.409	-2.546
InASIV	0.027	0.040	0.675
InGVEXP	-0.349**	0.136	-2.552
InTOP	0.178***	0.058	3.687
InOSIV	0.154*	0.070	2.077
Model Diagnostics			
R-squared	0.998	Mean dependent variable	20.49
Adjusted R-squared	0.997	Durbin-Watson Statistics	2.053
F-statistic	523.523	Prob (F-statistic)	0.000

***, ** and * denotes significance levels at 1%, 5% and 10% respectively.Dependent variable denoted as *InGDP

Source: Authors' calculation.

The Error Correction Model

In Table 5, the estimated ECM indicates how the short-run coefficients are associated with the long-run relationship. An *F*-statistics of 5.07 at 1% implies the short-run model variables totally explain GDP growth (dependent variable). The R^2 value shows that 63% of the change in economic growth can be precisely explained by the models' selected independent variables. The absence of first-order autocorrelation in the error terms is indicated by the Durbin-Watson's statistics of

2.01. An additional indicator that we are not performing a spurious regression is the Durbin-Watson's value higher than the R^2. Per our expectation, at 1% significance level, coefficient of the lagged error correction term (ECT) is negative (-1.008) indicating a long-run relationship among the variables in our model results previously indicated in Table 4. It shows that more than 100 percent of the past year's instability or disequilibrium is amended before the present year ends. The short-run parameters indicate that government expenditure at 5% with negative coefficient and trade openness at 5% significant level with positive coefficient had an important impact on economic growth. This implies the presence of causality in at least one direction.

Table 5. Error correction representation for the selected ARDL model

Variable*	Coef.	Std. Error	t-stat.
Constant	0.003	0.041	0.081
ΔInASIV	0.050	0.059	0.851
ΔInGVEXP	-0.277**	0.130	-2.416
ΔInTOP	0.255**	0.100	2.544
ΔInOSIV	0.146	0.095	1.535
ECT	-1.008***	0.251	-4.011
Model Diagnostics			
R-squared	0.632	Akaike info criterion	0.836
Log-likelihood	29.15	Schwarz criterion	0.575
F-statistic	5.078	Hannan-Quinn criterion	0.736
Prob(F-statistic)	0.000	Durbin-Watson	2.013

***, ** and * denotes significance levels at 1%, 5% and 10% respectively. *InGDP as a dependent variable
Source: Authors' calculation based on national data.

The Pairwise Granger Causality Test

At 5% we determined the short-term causality. We relied on the results from the pairwise Granger causality test. Table 6, shows no causality between economic growth and agricultural investments and vice versa. Government expenditure and domestic agricultural investment reveals the lack of causality in both directions. Hence, confirming the neutrality idea of no Granger causality as well. Causality exists between other sector investments and economic growth, economic growth and government expenditure index, as well as trade openness index. No causality exists between trade openness and domestic agriculture sector investments. Similarly, the study maintained the neutrality concept of no Granger causality between other sector investments and domestic agriculture sector investments.

Table 6. Pairwise Granger causality test results on the direction of causality

Variable	F-statistics					Direction of causality
	InGDP	InASIV	InGVEXP	InOSIV	InTOP	
InGDP	-	1.971	2.050	3.517*	1.381	InOSIVIntoInGDP
InASIV	0.135	-	1.245	0.234	0.402	-
InGVEXP	3.329*	0.411	-	0.139	2.025	InGDPIntoInGVEXP
InOSIV	0.464	3.083	2.682	-	0.907	-
InTOP	4.215*	2.199	1.249	1.570	-	InGDPIntoInTOP

* denotes statistical significance at 5% level.
Source: Authors'calculation based on national data.

Model DiagnosticsTests

A shown in Table 7, diagnostic tests were performed to verify the robustness and credibility of our models.

The results of heteroskedasticity tests such as ARCH, Breusch-Pagan-Godfrey, Harvey, Glejser fits well with our assumption of the lack of heteroskedasticity since probabilities exceed 5%. Breusch-Godfrey serial correlation for all models was higher than 5% supporting the null hypothesis.

Hence, our models are not suffering from serial correlation.

The normality test of Jarque-Bera indicates that our residuals are normally distributed.

Table 7. Model diagnostics tests

Diagnostics tests	Dependent variables				
	InGDP	InASIV	InGVEXP	InTOP	InOSIV
Heteroskedasticity ARCH	0.163	0.187	0.961	0.108	0.691
HeteroskedasticityBreusch-Pagan-Godfrey	0.416	0.608	0.875	0.062	0.998
Heteroskedasticity Harvey	0.576	0.478	0.487	0.330	0.893
HeteroskedasticityGlejser	0.455	0.443	0.569	0.158	0.997
Breusch-Godfrey serial correlation LM	0.204	0.543	0.833	0.890	0.541
Jarque-Bera	0.112	0.923	0.123	0.563	0.113

Source: Authors' calculation based on national data.

Adequate investments into the agriculture sector is very important for developing countries since it goes a long way to reduce hunger and poverty as well as promoting local production either at the subsistence or commercial level. The high rate of food importation by most African countries has eased the problem of severe food shortages, however, the high food prices make it difficult for the poor to afford. Similar to Ghana, many children in other Sub-Saharan African countries continue to suffer from malnutrition which automatically undermines one prime aim of the United Nations Sustainable Development goals - ending hunger, achieving food security, and improved nutrition [18]. Though some sectors are considered very important than others, it is evident that all the economic sectors of a country are interlinked and somehow dependent on each other. From Table 4, the long-run coefficient of domestic agriculture sector investments was positive, but was not a determinant of economy growth due to inadequate investments and the other inherent problems facing the sector. However, the minuscule growth recorded in the sector could be attributed to the influx of foreign direct investments and projects executed by development partners [5]. This result contradicts the findings of [8, 16, 28] and in line with [22, 28]. The problems facing the Ghanaian agriculture sector includes: (1) years of insufficient budgetary allocations leading to distraction of major supportingservices such as research and development, and extension mechanisms [7]; (2) limited financial incentives for farmers due poor organization of available financial institutions [4]; (3) low productivity resulting from the lack of modern irrigation facilitates; (4) lack of requisite amenities such as roads, warehouses, electricity necessary for both farming and non-farming activities; (5) massive food importation due to lack of well-functioning processing plants, consequently degrading the value of locally produced items; (6) customary system of land ownership resulting in conflicts and its subsequent discouragement of agricultural investors; and (7) rural-urban migration by young energetic people due to the deteriorating living conditions in rural areas, hence depriving the agriculture sector of the requisite human capital [23]. Also, the negatively signed coefficient of general government expenditure can be attributed to the fact that a larger portion of government's expenditure goes into the payment of salaries, running of programs such as free compulsory basic education, school feeding, free national health insurance scheme, food aid, and disaster relief. As opposed to government expenditure index, the coefficient of trade openness index was positive and significant at 1%. Per the long run estimates, and consistent with [5], transparency in trade increases economic growth by 17.8%. Also, economic growth was positively enhanced by other sector investments. This disputes the previous works of [1]. Certainly, in 2019, economic sectors GDP additions was service-47.2%, industrial-34.2%, and agriculture-18.6%. A negative ECT in table 5 shows an existence of long-run relationship, as well as causality among the variables. Government expenditure and trade openness produced a short-run term effect on the economy. Alfa & Garba [2] stated the positive impact of Trade openness on economic growth, especially for low and middle-income countries. It aids in improving imports and exports, leading to effective and efficient production processes resulting from technological advancement. Nevertheless, trade is not the sole factor to determine the economic growth status of a country. The reason the developed economies have lower value in this metric is that they have diversified economies, which are increasingly dominated by domestic services, and lower share of export-oriented industries as a part of the overall economy. However, due to the various economic activities taking place in a country, the total gross domestic product can also be impacted by other government expenditure. In a nutshell, the need for trade in less developed economies is higher compared to developed ones because the latter can supply the domestic market from their capacity but not the former. Also, in the short-run, government's investments into other sectors as well as the agriculture sector investments were positive but did not cause any significant economic growth in this model. This is true especially for investments made in the service sector because start-up costs involved are high as well as production and sales levels become profitable over time. From Table 6, Granger causality was used as a good predictor of causality rather that those discovered in the ECM. Causality in the short-run existed between government expenditure and economic growth, as well as trade openness and economic growth. Finally, causality existed between growth in the economy and investments into the services and industrial sectors respectively. The above discovery suggests that government should endeavour to enact relevant policies, properly allocate its budget, and promote trade and investment in the country if short-run economic growth is desired.

CONCLUSIONS

Data from 1965 to 2020 was used to demonstrate causal relationship between economic growth and domestic agriculture investments, other sector investments, trade openness, and government expenditure. Long-run and short-run estimates indicated investments into domestic agriculture to be non-determinant of economic growth; indicating that growth in the economy from 1965-2020emerged from other sectors as well as other economic activities. However, based on this result we cannot completely nullify the fact that agriculture does not cause economic growth in Ghana because many studies have tried to justify that the growth achieved in the agricultural sector is from foreign direct investments and donor-funded projects without considering domestic government investment in their models [5, 11]. An example is the on-going five-year program (2017- 2022) dubbed “Planting for Food and Jobs’’ solely sponsored by the Canadian government to revamp the agriculture sector. In the long-run, while trade openness and other sector investments positively contributed to economic growth, government expenditure though significant, negatively affected economic growth since a larger portion of this figure goes into the payment of civil servants’ salaries and rural livelihood projects. Lack of causality existed from agricultural investments to economic growth and vice versa. A unidirectional one existed from other sector investments to economic growth, economic growth to government expenditure, and economic growth to trade openness. Since less developed economies are opting for self-sufficiency and development instead of donor funds and foreign aids which comes with many constraints, we strongly advocate enacting relevant government policies that seek to make trade policies more flexible, as well as placing emphasis on domestic agricultural investments. Specifically, such policy instruments should be aimed at: (1) allocating the agreed 10% of government’s budget during the initiation of CAADP in 2013 to the agricultural sector; (2) establishing stringent monitoring and evaluation platforms to prevent diversion of funds intended for agricultural purposes; (3) developing rural areas as well as basic amenities to encourage young graduates and extension agents to reside and work in agricultural communities; and (4) making farming credit readily available to qualified smallholder farmers.

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STUDY ABOUT EVOLUTION OF THE ROMANIAN RAPESEED MARKET AND ROMANIA'S POSITION IN THE INTERNATIONAL TRADE WITH RAPESEED

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Abstract

This paper aimed to analyse the evolution of the Romanian rapeseed market during recent years and its contribution in the international trade with rapeseed. The research method is based on a quantitative approach, based on national and international time data series related with production and trade. The results indicated that Romania became a significant player on EU rapeseed market, and many Romanian farmers focused in the last years on rapeseed production, due the high imports demand on international markets and favourable intern production context.

Key words: *trade, rapeseed, market, Romania*

INTRODUCTION

The decision reasons to cultivate rapeseed in Romania was studied before for the period 2007-2013 and the motivation was related with export potential [3]. The evolution of rapeseed surfaces was positive and impressive, if compared with areas cultivated some decades before [1]. The rapeseed cultivation in Romania was encouraged by its moderate temperature requirements, but its demanding for moisture might be an important concern in near future for the Romanian farmers in the context of climate change [2] and obtained yield under EU average. New options in the use of rapeseed as the biochar obtained by pyrolysis were fashioned in other studies related with use of renewable resource [5]. Similar uses developed in the last decades can only lead to the development of the rapeseed market. In a study from 2019 Romania was not include in the major EU countries - producers of oilseed from rapeseeds, which means that Romania processing of rapeseed is not a major target, being preferred the exports of rapeseed as raw material [10]. At world level, rapeseed production is ranked in the second place after the soya beans, but before sunflower. In average EU cultivated in recent years over 5.5 million ha of rapeseed, with an average oilseed production of 17.25 million tonnes, rapeseed being the main oilseed crop at EU level [4]. EU imported only in the agriculture year 2022-2023, over 6.834 thousand to of rapeseed, in order to cover an internal consumption of 25.842 thousand to.

In this context, the aim of this study was to analyze cultivated surfaces, yields, production and trade with rapeseeds and also Romania's position in the international market.

MATERIALS AND METHODS

Both statistic and trade indicators were used in this paper. We analysed the evolution of rapeseed sector in Romania, in terms of surfaces, yields and total production trend in the recent years. We also analysed the evolution of the Romanian trade balance for the rapeseed. The destination of Romanian rapeseed exports in the last years were also considered within this paper. At the world level we considered the evolution of the trade exports and imports for the main players on the international world rapeseed markets. The data were provided by International Trade

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Centre - ITC and National Institute of Statistic - INSSE from Romania.

RESULTS AND DISCUSSIONS

In 2021 the rapeseed surfaces cultivated in Romania were about 446 thousand ha, that produced 1.375 million to [8], but in some years we could notice that the rapeseed surfaces exceeded 600 thousand ha. At national level rapeseed ranked among oleaginous plants, after sunflower, which is usual cultivate on over 1 million ha.

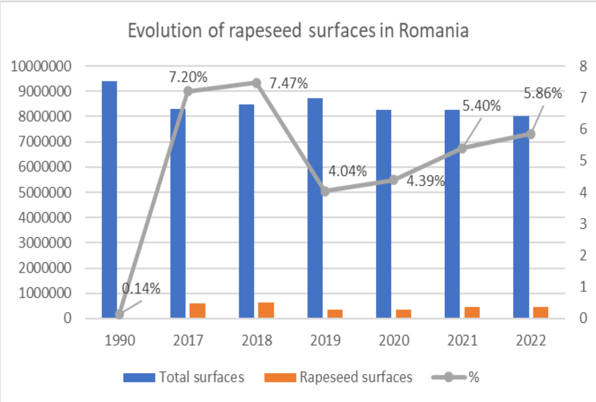

Fig.1. Evolution of the rapeseed surfaces in Romania (ha, %)
Source: INSSE [7].

In 2017 and 2018 Romania produced over 1.6 million to of rapeseed, so it will not be a surprise if in the next decade will reach a production of over 2 million to. For this assumption we considered that the yields are still very low in Romania and can grow significant, based on improved technology and new rape varieties.

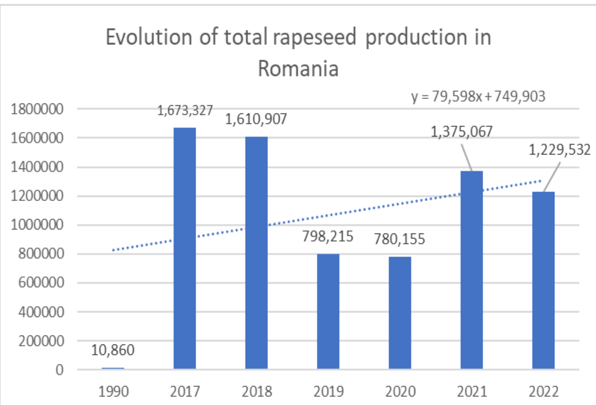

Fig. 2. Evolution of the rapeseed production in Romania (to)
Source: INSSE [7].

Even if Romania is an important rapeseed producer in EU, the rapeseed yield exceeded only in the favourable years 3 to per ha. The international context was favourable for Romanian farmers that focused in the last decade on rapeseed production: EU was a net importer of oilseed, the option of increasing areas cultivated with rapeseed within the other EU countries were limited, the consumption of rapeseed meal had a positive trend and the oilseed prices were at historical high levels.

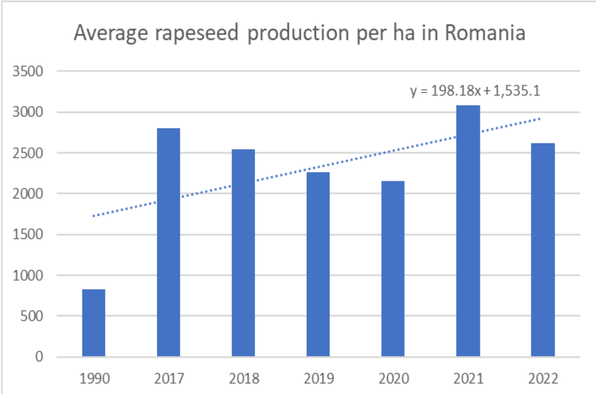

Fig. 3. Evolution of the rapeseed yields in Romania (kg/ha)
Source: INSSE [7].

If in 2003 Romania exported 0.03% from the entire World exports of rapeseed, in 2016 was recorded the highest share of Romanian rapeseed exports in the World exports with rapeseed, of 6.59 %.

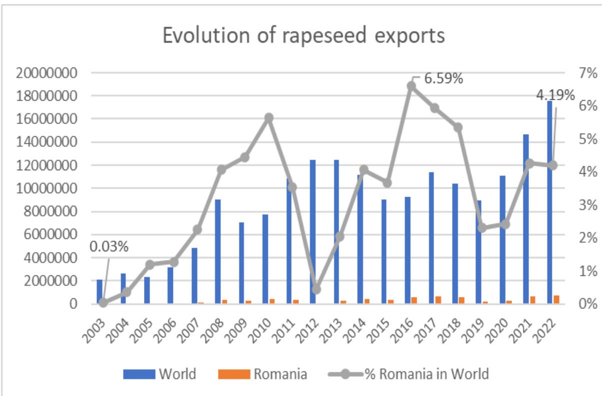

Fig. 4. Share of Romanian rapeseed exports in the World exports with rapeseed (thousand $, %)
Source: ITC [9].

Canada is the main rapeseed exporter in the world. More than one third of the world rapeseed exports are delivered from Canada, but Romania gained an important position in last years in the top of the world rapeseed exporters. While the Australia is not a competitor for Romania, due to the long distance between EU an Australia, Ukraine is a country with huge export influence on the EU and World markets. In the EU, Netherland and France are the countries that influence the world export prices and the entire volume of exports.

Table 1. World main exporters of rapeseed (thousand $)

	2017	2018	2019	2020	2021
Total World	11,400,972	10,397,101	8,944,350	11,090,593	14,662,328
Canada	5,051,976	4,497,330	3,240,599	4,687,367	5,097,339
Australia	1,283,623	937,684	675,343	793,547	2,207,745
Ukraine	881,546	1,010,936	1,282,422	1,007,019	1,690,866
Netherland	597,699	405,304	431,404	867,995	96,835
France	730,511	726,66	782,063	634,497	959,793
Romania	676,276	563,247	206,279	262,037	629,776
Belgium	227,073	284,886	137,072	447,367	406,938
Lithuania	99,22	90,348	135,453	305,895	351,147
Hungary	346,169	305,031	368,075	345,991	319,443
Czech Republic	116,904	140,579	18,659	160,767	208,432

Source: ITC, 2023 [9].

Germany is the main importer of rapeseed in the world, followed by Japan and China. Germany is using large quantities of rapeseed in the production of biodiesel and for animal feed.

Table 2. World main importers of rapeseed (thousand $)

	2017	2018	2019	2020	2021
Total World	11,690,512	10,958,558	9,559,738	11,368,552	15,110,843
Germany	2,737,799	2,524,213	2,453,642	2,666,733	3,390,667
Japan	1,153,170	1,125,663	1,032,930	965,990	1,603,407
China	2,162,153	2,225,856	1,224,336	1,363,515	1,540,091
Belgium	1,104,098	1,030,007	843,986	960,125	1,335,124
France	582,448	456,954	572,372	714,677	1,033,761
Netherland	470,061	135,066	739,549	1,021,778	908,421
Mexico	702,132	649,281	0	560,054	736,290
UAE	402,918	362,394	317,930	500,194	711,643
UK	154,001	93,242	162,379	234,259	567,909
Poland	222,861	336,478	241,320	210,675	352,677

Data source: ITC, 2023 [9].

Japan is using rapeseed as a source of vegetable oil, known as canola oil in some regions. This is why Japan imports large quantities of rapeseed, in order to produce edible oil for cooking and food processing. Canola oil is known for its low saturated fat content and high levels of healthy monounsaturated and polyunsaturated fats, making it a popular choice for health-conscious consumers [6]. China became one of the main world producers of rapeseed, after Canada, which helped them lowering the imports of rapeseed in the last years.

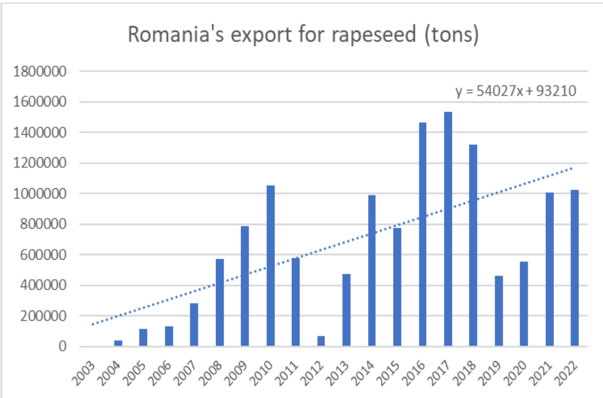

Fig.5. Evolution of Romania`s exports of rapeseed (to), Source: ITC [9].

Most part of the Romania rapeseed production is delivered on the EU market. The exports level is depending on yearly production, but the trend was significant positive in the last decade.

Table 3. Romanian main destinations of the rapeseed exports and intra EU deliveries (to)

	2018	2019	2020	2021	2022
World	1,320,200	460,019	554,779	1,006,963	1,021,306
Belgium	196,504	68,318	72,334	169,420	222,598
Germany	407,635	122,457	99,707	116,115	162,804
Netherlands	272,249	122,163	206,973	289,313	143,576
France	123,668	3,813	1,972	151,445	118,239
Hungary	33,083	23,942	33,943	94,557	101,235
Czech Republic	87,341	70,526	100,745	74,267	96,015
United Kingdom	549	3,017	4,293	0	52,589
Poland	91,192	27,939	9,529	45,102	49,282
Pakistan	29,414	0	0	0	47,000
Slovakia	5,503	5,252	8,415	13,207	7,178

Data source: ITC, 2023, [9].

In 2022 from 1 million to that left Romania, over 222 thousand to were delivered to Belgium, more than 162 thousand to were sent in Germany and more than 143 thousand to of rapeseed arrived in Netherland from Romania. Pakistan was the main non-EU destination of the Romanian rapeseed exports, with over 47 thousand to.

Romania is a net exporter of rapeseed, and the trade balance of rapeseed improved in the last years, recording the highest level of 615,377 thousand $ in 2017.

In 2022, the trade balance indicated a surplus of 440,826 thousand $ (Fig. 7).

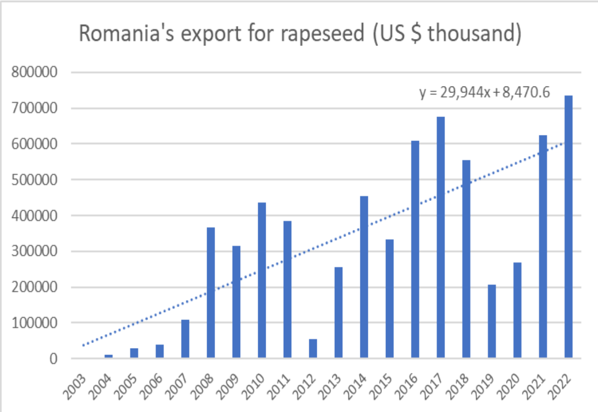

Fig. 6. Evolution of Romania`s exports of rapeseed (value, thousand $)
Source: ITC [9].

Table 4. Romanian main destinations of the rapeseed exports and intra EU deliveries (thousand $)

	2018	2019	2020	2021	2022
World	554,551	206,216	268,942	624,886	734,524
Belgium	79,523	28,531	32,393	106,114	150,987
Germany	171,088	53,652	49,495	71,540	128,097
Netherlands	115,639	51,048	92,833	177,393	100,578
France	56,427	8,538	9,660	83,843	80,639
Hungary	13,152	11,246	15,506	64,483	69,851
Czech Republic	33,431	28,082	43,140	44,446	66,313
Poland	36,505	11,078	4,133	27,432	37,790
United Kingdom	238	2,294	3,354	0	36,269
Pakistan	12,709	0	0	0	32,593
Bulgaria	3,462	2,951	4,837	17,094	10,080

Source: ITC, 2023 [9].

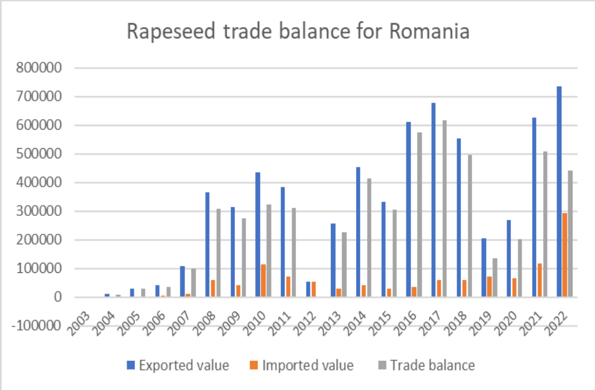

Fig. 7. Evolution of Romania`s trade balance for rapeseed (thousand $)
Source: ITC [9].

CONCLUSIONS

Rapeseed production is a major option for the Romanian farmers. The Romania delivers most part of its yearly production in the EU, and also export important quantities in the non-EU countries. The increase of rapeseed products on world level maintained the prices high on the international rapeseed markets, and offer producer stability in their production intention. The climate changes are the main challenges for the farmers in the rapeseed sector, while the selling rapeseed most as raw material indicates the very low level of processing rapeseed in Romania, which could produce huge quantities of rapeseed oil and sell it at very attractive prices.

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DETERMINANTS OF TECHNICAL EFFICIENCY AMONG DAIRY FARMS IN TUNISIA

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Abstract

This study examines the determining factors of the technical efficiency of dairy farms in Tunisia. A stochastic production frontier and a two-limit Tobit models were used to analyze technical efficiency (TE) for a sample of 108 Tunisian cattle breeders. The empirical results suggest that TE ranges from 45% to 96% and that a purebred herd composition and a favorable location for breeding system including pasture and grazed grass lead to greater efficiency. In addition, we found that dairy farmers could increase their performance by joining a professional organization. The implications of these finding for development strategies of the Tunisian dairy sector were examined.

Key words: *milk production, performance, breeding system, frontier, Tobit model*

INTRODUCTION

To achieve food self-sufficiency in dairy products, experiencing a sustained increase, Tunisia has propelled the orientation of the replacement of local dairy breeds by imported breeds with important characteristics in terms of yield and economic profitability. The composition of the herd reversed from 2009 with a share of pure breeds (holstein, alpine brown, tarentaise) exceeding 50% (GIV Lait, 2018)[9]. An intensive and semi-intensive breeding system has emerged; even in regions with fairly restrictive climatic conditions, especially in the center of the country. This strategy immediately produced its effects quite a significant increase in production, reaching levels sometimes exceeding the country's needs. Indeed, milk production, around 1,400 million liters in 2015, exceeds the country's need for consumption of milk and products, which is around 109.9 l/capita (INS, 2015) [11]. In recent years, a reversal of the trend has begun to be observed, under the effect of the fall in fodder products following the succession of years of drought and the costly charge of concentrates propelled by the exorbitant prices at the import. The activity has become unprofitable pushing increasing number of farmers to sell their cows, especially in areas with limited options in terms of greenery. Indeed, the food needs of the new imported breeds are significant and a breeding system based solely on dry fodder and concentrate has proven to be unprofitable, especially since the retail prices remain administered by the State. In this context, it is essential to understand the factors assuring an adequate level of profitability of this activity. This will make it possible to better adapt the breeding system to guarantee the sustainability of the farm. Measuring the technical efficiency of dairy farms, referring to the maximum level of production that can be achieved given the quantities of production inputs and understanding the determining factors of a high level of efficiency will help meet this need. To measure technical efficiency, Farell (1957) [8] proposed to use a production frontier making it possible to compare the technical performance of firms respectably. This frontier illustrates the maximum level of production that can be achieved by involving different combinations of factors according to a specific technology. The most successful firms will be located on this border and will serve as a reference to determine the degree of inefficiency of firms located below the frontier. On the methodological level, the estimation of the production frontier can be carried out according to a parametric or not parametric approach. The first approach requires identifying a precise form of the production function. The measure of technical efficiency involves estimating the parameters of the chosen form of the production function. Aigner and Chu (1968) [2] introduced the deterministic form of this methodology, which utilizes deviations from estimated production frontier values as measures of technical inefficiency. Later works of Aigner et al. (1977) [3] and Meeusen and van den Broeck (1977) [15] led to the establishment of a stochastic approach, allowing measurement errors and random effects to be taken into account. This approach allows the decomposition of the error term, reflecting the difference between the levels of estimated and observed production, between the inefficiency technique and random errors.

Regarding the non-parametric approach, it incorporates all methods that do not use the specification of a particular form of the production function. We particularly distinguish the Data Envelopment method Analysis (DEA) which was introduced by Charnes and al. (1978) [4] and the Free Disposal Hall (FDH) analysis returning to Deprins et al. (1984) [6]. The aim of the paper is to identify the determining factors of the efficiency of Tunisian dairy farms. To this end, we use a stochastic production frontier to analyze the technical efficiency of a representative sample of dairy farmers. The calculated efficiency scores are then regressed on a set of explanatory variables including the dairy farm environment and the breeding system. The results of this analysis may be crucial for decision-makers in order to adapt the development orientations of the Tunisian dairy sector.

MATERIALS AND METHODS

Measurement and determinants of technical efficiency

To measure the technical efficiency of dairy farms in Tunisia, a stochastic production frontier model was employed. This model was originally proposed by Aigner et al. (1977) [3] and subsequently modified by Meeusen and van den Broeck (1977) [15]. This model has the following general form:

$$Y_i = f(x_i, \beta)e^{v_i - u_i} \text{ ....(1)}$$

where: Y_i and x_i are, respectively, the output and the input vectors of inputs of farm$i$, The vector of unknown parameters to be estimated is denoted by β, while the functional form of the frontier is represented by $f(.)$, v_i is the vector of Gaussian random errors i.e.: $v_i: N(0, \sigma_{v_i}^2). u_i$ represents non-negative random factors, linked to the technical inefficiency of production. Indeed, $u_i = 0$ when the production level is on the frontier. They are assumed to follow a positive normal distribution, i.e.:u_i: $N^+ (0, \sigma_{u_i}^2)$.

The estimation of this empirical model is carried out according to the maximum likelihood method. For a sample of size n, the log-likelihood function has the following form:

$$lnL(Y, \beta, \sigma, \lambda) = -\frac{n}{2}\ln\left(\frac{\pi\sigma^2}{2}\right) + \sum_{i=1}^{n} ln\Phi(\frac{\varepsilon_i\lambda}{\sigma}) - \frac{1}{2\sigma^2}\sum_{i=1}^{n}\varepsilon_i^2$$

$$\text{..(2)}$$

where: $\Phi(.)$ denotes the normal distribution function,

$$\varepsilon_i = v_i - u_i, \sigma^2 = \sigma_{v_i}^2 + \sigma_{u_i}^2, \lambda = \frac{\sigma_u}{\sigma_v}. \text{ ....(3)}$$

If $\lambda = 0$, there are no technical inefficiency effects and all deviations from the frontier are due to errors.

The technical efficiency (TE) of a farm is defined as the ratio between the observed output Y_i and that corresponding to the frontier levelY_i^* given the used inputs. Thus, the technical efficiency of the farm$i$ is given by:

$$TE = \frac{Y_i}{Y_i^*} = \frac{f(x_i,\beta)e^{v_i - u_i}}{f(x_i,\beta)e^{v_i}} = e^{-u_i} \text{ ....(4)}$$

To measure the technical efficiency of dairy farms in Tunisia we used a Cobb-Douglass functional form of the frontier. Therefore, our empirical model admits the following logarithmic representation:

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + v_i - u_i \quad \text{.....(5)}$$

where:
Y_i is the annual milk production of farm i in liters; X_{1i} is feeding costs; X_{2i} is the herd size; X_{3i} is the active labor on the farm; X_{4i} is land endowment (hectares).
To identify the determinants of technical efficiency of dairy farms in Tunisia, we used a two-limit Tobit model to regress efficiency scores on a set of explanatory variables given that the efficiency scores are bounded between zero and one. The literature review shows that inefficiency models generally integrate exogenous factors related to production systems, managerial, environmental and socio-economic characteristics. Given that this study focuses on a population of cattle breeders with similar socio-economic characteristics and managerial capacities, this regression employs variables that relate to the breeding system and environmental factors. Table 1 summarizes the variables utilized in this study along with their corresponding descriptions.

Table 1. Explanatory variables in the inefficiency effects model and their descriptions

Variables	Description
Region	Farmers region (1 if northern region and 0 otherwise)
PFA	Professional farmers' organization membership (1 if yes and 0 otherwise)
IFAA	Irrigated fodder agricultural area (Ha)
Herd	Herd composition (1 if purebred herd and 0 otherwise)
Concentrated-feeding (Cf)	Amount of concentrated feed per cow in kg

Source: author's conception.

The technical inefficiency model is specified by:

$$TE_i = \delta_0 + \delta_1 Region_i + \delta_2 PFA_i + \delta_3 IFAA_i + \delta_4 Herd_i + \delta_4 \ln(Cf)_i + \omega_i \quad \text{.....(6)}$$

Data collection
Detailed data on 108 small dairy farms were collected in 2001. A random sample was compiled to be representative of the different cattle breeding regions in Tunisia, as well as the different breeding systems (intensive, extensive and landless) with their variety in herd size and composition.
Table 2 summarizes the structure of the surveyed sample according to the stratification criteria.

Table 2. Sample structure

Variables	Definition	Percentage (%)
Region	North Otherwise	33.3 66.6
Herd size	< 3 3-8 > 60	45.0 49.2 5.8
Herd composition	Pure race Otherwise	55.3 44.7

Source: author's conception.

The questionnaire includes different sections. The first section is devoted to collect information on the specificities of the farm (region, areas, size of the herd and its composition). In the second section, respondents were asked to provide information on production levels and different cost categories. This includes feeding costs, deployed labor and operational expenses. The final section includes information on livestock management and market integration.

RESULTS AND DISCUSSIONS

Maximum likelihood parameter estimates for the production frontier model is presented in Table 3. All the estimated coefficients are significant and appeared with the expected signs. The coefficient λ is different from zero indicating a significant effect of technical inefficiency on the production of the dairy farm
The scale elasticity (i.e., the sum of all the elasticities of output) was 1.117, revealing a slight increasing return to scale. This result implies that the level of productivity that grows with improvements in technology and efficiency also depends on the scale of the farm.

The next step was to obtain the technical efficiency (TE) scores of the sampled dairy farms. Table 4 shows the distribution of TE scores.

Table 3. Estimated Cobb-Douglas Dairy Farm Production Function

Variable	Estimated coefficient	Standard Error	z-ratio
Feeding costs	0.219	0.044	5.01
Herd size	0.752	0.057	13.18
Active labor	0.109	0.040	2.66
Land endowment	0.037	0.021	1.76
Constant	5.953	0.490	12.14
σ_u	0.141		
σ_u	0.321		
λ	2.284		

Source: author's conception.

Table 4. Distribution of technical efficiency (TE) scores

TE interval (%)	Farms (n)	Farms (%)	Mean TE
]40, 60]	6	5.6	0.52
]60, 80]	37	34.3	0.72
]80,100]	65	60.2	0.87
Overall	**108**	**100**	**0.80**

Source: author's conception.

Results show that the sample overall average technical efficiency measure is 80%. Our findings are consistent with those of Lachaal et al. (2002) [12], who reported an average technical efficiency of 78%. This indicates that Tunisian dairy farms could increase their milk production by approximately 20% by improving the efficiency of their production inputs.

Frequency distribution results indicate that only 5.6% of the dairy farmers in our sample achieved a technical efficiency score below 60% (Table 4). Although that the majority of the farms (60.2%) achieved technical efficiency scores over than 80%, improving efficiency score for the remaining firms is essential for their durability. Indeed, given the administration of selling price of milk, reaching positive returns is not easy task for farmers. Results of the two-limit Tobit model presented in table 5 below, show determining factors of efficiency of Tunisian dairy firms.

Table 5. Estimated Two-limit Tobit Model

Variable	Estimated coefficient	Standard Error	z-ratio
Region	0.052	0.026	2.04
PFA	0.058	0.029	1.93
IFAA	0.016	0.008	1.93
Herd	0.112	0.031	3.59
Cf	- 0.012	0.017	0.69
Constant	0.713	0.058	12.29

Source: author's conception.

As expected, the most important factor in dairy farm efficiency in Tunisia is herd composition. Dairy farms raising only purebred cows are able to reach an efficiency score 11% higher than farms with the same characteristics and whose herd is made up of local or mixed breeds. Furthermore, a 5% higher efficiency score may be achieved by dairy farms located in the northern regions of the country with appropriate climatic conditions for high rainfall levels and abundance of grass. Similar results were found by Tauer et al (1987) [17] who claim that location in the northwest or central regions of New York will increase a farmer's technical efficiency by three and four percentage points respectively because these regions have the most productive soils and best weather in the state.

The importance of the breeding system on the dairy farm efficiency is also shown by the positive impact of irrigated fodder areas. Indeed, 1 hectare of irrigated fodder may increase farm efficiency by 1.6%. Although it is statistically insignificant, the quantity of concentrate per cow variable appeared with a negative sign, which implies that farms distributing large quantities of concentrate feed due to insufficient pasture and grazed grass are less efficient. This demonstrates that with high prices of imported inputs, aboveground farming systems based essentially on dry feed would no longer allow dairy farms to achieve high enough levels of efficiency to generate sufficient income.

On the other hand, the membership of dairy farms in a professional organization allowing the purchase of inputs at competitive prices makes it possible to achieve a 6% higher level of technical efficiency.

In recent years, the dairy sector in Tunisia has had difficulty overcoming the problems linked to the hardening of climatic conditions and the increase in world livestock feed prices.A growing number of breeders have been forced to sell their livestock due to lack of profitability. This demonstrates that the current situation implies that the sustainability of dairy farms in Tunisia is dependent on their ability to generate high yield levels to overcome these difficulties. This article aims to identify the characteristics of dairy farms that are capable of achieving high levels of performance. To accomplish this, technical efficiency scores of Tunisian dairy farms are estimated, and the factors that contribute to this efficiency are analyzed.

According to our findings, the main factors of efficiency of the dairy farm are a purebred composition of the herd and a breeding system including pasture and grazed grass. Although it is well known that purebred cows have higher milk productivity than local or mixed breeds, these results may have important implications for the Tunisian dairy sector. They indicate that breed choice is not sufficient to achieve high levels of performance. The breeding system should be adapted. Indeed, purebred cows can achieve high yields, but require higher feed supply. So, if the breeding system does not allow relying on natural pastures or grazed grass produced by the farm, the cost of feeding becomes unreasonable and the profitability of the dairy farm is no longer guaranteed.

Several studies have demonstrated the importance of pasture and grazed grass use on the profitability of dairy farming. Extended grazing seasons offer significant advantages, according to Läpple et al. (2012) [13]. Increased profitability is associated with a higher proportion of grazed grass in the diet, as demonstrated by Dillon et al. (2002) [7]. Conversely, as the proportion of purchased feed on dairy farms rises, production costs per hectare and per ton of fat and protein also increase, as shown by Shalloo et al. (2004) [16].

The characteristics of dairy farms in Tunisia contradict the implications of these results. Indeed, in the northern regions where rainfall is high and grass is abundant, the herds are mainly composed of local or mixed breeds, while in the arid regions of the center, cattle breeding is based exclusively on pure breeds. This implies that in the northern regions there are opportunities to improve the efficiency of dairy farming by replacing local or mixed herds with purebreds, whereas in other parts of the country where dairy farming cattle is practiced above ground the possibilities for improvement are very limited.

Furthermore, the membership of a professional organization is a relevant factor of efficiency of dairy farm in Tunisia.

Indeed, these organizations carry out group purchases of inputs for the benefit of their members and allow easier access to the market. A similar result was found by Abdelhafidh et al. (2018) [1] for Tunisian case. They assert that cooperative can largely support farmers and reduce the influence of the transaction cost and consequently improve the farms' productivity. The role of cooperative membership in enhancing dairy farms performance has been demonstrated in several foreign countries. In a study on the relationship between cooperatives and U.S. farm efficiency, Chen, Y. C. (1997) [5] found that cooperative membership has positive relationship with farm efficiency in the small and large herd size groups especially when farms have intensive relationship with cooperatives. Mahida et al. (2018) [14] show that membership in dairy cooperatives increases the efficiency coefficient of Indian farms by about 4%.

Hanisch et al. (2013) [10] conducted a study on the competitive yardstick effect of agricultural cooperatives on the prices paid to farmers. The study found that in the European dairy sector, agricultural cooperatives provide higher farm-gate prices to farmers.

CONCLUSIONS

Our empirical results can be very useful in determining the strategic direction of the development of the dairy sector in Tunisia. The main idea is that cattle breeding should be encouraged where it is possible to achieve high performance. Some regions with limited rainfall would simply be unsuitable for sustainable dairy production. Moreover, the creation of a greater number of dairy cooperatives will allow small farmers to be more efficient by reducing their costs and improving their managerial skills.

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VALUATION OF TECHNOLOGICAL FEATURES OF TOBACCO SEED CULTIVATION IN UKRAINE AND ITS ECONOMIC EFFICIENCY

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Abstract

The article provides a valuation of the technological features of cultivating new perspective varieties of Ukrainian selection tobacco seeds, which have high resistance to biotic and abiotic factors, good raw material quality, and optimal levels of nicotine, carbohydrates, and proteins. The scientific principles of cultivation and realization of high productive, competitive tobacco varieties, such as Berley 38, Berley 46, Ternopil 14, and Ternopil Perspective, are substantiated. The economic efficiency of tobacco seed production for Ukrainian research institutions is determined. Only specialized research institutions with corresponding scientific potential and material-technical base should be engaged in tobacco seed cultivation and realization. The production of tobacco seed varieties with optimal chemical composition will increase the efficiency of tobacco production and competitiveness of national seed production.

Key words: *tobacco, variety, selection, seed production, economic efficiency*

INTRODUCTION

The world experience in cultivating agricultural crops confirms the significance of seed varieties in increasing plant production. To obtain a high yield of quality tobacco raw materials, it is crucial to have a scientifically grounded seed system and implement comprehensive measures that fully utilize the potential of the selected variety. The variety itself plays a leading role in increasing the yield and overall harvest of tobacco. The economic value of seed material is associated with the internal hereditary properties inherent in the seed of a particular variety and is determined by the number of formed characteristics inherent in it (yield, resistance to diseases, droughts, etc.). The implementation of the achievements of *Nicotiana tabacum* L. tobacco breeding is possible only with a well-organized seed system, the main tasks of which are to increase the seed productivity of varieties by breeding, accelerate seed multiplication, maintain genetically determined characteristics and properties of the varieties used in production. Given the requirements for modern tobacco varieties, seed productivity, improvement of seed production technology, and quality improvement (similarity of BN (superelite) seeds should be at least 90%, and BN (elite) - 80%) are of paramount importance. Such quality can be obtained provided there is genetically determined high seed productivity and strict adherence to a complex of agrotechnical measures that contribute to providing conditions for seed formation, progressive methods of its post-harvest processing, and preparation for sowing.

The development of new varieties that combine high seed productivity and stable yields of dry leaves with high product quality will help solve the pressing issue of the tobacco industry in Ukraine, which is to provide the tobacco industry with raw materials with optimal levels of nicotine, carbohydrates, and proteins.

Analysis of long-term literature data from foreign and domestic scientists shows that tobacco breeding and seed production are the foundation for the development of competitive production of tobacco raw materials [1, 12, 16, 17, 18]. Scientific research on tobacco seed production has always been associated with the development of breeding work.

Over time, the Ukrainian Tobacco Research Station has developed numerous tobacco varieties that no longer meet the productivity and technological quality requirements for raw materials. These varieties have lost their competitiveness in the Ukrainian tobacco market. To address this, there has been a demand for the creation of new tobacco varieties and hybrids that possess valuable economic traits, ecological adaptability, disease resistance, and high-quality chemical composition. The focus is on developing varieties that can meet the evolving needs of the tobacco industry, ensuring sustainable and successful tobacco production in Ukraine. [2, 3]. In Ukraine, Gritsai L.L. and Sarichev Yu.F. studied the methods of breeding and seed production in primary and elite ranks [7, 17]. In 2012, the scientists from the scientific and technological department of Tobacco Growing at the Ternopil State Agricultural Experimental Station, which was established following the reorganization of the Ukrainian Tobacco Research Station, developed scientific and methodological recommendations. These recommendations aimed to enhance the sowing and yield qualities of the seed for new perspective tobacco varieties. By providing guidelines and techniques based on scientific research, the scientists aimed to improve the overall cultivation and productivity of these new tobacco varieties, contributing to the advancement of tobacco farming practices in Ukraine [4].

Scientists from Zakarpatska Agricultural Experimental Station of the National Academy of Agrarian Sciences are involved in tobacco breeding. In recent years, Savina O.I. and Sheidyk K.A. have initiated research that has shown that the seed productivity of tobacco depends on the shape and density of the inflorescence, while the size of the flower, its color, and other features of the flower and capsule shape do not affect the productivity of tobacco. The conical shape of the inflorescence ensures high rates of seed productivity and viability [18, 20]. Savina O.I. has described the variability of the structure of tobacco flowers in apomixis. In order to establish the characteristic morphological features of the inflorescence and flower structure in different apomictic forms of tobacco, the author has developed a classifier [19]. According to Kovalyuk O.M., Sheidyk K.A. and Glyudzik-Shemota M.Yu., the problem of seed quality variability is important both theoretically and practically. As the authors rightly note, seed quality is formed under the influence of factors that determine the degree of modification variability of plants. Therefore, knowledge of the directions and nature of this variability is fundamental for managing it and developing effective technology for producing high-quality seed [5, 6, 9].

Further study of the generative characteristics of tobacco was carried out by Kovalyuk O.M. As a result of observations of the growth and development of generative characteristics, the need for selection of biotypes that are genetically capable of withstanding negative environmental factors with a high genetic potential for yield and quality without reducing seed productivity has been established [10].

Theoretical generalization and solving scientific problems in tobacco cultivation involve enhancing various elements of tobacco cultivation technology. This includes improving fertilizer application techniques and understanding the productivity patterns of different tobacco varieties in the specific conditions of the Western Forest-Steppe region. These aspects were described by Sikora Yu.V., who likely conducted research and studies in this field. By analyzing and synthesizing theoretical knowledge and addressing scientific challenges, researchers can develop more effective cultivation methods and optimize the use of resources to maximize the yield and quality of tobacco in the Western Forest-Steppe region [11, 21, 22].

The Tobacco Research Station of the National Scientific Center "Institute of Agriculture NAAS" conducts scientific research on tobacco in the Central Forest-Steppe zone of Ukraine but does not produce tobacco seeds

[13, 14]. Scientific research on Berley-type tobacco varieties is carried out in Macedonia and Bulgaria [15, 16]. There is very little or no scientific work on studying the tobacco seed market and the effectiveness of seed production in Ukraine, as well as in other countries. Therefore, research on evaluating the technological features of growing seed of new perspective Ukrainian breeding varieties of tobacco and determining the indicators of economic efficiency of seed production is becoming relevant.

MATERIALS AND METHODS

Scientific research was conducted in the Southern agro-climatic region of the Transnistrian zone of Ukraine, specifically on gray podzolic soils. The soil composition includes 1.6% humus, 1.68 mg of available phosphorus, and 10.2 mg of potassium per 100 g of soil, with a pH of 5.6. The research took place in field number 1 of the seven-year crop rotation at the scientific and technological department of tobacco growing in the Ternopil State Agricultural Experimental Station of the Institute of Feed Research and Agriculture of Podillia of the NAAS from 2017 to 2021.

The sum of active temperatures in Ternopil region is 2,550-2,600°C, and in the southern part of the region (where the scientific and technological department of tobacco growing is located) it is approximately 2,800°C. The period with an average daily temperature above +10 °C lasts for 160-165 days. During this period, amount of precipitation is 370-420 mm, and throughout the year it is 570-680 mm.

The weather conditions during 2017-2021 were generally favorable for the growth and development of tobacco plants. There was sufficient rainfall throughout the vegetation period, and the sum of active temperatures was mostly higher than normal, except for 2021 (Table 1).

Table 1. Hydrothermal conditions during the tobacco growing seasonat the Ternopil State Agricultural Experimental Station for the years 2017-2021

Indexes	Years				
	2017	2018	2019	2020	2021
∑ precipitation, mm	216.3	338.9	416.0	491.0	511.0
∑ temperature	4,002	3,118	3,183	3,003	2,773
HTC (hydrotechnical coefficient)	0.50	1.08	1.31	1.64	1.84
Characteristics of the vegetation period	dry	sufficiently moist	sufficiently moist	excessivel y moist	excessively moist
Duration of the vegetation period	180	170	164	175	161

Source: calculation based on the own annual scientific reports for the years 2017-2021.

The natural-climatic conditions of the research site and the duration of the growing season are favorable for the ripening of tobacco seeds and contribute to achieving planting conditions for elite and super-elite planting materials. The research materials consisted of promising tobacco varieties of Ukrainian selection, including Krupnolisty (Ternopil 14, Ternopil perspective) and Berley (Berley 38, Berley 46) varieties. These varieties were developed by the scientific and technological department of the Ternopil State Agricultural Experimental Station and are listed in the State Register of plant varieties approved for distribution in Ukraine. They are known for their high resistance to biotic and abiotic factors, as well as their high yield and good quality of raw materials.

The research used a measurement-weighting method for measuring biometric indicators of tobacco plants, laboratory methods for determining the similarity of basic and base tobacco seeds and the quality composition of tobacco raw materials, and statistical methods for identifying the degree of dominance and selection schemes using genetic recombination of genes with diallel crossing and subsequent selection. The $NIR_{0,05}$ (minimum significant difference at the 5% level of significance) and economic indicators of the implementation of elite seeds of different tobacco varieties were determined using calculation and mathematical-statistical methods.

RESULTS AND DISCUSSIONS

The task of seed production is to produce high-quality seed in the required quantity to fully meet the needs of the corresponding tobacco cultivation zone, while preserving the biological and economic properties of the variety, and also ensuring control over the varietal qualities of the seed.

Primary seed production is the initial stage preceding the cultivation of elite seed, which includes the selection of the source material, evaluation of its offspring, and obtaining super-elite seed. Primary seed production of tobacco in our department is carried out by the method of individual family selection with offspring verification for two years according to the scheme shown in Figure 1.

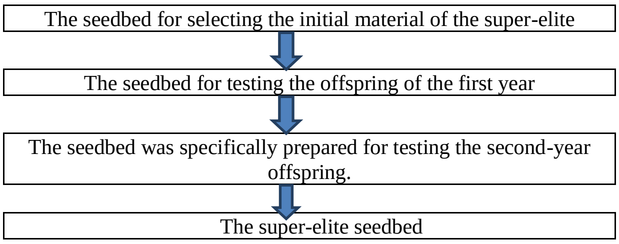

Fig. 1. Scheme of primary tobacco seed production
Source: [4].

Every year a two-year supply of elite seed of perspective varieties is produced. The creation of such a reserve fund is dictated by the long period of post-harvest maturation of the collected seed, which, for the most part, improves its sowing qualities only in the next year of storage.

Tobacco is a seedling crop, and it is necessary to grow the required amount of seedlings for planting in open ground. The seeding rate of tobacco seeds per 1 hectare is 35-40 grams, and from one hectare, it is possible to harvest 80-120 kg of seed. Such a result is achieved by observing the basic agrotechnical techniques of growing tobacco seeds, which include:

-planting tobacco seedlings in the field at optimal times from April 25 to May 10;

-a combined method of collecting leaves (the first two tiers are harvested when technically ripe, while the rest of the leaves are harvested when slightly overripe to ensure a prolonged process of photosynthesis for seed ripening;

-formation of inflorescences (removal of flowers and buds that appear later than central ones, which promotes the production of full-fledged seeds and accelerates their ripening;

-maintaining spatial isolation (not less than 300 meters between varieties) to ensure the purity of the variety.

In order to store seeds in a warehouse for a long period of time, it is necessary to create appropriate conditions throughout the year: the air temperature should not be lower than 12-15°C and the relative humidity of the air should not be higher than 70%. The typicality of the variety, its productivity, and the quality of the raw material are maintained at the achieved breeding level and improved through periodic selection of super elite, mostly every 4-5 years.

In previous years, the main task of tobacco breeding was to increase the volume of produced variety seeds. At the current stage of tobacco farming, in our opinion, the priority is the cultivation of new competitive tobacco varieties (BN, elite) with good commercial range and optimal levels of nicotine, proteins, and carbohydrates in tobacco raw materials.

The Ternopil State Agricultural Research Station stands out as the sole entity within the Ukrainian National Academy of Agrarian Sciences system, engaged in the production and commercialization of exclusive seeds derived from its own assortment of tobacco varieties. These seeds are made available to legal entities involved in tobacco production, as well as meeting the requirements of individual small-scale farming operations.

The breeding and genetic potential of our institution includes 157 tobacco varieties: 52.9% (83 variety samples) of the Eastern subtype, which includes the variety types Large-leaf – 21.0% (33), Americana – 12.1% (19), Basma – 6.4% (10), Herzegovina – 2.5% (4), Trabzon – 4.5% (7), Samsun – 4.5% (7), Dubek – 1.9% (3); 25.5% (40 variety samples) of the American subtype, including Burley – 11.5% (18) and Virginia - 14% (22); 3.2% (5 variety samples) of the Southern subtype (Kerty variety type) and 18.4% or 29

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variety samples of other tobacco variety types (Figure 2).

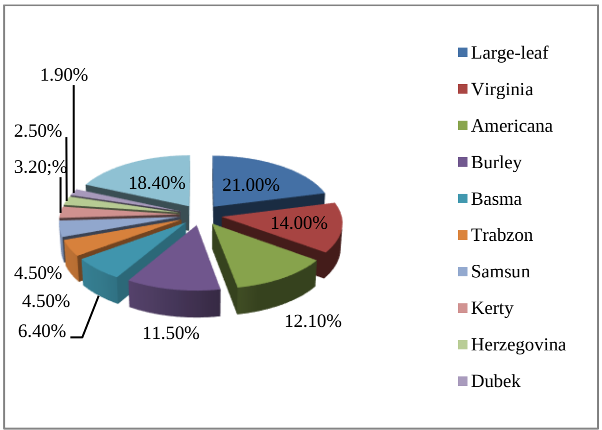

Fig. 2. Genetic potential of tobacco breeding
Source: author's calculation.

For comparison, the selection potential of *Nicotiana tabacum* L. in Bulgaria includes 158 varieties, of which 130 are of the Southern (Orientalis) subspecies, 28 are of the American (Americana) subspecies, including 17 of the Virginia type and 10 of the Burley type [12]. The tobacco collection in Poland comprises a total of 803 samples, sourced from various regions. Approximately one-third of these samples are derived from Polish breeding centers, primarily the Institute of Soil Science and Plant Cultivation (IUNG)_ located in Pulawy. A notable portion of the collection, more than seventy samples, originates from the United States, while an equal number is obtained from the former USSR, with a focus on its European region, particularly the Krasnodar Territory. Additionally, there are varieties obtained from countries such as Canada and Australia, as well as France, Germany, Romania, Italy, Hungary, and other European nations. The collection also includes samples obtained from South America, Asia, and Africa, representing a diverse range of tobacco varieties sourced from a total of 30 countries [1].

The tobacco varieties created by the breeders from the scientific and technological department of tobacco cultivation at the Ternopil State Agricultural Experimental Station have experienced significant popularity in recent years. These varieties have undergone rigorous evaluation and have been officially recognized by being included in the State Register of plant varieties authorized for distribution in Ukraine. As a result, they have garnered substantial demand within the country. These particular varieties exhibit exceptional resistance to both biotic and abiotic factors, showcasing their ability to withstand various pests, diseases, and environmental challenges. Moreover, they are known for their high productivity, consistently yielding abundant crops. Additionally, the quality of the tobacco raw materials produced by these varieties is widely regarded as excellent, meeting or exceeding the desired standards. Phenological observations of plant growth and development show that these are varieties: Burley 38, Burley 46, Ternopil 14, and Ternopil perspective. The results are shown in Table 2.

Table 2. Average biometric indicators and yield of perspective tobacco varieties at the Ternopil State Agricultural Experimental Station for 2017-2021

№ s/n	Variety	Plant height, cm	Number of technical leaves, pcs	Leaf size, cm		Yield, t/ha	
				length	width	actual	+, - to standard
1.	Berley 38 (standard)	145	24	40	25	2.47	–
2.	Berley 46	175	25	55	32	3.29	+0.82
3.	Ternopil 7 (standard)	205	25	47	26	2.69	–
4.	Ternopil 14	210	25	52	25	2.82	+0.13
5.	Ternopil perspective	170	25	45	26	2.86	+0.17

NIR_{05} – 2.5 c/ha.
Source: own calculation based on annual scientific reports for 2017-2021.

Tobacco variety Berley 38 was entered into the State Register of Plant Varieties Suitable for Distribution in Ukraine in 2001 and is a standard variety for Berley-type tobaccos. It is a skeleton-type raw material with an elliptical plant habit and a height of 125-150 cm. It has 23-24 technical leaves, with a leaf plate size of 45x24 cm. The average yield is 3.0 t/ha, with a yield of higher-grade varieties up to 82-82%. The nicotine content is 1.9%, with 6.7% protein and 1.56% carbohydrates. The dried raw material is brown. It is a medium-late maturing variety with a vegetation period of 119 days, and it is complex-resistant to diseases. Care for seedlings and cultivation techniques are generally accepted for Berley-type tobaccos. The optimal planting dates are the first and second decades of May, with a planting density of 70x40 cm. It has valuable economic characteristics, being high-yielding despite relatively low growth due to the high materiality of the leaf plate.

After years of dedicated breeding efforts, a groundbreaking tobacco variety named Berley 46 has been successfully developed. This new variety possesses notable advantages in terms of both biological and economic characteristics compared to the standard variety, Berley 38. Berley 46 showcases improved traits that offer enhanced performance and potential benefits in various aspects of tobacco cultivation and production. The plant habit of Berley 46 is conical, with skeleton-type raw material. It is characterized by the uniform ripening of leaves in tiers. Berley 46 features wide-elliptical-shaped leaves with a moderately pointed top. Notably, this variety exhibits resistance to adverse soil and climatic conditions, making it well-suited for challenging environments. It also possesses a complex resistance profile against various diseases, including Peronospora tabacina, Tomato spotted wilt virus, Potato virus G, and Pseudomonas syringae. This robust resistance helps protect the plant from these harmful pathogens, ensuring the overall health and productivity of the tobacco crop. It is suitable for pesticide-free cultivation technology. The Berley 46 tobacco variety was obtained through individual selection in populations of intervarietal hybrids Berley Polsky x Banat. Berley Polsky tobacco variety is known for its high nicotine content and yellow leaf color, while the Banat tobacco variety excels in plant height and disease/pest resistance.The height of the plants is 175 cm. The certificate of state registration of the Berley 46 plant variety (No.161042 of November 30, 2016) confirms its registration. The new variety offers a significant advantage with its remarkable yield of tobacco raw materials, reaching 3.29 tons per hectare. This yield surpasses the standard variety by 0.82 tons per hectare. Additionally, the new variety demonstrates a higher production of premium-grade tobacco, with an estimated range of 90-95%. Moreover, the chemical composition of the raw material from this variety is noteworthy, with a nicotine content of 2.08%, protein content of 5.42%, and carbohydrate content of 1.11%. These favorable attributes make the new variety highly desirable for its impressive yield, quality, and chemical composition of the tobacco raw materials it produces. The dried raw material is light brown.

The Ternopil 7 tobacco variety was included in the State Register of plant varieties suitable for distribution in Ukraine in 1995, and it is a standard variety for Large-leaf type tobaccos. It is characterized by high resistance to adverse soil and climatic conditions, complex disease resistance, resistance to drying out of lower leaves, and medium ripening. The planting scheme is 70x25 cm. The plant has an oval-cylindrical habit, is tall, with an average plant height of 205 cm, the leaf base is sessile, with 25 leaflets of medium layer size, 47x26 cm. The average yield is 2.69 t/ha. The average material density is 0.481 g/cm^2. The nicotine content is 1.3%, protein content is 4.35%, and carbohydrate content is 1.65%. The output of higher-grade products is 80%.

The Ternopil 14 variety is listed in the State Register of plant varieties suitable for distribution in Ukraine since 1999. It was developed through individual selection from the super-elite lines of the Ternopil 7 variety. Planting density is 70x25 cm. The plant has an oval-cylindrical habit, grows tall up to 210 cm, with the leaf base sitting on the stem, and 25 leaves sized 52x25 cm. The average material yield is 0.450 g/cm^2. The nicotine content is 1.2%, protein content is 6.4%, and carbohydrate content is 2.1%. The output of

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higher-grade varieties is 80%. The variety is complex-resistant to diseases. The average yield is 2.82 t/ha, which is 0.13 t/ha higher than the standard variety. The output of higher-grade varieties is 82%. The color of the dry leaves is yellow-brown. The new variety is recommended for cultivation in small-scale and individual farms, and it has successfully undergone ecological testing in the steppe zone of Ukraine, including the Kherson region and AR Crimea. The testing results have shown positive outcomes, confirming the variety's suitability and adaptability to the specific environmental conditions of these regions.

The tobacco variety Ternopil perspective, belonging to the large-leaved type, has been included in the State Register of plant varieties approved for cultivation in Ukraine since 2008. This variety was developed through individual selection within populations of intervarietal hybrids, specifically Virginia 22 x Ternopil 14. Its inclusion in the State Register signifies its recognition and approval by the relevant authorities for cultivation in Ukraine. It belongs to the skeleton type of raw material. The variety is complex-resistant to diseases. The planting density is 70x30 cm. The plant habit is doubly conical. The average plant height is 160-170 cm. The Ternopil perspective tobacco variety features 25 technically mature leaves that are egg-shaped with moderately pointed tips. The leaf blade size measures 45x26 cm. It has a nicotine content of 1.61%, carbohydrates content of 3.6%, and proteins content of 4.58%. The average weight per unit area is 0.566 g/cm2.The color of the ripe leaf in the field is light green, and the dried raw material is light brown. The average yield is 2.86 t/ha, which is 0.18 t/ha more than the standard variety Ternopil 7. The yield of higher quality grades is 85%.

The quality of tobacco raw material is influenced by its chemical composition, which encompasses more than 70 different substances.

However, the main indicators used for evaluation are nicotine, carbohydrates, and protein substances [8, 23, 24].

There are significant differences between the production of tobacco seeds and other agricultural crops.

The harvested crop of grains (winter and spring wheat, barley, buckwheat) and technical crops (rapeseed, sunflower) is sold in the current or next year.

Tobacco seeds can maintain their sowing qualities (similarity, color, smell) for 5-7 years, so it can be sold during this period.

The revenue from the sale of tobacco seeds is one of the main sources of funding for the scientific and technological department of tobacco cultivation, where scientific work in the field of tobacco seed production is organized at the highest level in Ukraine.

Table 3 shows the amount of tobacco seed sold in 2017-2021 and the revenue from its sale.

The sale of seeds is preceded by their certification by the State Enterprise "State Center for Certification and Expertise of Agricultural Products". Seed testing is carried out in accordance with the requirements of DSTU 4138-2002 Seeds of Agricultural Crops. Method for determining quality and DSTU 2340-93 Seeds of Agricultural Crops. Sowing and varietal qualities.

As can be seen from Table 3, the Berley 38 variety had a higher share in the structure of seed sales for two years: 99.4% in 2017 and 62.1% in 2018.

Starting from 2019, the revenue from the sale of Berley 46 seeds has been occupying a significant share in the structure of tobacco seed sales: 49.8% in 2019, 31.8% in 2020, and 58.9% in 2021. Both Berley 38 and Berley 46 belong to the Berley variety type, while varieties of the Large-Leaved type, such as Ternopil 7, Ternopil 14, and Ternopil perspective, surpass Berley types only in 2020 – 54.5%, while in other years they occupy a small share: 0.6% in 2017, 37.9% in 2018, 24.4% in 2019, and 32.0% in 2021.

According to the technological process, 10 hectares of tobacco plantations provide year-round work for 18-22 rural workers, and during the seasonal work period, 48-50 people are employed in tobacco farming.

Table 3. Implementation of elite tobacco seed by Ternopil State Agricultural Experimental Station for 2017-2021 (sorted by varieties)

Variety name	Quantity sold, kg	Revenue, thousand UAH*	% of Total Sales
2017			
Burley 38	2.562	47.24	99.4
Ternopil perspective	0.015	0.30	0.6
Total per Year	**2.577**	**47.54**	**100**
2018			
Burley 38	2.060	57.90	62.1
Burley 46	0.120	3.48	3.6
Ternopil perspective	0.020	0.58	0.6
Ternopil 14	1.120	31.10	33.7
Total per Year	**3.320**	**93.06**	**100**
2019			
Burley 38	0.595	17.85	25.8
Burley 46	1.146	32.70	49.8
Ternopil perspective	0.518	14.81	22.5
Ternopil 14	0.043	1.30	1.9
Total per Year	**2.302**	**66.66**	**100**
2020			
Burley 38	0.810	24.30	13.7
Burley 46	1.875	53.60	31.8
Ternopil perspective	1.907	52.70	32.4
Ternopil 14	1.305	29.00	22.1
Total per Year	**5.897**	**191.52**	**100**
2021			
Burley 38	0.806	37.70	9.1
Burley 46	5.190	249.70	58.9
Ternopil perspective	0.122	6.10	1.4
Ternopil 14	2.702	122.00	30.6
Total per Year	**8.820**	**415.50**	**100**

Source: calculation based on annual scientific reports from 2017-2021
*UAH (hryvnia) -the national currency of Ukraine.

Over the past two years of research, the seed has provided a planting area of 168 hectares in 2020 and 252 hectares in 2021. In 2020, 740 jobs were created in tobacco farming, and in 2021, 1,100 rural workers provided their families with decent incomes. The economic feasibility and historical background have been decisive in the fact that tobacco occupies a significant share of the private land use structure in the Transnistrian region of Ukraine. Growing tobacco as a cash crop under modern conditions of rural self-employment provides a source of stable income for families, and traditions ensure the transfer of skills and knowledge from generation to generation.

Analysis of the realized seed allows us to conclude that agricultural producers prefer the Berley-type tobacco varieties, the raw material of which is characterized by better yield and higher nicotine content.

High efficiency of selection for obtaining quality varieties of the Berley type and relatively frequent variety replacements create favorable opportunities for the annual optimal formation of the varietal structure of production depending on the requirements and demand of the respective raw material segment of the market and rapidly changing market conditions.

Tobacco (*Nicotiana tabacum* L.) is one of the main industrial crops grown in Ukraine for the sake of the leaves, which are used to make cigarettes, cigars, pipe tobacco, and snuff. Green tobacco leaves are a raw material for obtaining food protein. Essential oil is obtained from tobacco inflorescences, which is used in the perfumery and chemical industries.

Table 4 shows indicators of the economic efficiency of tobacco seed production.

The cost of one kg of tobacco seed, including expenses for harvesting, post-harvest ripening, cleaning, and storage, ranged from 274 to 367 dollars per kilogram from 2019 to 2021.

At an average selling price of 1,119 to 1,726 dollars, a net profit of 861 to 1,359 dollars was obtained from the sale of one kilogram of elite tobacco seed.

Figure 3 shows the dynamics of the increase in cost, prices, and net profit from the sale of one kilogram of tobacco seed.

Table 4. Economic indicators of elite tobacco seed sales at the Ternopil State Agricultural Experimental Station for 2017-2021

Economic indicators	Years				
	2017	2018	2019	2020	2021
Seed sold, kg	2,577	3,320	2,302	5,897	8,820
Total seed cost, USD	472	790	594	1,616	3,237
Revenue from seed sales, total, USD	1,786	3,423	2,576	7,106	15,223
Net profit, total, USD	1,314	2,633	1,982	5,490	11,985
Cost of production per unit, USD/kg	183	238	258	274	367
Average selling price, USD/kg	693	1,031	1,119	1,205	1,726
Net profit per unit of production, USD/kg	510	793	861	931	1,359

Note. The average exchange rate of the US dollar: 2017 – 26.60 UAH, 2018 – 27.20 UAH, 2019 – 25.85 UAH, 2020 – 26.96 UAH, 2021 – 27.29 UAH.

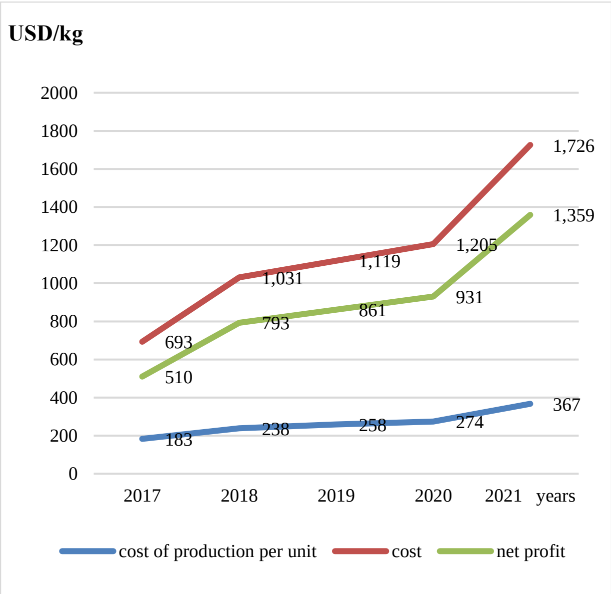

Fig.3. Dynamics of economic indicators of tobacco seed sales at the Ternopil State Agricultural Experimental Station for the years 2017-2021.
Source: author's calculation.

For many decades, our institution has been providing high-quality tobacco seed to the countries of the Caucasus (Georgia, Azerbaijan, Armenia) and Central Asia (Kazakhstan and Uzbekistan). The revenue from the sale of tobacco seed constituted a significant part of the income from the sale of agricultural products. After the collapse of the Soviet Union, the sale of tobacco seed is carried out only within Ukraine. At present, we provide tobacco growers in the Lviv, Ternopil, Chernivtsi, Cherkasy, Dnipropetrovsk, Kyiv, Khmelnytskyi and Zakarpatska regions of Ukraine with seed.
Therefore, the production of elite seed of high-yielding competitive varieties of tobacco is a good source of revenue for the special fund of the budget for scientific institutions that have the right and ability to engage in the seed production of this technical crop.

CONCLUSIONS

New perspective varieties of Ukrainian tobacco, which are highly resistant to biotic and abiotic factors, have good quality raw materials, and optimal levels of nicotine, carbohydrates, and proteins: Berley 38, Berley 46, Ternopil 14, and Ternopil perspective, have wide distribution and are in demand on the Ukrainian market.
Growing competitive varieties of tobacco seeds provides significant revenues to research institutions for the special fund of the budget. From the sale of one kilogram of elite tobacco seed, net profits range from $861 to $1,359.
The study of technological features of growing new promising varieties of Ukrainian tobacco seeds and their implementation in production will contribute to increasing the efficiency of tobacco production and the competitiveness of seed production in Ukraine.

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CLASTOGENIC POTENTIAL OF SOME CHEMICALS USED IN AGRICULTURE MONITORED THROUGH THE ALLIUM ASSAY

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Abstract

Many of the higher plants can be genetic models for the detection of environmental mutagens. One of the species often used in monitoring environmental pollution with pesticides is onion (Alium cepa). The Allium assay (Aa) is used with a high frequency in many studies to evaluate the cytotoxic and genotoxicity effects of various chemical substances in agricultural plants. This is based on the fact that compared to using animals for testing the Aa is more cost-effective and provides a large amount of data using a simple cultivation protocol without ethical concerns. In this context, the purpose of this study was to evaluate the clastogenic potential of two pesticides (Rancona fungicide and Mospilan insecticide) in plants through the Allium assay, using onion meristematic roots as biological material. The meristematic roots were exposed for 24 h to three different concentrations of pesticides as follows: 0.5, 1, and 2 µg/mL (Rancona) and 0.05, 0.1, 0.2 µg/mL (Mospilan). The obtained results showed that the tested pesticides induced the decrease, in variable percentages, of the mitotic index (MI %) in the onion meristematic cells, in all tested variants. Thus, compared to the control variant, the values of MI in the variants exposed to the pesticide treatment were between 38-54% (Rancona), respectively 30-48% in the variants treated with Mospilan. At the same time, there was a direct correlation between the pesticides concentration and the clastogenic effect observed in onion cells, through the appearance of several types of chromosomal and nuclear aberrations: sticky, fragments, bridges and chromosomal loss; nuclear dissolution and ring chromosomes. These results suggest caution when using the tested pesticides and mandatory compliance with the concentrations recommended by the producers, to avoid negative impact on plants and environment.

Key words: *pesticide, Allium assay, clastogenic, aneugenic, mitotic index, chromosomal aberrations*

INTRODUCTION

Conventional agriculture uses chemicals to protect plants and fertilizers to stimulate their growth and production. In organic farming, they are heavily restricted. However, in both types of agriculture, the EU is taking steps to make products safer for consumers. In this respect, EU chemicals and pesticides legislation aims to protect human health and the environment, as well as prevent barriers to trade. This includes rules governing the marketing and use of certain categories of chemical products, a set of harmonized restrictions on the placing on the market and use of specific dangerous substances, as well as rules governing major accidents and the export of dangerous substances [8]. The European Food Safety Authority (EFSA) assesses pesticides from a risk point of view and provides the European Commission and Member States with scientific support in the decision-making process [8].

Many studies show that pesticides are potentially carcinogenic and harmful to human health [4, 20, 22, 24] and to environment [3, 19]. Therefore, it is necessary to extend the assessment of cyto-genotoxicity of these chemicals by using different test systems. One of these test systems is the biological one, which also includes the *Allium* assay (Aa). Plants are effective indicators for the assessment of cytotoxicity and genotoxicity of chemical compounds in both plant and animal cells, as well as for in situ monitoring of environmental pollutants. Onion (*Allium cepa*), one of the frequently used indicator plants in biological tests, is a bulbous plant that belongs to the family *Amaryllidaceae*, genus *Allium*. Its efficiency as a toxicity bioindicator has been proven by the results of many studies [2, 5, 6, 7].

Rancona is a fungicide used for plant protection, which contains two active substances: 20 g/liter ipconazole + 50 g/liter imazalil. The fungicide is presented in the form of microemulsion with contact and systemic action, for the treatment of cereal seeds (wheat and barley). The dose recommended by the producerer: 1 liter/to of seeds (wheat) and 1.3 liters/to of seeds (barley). According to product information, Rancona provides excellent control of *Tilletia spp*. disease with both seed and soil transmission. It provides protection and safety to the seeds, favoring the complete and rapid emergence of the crop, without the need to increase the sowing dose [21].

Mospilan (active substance acetamiprid, 200 g/kg) is a systemic insecticide from the group of neonicotinoid products, with a broad spectrum of control. According to product information, it has a rapid effect, affecting the nervous system of insects that paralyze and die. This insecticide affects all development stages (egg-larva-adult); it is not affected by temperature, and its action lasts over three weeks. After application, the insecticide quickly penetrates the plants and is not washed away by rain or irrigation water. The dose recommended for onion by the producerer: 0.2 Kg/Ha, with a break time of 14 days [17]. Although their use brings an obvious profit to farmers, pesticide residues pollute the environment in a worrying way, especially in developing countries. Moreover, the danger extends to ecosystems and human population health. In the specialized literature there are many studies that use different biological tests to evaluate the cytotoxic and genotoxic potential of pesticides [9, 14, 15, 16]. In this context, the objective of this study was to evaluate the cyto-genotoxicity, via clastogenic potential, of two frequently used pesticides (Rancona and Mospilan) in plants, through the *Allium* assay, using onion meristematic roots exposed for 24 h to different concentrations of pesticides.

MATERIALS AND METHODS

The experiments were carried out in the Genetics laboratory of the Faculty of Agronomy, University of Craiova.

The two types of pesticides were purchased from a local phytosanitary store and the onion bulbs were purchased from the central market Craiova (Dolj County).

The biological material consisted of onion roots obtained from bulbs of medium size and weight put to germination in water (the control group) respectively in the pesticide solution with various concentrations, to determine the effective concentration value (EC_{50}), through the method described by Ozkara [18]. First of all was determined the inhibition of the onion meristematic roots growth. The range of concentrations for establishing the EC_{50} value was chosen starting from values that vary between three times higher and three times lower than the concentration recommended by the producers. Then, the lengths of roots were plotted against pesticides concentrations and the point showing 50 % growth was considered EC_{50} concentration. Thus, it was found that the dose that caused a 50% shortening in root length compared to the control group (i.e the EC_{50} values) were 1 μg/mL (Rancona) and 0.1 μg/mL (Mospilan).

The meristematic roots were exposed for 24 h to three different pesticide concentrations as follows: 0.5, 1, and 2 μg/mL (Rancona fungicide) and 0.05, 0.1, 0.2 μg/mL (Mospilan insecticide). These concentrations were established based on the EC_{50} value for each pesticide, namely: $1/2EC_{50}$; EC_{50} and $2xEC_{50}$.

A number of 10 onion bulbs were used for each treatment variant. After the 24 hours of exposure to pesticides, the onion roots were harvested and processed so that they could be studied under a microscope by going through the fixation stage (for 24 hours in Carnoy's fixative); hydrolysis (in 1N HCl for 5 minutes followed by 50% HCl for 15 minutes) and staining with Schiff's reagent.

Microscopic analyses were performed on Optika digitale microscope at 1000x magnification and 1,000 cells were counted in each microscopic slide.

To evaluate the cytotoxic and clastogenic potential of pesticides, the following calculation formulas were used:

Mitotic Index (MI%) = (Number of mitotic cells/Total number of cells) x 100;

Mitotic index of prophase (MIP%) = (Number of cells in prophase/Number of dividing cells) X 100;
Mitotic index of metaphase (MIM%) = (Number of cells in metaphase/Number of dividing cells) x 100;
Mitotic index of anaphase (MIA%) = (Number of cells in anaphase/Number of dividing cells) x 100;
Mitotic index of telophase (MIT%) = Number of cells in telophase/Number of dividing cells) x 100;
Chromosomal and nuclear aberrations (CNA%) = Total number of aberrant cells/Total number of cells in division x 100.
Analysis of variance (ANOVA) and statistical analyses were performed using SPSS package program. Also, the standard deviation (SD) was used at a probability level of $p \leq 0.05\%$ subsequent to the ANOVA analysis.

RESULTS AND DISCUSSIONS

The mitotic index (MI) is a parameter that allows estimating the frequency of cell division, and the inhibition of mitotic activity in certain percentages suggests the phenomenon of cytotoxicity in plants [12].

Table 1. The cyto-genotoxic potential of the tested fungicides throught Aa

Pesticide /Variant /Conc. (µg/mL)	MI (%)±SD	MIP (%)	MIM (%)	MIA (%)	MIT (%)
Rancona					
Control	71.23±1.52	36.29	18.28	9.52	7.14
V_1/0.5	38.15±3.92*	25.31	7.24	3.18	2.42
V_2/1	31.17±4.38*	18.12	8.93	2.15	1.97
V_3/2	27.31±1.68*	12.54	7.23	4.40	3.14
Mospilan					
Control	83.31±2.19	40.11	20.33	11.85	11.02
V_1/0.05	40.15±4.12*	19.02	9.12	6.18	5.83
V_2/0.1	35.95±3.68*	21.37	7.15	4.01	3.42
V_3/0.2	24.65±2.51*	9.45	6.28	5.96	2.96

Aa=*Allium* assay; MI%=Mitotic Index; SD=Standard deviation; MIP%=Mitotic index of prophase; MIM%=Mitotic index of metaphase; MIA%=Mitotic index of anaphase; MIT%=Mitotic index of telophase.
*Mean statistically significant at $p \leq 0.05$ subsequent to the ANOVA analysis.
Source: Own calculation.

The results obtained in this study indicated a decrease of the MI values in all tested variants for both pesticides, which suggests a considerable cyto-genotoxic potential of the two pesticides (Table 1). Thus, following the treatment with Rancona fungicide, MI recorded values of 38.15% (V_1), 31.17 (V_2) and 27.31% (V_3).
In according to Sharma and Vig (2012), a significant decrease in MI suggests genotoxicity effect in cells. When this decrease reaches 50% it indicates a lethal effect on the cells [23].
It can be appreciated that at least in two variants (V_2 and V_3) the Rancona fungicide showed a strong genotoxic effect, even possibly lethal in plant cells. In these variants, %MI compared to Control was only 44% and 38% respectively.
Similar results were reported by other authors who tested other pesticides through Aa, namelly: Mancozeb [10], Imidacloprid and Iprodione [11], mixture of Imidacloprid, Imazalil and Tebuconazole [13], etc.
Regarding the indices of mitosis stages, the values recorded in treated variants were between 12.54-25.31% (MIP); 7.23-8.93% (MIM); 2.15-4.40% (MIA) and 1.97-3.14 (MIT).
As for Mospilan insecticide, MI recorded values of 40.15% (V_1), 35.93 (V_2) and 24.65% (V_3). It can be observed that all three showed a strong genotoxic and even possibly lethal in plant cells. In these variants, %MI compared to Control was reached between 30-48%.
Regarding the indices of mitosis stages, the values recorded in treated variants were between 9.45-19.02% (MIP); 6.28-9.12% (MIM); 4.01-6.18% (MIA) and 2.96-5.83 (MIT). The results obtained suggest a direct correlation between the increase of pesticides concentration and the decrease of MI (Figure 1).

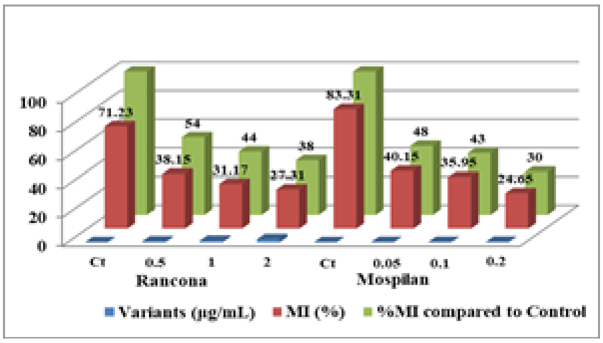

Fig. 1. Correlation between the increase of pesticides concentration and the decrease of MI.
Source: Own design.

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Results reported by Adesuyi et al. (2018) suggest that the cytotoxic effects of pesticides on plants may be the direct effect of chromosome aberrations in mitosis [1].
Generally, the chromosomal aberrations occurrence reflects the clastogenic effect of some stressors on plant genome. In this study, the clastogenic and aneugenic potential of Rancona and Mospilan pesticides at the tested concentrations was manifested by the identification of a large number of different chromosomal and nuclear aberrations, such as: sticky, fragments, bridges and chromosomal loss; ring chromosomes, nuclear dissolution, etc. (Figure 2 and Figure 3).

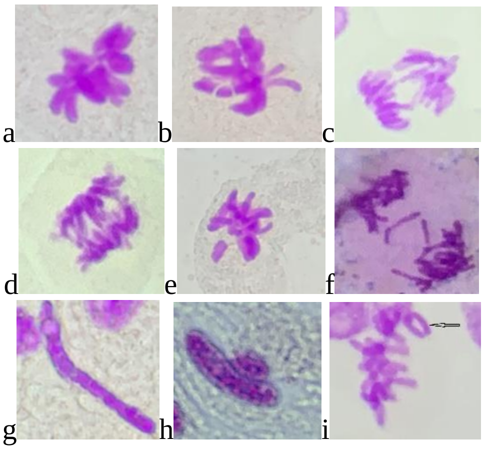

Fig. 2. The chromosomal and nuclear aberrations induced by Rancona and Mospilan pesticides in plant cells through the *Allium* assay: (a) sticky methaphase; (b) fragmented chromosomes; (c, d) bridges; (e, f) chromosomal loss; (g, h) nuclear dissolution; (i) ring chromosome.
Source: Own identification and cuantification.

It was also calculated the chromosomal and nuclear aberrations index (CNA%), the results obtained showing significant and distinctly significant statistical differences from the control (Figure 3).
Thus, in the cells of the meristematic roots of *A. cepa* treated with the fungicide Rancona, various chromosomal and nuclear aberrations were identified, the most frequently encountered being those of the stickiness, chromosomal loss and nuclear dissolution type, all registering CNA values significantly and distinctly significantly higher than the control variant of 29.43% in V_1 (0.5 µg/mL), 38.75% in V_2 (1 µg/mL) and respectively 62.31% in V_3 (2 µg/mL).

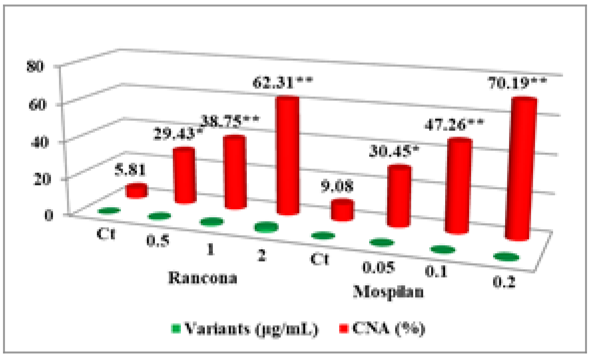

Fig. 3. The clastogenic and aneugenic potential of two pesticides in plant cells quantified by chromosomal and nuclear aberrations index (CNA%).
*Mean statistically significant and **distinctly significant compared to Control.
Source: Own design.

In the case of treatment with Mospilan, the most frequently abnormalities were fragments, bridges and ring chromosomes, all registering CNA values significantly and distinctly significantly higher than the control variant of 30.45% in V1 (0.05 µg/mL), 47.26% in V2 (0.1 µg/mL) and respectively 70.19% in V3 (0.2 µg/mL).
The results obtained indicate a high clastogenic potential of both pesticides, at the tested concentrations, and suggest caution in their use, with mandatory compliance with the doses recommended by the producers. The clastogenic potential is particularly indicated by the appearance of chromosomal aberrations such as bridges, fragments and rings.
Also, the results obtained confirm the suitability of the *Allium* assay for evaluating and monitoring the cyto-genotoxic, clastogenic and aneugenic effects of chemicals in plant and animal cells, as well as the toxicity to the environment.

CONCLUSIONS

Plants are effective indicators for the assessment of cytotoxicity and genotoxicity/clastogenity of chemical compounds in cells and, from this point of view, *Allium cepa* is one of the frequently used bioindicator, through the *Allium* assay protocol.
The results obtained showed a high decrease of the mitotic index values in all tested variants for both pesticides, which suggests

theirs cyto-genotoxic potential in plant cells. Also, the chromosomal aberrations like bridges, fragments and rings reflect the clastogenic effect of tested pesticides on plant genome.

There are not many studies into the clastogenic effects of the tested pesticides in *A. cepa*, although they are frequently used in agriculture. Therefore, further studies are needed, for providing new informations about harmful potential of these pesticides in plant cells and environment too.

However, the obtained results suggest that, at the doses recommended by the manufacturer, both pesticides can be used safely for plant protection. The issue that remains is that of excessive use, without respecting the concentrations recommended and the break time between treatments.

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SOME SUSTAINABLE DEPOLLUTION STRATEGIES APPLIED IN INTEGRATED ENVIRONMENTAL PROTECTION MANAGEMENT IN AGRICULTURE

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Abstract

The global problems of humanity are closely related to the problems of the environment. At the same time as the development of the society, various imbalances appeared that led to significant environmental pollution. Activities regarding the protection and conservation of the environment and the stability of ecological systems are vital for supporting the process of sustainable development and ecological management in contemporary society. A sustainable agricultural environmental protection management program involves optimizing integrated methods of ecological reconstruction, increasing biodiversity, restoring biotope factors, maintaining fertility and controlling soil erosion. In this context, the purpose of this paper was to review some sustainable depollution strategies, emphasizing the organic farming, phytoremediation and waste management. The first of these strategies, organic farming, has a positive impact on the environment, because it promotes the responsible and sustainable use of energy and natural resources and preserving biodiversity. On the other hand, the phytoremediation can be applied for the environmental elimination of pesticides, solvents, and seepage from landfills. In terms of agricultural waste management, the waste composting is a sustainable solution of environmental pollution prevention, for the real contribution in bioremediation, weed control, erosion reduction and increasing of biodiversity, all these benefits being doubled by the use of compost as an organic fertilizer, of course.

Key words**:** *sustainable, management, agriculture, depollution, environmental*

INTRODUCTION

The agricultural production activity has experienced, over time, a continuous process of updating to the increased requirements of food for an increasingly numerous human population and with increasing demands towards the diversity and quality of food.

The agriculture practiced in Romania is mostly polluting, and the pollution phenomenon is known by the specialists in the field of environmental protection. On the other hand, pollution, as a process of degradation of the quality of environmental factors, vital for human health, has not always been recognized by political factors and there is still a lack of the resources necessary to highlight all the aspects that pollution entails [1].

In according to Voicea et al. (2020), some issues of environmental pollution caused by agricultural activities in Romania are: evacuation of wastewater, untreated or incompletely treated, from the animal's industrial breeding complexes, into the surface waters and into the drainage network; the excessive use of manure (over 100 t/ha), at intervals of 2-3 years, which results in the accumulation of nitrates in feed, as well as leaching into the groundwater table; he intensification of the phenomenon of soil erosion on sloping lands and the degradation of the soil structure as a result of the decrease in the content of organic matter, etc. [36].

Pesticides (especially fungicides and insecticides) but also fertilizers are chemicals commonly used in agriculture but are also the elements that make agriculture to be one of the biggest polluters of the environment [26]. The long-term effects are, in addition to damaging environmental health, the deterioration of the primary consumers health as well as the decrease of biodiversity [17].

In this context, the objective of this study was to review some sustainable depollution strategies applied in integrated environmental protection management in agriculture, emphasizing the organic farming, phytoremediation and waste management.

MATERIALS AND METHODS

The research method consisted in identifying, accessing and selecting of several scientific results in proposed topic, published in various journals indexed in WOS, Clarivate Analytics, Scopus and Springer databases. Some articles from specialized online magazines, such as Agrimedia and Biz, were also taken into account. Certain results have been compiled into tables and figures respectively.

RESULTS AND DISCUSSIONS

Agricultural pollution generally occurs due to chemical fertilizers and pesticides used for fertilization and protection of agricultural crops against diseases, pests and weeds. However, these extremely toxic substances with great chemical stability over time are spread in low concentrations on the field, but the very large extent of treated cultivated surfaces contributes to a worrying pollution of the environment and especially of soil and water.

In 2019, share of emissions from the non-food and agri-food sector in global greenhouse gas emissions was of the 69% and 31% respectivelly (Figure 1). The first three categories of chemical compounds that showed the highest emissions were nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) [18].

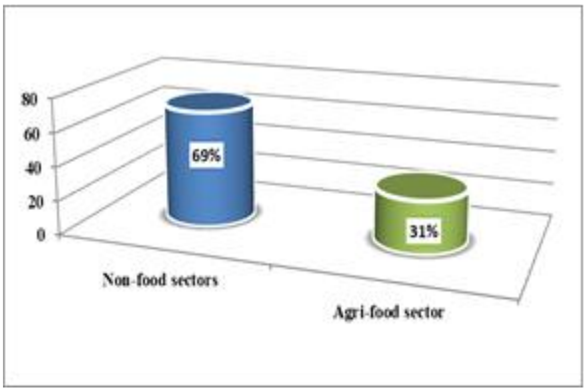

Fig. 1. Share of emissions from the non-food and agri-food sector in global greenhouse gas emissions (2019).
Source: Own design based on [14].

The largest share of the activities that lead to water pollution is the inefficient use of fertilizers in agriculture, along with the improper storage of manure. The meteoric waters wash the fields and carry the chemical substances from the fields that they introduce directly into the surface waters or the groundwater table. An essential characteristic of these waters is that they cannot be collected, concentrated and purified.

Also, agricultural pollution appears today due to the wastewater discharged from animal husbandry complexes, which contain large amounts of organic substances, viruses and bacteria.

In the case of underground water resources, pollution occurs through the infiltration of solid and liquid impurity substances due to meteoric waters that wash away the garbage deposited in the soil and sewage waters that enter the soil through the leaks in the pipeline network.

Nitrogen used in agriculture is the main source of water pollution. This is precisely why mitigation strategies are needed to minimize global N pollution and to implement agricultural management practices for sustainable environmental protection [26].

Nitrogen that pollutes groundwater, as well as surface water, can have many sources. Thus, the point sources are those that can be well located, represented by a single objective. The point pollution from agricultural sources can be caused by semi-liquid and liquid animal manure, solid manure and effluents from silos, untreated or insufficiently treated wastewater and runoff from mineral and organic fertilizer deposits.

The impact of agricultural production to environment is of concern to the globally level [4, 26]. Therefore, the concept of sustainable development should become the main concern of farmers [16, 22, 31]. However, there are some difficulties about seek temporary, material, and intellectual resources [16].

Protecting the environment is the only way that life can continue to thrive, and from this point of view, three of the most sustainable technologies applied within the concept of integrated environmental protection in agriculture can be exemplified below.

1. Organic farming

Organic farming produces plant and animal raw materials by using natural substances and processes. The biodiversity is a key strategy for pest control. For example, instead of synthetic chemical pesticides, organic farmers can introduce natural predators, helpful insects, and crop rotation. Also, organic farming has been promoted to restore soil health and fertility status through the addition of organic matter [12]. Another advantage of organic farming that shows its sustainability in environmental protection is the potential for reducing greenhouse gas emissions and improving organic carbon sequestration [18, 30].

Organic farming is full of promise and benefits too: animal health and welfare; protection of biodiversity (organic farmers can provide food and homes for wild species, maintain healthy soils, and reduce water pollution); combating soil erosion by crop rotation, intercropping and minimum tillage; water conservation, etc.

Therefore, organic farming has a limited impact on the environment, because it promotes the responsible and sustainable use of energy and natural resources and preserving/increase biodiversity. Also, organic farming promotes long-term environmental protection in particular due to the certification rules that certain inspection bodies check for compliance. Some of these rules include banning pesticides, due to their adverse effects on human beings.

According to many studies in the field, other positive effects of organic farming on the environment are the following:

- Restoring of natural balances by using crop rotation [40], associated and interspersed crops, agroforestry curtains and hedges [25], the application of green manure [2, 23], mulching [34], as well as the application of biotechnological methods of plant protection [21];
- Organic farms use 45% less energy compared to conventional ones [33]. Less energy means fewer fuels being burned which slows the production of greenhouse gasses. In addition, using organic pesticides has reduced the amount of nitrous oxide that gets introduced into the atmosphere. Nitrous oxide is considered one of the most damaging greenhouse gasses and one of the main ingredients in chemical pesticides [33];
- Reducing global environmental problems such as global warming and desertification;
- Reduce or eliminates the use of pesticides and highly soluble forms of nitrogen;
- Because fossil fuel-based fertilizers and most synthetic pesticides are prohibited in organic farming, this agricultural sistem has a significantly lower carbon footprint. The production of these farm chemicals are energy intensive. According to Walling et al. (2020), the elimination of synthetic nitrogen fertilizers alone, as is required in organic systems, could lower direct global agricultural greenhouse gas emissions by about 20% [37] Therefore, organic farmers are already controlling pollution.

The analysis of the greenhouse gas emissions from plant production can be carried out by examining the carbon footprint of a product from the extraction of raw materials and energy to the harvesting within the system from ″cradle-to-farm-gate″ and ″gate-to-gate″ (Figure 2) [18].

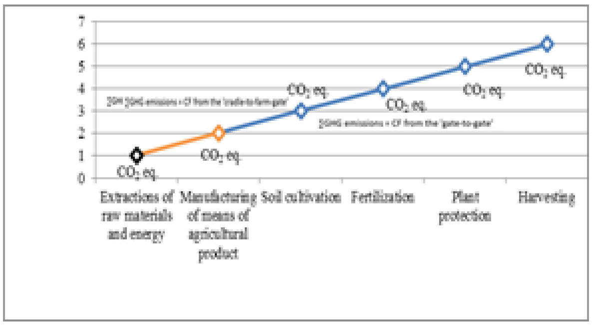

Fig. 2. The greenhouse gas emissions from plant production by examining the carbon footprint.
Source: Own design based on [18].

According to a recent report of IFOAM Organics Europe (2022), from the point of view of organic agricultural crops, forecasts show an increase of more than 25% by 2030, such as legumes, which increase to 73%, and permanent pastures, which increase from 12% to 32% in this scenario. Other crops, however, are well below the average share of the 2020 organic area, including cereals, oilseeds, potatoes and total arable, which would increase from 7% to 20% [13].

In the case of animal and poultry breeding, the current global situation already ensures a 7% reduction in the number of ruminants per unit area and forecasts for 2030 are for a further reduction of 11% of the total number of animals in the EU27. However, this reduction will be more pronounced in the category of pigs and poultry and smaller in ruminants [13].

In the 25% organic area growth scenarios at the EU level, the top of countries are represented by Germany, Spain, France and Italy but also Austria and Sweden (Figure 3). Thus, Germany, from 10% UAA (Total utilisable agricultural area) in 2020 would reach 15% UAA (in 2030 linear growth scenario) and even 30% UAA (in 2030 higher linear growth scenario); Spain, from 10% UAA in 2020 would reach 14% UAA (in 2030 linear growth scenario) and 25% UAA (in 2030 higher linear growth scenario); France, from 9% UAA in 2020 would reach 18% UAA (in 2030 linear growth scenario) and 30% UAA (in 2030 higher linear growth scenario); Italy, from 16% UAA in 2020 would reach 20% UAA (in 2030 linear growth scenario) and 40% UAA (in 2030 higher linear growth scenario), etc. [13].

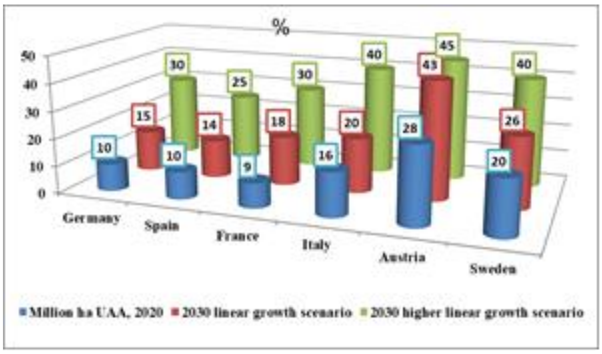

Fig. 3. The 25% organic area growth scenarios at the EU level.
UAA=Total utilisable agricultural area.
Source: Own design based on [13].

Romania has a strategy for sustainable development, a set of indicators that show where we are in terms of sustainability, but also a circular economy strategy, the first strategy on this subject, which is also relevant for the agricultural sector. Moreover, Romania has at its disposal almost 100 billion euros until 2027, to achieve sustainability objectives by building partnerships. Private companies are the main players, including banks [32].

2. Phytoremediation

Phytoremediation is a sustainable strategy that involves the use of plants to remove organic or inorganic pollutants from the soil [6, 20] and even water [3]. The phytoremediation can be applied for the environmental elimination of pesticides, solvents, crude oil and seepage from landfills. The mechanisms of this strategy include phytoaccumulation, phytodegradation and phytostabilization expressed by degradation through metabolism by plants or enhanced microbial action; vaporization as the plant transpires; extraction-accumulation, then collection, recycling or disposal; containment by adsorption or otherwise reducing movement or availability [9, 20, 15, 24].

In practical terms, plant roots assimilate pollutants and transfer them to the stem and leaves. Pollutants then degrade in the plant tissues; from this point of view, plants produce certain enzymes (dehalogenase and oxygenase) [5, 7, 28] that help to catalyze degradation (Table 1), as well as chemical compounds that determine the immobilization of pollutants when the roots come into contact with the soil [21].

Table 1. Applications of some microbial enzymes to phytoremediation

Enzymes	Applications
Pseudomonas putida	Degradation of synthetic dyes
Streptomyces cyaneus	Oxidation of BPA, DFC, and MFA micropollutants
Anoxybacillus gonensis	Bioremediation of wastewater
Bacillus subtilis	
Pseudomonas sp.	Degradation of halogen acid
Ancylobacter aquaticus	
Pseudomonas sp.	

Source: Own compilation based on [7, 11, 39, 41].

There are many plant species that have the ability to store various pollutants in their roots. These plants can be transplanted to contaminated sites and when the roots become loaded with pollutants, these plants can be removed. Thus, plants that accumulate large amounts can remove or store significant amounts of pollutants. For example, lead concentrations in plant tissues are directly proportional to lead concentrations in the soil.

Plants with high phytoremediation potential can be species from the spontaneous flora that grow in polluted places or cultivated plants that have specific traits, determined by the polluting environment. Some of the most commonly used plant species for phytoremediation are shown in Table 2.

Table 2. Plants with high phytoremediation potential

Species	Remarks
Populus sp.	Decontamination of soils contaminated with nitrates
Nicotiana tabacum	Cd higher in stems and leaves
Zea mays	Chelators induced the phytoextraction of Pb and Ti
Brassica juncea	Decontamination of soils contaminated with Pb
Solanum nigrum	Polyaspartate or liquid amino acid fertilizer enhance the extraction process
Pelargonium hortorum	EDTA enhanced Pb and Cd phytoextraction
Commelina communis	Hyperacumulator species of *Commelina* had Cu concentration >1000 µg/g

Source: Own compilation based on [9, 19, 20, 27].

Phytoremediation is a long-term remedial process. Although it has undeniable advantages, however, there are also a number of disadvantages, such as: high concentrations of hazardous substances can be toxic for plants; sometimes it can only be done in certain seasons, depending on the locations; can transfer pollutants between environments (from soil to air); the toxicity and bioavailability of degradation products are not always known; the products can be mobilized in underground waters or bioaccumulated in animals, etc.

3. Waste management

The world's rapid population growth increases the challenges of sustainable waste management to keep up with the demands of modern life. This involves adopting new practices to protect and conserve resources and moving to a circular economy. By introducing circular economy principles into waste management strategies, the level of environmental pollution can be reduced, while promoting economic growth [10].

The need to protect the environment and maintain people's health required the discovery and implementation of appropriate solutions to successfully collect and recycle hazardous and non-hazardous waste. Romania's accession to the European Union also attracted the emergence of a new policy carried out in this sense by the Romanian authorities, according to European trends.

To ensure the sustainability of waste management in agriculture, the link between economic growth and the environmental impact associated with waste generation must be broken [8].

Waste management involves: identifying the categories of waste that a company generates, making monthly records, annual reports, handing over waste to collection centers, capitalizing on resources by reusing recoverable parts. The record of the management must be made by companies and specialized persons, trained in this regard.

The management of agricultural waste involves the management of compostable residues, the separate collection of biodegradable waste, the recycling of waste from pesticide and/or fertilizer packaging (paper, glass, plastic and metal), green waste, etc. It is necessary to create a waste management plan of this type in order to collect and recycle it. Very often the burning of vegetable remains was used, but it is a polluting method, which should no longer be considered a viable solution. The most recommended way to manage some of this waste is composting and using the compost as an organic fertilizer [38].

Improper management of agricultural waste can lead to the release of pollutants into the environment, contamination of water and soil, threats to the health of the population and animals, so certain methods and appropriate sustainable solutions must be considered.

From this point of view, the steps for sustainable agricultural waste management are as follows: consultancy (specialists must propose the best methods for waste disposal); pre-collection of waste (in different containers, of different colors depending on the type of waste they contain); waste transport (it is mandatory that the transport is carried out very quickly, with special vehicles from the customer to the final recyclers); intermediate processing (by selecting, shredding or compacting residues); continuous information (companies specialized in waste management constantly inform their collaborators about changes in the legislation in the field, so that there is no risk of non-compliance with the law).

Agricultural waste composting is a sustainable solution in the context of integrated management of environmental pollution prevention, for the real contribution in bioremediation [35], weed and plant disease control [29], soil erosion management, increasing of biodiversity and reduces environmental risks involved of synthetic fertilizers [38].

The management of agricultural waste in the correct way must become a permanent practice of all the factors involved, because only in this way there are real chances of reducing environmental pollution. However, there is a constant need for the help of waste management specialists, who can find the best solutions in a short time, for a sustainable management of agricultural waste management and beyond.

CONCLUSIONS

Globally, the agriculture system has changed significantly during the past decades and for sure, will continue to change in the future. The intensive chemicalization in agriculture offers marketing advantages and mostly lower unit cost of production compared to smaller sized operations. However, increased farms size brings new management challenges for environmental protection.

Sustainable agriculture strategies have a hight impact worldwide because of their healthier crops and food product. For the sustainable protection of the environment is needed the implementation of cost-effective environmental technologies and make the transition from the applied technologies toward environmentally oriented ones. From this point of view, organic farming is one of the sustainable strategies to environmental protection and the mitigation of climate changes.

Strategies and decisions about environment protection must be made together with farmers, through education and partnership, because every day they work in the environment, with the environment and take care of it because they want profitable and resilient agricultural productions.

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ROMANIA'S AGRICULTURAL LAND FUND AND THE DYNAMICS OF THE LAND OWNERSHIP DURING THE PERIOD 1990 – 2020

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Abstract

The purpose of this study is to analyze the stages through which Romanian agriculture and the land of ownership had passed, namely the evolution of the Agricultural Land Fund, the dynamics of land use by categories of use, starting with the post-communist period, during which the agricultural land division was a notable process for this period for Romania, as for all former communist countries. The research showed that the degree of land fragmentation is high in our country, the greatest division being found in the category of areas below 0.5 ha, with 1.06 million owners (farms with or without legal entity, natural persons, individuals, companies etc.), summing up an area under exploitation of 261.92 thousand ha. On average, a number of 500.68 thousand owners work small areas of land in the size category of 0.5 – 1 ha, 1 – 2 ha and 2 – 5 ha. To examine this situation, there were used and processed a wide range of socio-economic statistical data (land use mode, agricultural land structure and utilised agricultural area by size classes), provided by different official databases. Although Romania is located in a geographical area with high quality of land and a favorable climate for agriculture, our country is still struggling to recover the competitiveness gap compared to countries with a similar communist period from Europe, considering the fact that the large number of land owners (approximately 2.84 million), do not support the stimulation of competitiveness in agriculture, land fragmentation being manifestly pronounced and obvious.

Key words**:** *agricultural land fund, land use, land fragmentation, Romania, post-communist period*

INTRODUCTION

In Romania, the cultivation of agricultural land (exploitation of the land through agricultural activities) is a millennial tradition and still represents one of the important branches of the national economy; in recent years, the contribution of agriculture to GDP (Gross Domestic Product) being on average 6% per year. With an area of 23,839.07 thousand ha, Romania occupies 7 % of the surface of the European Union, over 60 % of these land resources being intended for agriculture [6].

The territory of Romania includes the major categories of relief, proportional, symmetrical and spread out concentrically around the circle of the Romanian Carpathians: mountains 31%, hills and plateaus 36%, plains and meadows 33%, arranged in an amphitheater aspect of the major relief shapes, with a relatively uniform distribution of the five named above forms of relief [14]. The climate is temperate continental transitional to excessive and with external influences: oceanic in the West, Mediterranean in the South-West, continental excessive in the East, transitional in the South, North Baltic in the North-East and maritime on the coast. The average annual temperature is 110 C in the South and 80C in the North. The average annual precipitation is variable depending on the altitude: approximately 500 mm in the plains, 700 mm in the hills and 1,000 - 1,400 mm in the mountain areas, identifying itself through these characteristics as a country predominantly to agricultural activities [20].

This relief and its climate ranked Romania on the 6th place in the European Union in terms of arable land per capita, with nearly 0.41 ha of arable land, a value higher than many countries in the European Union, such as Italy (0.11 ha/inhabitant), Germany (0.14 ha/inhabitant), where the EU 27 average is 0.212 ha/inhabitant [8].

The development of Romanian agriculture was relatively dynamic, the post-communist period being marked by fundamental transformations in agriculture, collective and state ownership being replaced by private ownership [21].

Starting with 1989, the decline of the communist regime, during which agriculture had become collective farming, after the Second World War and reorganized by Ceaușescu in the 70s and 80s [26], led to deep changes in all fields of activity, one of the first branches affected by this transformation being agriculture, as a result of the change in the type of ownership, the type of agriculture and the spatial distribution of the main categories of land use [1].

Decollectivisation farming and restitution of land to former owners are among the most dramatics elements of the economic transition [3].

The next reform after the communist regime, regarding land and the recognition of ownership rights, was represented by Law 18/1991, by which initially a maximum of 10 ha of land was returned to each owner. With the transition to the market economy and the accession to the European Union (after 2007), Romania adopted the European Community Policies. In this period, the type of agriculture was that the rural households shared the land and produced on common basis in the newly formed cooperatives. The decision to farm collectively is explained by the slowly response of the households (small farms) to developing competitive markets [2].

After a short period of time, the number of cooperatives decreased and there was a massive return to small-scale peasant farming [22].

Also during this period, entered in force the Law 1/11 January 2000 for the reconstitution of the right of ownership over agricultural and forestry lands requested according to the provisions of The Land Law No.18/1991 and Law No.169/1997.

This Law stated that the agricultural land will be back off up to 50 ha of arable land and 30 ha of wooded land. Meanwhile, the former land owners have been organized themselves in various associative forms (Law no. 36/1991), within three categories of individual agricultural enterprises, distributed of size, as the following: family farms, from 1 to 100 ha, with an average area of 48 ha and a share of 31.8% of agricultural land; private commercial farms, including those owned by the state, ranging from 100 ha to over 10,000 ha, with an average area of 424.5 ha, representing 34.82 % of the country's agricultural area, and non-subsidized subsistence farms (2,736.7 thousand units), with an average area of 1.79 ha and a share of 33.9% of the total agricultural area [14].

As state subsidies and agriculture markets ceased to be active over time, new land management policies were issued and land reforms led to massive transfers of land ownership [10].

Thus, the transition to a market economy threw agriculture in an uncertainty zone by returning land to owners, disappearing the control of markets, reducing the demand for products, damaging the irrigation systems and increasing unemployment.

The agricultural potential of Romania was and is still very high, but it is neutralised by the strong fragmentation of property and the large number of land plots, where the farming in a competitive agriculture is not viable. As a direct consequence, this subsistence farming slows down the performance of the Romanian agricultural sector [4].

In this context, the purpose of the study is the temporal and spatial analysis of the change in the main categories of land use in the period 1990-2020.

MATERIALS AND METHODS

The study was based on the data provided by the National Institute of Statistics, INSSE (Romanian Statistical Yearbooks 1990-2020; General Agricultural Census, 2010, 2020; TEMPO-Online database etc.), and other databases, identifying and analyzing the main factors that affected the evolution of agricultural land use and the transfer of property from the state (Agricultural Production Cooperatives, CAPs) to the owners.

The analized indicators were: the size of the agricultural holdings, the land areas owned and the evolution of the agricultural land fund over the last 30 years.

This study reports land use and outlines the causes and effects of environmental change from the fall of the communist regime to the present.

The documentation of the subject by selecting relevant bibliographic litterature and processing data on land use, referred to: agricultural land (arable land, vines, orchards, pastures and hayfields) and non-agricultural land, respectively.

RESULTS AND DISCUSSIONS

In the last thirty years, Romania's agriculture passed through many changes at the organizational level and the use of land.

With a total area of 238,397.07 km^2 [24], Romania ranks 12th in size, at the European level, with a general land fund comprising of arable land (39.2%), forests (28%), meadows and hayfields (20.5%), vineyards and orchards (2.3 %), buildings, roads and highways (4.5 %), waters and ponds (3.7 %) and other areas (1.8 %).

In 2020, the agricultural area was 14,133.15 thousand ha, representing 59.28% of the total area of the land fund, determined in 2010 when it was 14,634.43, decreasing by 501.28 thousand ha, referred to the level of 2020 and by 635.87 thousand ha, compared with the year 1990 (Table 1).

During the period 1990 - 2005, in the Southern Romania, the phenomenon of the agricultural land abandonment was manifested [16], with an dropout rate of 21.1%, due to the unfavorable topography, the high level of land division, the decreasing income in agriculture, the insecurity ownership, lack of agricultural machinery and demographic developments during the transition period.

By 2005 year, 95.6 % of the country's agricultural area was returned to the former owners or their legal heirs, and by 2010, almost all of the agricultural area become in private system, so that later half of these areas would be leased [15].

This right of private ownership over the lands that were in the patrimony of agricultural production cooperatives (CAP), was made under the conditions of law 18/1991, by reconstituting the right of ownership. According to Chap. II, art (2), the provisions of this law benefited the cooperative members (who brought land to the agricultural production cooperative or whose land was taken over, in any way), their heirs and other specifically established persons. The establishment of the property right was done by issuing a Title of ownership, within the limit of a minimum area of 0.5 ha for each entitled person and a maximum of 10 ha per family, in arable equivalent [23], later being completed with up to 50 ha [12].

In the capitalism, agriculture came with new challenges for farmers, land management became expensive and they were found solution in selling the land in several forms.

These challenge of the agricultural transition was important for Romania, the legal reforms were postponed and the process of privatization of agriculture became difficult and lasting, therefore the practice of subsistence agriculture has come back naturally [7].

Romanian agriculture developed after the 2000s, with the emergence of land consolidation following the purchase or lease of land, especially after 2007 with Romania's accession to the European Union, when large holdings with Romanian and foreign capital made new land acquisitions, but also by encouraging various associative forms [9].

The European financing through the funds of the SAPARD program (Special Accession Program for Agriculture and Rural Development - €500,000,000) to support the development of agriculture and the rural environment, which named the financing of several projects with reference to agricultural land and the change of use, led to significant spatial changes in agriculture, either by land use classes [19].

Currently, the lands are distributed according to the Land Fund, and are worked in private ownership, are leased, or "given in part" or have other modes of ownership.

Romania's land fund is made up of all land of any kind, regardless of destination, the title on the basis of which they are defined as public or private domain of which they are a part [23].

According to the same Law 18/1991, the land in our country is divided into five land groups, depending on the destination:

a) Agricultural lands:

- productive agricultural lands: arable; orchards; wine nurseries and vines; fruit, hop and mulberry plantations; permanent meadows; greenhouses, solariums and nurseries etc.;
- lands with forest vegetation, if they are not part of forestry, wooded pastures etc.;
- lands covered by constructions and agro-zootechnical installations; fisheries and land improvement developments; technological and agricultural exploitation roads; platforms and storage spaces that serve the needs of agricultural production;
- non-productive lands that can be arranged within the improvement perimeters and used for agricultural production [11].

b) Forestry lands, namely: wooded lands or those that serve the needs of culture, production or forestry administration; lands intended for afforestation and non-productive ones (cliffs, steeps, boulders, ravines, torrents), if they are included in the forestry facilities;

c) Lands permanently under water, namely: surfaces covered, permanently or for most of the year, by standing water (lakes, ponds, territorial sea) or flowing water (rivers, streams), the bottom of inland maritime waters and territorial seas;

d) Intra-village lands, related to urban and rural localities, on which the constructions, other facilities of the localities are located, including agricultural and forest lands; "all the lands, regardless of the category of use, located in the perimeter of urban and rural localities as a establishment result of the border limit for the intra-village, according to the legislation in force" [13].

e) Land with special destinations, such as land used for road, rail, naval and air transport; the lands with constructions and related installations; constructions and hydrotechnical, thermal, electricity and natural gas transport, telecommunications installations; lands intended for mining and oil exploitation, quarries and dumps of any kind; for defence needs; beaches, reserves, natural monuments, archaeological and historical ensembles and sites and the like [18].

The structure of land use and the variety of land use categories, closely related to the location of natural components, such as the climate and the specificity of the relief, determined the division into two land categories.

These two categories of land having the same economic destination, created naturally or artificially, are:

a) Agricultural, land that is permanently cultivated, used mainly for vegetable agricultural production and comprises 14,133.15 thousand hectares, of which: arable land 8,564.91 thousand hectares, pastures and hayfields 3,723.52 thousand hectares, orchards and fruit trees 343.83 thousand ha and vines 1500.88 thousand hectares, at the level of 2020 [17].

According to the use of land, a) the arable area is occupied by: cereal crops for grains; dried legumes and protein crops for grains; industrial plants (fiber plants, oil plants, medicinal plants, aromatic plants and spices); rooted; fresh vegetables, melons and strawberries; ornamental flowers and plants; forage plants harvested green; plants for the production of seeds and seeds for sale; other crops in arable land and fallow arable land.

b) Non-agricultural surfaces, with forestry destination, with a total area of 9,705.92 thousand ha, includes: forests and forest vegetation (6,730 thousand ha); lands permanently under water (830 thousand ha); lands with buildings (760 thousand ha); roads and railways (390 thousand ha), respectively degraded and unproductive land (490 thousand ha) [17].

Over the last 30 years, the changes in the use of agricultural and non-agricultural land, reflected a downward trend in agricultural areas. If in 1990 Romania has had 14,769.02 thousand ha of agricultural land, by 2020 this surface decreased, reaching a total of 14,133.15 thousand ha (Table 1).

Table 1. Land use (thousand ha)

Land use/Year	Year 1990	Year 2004	Year 2014	Year 2020
Agricultural land (thousand ha)	14,769.02	14,711.55	14,630.07	14,133.15
Non-agricultural land (thousand ha)	9,070.05	9,127.51	9,208.99	9,705.92
Total area (thousand ha)	**23,839.07**	**23,839.07**	**23,839.07**	**23,839.07**

Source: Own determination based on [17].

The difference of 635.87 thousand ha, that lost their characteristic of agricultural land, can be found added to the non-agricultural land (in 2020), the reason being the transfer of land to the forestry and construction sectors. (Figure 1).

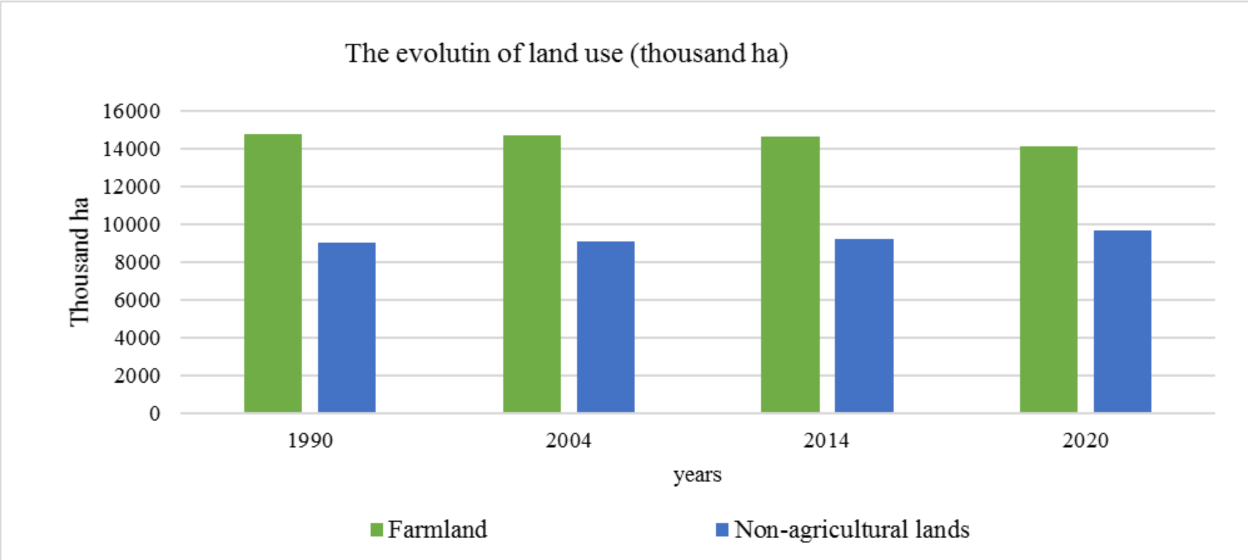

Fig. 1. The evolution of land use (thousand ha)
Source: Own design based on the data from [17].

In 2020, out of the total agricultural area of Romania (14,133.15 thousand ha), about 60.60% has been represented by the arable land, decreasing by 3.38%, compared to 1990 year (Table 2).

The same downward trend was recorded for the use of pastures and meadows, with a difference of 5.66 % currently, compared to the year 1990.

Table 2. Dynamics of the structure of agricultural land according to the mode of use, in the period 1990-2010

Category of use	Year 2020		Year 2010		Year 1990	
	Thousand ha	%	Thousand ha	%	Thousand ha	%
Arable	8,564.91	60.60	9,404.00	64.25	9,450.39	63.98
Pastures	3,723.52*	26.34	3,288.72	22.46	3,262.50	22.08
Meadows	-	-	1,529.61	10.45	1,465.36	9.92
Wineyards	1,500.88	10.62	213.57	1.45	277.37	1.87
Fruit plantation	343.83	2.43	198.57	1.35	313.38	2.12
Totally agricultural	**14,133.15**	**100**	**14,634.43**	**100**	**14,630.07**	**100**

* 3,723.52 thousand ha – Pastures + Grassland
Source: Own calculations based on the data from [17].

The area covered by vineyards and wine nurseries in the period 1990-2010 showed a regression due in particular to the restitution of land occupied by vines, to their rightful owners, from 277.37 thousand ha in 1990 to 213.57 thousand ha in 2010.

Due to the interest in cultivating new varieties, the areas with vineyards has touched 1,500.88 thousand ha, in 2020, increasing from 213.57 thousand ha in 2010, to 1,500.88 thousand ha in 2020, so in a range of more than 1,100 thousand ha.

Surfaces with fruit plantation have been recorded the same trend as vineyards and wine nurseries, the causes of the decrease being similar, the cultivated areas varying very little, remaining within the limits of 313.38 thousand ha and 343.83 thousand ha. However, in the last 10 years, we noticed that the areas occupied by fruit plantation have increased by 57.75%, from 198.57 thousand ha in 2010, reaching a total of 343.83 thousand ha in 2020, due to the interest of farmers in this sector.

Agricultural holdings without legal personality included: authorised natural persons, individual companies, family companies.

In 2003, after the full restitution of land ownership rights, in Romania there were around 4.5 million agricultural holdings with an average size of 3.1 ha of agricultural land per farm. Until 2013, the situation did not change significantly, there were 3.6 million agricultural holdings with an average size of 3.6 ha [25].

During the period 2013-2020, there were 3.6 million small holdings, but the situation has not improved much, because the number of holdings up to 5 ha was almost the same, namely 2.56 million.

The largest number of holdings (1,060,025), own areas of less than 0.5 ha, summing a total area of 261.92 thousand ha, followed by the 519,436 agricultural holdings, that hold between 2 - 5 ha with a total area of 519.36 thousand ha and 511,457 agricultural holdings owned between 1 - 2 ha, totalling an area of 728.64 thousand ha (Table 3).

Table 3. The used agricultural area, by size classes (0 – 20 ha) of the used agricultural area, thousand ha, year 2022

Owner type	**Size classes individual agricultural holdings**					
	Below 0.5 (ha)	**0.5 – 1 (ha)**	**1 – 2 (ha)**	**2 – 5 (ha)**	**5 – 10 (ha)**	**10 – 20 (ha)**
Agricultural holdings with or without legal personality, natural persons, ndividual persons, companies/ agricultural associations, etc. (thousand ha)	261.92	325.25	728.64	160.03	108.81	763.09
Number of holdings	**1,060,025**	**471,148**	**511,457**	**519,436**	**161,021**	**56,200**

Source: Own determination based on the data from [17].

Table 4. The utilised agricultural area in agricultural holdings, by size class (20 – over 1,000 ha), thousand ha, year 2022

Owner type	**Size of holding**					
	20 – 30 (ha)	**30 – 50 (ha)**	**50 – 100 (ha)**	**100 – 500 (ha)**	**500 – 1,000 (ha)**	**Over 1,000 (ha)**
The area of agricultural holdings with or without legal personality, natural persons, individuals, companies, etc. (thousand ha)	442.00	664.18	784.39	2,773.09	1,330.99	2,000.75
Number of holdings	**18,161**	**16,890**	**11,148**	**13,082**	**1,925**	**1,003**

Source: Own determination based on thedata from [17].

Also, the agricultural holdings that have areas between 0.5 – 1 ha are very numerous, respectively 471,148, these holdings using a total area of 325.25 thousand ha of arable land (Table 3).

In Romania, the division of land and the agriculture on small areas are abviously, as from the total of 14,133.15 thousand arable ha, only 1,003 holdings, with a total area of 2,000.75 thousand ha, own areas between 500 - 1,000 ha (Table 4).

The following intermediate class is represented by a number of 18,161 agricultural holdings with areas between 20-

30 ha, 16,890 holdings with areas between 30-50 ha, and 11,148 holdings with between 50-100 ha of agricultural land, representing a total area of 1,890.57 thousand ha (Figure 2).

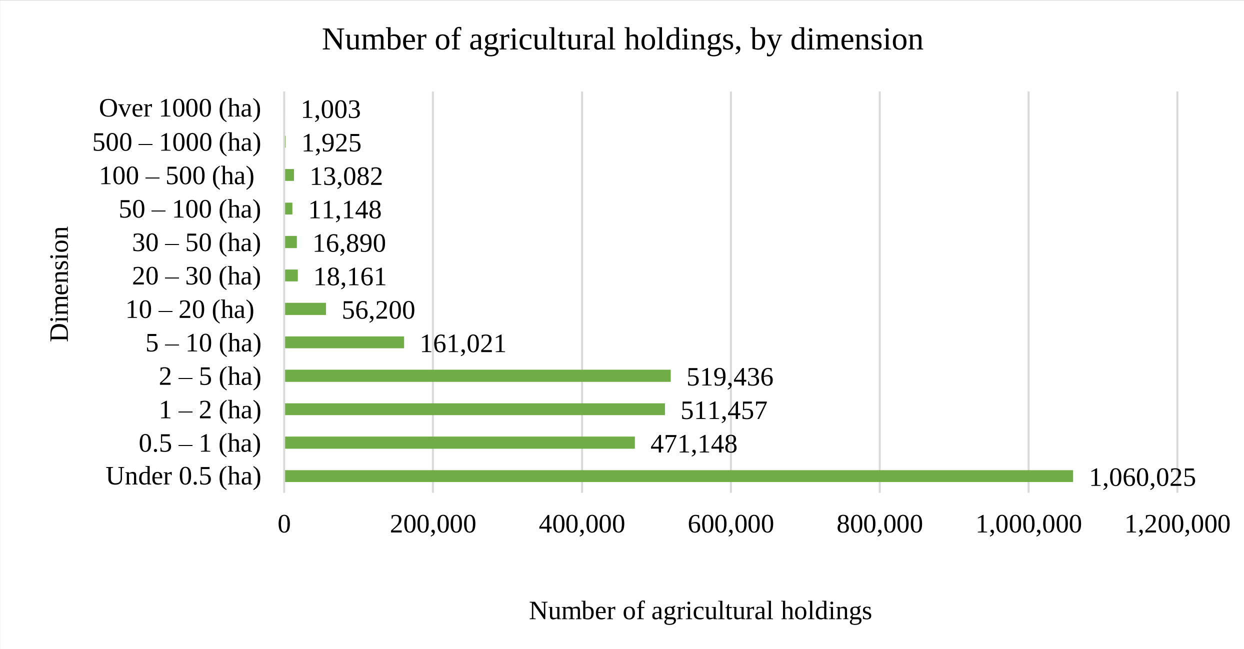

Fig. 2. Number of agricultural holdings by size class, year 2022
Source: Own design based on the data from INSSE.ro, Accessed on June 10, 2023 [17].

The number of agricultural holdings in 2020 is very bad as follows - out of a total of 2.84 million holdings, 2.56 million work land up to 5 ha, and only 44.04 thousand have areas larger than 50 ha.
In Romania, the division of agricultural land is a result of the fact that the process of land restitution of agricultural properties was not supported by structural agricultural policy measures implemented in proper time and with the appropriate financial allocation, thus, the Land Fund Law is considered the weaker legal construction of agrarian reform, with the most serious consequences for rural areas [5].

CONCLUSIONS

This study led to the following conclusions:
-The socio-economic process of the last 30 years, determined by the post-communist period, caused sharp changes in the evolution of the structure and the way that agricultural land is used.
-Following the decollectivization and privatization of agriculture, respectively the adoption of several strategies for the implementation of land reforms, agriculture went through deep transformations, which led to the expansion of private ownership of agricultural land.
-Although the Romanians initially enjoyed the re-appropriation and the regaining of land machinery and agricultural equipment to work the land, led them to establish themselves in diverse forms of association, so that the land would later be given to tenants (land leases/those who rent the land), in many cases to be abandoned or even to be sold.
-In 2020, from 14,133.15 thousand ha of agricultural land, a share of 60.6% was occupied by arable land, 26.34% was covered by pastures and hayfields, 10.62% by vines and only a part of 2.43% of the agricultural area was occupied to the orchards and fruit trees.
- The dynamics of the Romanian agriculture has made incontestable the high level of land division, these being reflected by the small area of land (under 0.5 ha) that most of the agricultural holdings own (1.06 mil) and the large number of plots returning to the holding, followed by another 1.5 million holdings that own equally small areas, between 0.5 - 5 ha.

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STUDY ON THE INFLUENCE OF THE COVID-19 PANDEMIC ON TOURIST CIRCULATION IN THE MARAMURES COUNTY, ROMANIA

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Abstract

The study is a continuation of the research previously undertaken in the beautiful and authentic area of Maramureș, where the influence of the pandemic in the period 2016-2020 on the tourist circulation was primarily followed. In the first part, an analysis was carried out on the main aspects that can positively or negatively influence the attraction and circulation of tourists in the researched area, such as the accessibility study and road, rail and air infrastructures. After that, aspects were studied regarding the demographic evolution of the population and its occupation in different areas, which can directly influence the activity and tourist circulation in the area. Also, the main cultural, social and sanitary facilities that can contribute to the significant increase in the qualitative value of a tourist destination and implicitly the tourist circulation were studied. Finally, based on the analyzed and interpreted data regarding the main indices that characterize tourist circulation in the studied area, it was concluded that the pandemic had a significantly negative influence on tourist circulation, especially in 2020, when it was also the peak year of this one.

***Key words*:** *agritourism, pandemic, rural tourism, tourist circulation*

INTRODUCTION

Previous studies of international tourist circulation have found that Europe dominates international tourism, accounting for over 60% of total arrivals and receipts. America ranks second with over 20%, followed by East Asia and the Pacific with around 14%, but this area has seen sustained growth in recent years, with Africa, the Middle East and South Asia accounting for over 6%. It has also been found that this is a complex economic phenomenon, with many goals, and sometimes with different directions, which means that at the moment its role is recognized as a factor in ensuring the sustainability of world and national economic growth and combating poverty and underdevelopment [3, 15].

National and international tourist circulation represents the movement in time and space of tourist flows, and the latter are movements of consumers of material goods and services, as well as operations related to them (reservations, expense accounts, etc.) [6, 26]. Tourist circulation in general can be influenced by: language and culture affinities, tourist and administrative facilities, strong motivations, domestic demand is not sufficiently satisfied, export of own tourist products, competition offers specific, clearly differentiated tourist products [1, 10]. At the global and national level, a thorny problem of tourist circulation is seasonality, a phenomenon that has created great problems in terms of maintaining the activity and the specialized staff in tourism. From this point of view, WTO specialists considers that the international tourist circulation includes two major categories of tourism, namely: - sun tourism motivated by natural factors and called "sunlust"; - knowledge tourism motivated by culture, science and bearing the name "wonderlust" [4, 23]. The specialized tourism literature contains numerous references regarding the factors that influence the development of national and international tourism [8, 14]. In Romania, the poor satisfaction of domestic demand stems from the following reasons: the low quantity and inadequate quality of the national offer, as well as the greater attraction presented by the tourist offer of other countries. Based on the statistics of the World Tourism Organization (WTO), it was concluded that the main motivation of tourist circulation is vacation, 70% of the total world arrivals, and satisfaction is one of its most important stimuli [11, 27]. Also, from this it was found that the tourist circulation is directly influenced by the tourist demand, which presents the following essential particularities; - dynamic character; - concentration in economically developed countries and regions; - diversity, heterogeneity and instability in motivation; - accentuated and rigid seasonality, due to strict regulations as well as due to psycho-social, cultural and natural factors [12, 16]. Tourist consumption, which depends on national income and individual income, has an influence on tourist circulation both nationally and internationally, even if for a very long-time tourism was considered a luxury, and in recent decades, due to the extent of the development of this phenomenon, tourism has become a consumer good [5, 17]. Based on the data provided by the International Ecotourism Society (TIES), it was concluded that experimental niche tourism, such as tourism based on ecological principles (agritourism, rural tourism and ecotourism) will experience a very rapid development, the international market of this type of tourism, will increase on average by at least 10-12 % year-1 [24]. This increase was due to the fact that tourists have come to the conclusion that tourism based on ecological and sustainable principles is not necessarily accompanied by a lack of comfort [19]. Tourists who practice this type of tourism stated that this activity itself constitutes a positive vacation experience and that the unique experience they have is the most important reason why they go on vacation [30]. Starting from the above, we considered it opportune to carry out this study in the Maramureș County, especially now that the tourist circulation at the level of the area and even at the level of the entire country, has been significantly affected by the pandemic and its effects [13].

MATERIALS AND METHODS

The study carried out by us is a complement to the study carried out previously and published in the work ”Study on the current stage of development, planning and promotion of rural tourism and agritourism in the ethnographic area of Maramureș”, in which several aspects regarding the tourist potential of area and those regarding the current stage of development of rural tourism and agritourism [9]. Having these aspects analyzed and interpreted previously, we thought to complete this study with aspects regarding the impact of the pandemic on the tourist circulation in the same Maramureș County.

In this study, unlike the previous study, we will no longer insist on the aspects related to the natural and anthropogenic tourist resources, as a defining factor of the tourist attraction, and we will directly present aspects related to the tourist circulation. The main aspects targeted were primarily an overview of accessibility in the area by rail, road and air, the study of the socio-economic and socio-cultural factors that directly contribute to the influence of tourist circulation in the area. In addition to these aspects, the main indicators that define the tourist circulation in the area were studied, such as: the number of tourist arrivals and overnight stays in rural and agritouristic boarding houses, the average length of stay, the average number of tourists arriving per day and the degree of occupancy of boarding houses [2, 7].

The data for solving the proposed theme and all the objectives related to the tourist circulation in the Maramureș County were collected from the field and from the National Institute of Statistics (NIS), after which they were processed and interpreted in a scientific and rigorous way, formulating a series of conclusions and recommendations.

RESULTS AND DISCUSSIONS

In order to solve the proposed objectives, a study was first carried out regarding the position and accessibility of tourists in the area, because this aspect can positively or negatively influence the attraction of tourists in the area and their circulation.

Accessibility in the Maramureș County

The main access routes to the area are by rail, road and air, especially for foreign tourists.

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In 2018, the railway network in Maramureș County was 207 km in total length, an unchanged value since 2010, this being in a moderate but constant decrease since 1990. Of the total railway lines, 64 percent represent normal single-track lines. The technical condition of the railway network is generally good. However, the level of equipment and the technical condition of the lines do not allow train speeds higher than 60 - 80 km/h.

The road network is not an advantage for the Maramureș County, the public road network being relatively poorly represented. In 2018, the length of public roads was 1,809 km, of which 79.50% (1,438 km) represented county and communal roads and 20.50% (371 km) national roads. The length of public roads in Maramureș County represents 14.20% of all public roads in the North-West Development Region and 2.1% of public roads in Romania [28, 20]. The advantage they present is that they ensure good internal and international openness, facilitating access from and to other states. The most important international roads are: European Road DN1C (E58) and DN18.

Accessibility in the area by air is ensured by the Baia Mare Airport, which was established on the current site in 1964, when the construction of the concrete runway began. It was later extended to its current length of 1,800 m (30 m wide, plus 7.5 m concrete shoulders on each side of the runway). Baia Mare Airport currently has the status of autonomous management with particular specificity, being subordinated to the Maramureș County Council [22].

Population and cultural, social and sanitary facilities

Another aspect that can contribute to the increase of tourist circulation in the studied area is related to the population, because it can influence the increase in the number of visits made by relatives and their knowledge in the area of origin, and the large number of the active population in a certain area can contribute to the sustained development of all sectors of economic activity and implicitly to the development of this area.

From Figure 1 it can be seen that the demographic evolution of Maramureș County, as population by domicile, starting from 1930 and until 2018 (January 1), took place as follows, until 1966 there was a relatively large increase, this continued in a more moderate pace until 1992, after which a constant decrease was achieved until 1998, with approximately 10,000 - 15,000 inhabitants per year. This fact was primarily due to the massive migration of the active population, with the emergence of the possibility to move freely, to Western countries, where the inhabitants of the area were able to lead a more decent life and where they found better-paid jobs.

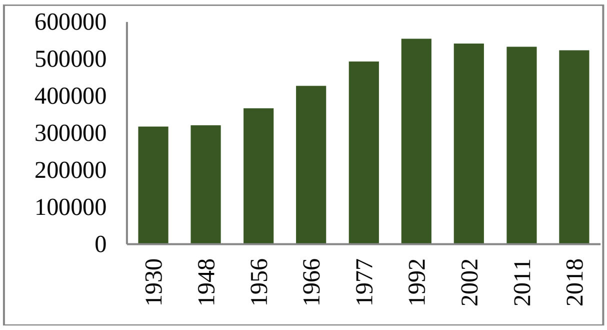

Fig. 1. Evolution of the population by place of residence in Maramureș County (1930-2018)
Source: processing according to data collected from the field and from NIS [21].

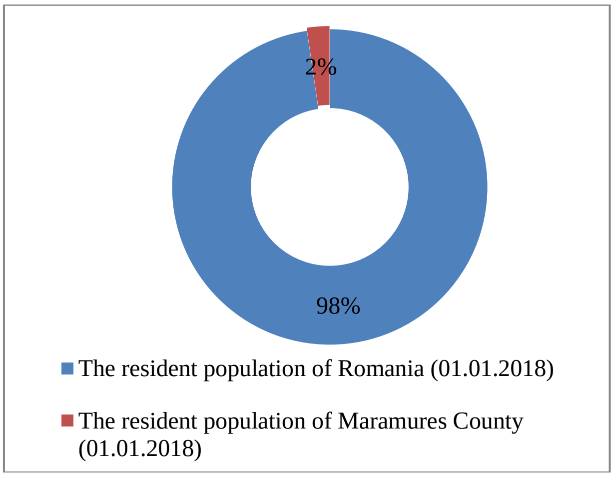

Fig. 2. The resident population of Maramureș County (01.01.2018)
Source: processing according to data collected from the field and from NIS [20].

Regarding the resident population of Maramureș County, the study found that on January 1, 2018, it was 463,354 inhabitants, which represented 2.37% of the total resident population of Romania at that time, of 19,530,631 inhabitants (Figure 2).

Also, a very important aspect in terms of tourist circulation in the area is related to the type of occupation of the civilian population. Table 1 shows that, at the level of 2018, the highest share of the civilian population employed in the activities of the national economy is in the industrial sector with 56.9 thousand people out of a total of 194.3 thousand, and the lowest share in the extractive industry and in the field of real estate transactions, with 500 places each. The small percentage of residents from the extractive industry indicates that since 2007, with the entry of our country into the European Union, this sector had to be drastically reduced, due to the high degree of pollution. It was a beneficial thing for the tourist activity in the area, because some of them had to reorient themselves towards the tourism activity and the most important aspect is that the degree of pollution of the area was considerably reduced. Also, from this table and from the study carried out, it was found that the number of tourist structures in the area increased, reaching approximately 130 in 2018 and 156 in 2020. This increase also led to an increase in the number of people working in the hotel sector and restaurants, reaching the level of 2018, at 4,200 people, an aspect that has a direct impact on the evolution of tourist circulation. The active population can contribute to the development of the tourist sector in the area and implicitly to the revival of tourist circulation.

Table 1. The civilian population employed by activities of the national economy at the level of section CAEN Rev. 2 Year 2018

Activities of the national economy	**Thousands of people**	**Activities of the national economy**	**Thousands of people**
1. agriculture, forestry and fishing	52.3	10. financial intermediation and insurance	1.5
2. industry	56.9	11. real estate transactions	0.5
3. production and supply of electricity and heating, gas, hot water and air conditioning	0.6	12. professional, scientific and technical activities	2.6
4. water distribution; sanitation, management waste, decontamination activities	2.5	13. administrative service activities and support services activities	3.3
5. constructions	12.2	14. public administration and defense; social insurance from the public system	3.6
6. wholesale and retail trade; motor vehicle and motorcycle repair	23.3	15. education	8.7
7. transportation and storage	9.8	16. health and social assistance	9.6
8. hotels and restaurants	**4.2**	17. performance, cultural and recreational activities	1.1
9. information and communications	1.3	18. other service activities	3.4
		Total	194.3

Source: processing according to data collected from the field and from NIS [21].

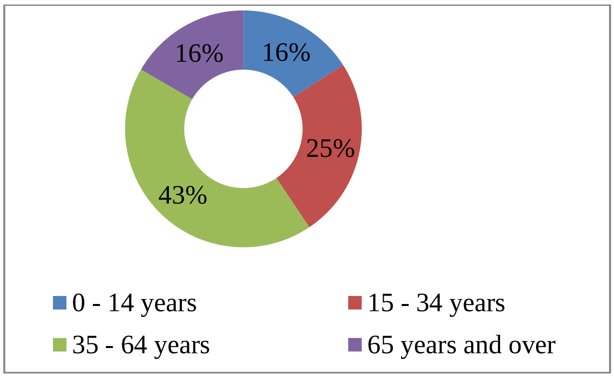

Fig. 3. Structure of the resident population of Maramureș County on January 1, 2018 by age category
Source: processing according to data collected from the field and from NIS [21].

Figure 3 shows that the structure of the resident population in the Maramureș area, on January 1, 2018, according to age categories is as follows: the largest age category is represented by the category between 35 - 64 years, with a weight of 43%, followed by the category between 15 - 34 years, with a percentage of 25%. The young and newly born population is increasingly reduced, with the same percentage of representation as the inactive elderly population over 65, of only 16%.

From the same study we found that from the structure of the resident population in Maramureș during the analyzed period according to the living environments, it is presented as follows; - the urban population is

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265,199 inhabitants, and the rural population is 198,155 inhabitants.

Technical - building, social, cultural, commercial, sanitary facilities are aspects that can contribute to increasing the attractiveness and quality of a tourist destination, a fact that led to an analysis regarding cultural facilities: theaters-1, cinemas-2, museums -20, libraries-65, art institutions-4, cultural hostels-60, houses of culture-12, ethnographic museums Baia Mare Ethnography and Folk Art Museum, Lăpuș Village Museum Collections, Maramureș Museum in Sighetu Marmației and Ethnography Museum and History from Vișeul de Sus. The cults are represented as follows; from the total of 473 churches: - 361 are Orthodox; - 54 Greek - Catholic - 30 Reformed - 29 Roman - Catholic. There are also many monasteries in the area - 36, of which: - 31 Orthodox and 5 Greco-Catholic.

In terms of education, Maramureș has an extensive and diversified network of public and private educational institutions, covering all educational levels. Following the reform process in the educational system, a total number of 354 units were identified in the area, with about 4,700 classes, and of these, 203 are in the urban environment, and 151 in the countryside. Of the total of those with legal personality, 174 are in the public system and 28 in the private system (accredited and authorized) and 2 student palaces and clubs, the House of the Didactic Corps, the County Centre for Educational Resources and Assistance and the County School Inspectorate. Regarding higher education, there are 4 universities operating in Maramureș, of which 2 are public and 2 are private, with over 5,188 students.

Regarding the sanitary facilities, it was observed that there are: 8-Public hospitals; 7-Private medical units with continuous and one-day hospitalization beds; 24-Medical analysis laboratories; 2-Medico-social assistance units; 1- County ambulance service, with 6 substations organized at county level; 270-Family medicine offices/general medicine; 12-Centres of permanence; 349-Dental offices.

From what has been presented, it can be seen that the level of general facilities at the level of the studied area is a good one, which can ensure services both for the resident population and for all tourists visiting the area, at a very good level.

Based on the study carried out and the data obtained, the main statistical indicators characterizing the tourist circulation in the tourist and agritourism boarding houses in the Maramureș County were calculated and interpreted.

Indices that characterize tourist circulation in the studied area

Arrivals of tourists in rural and agritouristic boarding houses

As is known, the number of tourists staying in tourist accommodation units is represented by all people (Romanians and foreigners) who travel outside the localities where they have their permanent residence, for a period of less than 12 months and stay at least one night in a tourist accommodation unit, and the main reason for the trip is other than to carry out a remunerated activity in the places visited.

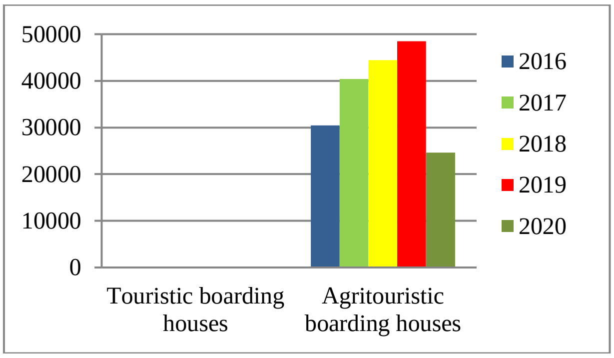

Fig. 4. Total number of tourists arriving per year in tourist reception structures by types structures in the period 2016-2020

Source: processing according to data collected from the field and from NIS [21].

From Table 2, it can be seen that the evolution of the number of tourists registers a sustained increase, being the result of the increase in demand and consumption for this form of tourism until 2019, with 2020 having a dramatic decrease, below the last reference year, 2016. Practicing rural tourism is accessible to all categories of consumers and thus the prices and tariffs must be accessible to all those who choose this form of tourism. As a result, the basis of the highlighted results regarding the number of tourists arriving in rural tourist boarding houses, viewed from the point of view of classification by comfort category, is also the financial situation that tourists face.

Figure 4 highlights the fact that the number of arrivals in agritourism boarding houses in Maramureș in the period 2016-2020 had a visible growth trend from 2016 (30,465 people), until 2019 (48,452 people), and then in the last year, due to the pandemic situation, a drastic decrease, by half - 24,463 people arrived. Regarding the situation of tourist boarding houses, table 4 highlights the fact that the number of arrivals in tourist boarding houses in Maramureș in the period 2016-2020, remained relatively constant until 2020, where due to the pandemic situation, the number of arrivals also decreased here, to only 92 people.

Table 2. Arrivals and overnight stays of tourists in tourist reception structures on types of structures in the period 2016-2020

Tourist reception structures	Localities	Arrivals					Overnights				
		number of tourists/years					number of tourists/years				
		2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Touristic boarding	Vadu Izei	121	110	141	136	92	171	167	344	396	294
Agritouristic boarding houses	Băiuț	121	138	109	77	69	255	429	399	193	121
-	Bârsana	1346	649	1,307	1,163	126	1,846	1,364	2,093	2,381	173
-	Băsești	15	-	-	-	-	30	-	-	-	-
-	Bogdan Vodă	180	107	178	181	112	323	261	349	332	174
-	Botiza	698	782	861	1,334	514	1,224	1,858	2,020	2,799	908
-	Budești	540	796	1,174	1,198	859	1,396	1,984	2,846	3,271	1,897
-	Călinești	-	119	184	549	565	-	243	337	1,120	1,504
-	Cernești	-	319	275	-	-	-	563	601	-	-
-	Cicârlău	623	509	240	276	21	1,200	670	443	477	32
-	Coaș	441	681	538	-	-	622	892	996	-	-
-	Colțău	646	1,093	1,295	1,222	365	978	1,957	2,446	2,297	593
-	Copalnic-	96	89	115	197	100	232	275	226	387	153
-	Desești	735	1,485	1,167	1,034	1,264	1,699	3,216	2,544	2,268	3,121
-	Dumbrăvița	591	396	402	540	163	696	726	892	1,095	282
-	Giulești	413	388	573	702	284	2,007	1,022	1,177	1,488	522
-	Groșii	-	-	-	-	8	-	-	-	-	10
-	Ieud	392	567	559	637	413	761	1,164	1,318	1,299	839
-	Mireșu Mare	88	72	90	106	20	110	182	260	280	100
-	Moisei	2,920	3,343	4,714	5,560	2,843	5,562	5,991	9,140	9,871	5,370
-	Ocna Şugatag	6,313	8,311	7,321	8,416	4,101	12,808	16,729	17,055	20,667	9,430
-	Oncești	597	1,258	1,488	1,976	815	800	2,341	2,837	3,889	1,278
-	Petrova	62	3,055	4,986	2,521	1,274	218	5,679	8,054	6,467	2,859
-	Poienile Izei	901	885	1,186	1,423	846	1,576	2,034	2,816	3,231	1,960
-	Recea	2,409	2,064	1,748	2,097	548	2,746	2,543	2,981	3,866	677
-	Rona de jos	-	350	94	101	40	-	980	186	230	48
-	Rona de sus	593	696	675	1,604	889	952	1,609	1,351	3,876	1,826
-	Ruscova	-	-	878	756	467	-	-	1,712	1,638	1,097
-	Săcălășeni	99	144	128	174	72	159	367	269	317	114
-	Săcel	1,348	1,843	1,575	1,171	514	2,647	2,725	3,292	2,486	942
-	Săpânța	170	288	900	1,295	601	335	766	1,843	2,396	994
-	Sarasău	1,099	2,057	2,596	2,409	2,036	1,711	3,599	5,625	5,881	4,391
-	Satulung	54	49	128	195	121	114	118	407	493	453
-	Șieu	79	207	301	749	281	167	710	750	1,545	487
-	Șișești	891	1,188	1,256	1,361	796	1,692	2,003	2,063	2,190	1,246
-	Strâmtura	728	491	487	523	413	1,376	986	1,041	1,251	1,018
-	Suciu de sus	382	462	495	588	279	877	996	1,424	1,614	695
-	Vadu Izei	3,959	4,739	3,761	5,232	2,617	6,497	8,410	8,516	12,296	4,679
-	Valea	387	422	341	480	149	628	607	596	836	233
-	Vișeu de jos	549	352	327	605	57	1,167	654	520	1,073	73
	Total	***30,465***	***40,394***	***44,452***	***48,452***	***24,642***	***55,411***	***76,653***	***91,425***	***105,800***	***50,299***

Source: processing according to data collected from the field and from NIS [21].

Tourists' overnight stays in rural and agritouristic boarding houses

The tourist overnight stay is the 24-hour interval, starting from the hotel time, for which a person is registered in the tourist accommodation space and benefits from accommodation at the rate related to the occupied space, even if the actual length of stay is lower than the mentioned interval.

Table 3. The average length of stay and the number of tourists arriving per day in the structures of tourist reception in the period 2016-2020

Tourist reception structures	Localities	Average duration of stay - days/year					Number of tourists/days				
		Years					Years				
		2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Touristic boarding houses	Vadu Izei	1.41	1.51	2.43	2.91	3.19	0.33	0.3	0.38	0.37	0.25
Agritouristic boarding houses	Băiuț	2.1	3.1	3.66	2.5	1.75	0.33	0.38	0.29	0.21	0.18
-	Bârsana	1.37	2.1	1.60	2.04	1.37	3.68	1.77	3.58	3.18	0.34
-	Băsești	2.0	-	-	-	-	0.04	-	-	-	-
-	Bogdan Vodă	1.80	2.43	1.96	1.83	1.55	0.49	0.29	0.48	0.49	0.36
-	Botiza	1.75	2.37	2.34	2.09	1.76	1.91	2.14	2.35	3.65	1.4
-	Budești	2.58	2.49	2.42	2.73	2.2	1.47	2.18	3.21	3.28	2.35
-	Călinești	-	2.04	1.83	2.04	2.66	-	0.32	0.50	1.5	1.55
-	Cernești	-	1.76	2.18	-	-	-	0.87	0.75	-	-
-	Cicârlău	1.92	1.31	1.84	1.72	1.52	1.7	1.39	0.65	0.76	0.05
-	Coaș	1.5	1.3	1.85	-	-	1.2	1.86	1.47	-	-
-	Colțău	1.51	1.79	1.88	1.87	1.62	1.76	2.99	3.54	3.34	1.0
-	Copalnic-	2.41	3.09	1.96	1.97	1.53	0.26	0.25	0.31	0.53	0.27
-	Desești	2.31	2.16	2.17	2.19	2.46	2.01	4.06	3.19	2.83	3.46
-	Dumbrăvița	1.17	1.83	2.21	2.02	1.73	1.61	1.08	1.1	1.47	0.44
-	Giulești	4.85	2.63	2.05	2.11	1.83	1.13	1.06	1.56	1.92	0.77
-	Groșii	-	-	-	-	1.25	-	-	-	-	0.02
-	Ieud	1.94	2.05	2.35	2.03	2.03	1.07	1.55	1.53	1.74	1.13
-	Mireșu Mare	1.25	2.52	2.88	2.64	5.0	0.24	0.23	0.25	0.26	0.05
-	Moisei	1.9	1.79	1.93	1.77	1.88	8.0	9.15	12.91	15.23	7.78
-	Ocna Șugatag	2.02	2.01	2.32	2.45	2.29	17.29	22.76	20.1	23.05	11.23
-	Oncești	1.34	1.86	1.90	1.96	1.56	1.63	3.44	4.07	5.41	2.23
-	Petrova	3.51	1.85	1.61	2.56	2.24	0.16	8.36	13.66	6.9	3.49
-	Poienile Izei	1.74	2.29	2.37	2.27	2.31	2.46	2.42	3.24	3.89	2.31
-	Recea	1.14	1.23	1.67	1.84	1.23	6.6	5.65	4.78	3.74	1.5
-	Rona de jos	-	2.8	1.97	2.27	1.2	-	0.95	0.25	0.27	0.1
-	Rona de sus	1.60	2.31	2.0	2.41	2.05	1.62	1.9	1.84	4.39	2.43
-	Ruscova	-	-	1.94	2.16	2.34	-	-	2.4	2.07	1.27
-	Săcălășeni	1.6	2.54	2.1	1.82	1.58	0.27	0.39	0.35	0.47	0.19
-	Săcel	1.96	1.47	2.09	2.12	1.83	3.69	5.04	4.31	3.2	1.4
-	Săpânța	1.97	2.65	2.04	1.85	1.65	0.46	0.78	2.46	3.54	1.64
-	Sarasău	1.55	1.74	2.16	2.44	2.15	3.01	5.63	7.11	6.6	5.57
-	Satulung	2.11	2.4	3.17	2.52	3.74	0.14	0.13	0.35	0.53	0.33
-	Șieu	2.11	3.42	2.49	2.07	1.73	79	207	301	749	281
-	Șișești	1.89	1.68	1.64	1.60	1.56	0.21	3.25	3.44	3.72	2.18
-	Strâmtura	1.89	2.0	2.13	2.39	2.46	1.99	1.34	1.33	1.43	1.13
-	Suciu de sus	2.29	2.15	2.87	2.74	2.49	1.04	1.26	1.35	1.61	0.76
-	Vadu Izei	1.64	1.77	2.26	2.35	1.78	10.84	12.98	10.3	14.33	7.17
-	Valea	1.62	1.42	1.74	1.74	1.56	1.06	1.15	0.93	1.31	0.4
-	Vișeu de jos	2.12	1.85	1.59	1.77	1.28	1.5	0.96	0.89	1.65	0.15
Total		***1.81***	***1.89***	***2.05***	***2.18***	***2.04***	***80.5***	***110.7***	***121.8***	***132.7***	***67.5***

Source: processing according to data collected from the field and from NIS [21].

The overnight stays related to the additionally installed beds (paid by customers) are also taken into account. In the period 2016-2020, according to Table 3 and figure 5, there is an upward evolution in the number of overnight stays by tourists in the agritouristic boarding houses in Maramureș, until 2019 (105,800 overnight stays), and in 2020 (50,299 overnight stays) there is a decrease very high, below the last reference year, 2016 (55,411 overnight stays), the decrease also being caused by the pandemic situation in 2020 and the restrictions during it.

In the period 2016-2020, according to table 3 and figure 5, there is an upward evolution in the number of overnight stays by tourists in the agritouristic boarding houses in Maramureș, until 2019 (105,800 overnight stays), and in 2020 (50,299 overnight stays) there is a decrease very high, below the last reference year, 2016 (55,411 overnight stays), the decrease also being caused by the pandemic situation in 2020 and the restrictions during it. Regarding the tourist boarding houses, it is highlighted in table 3 that the number of overnight stays in Maramureş from 2016-2020 increased from 171 overnight stays in 2016 to 396 overnight stays in 2019, then in 2020, due to the restrictions imposed by pandemic, the number of overnight stays dropped to only 294 people.

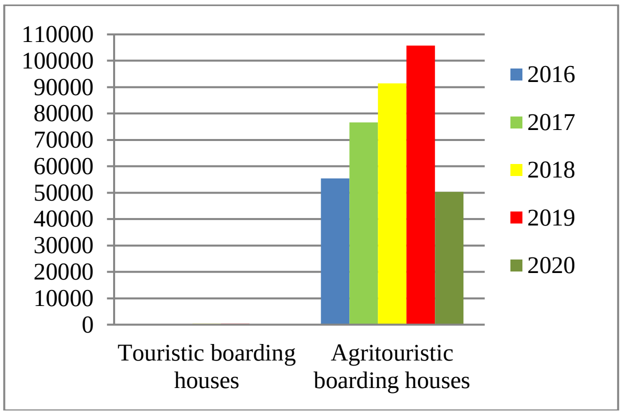

Fig. 5. Total overnight stays of tourists arriving per year in tourist reception structures on types of structures in the period 2016-2020
Source: processing according to data collected from the field and from NIS [21].

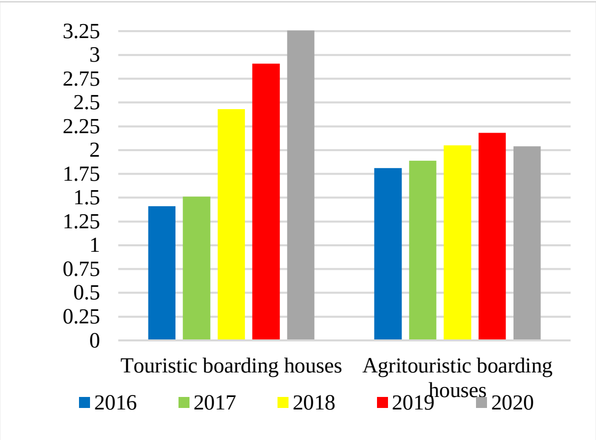

Fig. 6. Average length of stay
Source: processing according to data collected from the field and from NIS [21].

Regarding the average length of stay in agritourism boarding houses in the Maramureş area, table 3 and figure 6 show a progressive increase from 1.81, in 2016, to 2.18 in 2019, and in 2020, at the peak of the pandemic, an insignificant reduction, of only 0.14 units, due to the preference of tourists to visit during this period, the more secluded areas that allowed them some isolation, according to the requirements imposed.

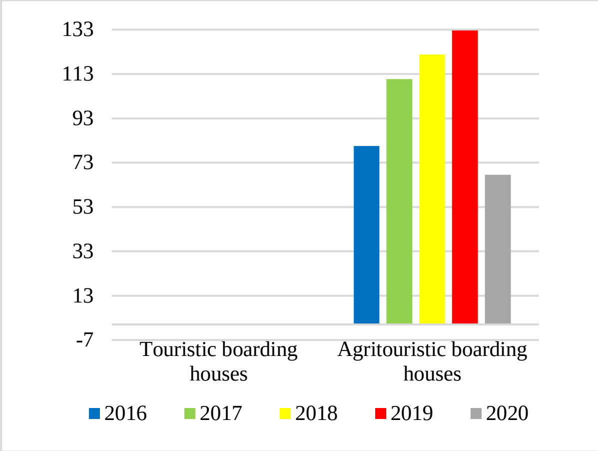

Fig. 7. Number of tourists arriving per day
Source: processing according to data collected from the field and from NIS [21].

With regard to the number of tourists arriving per day, it can be seen from the same table and figure 7, an obvious increase per year, reaching the maximum value of 132.7 tourists in 2019, later in 2020 reducing substantially, to only 67.5, in first of all due to the restrictions imposed on tourist reception structures to strictly comply with all safety regulations.

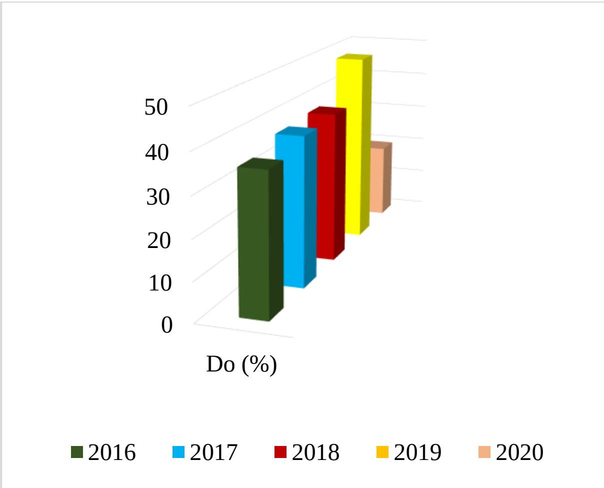

Fig. 8. The degree of occupancy (Do) of agritouristic boarding houses
Source: processing according to data collected from the field and from NIS [21].

From the point of view of the degree of occupancy, especially of the agritourism boarding houses, it can be seen from Figure 8 that this is a very good one for the entire period under study, increasing until 2019, to over 49.51%, a value that exceeds by over 30%, on the national level, corresponding to the analyzed period. The lowest value was recorded in 2020, of only 19.67%, due to the restriction applied to all tourist reception structures from us in the country, not to stay at the maximum capacity of 100% and to respect certain values depending on the infection rate in the area at that time.

Based on the study, we made some recommendations that could lead to an increase in the value of tourist circulation in the Maramureș County, such as the start and implementation here of a program similar to the one called ”The European Gastronomy Region”, applied in 2019, and which aims to raise awareness of the importance of cultural and gastronomic uniqueness, to promote, among other things, better tourism standards. The program was successfully implemented in Sibiu, offering the opportunity to promote Transylvanian gastronomy on an international level. From what we found, it could be successfully implemented in the Maramureș area and throughout the country, in order to develop new tourist products based on gastronomy and lifestyle specific to each ethnographic area, an aspect that will significantly contribute to attracting tourists to the area and will lead to increased tourist circulation between the various historical provinces of the country. The Maramureș County must use all its assets to the maximum.

Another program that could be implemented at the level of the researched area and that will contribute substantially to the revival of tourist circulation especially after the pandemic period, is the "Nature and adventure" program which represents a niche field of tourism and is a combination of all forms of ecologically specific tourism (agritourism, rural tourism, ecotourism), with sports tourism activities. All these new forms of tourism contribute to the wider development of sustainable tourism, from all economic, social and environmental points of view. The studied area and even the entire country offer competitive prices for such tourist packages and have certified destinations and private operators that also deal with this niche tourism. The tourist packages focus on the Carpathian Mountains, where there are over 77% of the remaining virgin forests [25], untouched natural landscapes, village traditions, customs and rituals, preserved with sanctity in the countryside, authentic, natural and traditional products accompanied by selected wines [18], handicrafts and workshops, wooden churches and monasteries of unique beauty [29], all part of the tangible and intangible heritage of the area and of Romania.

CONCLUSIONS

From the study we found, first of all, that in the Maramureș County, accommodation and meal services can be offered to tourists in authentic, personalized conditions and with a strong note of local specificity, and permanent craft exhibitions (for sale) or museums can be organized ethnographic in the open air. It was also noted that this area is a true enclave of preserving and perpetuating folklore and especially ethnography (wear, work techniques, architecture, furnishing and interior decoration, etc.) in their original traditional forms.

These aspects that give the area the possibility of having an original, diversified, very good quality tourist offer, organized and managed by the local people, led to the sustained increase in tourist circulation during the studied period, a phenomenon that can be seen from the evolution of the number of tourists, which registered a sustained growth of approximately 59%, until 2019. This is the result of the increase in demand and consumption for this form of tourism until 2020, when a dramatic decrease is observed, below the last reference year, 2016, due mainly to the restrictions imposed in this peak year of the pandemic. Regarding the situation of the tourist boarding houses, the number of arrivals in the tourist boarding houses in the area during 2016-2020 remained relatively constant until 2020, where due to the same conditions it dropped drastically, below the reference year 2016.

In the case of overnight stays, there was an upward evolution of approximately 91% in the number of overnight stays by tourists in agro-tourism boarding houses in Maramureș, until 2019, compared to 2016, but in 2020, a very large decrease was noted, below 2016, the decrease being caused by the special situation during the pandemic. The evolution of this indicator in tourist boarding houses showed as follows: the number of overnight stays in Maramureș County in the period 2016-2020 doubled from 2016 to 2019, then in 2020, the number of overnight stays fell below 2018.

Analyzing the above and the current state of tourism development in the region, we can confidently state that it has not reached a maximum level of development, despite the rich and varied potential, and its development prospects are promising provided there is a greater awareness of public authorities and of the private sector, but especially of consumers, regarding the capacity of agritourism and rural tourism to contribute to the preservation of natural and cultural heritage and to the improvement of living standards in this region of the country.

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FISCALIZATION REFORM IN ALBANIA: AN ECONOMETRIC APPROACH TO STATE BUDGET REVENUES FROM FISCALIZED ENTERPRISES

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Abstract

The items that include public revenues in the state budget are very important for the economy, public expenditures, sustainability and growth depend on them. The functioning of the fiscal system in Albania has been particularly complicated for an important branch of the economy such as agriculture. It contributes approximately 18.4% to GDP, including 30% of employees. The Albanian government (January 1, 2021) started the implementation of the fiscalization platform, with the aim of collecting taxes in a more transparent way, especially the value–added tax, as one of the most difficult taxes to collect. Fiscalization represents a new digitized system of real–time reporting of the VAT situation for taxpaying subjects. The new innovative practice represents a comprehensive reform, especially in the field of issuing invoices, with an impact on taxpayers' income and the tracking of expenses. Considering the research gap, the study provides a general evaluation of the effects of fiscalization on the revenues collected from VAT, through an econometric approach. The results of the measurement (so far), show that the new fiscalization platform applied has influenced the increase in the number of businesses registered with a Unique Taxpayer Identification Number, formalizing the work of the majority of them. While the reform offers a positive development for public finances and in accordance with EU standards, a new continuous innovative approach in assisting new practices, logistics and the sustainability of management systems (cyber security) is recommended.

***Key words*:** *fiscalized taxpayers, state budget revenues, digital economy*

INTRODUCTION

The Albanian economy, despite its productivity and continuous structuring challenges, has not remained a spectator in the world of innovations and digitalization. Considering the consequences of the Covid–19, pandemic and lockdowns, sectors of the economy and especially financial services, private and public have been increasingly digitized. The digitalization of public services through e–Albania platform and overall economic developments have promoted financial improvement. Complications during the operation of the VAT system in some sectors (especially agriculture) and the tendency for efficiency and modernization have been a particular impetus for the new fiscalization process (January 1, 2021) in all transactions of economic activities. Albania's economy, through a challenging process of transition from a (completely) centralized economy to a free market economy, has been cyclically characterized by problems of efficiency of the fiscal system and transparency. The problem of taxes, natural evasive tendencies of some sectors (e.g. Agriculture), and the efforts to their efficiency and transparency have been the main characteristics of the reforms of the fiscalization system in other European countries as well. So, we can mention the process of fiscalization implemented in Italy (1980s), and new fiscalization in other transition countries or development, such as Poland, the Czech Republic, Slovakia, Sweden [5], etc. A transparent and fair fiscalization system includes the fiscal trend the influence on income redistribution and the creation of a more righteous society [27] etc.

The problem of the operation of the fiscalization system in Albania has been critical for economic transparency, business environment, and (foreign) investments and specifically for some sectors. So, farmers do not have the obligation to issue an invoice for the sale of goods or services, referring to the VAT law in Albania. Agricultural products are collected near the collection points, and it's the obligation of these points to make a tax invoice to the farmer by self–invoicing and crediting the value–added tax from the purchase of these agricultural products. The policies of formalization of the agricultural economy have been continuous and numerous. An early attempt to avoid the shadow economy and which still continues is the registration of the object of activity in the relevant tax authorities, with the identification number of the taxable person. The process in general has been complicated for the agricultural sector since there were no incentive schemes for these developments. The VAT compensation scheme, initially at the rate of 6%, was an incentive measure, as it helps them cover the VAT paid for the purchase of inputs and services for the production of agricultural products. And in order to benefit from this compensation measure, they were obliged to register with the tax authorities, that is, to be formalized in order to benefit. But the collection points of agricultural products are already facing difficulties as they used to buy the product at 6% and sell it at 20% and had to cover this difference of 14%. Therefore (after 2014), this value–added tax on purchases became 20%, making it easier for agricultural product collectors, because they will only pay the added value of the product. This measure would now stimulate farmers more because they would be paid more for their products. At the rate of 20% of value–added tax, they were more interested in registering as active businesses, leading to an increase in the number of registered farmers. The fact that the collector of agricultural products can self–invoice and credit the VAT makes our products more competitive on the domestic market in relation to imported products. With the fiscal package approved (2019), the VAT refund for small farmers for sales became 6% from the 20% that was applied in 2014. Now for the processors of agricultural products, it was more profitable to introduce the raw material through import companies, since they received the same product at the same price with 20% VAT, meanwhile, they receive the same product in the country, maybe with a cheaper price, but with 6% VAT. This year was approved the VAT exemption of agricultural raw materials. This has created an opportunity for the importing entities to reduce the selling prices to the farmers by the same amount. Farmers on the other hand, managed to reduce the costs of agricultural production, increasing investments in agriculture, as a profitable sector of the country's economy. Earlier (December 2020), the VAT payment limit was 5 million ALL of the turnover per year. Meanwhile, from (January 1) 2021, this threshold has increased for the annual turnover up to 10 million ALL. The increase in the VAT payment limit for the annual turnover from 5 million to 10 million has made it easier for farmers and is expected to eliminate duplicate Unique Taxpayer Identification Numbers within the family. A large number of the farmers have issued 2–3 Unique Taxpayer Identification Numbers within the family to avoid obligations. The change in the VAT payment band has indicated in the number of farmers declined. From (November) 2021, the VAT on agricultural inputs changed again, it was set at 10%, causing the production costs of agricultural products to increase again. As a result of the policy change, there have been fluctuations in the agricultural economy. Furthermore, another policy for the formalization of the agricultural economy, which has been applied (2022), is the fuel compensation scheme for agriculture. For all farmers with a farmer Unique Taxpayer Identification Number or entities with a commercial Unique Taxpayer Identification Number (natural or legal persons) with agricultural production activities, who own or use/rent agricultural land, who have a farm with a size of not less than 0.4 hectares, composed of from plots with an area of not less than 0.1 hectares each, and who work the land and serve agricultural crops with mechanized means will be able to benefit from an average of 70–100 litters of free oil for each hectare of planted land, depending on the crops agricultural. Taxpayers, subjects of VAT or profit tax, or simplified profit tax for small businesses according to the current relevant legislation, are obliged to issue an invoice as a recipient of products or services provided when purchasing goods from farmers or agricultural producers, who benefit from the compensation scheme. Even after the commencement of the full effect of the fiscalization provisions, in the case of the collection and purchase of agricultural products marketed by farmers, the invoice will be drawn up and fiscalized by the purchasing collector of agricultural products in harmony with the regulatory framework of the field. Thinking about this new approach, the most advisable action could be very close to the strategy of how to create incentives for formalization. This requires reforms in various areas, such as the taxation system, task legislation, product markets and improving the business climate, etc. If economic growth is not accompanied by income redistribution or increased employment levels, it may continue to encourage the growth of the informal economy, considering its specific characterizations. Furthermore, concerns over the informal economy and the areas where informal activities are more prevalent affect employment and productivity, and here we underline the importance of addressing specific policies. The formalization of informal activities is a primary task and is not simply and solely for tax collection or law enforcement purposes. Given the traditional culture of informality, instability and shocks from outside the system (eg pandemic), or currently fiercest (external) competition, tendencies towards the informal–compensatory economy may have become even more desirable, and typical illustrations, again in this case, come from the agricultural production and farm sectors.

The level of credit value-added tax for various periods is shown in Table 1 and the level of value-added tax for agricultural inputs is presented in Table 2.

Table 1. The level of credit value–added tax

The level of credit value–added tax.	
Period	**VAT (%)**
Until 2014	6%
2014–2019	20%
2019 up to date	6%

Source: General Directorate of Taxes [11].

Table 2. Value–added tax for agricultural inputs

Value–added tax for agricultural inputs.	
Period	**VAT (%)**
Until November 2021	0%
November 2021 up to date	10%

Source: General Directorate of Taxes [13].

Finally, in (January) 2021, initiated the new fiscal policy, that of digitizing sales and purchase transactions, reporting every transaction in real–time. This policy requires a new adaptation from what farmers and the rest of the links on the agricultural product were already used to. However, its full implementation has the expectation of further formalization of the agricultural economy, and eventually eliminating the shadow economy. The procedure now goes through the issuance of an electronic invoice. Each Unique Taxpayer Identification Number is obliged to provide internet 24 hours a day, to be equipped with a tablet, mobile or computer, to be equipped with NISA (National Agency for the Information Society) with an electronic certificate, and software to log in to the tax administration portal, the self–care portal. The use of technology helps the information to go through in real–time for both purchases and sales, VAT tax returns are also issued in real–time. Below is a view of the login of each economic entity in the self–care portal (Figure 1).

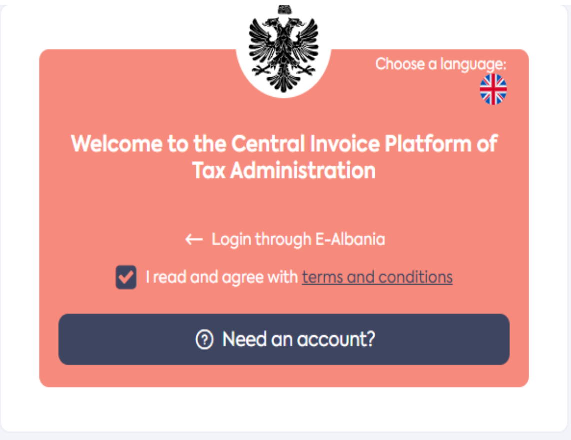

Fig.1. Log in the Self–Care portal
Source: https://efiskalizimi–app.tatime.gov.al/ [30].

Framework of the study

The latest technological developments and the implementation of the fiscal platform have contributed to the progress of the Albanian economy and in particular to its formalization. Individuals are aware, voluntarily or out of fear of intrusive policies, to be certified in one of the legal forms of business registration, increasing the number of active registered businesses. On the other hand, the fiscal platform through the self–care portal is bringing the tax administration closer to the business, making everything measurable in real–time. The focus of the study is an assessment of the relationship between the number of fiscalized businesses and revenues in the state budget. The link we have analyzed is between the number of active enterprises registered with a Unique Taxpayer Identification Number, as an obligation of the fiscalization law, with the revenues in the state budget. More concretely, tax revenues in the state budget consist mainly of revenues from VAT, Social and Health Insurance Contributions, Profit Tax and Personal Income Tax.

In this context, some research questions of interest are, what is the relationship between the increase in the number of registered and fiscalized active enterprises and revenues in the state budget? What are the costs and benefits of the new fiscalization reform? We will try to answer these questions through an econometric analysis of the variables under review.

Objectives and hypotheses

The study objective is an analysis of the impact of the fiscalization reform progress in Albania through an econometric approach, by measuring the impact of the most influential variables such as VAT income, social security and health contribution, profit income tax and personal income tax to the number of registered businesses. The study hypotheses are:

H_1: With the increase in income in the state budget from the Value Added Tax, the number of businesses registered and fiscalized through the new fiscalization platform has increased;

H_2: With the increase in income in the state budget from the Social Security and Health Contributions, the number of businesses registered and fiscalized through the new fiscalization platform has increased;

H_3: With the increase in income in the state budget from the Profit Tax, the number of businesses registered and fiscalized through the new fiscalization platform has increased;

H_4: With the increase in income in the state budget from the Personal Income Tax, the number of businesses registered and fiscalized through the new fiscalization platform has increased;

Literature review

Although research on the implementation of the new fiscal platform in Albania is lacking, studies about this very interesting research field are numerous and multidisciplinary. The problem of efficient control of VAT collections presents an issue addressed in the literature [20]. To argue the complexity of institutional, cultural, technical, and technological issues etc., related to fiscalization, and problems such as the role of government inspections and fair auditing, transparency and new methods to ensure that everyone pays taxes and VAT, etc., authors suggest the implementation of new fiscal technology, as a legally defined way to effectively control the collection of VAT [22].

Analyzing this problem and possible solutions related to collection efficiency, they found the impact of Electronic Tax Registries on the speed with which the taxpayer processed VAT and the cost of VAT processing. Other studies underline that government institutions should create preconditions that prevent, or at least reduce the level of tax fraud, which will improve tax control processes in order to make them fast and efficient and raise the awareness of buyers about people who do not issue invoices and do not pay taxes, by breaking tax laws and in the long run. Is the cause of higher taxes or some other types of public taxes [23]. By analyzing within a short–term analysis [18] (the first three years) was found that the implementation of the fiscalization law [16, 21] has resulted in an increase in tax revenues, encouraging citizens to ask for an invoice for the goods or services they receive and report if this is respected, improving the performance of the tax administration and reducing the shadow economy. According to this study, examining the total income per year (that is, the first nine months), an increase in them was evidenced by improving the practices against tax fraud from the fiscalisation process and especially the supervisory measures of issuing invoices in cash. The system of fiscalisation in Croatia as a model that tries to establish financial discipline on the basis of successful surveillance recording of cash transactions, which results in a balanced financing of public expenditures [24]. Moreover, fiscalisation means stricter supervision of taxpayers' income in order to collect it as effectively as possible [28]. In this study, the authors analyzed the implementation of fiscalisation, the impact on businesses and their response, finding advantages and disadvantages in the fiscalisation process and the general attitude towards it. The efficiency of fiscalisation can be improved by placing fiscal equipment in an automation system, where the collection of information is automated, and that additional efficiency can be achieved by viewing fiscalisation as a comprehensive part of the process of improving compliance, noting that new digital security capabilities must be required to ensure the fiscalisation process. This resulted from studying taxpayer compliance and administrative efficiency [2], observing fiscalisation as an independent process with government controls and examined the effects of this strategy on fiscal devices such as electronic cash registers (ECR), electronic fiscal devices (EFD), electronic fiscal printer (EFP). Through an econometric approach [4], where was analyzed the target of about 12,060 registered traders, identifying and extracting the main factors in specific themes. In a case study from developing countries [6], using a sample of 391 traders and secondary VAT data through an econometric approach applied a multivariate regression to study the relationship between VAT collection, compliance, bias and obligation to pay. The level of compliance showed that, on average, most traders (235) have respected the payment of VAT, underlining that fiscalisation is a solution to reduce fiscal evasion and revenue collection. Studies emphasize that, fiscalisation improves internal accountability, business management and control by recording and maintaining all sales without manipulation [26]. This is evidenced by the accurate description the data and shorter control periods by tax collectors.

However, fiscalisation is characterized by challenges, such as few equipment suppliers (or anti–competitive behavior), unrealistic deadlines and higher penalties, or even the degree of user–friendliness and compatibility with other equipment, etc. This is evidenced by the slow receipt of equipment due to lack of capacity and non–receipt of tax clearances because they were not taxed. Changing the strategy with the implementation of the fiscalisation process can contribute to sustainability and growth, where fiscalisation would become an integral part of the services provided by businesses [3].

Examining the decision–making framework of business and government [17], adapt a model of interaction between them called game theory.

The findings showed interaction results underlining that the optimal strategy for a business that chooses tax evasion is not to issue invoices only to loyal customers, which reduces the possibility of reporting and reduces the perceived risk of the business being audited. Higher penalties increase the government's payment function in the short run, but may reduce potential future revenue. Fiscalisation is the system that collects more data from citizens and this leads to more efficient and complete tax reporting [14], by helping authorities to improve their service to taxpayers even through pre–filled documents, which means fewer errors and faster tax reporting. Digitization of these processes helps communication and exchange of information between government and businesses. This leads to the reduction of administrative operations. Studies from Albania suggest that the process of fiscalization has a positive impact on the Albanian economy and SMEs, but Albania was found unprepared for the development of fiscalization [19]. Undoubtedly, the difficulties are numerous for both taxpayers and the tax administration, but nevertheless the benefits are such as:

• Saves time by avoiding manually preparing tax invoices and sending them to buyers;
• It is possible in real–time to verify the status of the buyer and receipt of the invoice from the buyer, facilitates the preparation of VAT sales books;
• It is possible to integrate sales into the accounting system, especially for enterprises that have large stocks;
• Information is crossed and reconciled between sellers and buyers;
• Abuses are prevented and identified more easily;
• Formality increases and unfair competition decreases;
• Increases the possibility of controlling and specifying fictitious inventories;
• Increasing the possibilities of tax authorities to control the implementation of the law;
• Expanding the tax base, increasing income and improving the distribution of the tax burden;
• Reducing informality helps to fight corruption and improve public services, etc.

However, the successful implementation of fiscalisation and its modernization in Albania involves wide and complex issues. The modernization of the system is related to fiscalization and the technical principles of implementation [29], but also to the organizational principles, the conception of a simplified tax system and the failure of each of them represent a risk for the activity of entrepreneurship and the economy.

MATERIALS AND METHODS

The study is based on panel data. Panel data is a combination of variance series and dynamic series. Specifically, the data are from the 14 Regional Tax Directorates of Albania, the period is 5 years, the variables are the income provided in the state budget from VAT and the active number of businesses operating in these 14 directorates.

Therefore, we mark with:

T= Number of periods (the years we will study), N=Number of units (Regional Directories by cities).

To specify what type of Panel Data we are dealing with, we analyze the number of data for T and the number of data for N.

If: T=N, we are dealing with Balanced Panel.
T<N, we are dealing with Short Panel.
T>N, we are dealing with Long Panel.

In our case, the data we have are, T=5, and N= 14, so T is smaller than N, so we say that we are studying Short Panel Data.

Since for each directory we have data for the same periods, i.e. moments of time, we say that we are dealing with balanced panel data, Balanced Short Panel Data.

From a methodological point of view, we have used the POOL OLS, Pooled Ordinary Least Square method to study the relationship between the variables.

RESULTS AND DISCCUSIONS

The data used are balanced panel data, because for each Regional Tax Directorate we have data for the same periods, i.e. moments of time. Therefore, based on these data, we can formulate three main types of regression models.

We created the general panel POOL OLS model:

$$Y_{it}=X_{1it}B_1+ X_{2it}B_2+ X_{3it}B_3+ X_{4it}B_4+v_{it} \quad (1)$$

This model evaluates the dependency of the variables: *Y–number of businesses registered with Unique Taxpayer Identification Number, which were fiscalized from January 1, 2021, and X_1–VAT income in the state budget, X_2–Social Security and Health Contributions, X_3–Profit income tax, X_4–Personal Income tax.*

In our case:

i = Berat, Dibra, Durres, Elbasan, Fieri, Gjirokastra, Korça, Kukës, Lezha, Saranda, Shkodra, Tirana, the Directorate of Large Taxpayers, Vlore.

t = 2017, 2018, 2019, 2020, 2021

m = 70

Table 2. Concept and variables.

Concept	Variables	Symbols
Revenue in the state budget	*VAT income*	X_1
	Social Security and Health Contributions	X_2
	Profit income tax	X_3
	Personal Income tax	X_4
Fiscalised enterprises	*Number of businesses registered with Unique Taxpayer Identification Numbers*	Y

Source: Authors' calculations.

In Fig. 2, it was analyzed the weight (in %) occupied by enterprises with active Unique Taxpayer Identification Number according to the Regional Tax Directorates throughout Albania since 2021. We conclude that the Tirana Regional Tax Directorate has the largest percentage of active enterprises, about 31% of the enterprises are concentrated in Tirana, converted in number, are 29,835 enterprises, followed by Fieri with 14% and Korça with 10%. In total, for the whole of Albania, there are 191,185 enterprises registered with active participation for the year 2021.

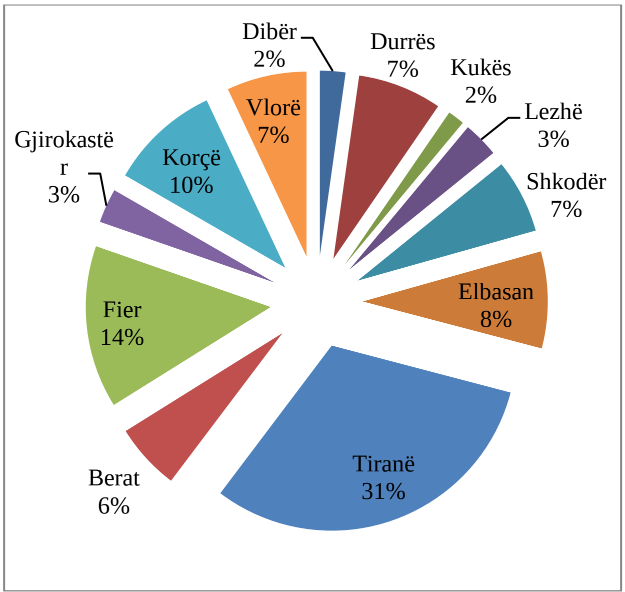

Fig. 2. Active businesses in accordance with the Regional Tax Division (2021) [17].
Source: General Directorate of Taxes.

VAT, one of the tax revenues in the state budget, occupies a significant position in tax revenues. Social and Health Insurance Contributions also play an important role. However, the identification of income from VAT has always been problematic.

That's why the Albanian government took the initiative of massive fiscalization. This was in order to have the most efficient control over the tax revenue.

In Fig. 3, it is shown a distribution of tax revenues, VAT, Social and Health Insurance Contributions, Profit Tax and Personal Income Tax for five consecutive years, 2017, 2018, 2019, 2020, 2021.

From the data, the Tirana Regional Directorate of Taxes and the Directorate of Large Taxpayers, with the largest number of enterprises, are the ones that provide the highest income in the state budget. In 2021, the tax revenues from VAT in the Tirana Regional Tax Directorate have resulted in the level of 13,780,973,000 ALL, followed by the Directorate of Large Taxpayers with 12,117,239,000 ALL. Summing up, Social and Health Insurance contributions have also been at a significantly higher level, and if we compare the year 2021, when the implementation of the fiscalization system began in Albania, with the year 2020, there is a significant increase in the level of income of VAT, Social and Health Insurance, Income or Personal Tax and Income Tax.

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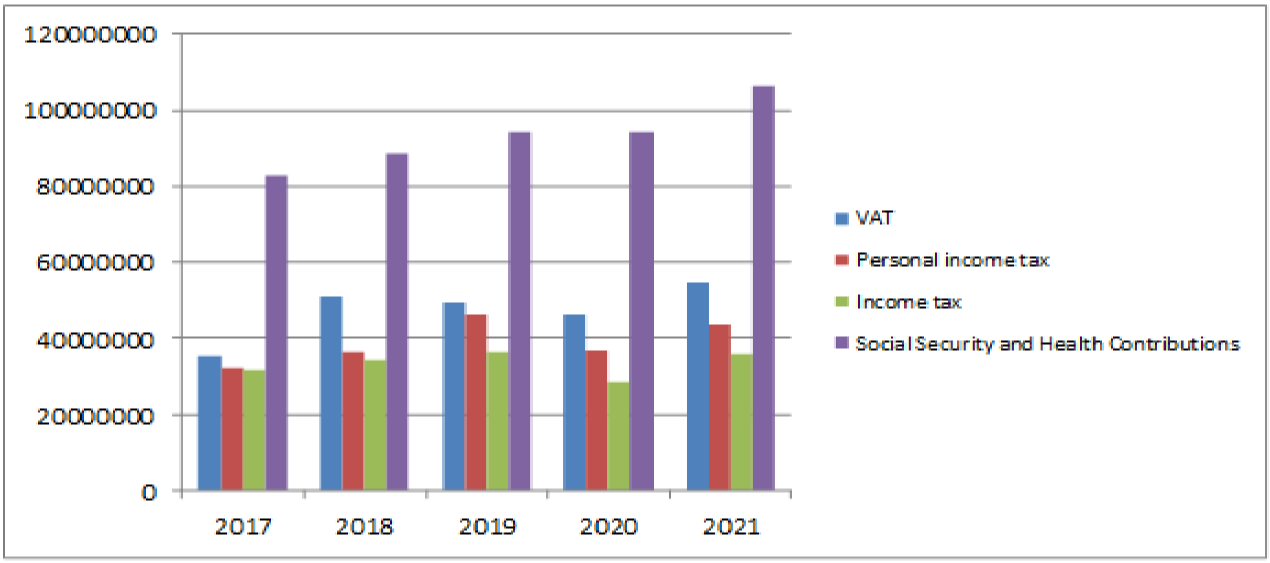

Fig. 3. The level of tax revenue in the state budget for the last five years (2017, 2018, 2019, 2020, 2021) [8, 9, 10, 11, 12, 13, 15, 25].
Source: General Directorate of Taxes.

The impact of the implementation of the fiscalization process in the enterprises is determined by different factors, whether these are at the individual level, at the institutional level, but not only.

Pooled Ordinary Least Square model

The general Least Square model is formulated in Table 3.

The model shows that the number of businesses registered in the last (5) years is statistically significant at the level of income in the state budget. And the significance level (0.00% <5%) indicates that the model is significant at a very good level.

Table 3. Pooled Ordinary Least Square model [8, 9, 10, 11, 12, 13, 15].

Dependent Variable: NO_REG_ENTERPRISES
Method: ~~Panel~~ Least Squares
Date: 02/28/23 Time: 11:26
Sample: 2017 2021
Periods included: 5
Cross-sections included: 14
Total panel (balanced) observations: 70

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7714.227	840.1805	9.181630	0.0000
VAT_INCOME	-0.000122	0.000238	-0.514084	0.6089
CONTRIB_INCOME	0.000639	0.000145	4.415922	0.0000
PROFITTAX_INCOME	0.000405	0.000282	1.436342	0.1557
PERSONAL_INCOMETAX	3.00E-05	0.000261	0.115080	0.9087

R-squared	0.632356	Mean dependent var	12665.11
Adjusted R-squared	0.609732	S.D. dependent var	8952.488
S.E. of regression	5592.751	Akaike info criterion	20.16508
Sum squared resid	2.03E+09	Schwarz criterion	20.32569
Log likelihood	-700.7778	Hannan-Quinn criter.	20.22887
F-statistic	27.95035	Durbin-Watson stat	0.040140
Prob(F-statistic)	0.000000		

Source: Authors' calculations.

No_reg_enterprises = 7714.2 - 0.000122*VAT_income + 0.000639*Contrib_income + 0.000405*Profittax_income + 3.00e-05*Personal_incometax

So, if the revenue provided by VAT will increase by 1 ALL keeping X_2, X_3, X_4 constant, the number of registered and fiscalized businesses will decrease by 0.122, this is because businesses are not subject to VAT payment when they are first registered, they become so when they reach the annual turnover of 10 million ALL. When income from social and health insurance contributions increases by 1 ALL while keeping constant income from VAT, profit tax and personal income tax, the number of registered–taxed businesses increases by 0.639. When income from profit tax increases by 1 ALL, keeping X1, X2, X4 constant the number of registered and taxed businesses increases by 0.405. And when income from personal income tax increases by 1 ALL, keeping X1, X2, X3 constant, the number of registered and taxed businesses increases by 3. The coefficient of determination R^2 in this model is 63%, which means 63% of the variance of the number of registered and fiscalized businesses in the framework of the fiscalization reform is determined by budget revenues such as VAT, social and health insurance contribution, profit tax and personal income tax, the rest is explained by the variance of the remaining factors.

Fixed effects model

We formulated the general model with fixed models:

$$Y_{it}=a_i+BX_{it}+v_{it} \qquad (2)$$

Based on the Prob (F–statistic), the model with fixed effects is statistically significant, but what we notice compared to the first model, is that the coefficient of determination is already higher. This improves the model even more, making the relationship between the variables stronger.

Fixed–effects model with dummy variables

In the model we will include n checker variables, as much as number of regional directorates. We will give each variable the value one for the corresponding directory and zero for the other directories. In this case the model with fixed effects with factors x-revenues in the state budget, will have the form:

$$Y_{it}=a_{11}d_{1i}+ a_{12}d_{2i}+ a_{13}d_{3i}+\ldots\ldots+ a_{114}d_{14i}+ X_{it}B +_{vit} \qquad (3)$$

No free constant is set in the model to avoid multicollinearity problems, because a dummy variable is used for each regional directory. According to the formulation, the coefficient a_{it} (intercepted) is different for different individuals. The differences between the Regional Directories are significant, but the other parameters do not have major changes from the above model, therefore we also try the model with random effects.

The random–effects model

In principle, the random effect model is different from the common effect and the fixed effect, especially this model does not use the principle of ordinary least squares, but using the principle of maximum likelihood or generalized least squares (but using the principle of maximum likelihood or general least squares).

$$Y_{it}=a+B'X_{it}+u_{i+}\, e_{it} \qquad (4)$$

For i = 1,2, ..., N and t = 1,2, ..., T.
where:
N = number of Regional Tax Directorates or cross section.
T = number of time periods.
E_{it} = is the residual as a whole, where the residual is a combination of cross section and time series.
Ui = represent the individual residual which is the random characteristic of the unit observation.
In the random effects model, residuals may be correlated across time and across regions or cross-sections. Therefore, this model assumes that there is an intercept variable for each regional directory and the intercept is a random variable. So there are two residual components in the random effect model. The first is the residual as a whole where the residual is a combination of cross section and time series. The second residual is an individual residual which is a random characteristic of the unit observation and remains at all times.

Hausman Test

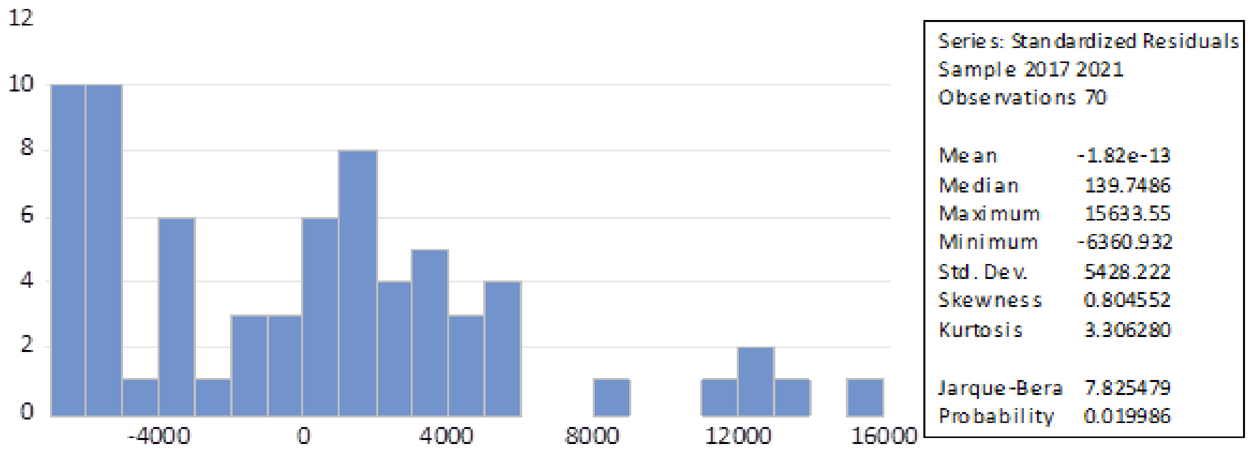

Fig. 4. Histogram, normality test
Source: Authors' calculations.

Table 4. Heteroskedasticity Test

Panel Cross-section Heteroskedasticity LR Test
Equation: EQ01
Specification: NO_REG_ENTERPRISES C VAT_INCOME
CONTRIB_INCOME PROFITTAX_INCOME PERSONAL_INCOMETAX
Null hypothesis: Residuals are homoskedastic

	Value	df	Probability
Likelihood ratio	91.76429	14	0.0000

LR test summary:

	Value	df
Restricted LogL	-700.7778	65
Unrestricted LogL	-654.8956	65

Unrestricted Test Equation:
Dependent Variable: NO_REG_ENTERPRISES
Method: Panel EGLS (Cross-section weights)
Date: 02/28/23 Time: 11:31
Sample: 2017 2021
Periods included: 5
Cross-sections included: 14
Total panel (balanced) observations: 70
Iterate weights to convergence
Convergence achieved after 26 weight iterations

Variable	Coefficient	Std. Error	t–Statistic	Prob.
C	10249.08	204.3581	50.15257	0.0000
VAT_INCOME	8.97E-05	4.87E-05	1.840887	0.0702
CONTRIB_INCOME	0.000376	3.81E-05	9.860384	0.0000
PROFITTAX_INCOME	0.000439	5.72E-05	7.674292	0.0000
PERSONAL_INCOMETAX	2.09E-05	5.05E-05	0.413384	0.6807

Weighted Statistics

R-squared	0.963782	Mean dependent var	55385.80
Adjusted R-squared	0.961554	S.D. dependent var	64189.95
S.E. of regression	5990.755	Akaike info criterion	18.85416
Sum squared resid	2.33E+09	Schwarz criterion	19.01477
Log likelihood	-654.8956	Hannan–Quinn criter.	18.91796
F-statistic	432.4258	Durbin–Watson stat	0.597917
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.578141	Mean dependent var	12665.11
Sum squared resid	2.33E+09	Durbin-Watson stat	0.036897

Source: Authors' calculations.

The Hausman test is a test used to determine the best method between fixed effect or random effect. The Hausman test is a statistical test to choose whether the most appropriate Fixed Effect or Random Effects model is used.

If it turns out: Basic hypothesis (H0): Choice RE (p> 0.05). Alternative hypothesis (H1): Choice of FE (p < 0.05)

In our model p=0.0351<0.05, we hold H1: We choose the model with fixed effects.

To analyze this even better, the Normality Test, the Histogram, comes to our aid (Fig.4).

A histogram is a graph that allows us to detect and show the frequency distribution (shape) of a continuous data set. This allows inspection of data for their underlying distribution (e.g. normal distribution), outliers, skewness, etc.

The Jarque–Bera test:

$$JB = n [(\sqrt{b1})2 / 6 + (b2 – 3)2 / 24] \quad (5)$$

helps us to test this best.

According to the above test, it turns out that the error term does not have a normal distribution, since p=0 <5%.

Table 5. Residual Cross-Section Dependence Test.

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: EQ01
Periods included: 5
Cross-sections included: 14
Total panel observations: 70
Note: non-zero cross-section means detected in data
Cross-section means were removed during computation of correlations

Test	Statistic	d.f.	Prob.
Breusch–Pagan LM	192.0859	91	0.0000
Pesaran scaled LM	7.492984		0.0000
Pesaran CD	7.237679		0.0000

Source: Authors calculations.

CONCLUSIONS

The study through an econometric approach provides an analysis of the impact of variables such as VAT income, contribution income, profit tax income, and personal income tax on the number of registered enterprises. The relationship between the number of active registered and fiscalized businesses and the level of revenues in the state budget remains significant. The outcome of this connection as argued in the study, was to the extent of 63%, which means that 63% of the variance of the number of registered and fiscalized businesses is determined by the increase in revenues in the state budget, and the rest explained by the variance of the remaining factors. The model that performed best in these relationships was the Pooled OSL model with fixed effects. Finally, we can underline that the implementation of the fiscal platform will ensure better performance and measurement of revenues in the state budget, while promoting the formalization of enterprises and avoiding the shadow economy and improving the business climate and foreign investments.

To have a clearer and more consistent picture of the impact of the number of registered and taxed businesses on the income in the state budget may take more time. Our paper refers to the changes (since January 2021) for the implementation of the new fiscalization platform and for more specific data according to sectors (e.g. agriculture) for registered businesses there was no information. These can also be considered limitations of the study. The increase in the number of registered businesses can be an effective prophylaxis against new current economic concerns such as evasion, unclear policies that affect the empowerment of businesses, business and investment climate, low competition and competitiveness, transparency and shadow economy [1] or the impact of fiscalization on possible losses [7]. Practically, improved fiscalization performance is a step forward in approaching the integration processes in the EU and exposes broader non–fiscal social issues such as the principle of social justice and social welfare, aspects of security (social and cyber security) and sustainability of the economic system. In the theoretical plan, other future studies can consider this theoretical framework by examining the progress of fiscalization, the dynamics and broad specifics (logistical, technological and administrative), etc. In our analysis, we are based on the number of registered and taxed active enterprises, but depending on the context there may be other variables that need to be analyzed for a longer period, such as policies related to the tax rate in years, or the form of organization of enterprises, etc.

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MODELING THE EFFECTIVENESS OF THE COCONUT DEVELOPMENT OFFICER (CDO) IN THE PARTICIPATORY COCONUT PLANTING PROJECT(PCPP)

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Abstract

The effectiveness of a coconut development officer (CDO) is an important factor in a coconut farmer's productivity and profitability. This article aimed to pave an explanation of the effectiveness of CDO in coconut farmers' view and determine its influencing factors. Secondary data were utilized from the existing paper in the literature and analyzed using standard descriptive statistics and ordered logistic regression analysis. Results depicted that CDOs of PCPP are "effective" in their assigned task based on the farmers' point of view. This implies that CDOs are doing their responsibilities and farmers have experienced an improvement in coconut growing activities. Moreover, the ordered regression model revealed that being a young farmer, with low education attainment, and good economic income, a farmer who owned a coconut field, training and seminars, and membership in any agricultural organization are predictors of the effectiveness of CDO based on farmers' perspective. Conclusively, to further enhance the CDO's effectiveness in their responsibilities, they must undergo some rigorous training about the new technologies and techniques in coconut farming.

Key words**:** *coconut development officer, coconut farmers, regression model, Philippines*

INTRODUCTION

The goal of the Philippine Coconut Authority (PCA) is to develop the coconut production and industry in the country to become globally competitive and to attain sustainability [6], [12], [16]. In fact, coconut farming is one of the sources of income for many rural farmers in the Philippines [16]. Hence, PCA is making a move to facilitate and guide the farmers to enhance their coconut growing activity as income generation. In that case, the PCA has formed a program called the Participatory Coconut Planting Project (PCPP)that will help the coconut farmers in the country how to plant and replant coconut trees with the newly discovered technologies [6], [7]. The program also will address the problems and issues that farmers are facing in coconut production and facilitate how to improve their profitability. Moreover, the PCA has formed a staff called the coconut development officer (CDO) who is responsible to facilitate, educate and guide the farmers in improving farm management and controlling pests and diseases of coconut trees [6].

In addition, CDO staff are also tasked to introduce the newly discovered innovative technology and research-based information to farmers through training and seminars. All the protocols of PCA in coconut farming are based on Good Agricultural Practices (GAP)[6], [12]. In [14], it is depicted that the country Philippines has a lot of poor and small-scale coconut farmers that need assistance to improve their productivity. It is worth noting that the effectiveness of CDO will results in the success of PCPP in improving the lives of coconut farmers and impact the economy of the country [6]. Hence, it is necessary to do research in evaluating the effectiveness of CDO in view to the farmers to collect useful information and remedy on how to improve the PCPP programs and its constituents.

In literature, research studies involving PCA projects and their functions to the Philippine company are scarce. Moreover, assessing the effectiveness of the performance of CDO in

PCPP has never been done in rural areas in Leyte, Philippines. Whence, the general goal of this study is to explain the effectiveness of CDO in coconut farmers' view and predict its influencing determinants. The purpose of this article is to expose the importance of CDO to coconut farmers' production and to gather information on how to improve their performance. The findings may also help the coconut farmers to know their role and their responsibilities in the PCPP program as well as their contribution to the economy. Moreover, the findings may be used as baseline information for some agricultural economists dealing with coconut growing and may contribute to the agricultural literature.

MATERIALS AND METHODS

The design of this article is descriptive-correlational research in which it describes the data of the study and determines the relationship between dependent and independent variables. Secondary and cross-sectional data were used in this study from the current article in the literature that dealt with the PCPP program of PCA [6]. The study summarizes the participation of coconut farmers in the PCPP and captures the influencing determinants. However, it does not focus on the effectiveness of the CDO as an extension agent to the farmers. Hence, this study is concentrating on the farmers' perception of how effective is the CDO's role in coconut growing and captures the significant causal factors affecting the farmers' view. The respondents of this study were coconut farmers in selected municipalities of the province of Leyte, Philippines that are under the PCPP program. In selecting the data, it has undergone clearing and excluding the outliers. Plus, the old farmers who are no anymore active in coconut planting were excluded. In that case, very old farmers aged 75 and above are eliminated. Hence, the study dealt with 132 coconut farmers as participants. The study employed the chosen variables which include the socio-demographic profile, farming profile, and farmers' perception of the effectiveness of CDO. For the socio-demographic profile of farmers, it includes their actual age in years, sex (male or female), civil status (married or not), educational status (Scoring guidelines: elementary level - 1, elementary graduate - 2, high school level - 3, high school graduate - 4, college level - 5, college graduate - 6), household size (members of the family), and annual income (in Philippine peso (PHP)).

As for the farming profile, it considered the following variables: tenurial status (owner or not), farm size (in hectares), number of years in farming, attending training in agriculture programs, and membership of any agricultural association. Thirdly, farmers' perception of the effectiveness of CDO in the following aspect: (1) technical capability of CDO staff ; (2) effective Sense of responsibility, seriousness, and dedication to services; (3) effective giving clear instructions to participants; (4) effective implementation of a monitoring system; and (5) effective settling/handling problems effectively. The five roles of CDO were evaluated by farmers on a scale of 1 to 5. Table 1 shows the scoring guidelines and their equivalent verbal description.

Table 1. Guidelines for the effectiveness of CDO

Total Perception Score	Ordered logistic code	Verbal description
1.00 – 1.80	0	Highly ineffective
1.81 – 2.60	1	Ineffective
2.61 – 3.40	2	Uncertain
3.41 – 4.20	3	Effective
4.21 – 5.00	4	Highly effective

Source: [2].

The questionnaire for the effectiveness of CDO has undergone validity by experts in agriculture and found that it is effective to capture the overall perception of coconut farmers towards the responsibility of CDO staff. In addition, the 5-item questions have a reliability coefficient of 0.92 and can be interpreted as reliable [5]. In the data management and analysis, the data were formatted in excel to fit in a statistical program called STATA version 14.0. After that, standard statistical measures (mean - M, standard deviation - SD, minimum (min) and maximum (max) value, frequency counts - n, percentages - %) were used to describe and give meaningful interpretation to the variables used in this study. In determining the predictors of the effectiveness of CDO staff from farmers' perspectives, an ordered logistic regression model was constructed. The dependent variable is treated ordinal as shown in Table 1 and the independent variables are the socio-demographic and farming profile of coconut farmers. Furthermore, standard diagnostic or post-estimation tests were conducted to ensure that the results provide a reliable interpretation and prediction.

RESULTS AND DISCUSSIONS

Profile of Coconut Farmers

The profile of the coconut farmers is presented in Table 2 using the standard descriptive measures. First, the farmers who are actively participating in the coconut planting project PCPP are aged from 18 to 74 years old and have a mean age is close to 52.42 years old (SD=13.59 years old). There are more male (67%) farmers who participated in the said project as opposed to female (33%) farmers. This result is expected since this type of work is masculine in nature. About 82% of these farmers are married and there are only 18% of them are not they are either single or widowers/widows. On average, these farmers are elementary graduate or high school level (M=2.88, SD=1.51) and some of them has also finished a college degree (max=6). The household size of these farmers is close to 4 members ranging from 1 to 11 members. On average, their annual income in coconut farming is close to 81,370.00 PHP (SD=112,973.50 PHP) and the minimum is 12,000.00 PHP and the maximum is 720,000.00 PHP. There are 72% of these farmers owned their coconut farms and about 28% of them are just tenants or workers. The average number of hectares of their coconut farm is close to 1.53 ha and ranges from 0.25 to 6 ha. Approximately, these farmers are being coconut farmers for 27.17 years (SD=14.70 years). The youngest is about 1 year of experience and the oldest is about 63 years of experience in coconut farming. Only 32% of these farmer has undergone training on the different new technologies in agriculture, particularly in coconut planting. And 68% of them have no proper training in the knowledge of coconut planting activities. In other words, their knowledge is just based on their experience and information from other farmers. In addition to that, about 54% of these farmers are members of the agricultural association or farmers' cooperatives, and 46% of these farmers do not have membership in any organization.

Table 2. Farmers’socio-demographic profile.

Variables	Mean	SD	min	max
Age[a]	52.42	13.59	18	74
Male[b]	0.67	0.47	0	1
Married[b]	0.82	0.39	0	1
Educational attainment	2.88	1.51	1	6
Household size	4.19	1.89	1	11
Annual income[c]	81370.45	112973.5	12000	720000
Farm owner[b]	0.72	0.45	0	1
Farm size[d]	1.53	1.36	0.25	6
Farming experience[a]	27.17	14.70	1	63
Training[b]	0.32	0.47	0	1
Membership[b]	0.54	0.50	0	1

Note: a - in years; b - dummy variable; c - in Philippine peso (PHP); d - in hectares (ha).
Source: Author’s calculation (2023).

Effectiveness of CDO in Farmers’ View

Table 3 shows that no farmers said that CDOs are highly ineffective in their assigned job. And only 5.3% of the farmers have experienced that CDOs are ineffective in imparting their knowledge on how to enhance planting coconut and how to implement the new practice management in their farm. In addition, about 17.42% of these farmers have perceived that they are uncertain if their job is effectively improving their lives as a farmer. This means that their productivity and economic income have not increased since they join the PCPP project and were guided by CDO. However, the dominant (41.67%) of these farmers have experienced the effectiveness of CDO officers. These farmers have improved their productivity and efficiency in coconut planting activities and improved their economic income as well [10]. They have also improved their practices in land and pest management [10]. In fact, there are farmers (35.61%) who said that CDO of PCPP is highly effective. This CDO staff serves as extension agents that help farmers in regard to their concerns and problems in coconut farming. In addition to that, CDOs are responsible for training coconut farmers on new innovative technologies and they also identify the problems and needs of farmers to give solutions [8]. On average, CDOs in PCPP are considered effective (M=4.03, SD=0.74) in their job as a helper and guide for coconut farmers in improving their coconut activities. Hence, the existence of CDO in PCPP is very relevant and serves as an educator and mediator to the coconut farmers as well as a problem solver. It is worth noting that smallholder coconut farmers are facing challenges nowadays, hence, they need guidance from experts to apply relevant technologies in solving their problems [13].

Table 3. Effectiveness of CDO in farmers' perspective

Effectivity category	Frequency (n)	Percentage (%)
Highly ineffective	0	0.00
Ineffective	7	5.30
Uncertain	23	17.42
Effective	55	41.67
Highly effective	47	35.61
Mean average (SD)	**4.03 (0.74) - Effective[a]**	

Note: a - See Table 1 for details.
Source: Author's calculation (2023).

Ordered Logistic Regression Model

Table 4 presents the constructed ordered logistic regression model which captures the influencing determinants of the effectiveness of CDO. Prior to that, the post-estimation or diagnostic tests for the model in the form of ordinary least square (OLS) has shown that the variance is constant and no omitted variable bias exists using the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity and Ramsey RESET test, respectively [11]. In addition to that, the model has no problem with multicollinearity with the aid of variance inflation factor (VIF) which results in VIF<10 [2]. Moreover, the residuals of the model are not normally distributed (W=0.97, p-value=0.006) based on the result of the Shapiro-Wilk W test for normal data. However, it is shown in the kernel density estimate graph that the residuals are almost normally distributed based on the normal density as presented in Fig. 1. In that case, the model is valid in giving the desired results which avoids bias and misleading interpretation. The ordered logistic regression model is significant (X^2=45.62, p-value<0.001) at a 1% level which indicates that statistically significant factors of the effectiveness of CDO exist. Plus, the coefficient of determination (R^2=0.145) has shown a model fit that implies that the effectiveness of CDO is governed by some determinants of coconut farmers.

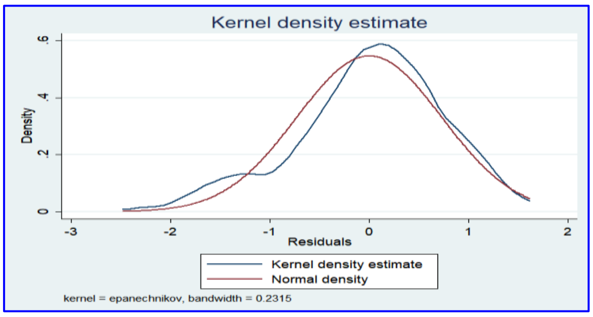

Fig. 1. Graph of k-density and normal density of residuals.
Source: Authors' construction (2023).

Hence, the following independent variables are significant factors of the effectiveness of CDO that include age (significant at 5% level), educational attainment (significant at 10% level), annual income (significant at 1% level), being an owner of coconut farm (significant at 1% level), training attended (significant at 5% level), and membership of any agricultural organization (significant at 1% level).

Table 4. Regression model (ordered logistic) for the effectiveness of CDO staff and its influencing factors

Causal Factors of Effectiveness of CDO	Ordered Logit Models	
	Coefficient	*Std Error*
Socio-demographic profile		
Age[a]	-0.047**	0.019
Male[b]	-0.026[ns]	0.400
Married[b]	0.108[ns]	0.472
Educational attainment	-0.295*	0.151
Household size	-0.034[ns]	0.092
log (Annual income[c])	2.601***	0.914
Farming profile		
Farm owner[b]	1.273***	0.468
Farm size[d]	0.051[ns]	0.145
Farming experience[a]	-0.018[ns]	0.018
Training[b]	1.051**	0.418
Membership[b]	1.167***	0.389
Observation	132	
χ^2-computed	45.62	
p-value (two-sided)	<0.001	
Pseudo R^2	0.145	

Note: a - in years; b - dummy variable; c - in Philippine peso (PHP); d - in hectares (ha); *p<0.10; **p<0.05***p<0.01.
Source: Author's calculation (2023).

The model reveals that younger farmers are positively influencing the effectiveness of CDO in their responsibilities. This means that if the farmers are more active and able to do the different activities in coconut planting and management, the CDO effectiveness is more likely to take place. Note that if the farmer is young, they can do more masculine work compared to older farmers [3]. Plus, as the age of a farmer increases, work productivity is decreasing [17], [18]. Secondly, the model depicted that farmers with low educational attainment say that CDOs are effective in their tasks. This means that farmers with less knowledge of higher education perceived that they are being helped by CDO to improve their productivity in coconut farming. This further indicates that being a coconut farmer does not have to attain a good education for their task as a worker on the farm. As long as they are guided by extension agents (i.e., CDO in PCPP), they can be more productive in their coconut activities [21]. In fact, most educated individuals are looking for a decent job to improve their economic income and live on to farm instead [4]. A farmer with a higher annual income said that CDOs are effective in their responsibilities. This implies that CDOs are doing their job well and have increased the productivity and economic profit of coconut farmers. In [6], it is stated that CDOs are taking a sense of responsibility as problem solvers and as a helper of the farmers' technical activities in coconut planting management. Moreover, the model reveals that a farmer who owned a coconut farm said that CDO staffs are effective in their work. It is worth noting that if a farmer owned the land, they take all the responsibilities and the economic profit which is more advantageous to other farmers who are just tenants. This indicates that they can directly observe the changes and benefits of having the guidance of CDO as they participated in the PCPP. In fact, farmers who owned their farms will not anymore pay labor and they don't have to share a portion of their profit [4], [15], [20]. Plus, training and workshops in agriculture are helping the coconut farmers to see the effectiveness of CDO as their educator. This indicates that farmers are being oriented rigorously with the different innovative technologies that might help in progressing the coconut growing [9]. According to [15], training and educational program in agriculture improve the farmers' knowledge, practices, and attitudes as well as their economic profitability. Furthermore, the model discloses that membership in any agricultural association is a significant factor in the coconut farmers' perspective that CDOs are effective agents. This means that the benefits of being a member of an association help the farmers experience the results of CDO's role in coconut growing activities. In [1] and [19], it is depicted that an agricultural association is vital to the farmers' concerns and needs which include information and capital.

CONCLUSIONS

This article aimed to explain how effective is the CDO of PCPP in a farmers' perspective and determine its statistically significant factors. The findings of this study revealed that CDOs are effective in their job as helpers of farmers to improve their coconut growing activities. Thus, they have done their duties as an educator and problem solvers in regard to assessing the coconut farmers in the PCPP program. Conclusively, being a young farmer, having low education attainment, and having a good economic income have influenced the farmers' view of the effectiveness of CDO. In addition, a farmer who owned their coconut field, training and seminars, and membership in a farmers association are predictors of the effectiveness of CDO. Hence, the CDO must be strengthened through rigorous training to educate young farmers and help them improve their practices and income. Furthermore, it is suggested that one may incorporate the farmers' happiness level and access to credit in coconut farming to elucidate their economic well-being for future studies.

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ASSESSMENT OF THE IMPLEMENTATION OF THE STRATEGIC SUPPORT GRANTED TO BENEFICIARY COMPANIES UNDER PROJECT POCU/227/3/8/117618 THROUGH THE ANALYSIS OF THE MAIN ECONOMIC AND FINANCIAL INDICATORS

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Abstract

The aim of this study is the analysis of the economic and financial indicators of the companies which benefited of the strategic support offered within Operational Programme Human Capital by implementation of Project POCU/227/3/8/117618. The project was developed starting from the premise of ensuring the sustainability of the measures and integrated activities and the targeted results. To set up this research study, it was used the following methodology: the comparison method and the structural analysis of profit. The obtained results showed that after the project completion, it validated the hypothesis that the experience gained within the project contributed to the increase in the performance of the SMEs benefiting from strategic support. The study carried out during the sustainability period, after exiting the operation, of the activity of the companies that benefited from strategic support, highlights the direct social and human impact, in the process of increasing the degree of competitiveness generated by the improvement of the technical-economic indicators of the majority of supported SMEs..

Key words: *sustainability, strategic planning. SMEs, economic and financial indicators*

INTRODUCTION

The project "Development of the workforce and SMEs in the fields of SNC/SNCDI, by ensuring improved working conditions and anticipating changes - We develop SMEs" carried out in the period 2018-2019, had as its general objective the support of at least 502 people (employees and entrepreneurs) and 46 SMEs, by facilitating access to integrated activities, measures and tools to increase employers' awareness of the importance and necessity of employee participation in professional training programs, to improve professional skills and entrepreneurial and for supporting businesses regarding strategic planning for anticipation and adaptation to change, with the aim of increasing the degree of anticipation and adaptability to changes and to the dynamics of economic sectors with competitive potential identified according to SNC and in correlation with SNCDI.

The project's activities led to the stimulation of high-performance human resources and capacities, with a direct social and human impact in the process of increasing the degree of competitiveness, with the aim of increasing the adaptation of SMEs' activity to the dynamics of economic sectors. In this way, a better understanding, coordination, integration and application of local/regional policies and strategies is achieved in order to support businesses to adapt and anticipate changes, an aspect that can support the process of sustainability of the services developed in this project. The concept of sustainability is made up of three pillars: economic, social and environmental. The sustainability of a project is based, first of all, on realism. Thus, the more objective the goals are, the organization will be able to fulfil its mission in the way it intended [4]. SMEs are particularly important in supporting social and regional development, thus having a valuable and productive approach at all levels of responsibility. These economic agents represent active and dynamic factors of a functional market economy. Having a significant importance at economic, social and political levels, SMEs are the basis of a modern society. Moreover, economic realities demonstrate the existence of a strong complementary relationships between large companies and SMEs [1].

The sustainability of the project is also based on the economic option by developing the parameters of creativity, efficiency, effectiveness and economic growth. In this context, the purpose of the paper is the analysis of the economic and financial indicators of the companies which benefited of the strategic support offered within Operational Programme Human Capital by implementation of Project POCU/227/3/8/ 117618. In this way, we tried to demonstrate that the experience gained by the companies that benefited from strategic support within the project contributed to the increase in the performance of SMEs.

MATERIALSAND METHODS

Within the POCU/227/3/8/117618 project, 46 small and medium-sized enterprises were selected and benefited from support for the realization of strategic planning. These companies operate in the South-Muntenia, South-East and Central Development Regions, both in urban and rural areas.

The priority sectors with a competitive advantage" in which these companies operate are presented in Table 1.

Table 1. The distribution of companies by fields of activity

Field of activity	No. of companies
Tourism and ecotourism	4
Textiles and leather	5
Wood and furniture	5
Creative industries	18
Information and communication technology	3
Food and beverage processing	8
Health and pharmaceuticals	1
Energy and environmental management	2
TOTAL	46

Source: Project target group of companies.

Figure 1 also shows the dispersion of the target companies by field of activity.

Starting from the hypothesis that the experience gained within the project, as a result of the implementation of strategic planning, contributed to the increase in the performance of SMEs benefiting from strategic support, we followed the evolution of the main economic efficiency indicators of these companies, in the period 2018-2021.

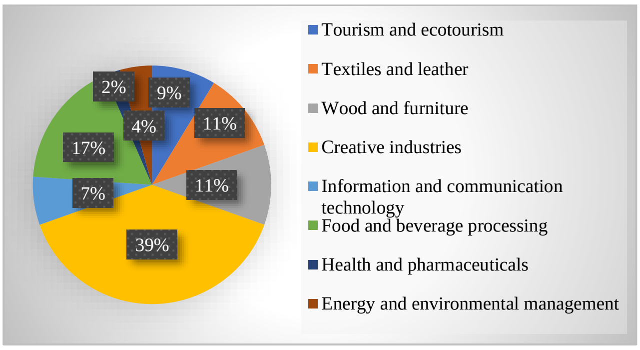

Fig 1. The distribution of companies by fields of activity
Source: Project data.

A classification of the economic efficiency indicators of SMEs, [10] expressed in the form of models, is:

a) the model of the mathematical ratio of the form:

■ economic effects for the appropriate efforts,
■ economic efforts for economic effects,

and when calculating these indicators, the annual effects can be taken into account, but especially the integral economic effects, the investment costs, but also the total investment and operating costs [2], [5].

This kind of indicators [12] is expressed in the form:

• specific efforts (costs) to obtain units of economic effects,
• effects (results) that are specific to the unit of measurement of the necessary costs, driven by the implementation of the project in the given version:
• rates of return and their inverse,
• coefficients

b) the model of the difference between total revenues (receipts) and total costs (expenses), considered over a time horizon equal to the duration of the investments, to which is added the duration of effective operation of the capacities that are put into operation.

The indicators obtained based on this model are of the type of gain or net profit obtained on account of the realization of a certain project.

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c) the model of total investment and operating costs, corresponding to the construction and operation needs of production or service capacities. With such indicators, the capital commitment is evaluated, consisting of the initial investment costs and the total operating costs.

d) the structure index model, both for costs and for some economic effects. This type of indicators is expressed in the form of share, specific weight or percentage.

The calculation method chosen was that of the difference between total incomes (receipts) and total costs (expenses), the indicators obtained being of the type of gain or net profit obtained. The published indicators from the annual financial statements/annual accounting reports of economic agents are based on the provisions of OMF no. 1420/2021 [10] regarding the publication of public information on the server of the Ministry of Finance [8].

In this regard, there were used annual data to track the evolution of both total revenue and total expenditure during 2018-2021. In addition, it was also evaluated the evolution of the number of employees in the same period, in order to identify changes in the activity of the companies and the impact of the changes on the organizational "culture" at the SME's level.

RESULTS AND DISCUSSIONS

Based on the economic-financial indicators revealed by public sources [8], the beneficiary enterprises of SME support services of the implementation of strategic planning within the project POCU/227/3/8/117618, have been grouped into 4 categories:

-companies that registered a profit during the analyzed period;

-companies that recorded losses during the analyzed period;

-companies that recorded losses and suspended their activity;

-delisted companies.

The empirical research, carried out during the sustainability period, after exiting the operation, of the activity of the companies that benefited from strategic support, highlights the direct social and human impact, in the process of increasing the degree of competitiveness generated by the improvement of the technical-economic indicators of the majority (63%) of SME's supported ones.

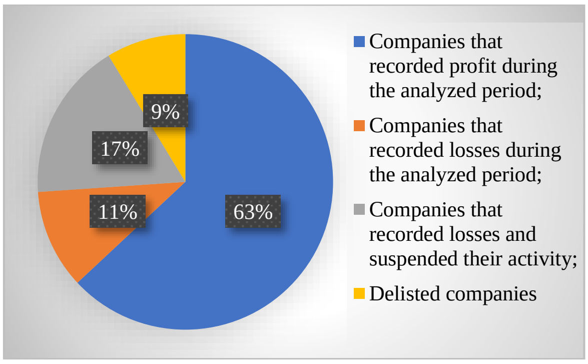

Fig 2. The share of supported company groups depending on the status of the activity
Source: https://www.listafirme.ro/ [7].

The effects of the multiple crises that directly affected the Romanian economy in the last 3 years and that are also reflected in the economic-financial indicators achieved by the supported companies, after exiting the operation, should not be ignored.

According to the data presented by the National Office of the Trade Register (ONRC), the number of delisted companies at the national level increased by 8.87% in the first seven months of 2022, compared to the same period last year. This brought up to 41,007 deregistered companies, according to the ONRC. By field of activity, the highest number of suspensions was recorded in the first six months in wholesale and retail trade, repair of motor vehicles and motorcycles, respectively 2,391 (+22.05%)), other service activities – 821 suspensions (+5.80%) and in professional, scientific and technical activities – 741 suspensions (+33.03%) [9].

The negative impact of the COVID-19 crisis on economic activity has led to significant unintended consequences for economies around the world, given the current extent of globalization and interconnection. While the trade in services showed some resistance during the financial crisis of 2008, this time the restriction measures to limit the virus and social isolation affected their consumption due to the specific characteristics of their nature: proximity of consumption, intangibility, heterogeneity, and perishability [11].

Paraschiv D et al. [11] evaluates the behavior of the major groups of traded services in the same period in Romania, to identify changes in the distribution of services, comparing the evolution of trade in services during the financial crisis and the current crisis. Imports of services are found to have declined more than exports. In addition, the export of services was less affected than the export of goods, while imports of services were affected more severely than the decline in imports of goods. Travel and tourism were the most affected, while the rest of the major sectors are seeing some recovery at the end of 2020.

The research carried out by Mihail Busu et al. in 2020 [3] investigates the relationship between three internal factors of a retail company (the number of employees, current assets and fixed assets) and the company's net profit. The multilinear regression model applied to retail companies to test the hypothesis demonstrated that internal factors of a retail company, influence not only customer satisfaction or macroeconomic factors, but also have an impact on company profitability.

The cross-functional analysis of the company's activities creates added value for all parties involved: customers, entrepreneurs, employees and the community [6].

CONCLUSIONS

One of the best ways for an organization to succeed in a project is to aim for small-scale changes at first so that it can measure results and gain experience in implementing other similar plans. Close monitoring of progress and results will lead to the realization of the efforts made in achieving the objectives. The study carried out during the sustainability period, after exiting the operation, of the activity of the companies that benefited from strategic support, highlights the direct social and human impact, in the process of increasing the degree of competitiveness generated by the improvement of the technical-economic indicators of the majority of supported SMEs.

The project's activities led to the stimulation of high-performance human resources and capacities, with a direct social and human impact in the process of increasing the degree of competitiveness, with the aim of increasing the adaptation of SMEs' activity to the dynamics of competitive sectors.

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SOCIO-ECONOMIC EFFECTS ON THE RURAL DEVELOPMENT IN ROMANIA IN THE FIRST YEAR OF THE COVID-19 PANDEMIC

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Abstract

The emergence of the COVID-19 crisis has represented a challenge for the entire world, generating new social and economic paradigms. Besides the many negative effects, there are also positive effects of the pandemic, and here we must emphasise the change of perspective with regard to the funding policies, which no longer target only the return to the situation before the pandemic, but a step forward, towards a green, digital and more resilient Europe. The immediate effects in the case of the Romanian countryside highlight the different reception of the pandemic shock across the territory. Starting from the calculation of the Rural Development Index at the county level for the period 2018-2020, with 2018 being the reference year, the evolution of the index was analyzed quantitatively and qualitatively from the perspective of the effects induced by the COVID-19 pandemic. Thus, while before the COVID-19 crisis, the rural development level registered a slight translation of counties from the lower to the upper part of the ranking, during the pandemic the process was reversed, even though at national level there is a constant appreciation of the rural development index.

Key words**:** *rural development, Covid-19 crisis, regional gaps*

INTRODUCTION

The Covid-19 pandemic has resulted in unprecedented challenges to the economy and the agri-food sector; the lesson that must be learnt is that certain shocks, be they health shocks, extreme weather events or armed conflicts, cannot be prevented. The agri-food sector resilience in the face of these challenges can be increased only by preparing the various actors in the agri-food value chain for a series of major structural changes that will have an impact on the entire sector.

Starting from Romania's situation before the Covid-19 crisis, characterised by major territorial disparities between different rural areas, this phenomenon significantly increased after the change of the political regime in 1989 and continued to perpetuate in the next period, even after Romania's accession to the EU. The Covid-19 pandemic found Romania with a large socio-economic gap between the country's rural regions [10]. The impact of the Covid-19 crisis and the economic recovery after the pandemic, in Romania, will take place asymmetrically, with significant differences across regions and sectors, and will depend on the effectiveness of economic recovery programmes [13].

The implications of the Covid-19 crisis on rural actors are mentioned in reference documents by the Food and Agriculture Organization of the United Nations and the European Commission. FAO warned that the Covid-19 pandemic could lead to a food crisis, which would affect the most vulnerable persons in the first place, including small farmers, who are facing challenges in the access to markets to sell their products, in the purchase of essential inputs and in the sale of products to consumers with low purchasing power. While the European Commissioner for agriculture highlighted that *"The COVID-19 pandemic has unprecedented consequences on society and economy. Farmers and every actor in the EU food supply chain are working hard to supply our daily food, despite the difficulties they are facing. The European Commission will continue to provide support to farmers and food producers, to collaborate with the EU member states and take all necessary measures to ensure the health and well-being of European citizens"* [8].

There were multiple immediate effects of the Covid-19 pandemic on the economy and the agri-food sector, among which: changing the consumption pattern through food shortage, frantic buying of products, price increases; internal and international movement restrictions; closing restaurants, hotels and schools; delays in the supply of raw materials to agricultural producers; production decline and decrease in the number of jobs; decline in foreign investment, etc.

The resilience of agri-food systems was an important issue after the immediate impact of the Covid-19 crisis, this being a major concern at EU level [5]. The first measures of the European Commission aimed at the temporary suspension of the Stability and Growth Pact (which allows high shares, above the limit of 60% of GDP, of the public debt and the increase of budgetary deficit above the limit of 3% of GDP in order to counteract the negative economic effects of the health crisis) over the entire period of the crisis [12]; this is an unprecedented measure in the EU history: the full suspension of the SGP, even though it is temporary, has never been applied since its adoption.

In a timeframe, the recovery of the EU economy can be seen in 3 directions [2]: 1) emergency measures aimed at ensuring liquidities to combat the negative impact on the European economy and society, adopted after the outbreak of the crisis; 2) measures to support solvency, support and restart businesses and resume economic and social activities and 3) economic recovery measures, the solvency and economic recovery components being found in the form of a new temporary recovery instrument NextGeneration EU (NGEU), adopted in late 2020, which strengthens the Union's post-2020 budget. NGEU has an allocated budget worth 750 billion euros in 2018 prices (about 806 billion in current prices) that strengthens the priorities and the budget of the Multiannual Financial Framework (MFF) 2021-2027, of 1,074.3 billion euros, in 2018 prices, relevant for the economic recovery and improving EU's resilience. The NGEU budget is funded from financial resources mobilised from financial markets (by issuing Eurobondss).

The context of COVID crisis has generated a change of vision and priorities at the level of long-term EU budget: *the recovery* being integrated in the programmes and new priorities and the strengthening of key areas for the post-crisis recovery that target the Multiannual Financial Framework 2021-2027, to the detriment of traditional areas dominant in the MFF in previous periods. In these conditions, although the agricultural policy and the cohesion policy remain the main chapters of the budget on the long term, with budget allocations of over 30% of the 2021-2027 MFF, their share has been decreasing compared to the period 2014-2020.

Compared to previous programming periods, a number of priorities – such as research & development, the Connecting Europe Facility, the EU Civil Protection Mechanism – have been strengthened and new priorities have been introduced, such as: health, fair transition, digital transformation, etc.

The EU recovery, in the context of MFF 2021-2027 and NGEU, is not limited to financing measures *to return to the pre-crisis status quo*, it rather aims *to achieve a step forward that involves undoing the short-term damages caused by the crisis in a way that also invests in the Union's future on the long term* [7], to make Europe ***greener, more digital and more resilient***.

The ***green economy*** elements and the green transition become permanent points on the strategic agenda of the European Union. A series of documents – targeting the previous programming period "*Towards a sustainable Europe by 2030*", as well as the present and next period – the EU Strategic Agenda for 2019-2024 – highlight the need to move from a linear to a circular economy and the importance of sustainable development to reduce the negative impact of the economy on the environment [6].

Digital transformation is an important pillar in achieving the objective of *developing a solid and dynamic base* from the EU Strategic Agenda 2019-2024, representing the core element for the implementation of the EU's priority *Europe fit for the digital age* from the political agenda of the European Commission for the period 2019-2024 [9].

Digitalisation/digital transformation aims at creating new development opportunities for regional and national economies, as well as at improving citizens' quality of life and promoting sustainable development. The digitalisation effects are perceived in all areas of economic, social and political life [3].

Resilience is defined by the European Commission as "*a broader concept applicable at the level of society and its components, including aspects of democracy, trust in institutions, sustainable development and reform capacity*" and is correlated with the political and external security context, economic resilience and environmental challenges and risks (climate change).

In the European discourse, the ***resilience*** concept was introduced by the European Commission in 2012, being associated, in a first stage, with addressing the issue of security and food crisis: resilience is defined as *the ability of an individual, community, country or region to adapt and recover quickly after a crisis or shock* (COM (2012) 586 final) and implies: a) the intrinsic capacity of a community/region/system to withstand a shock or crisis and b) the ability of the entity concerned to withstand and quickly recover after the shock or crisis that has affected it.

The predictors of a ***resilient*** economy/society assume a number of characteristics that these should meet [1]: *digital development, education, gender equality, public spending, innovation, labour market policies, macro-economic indicators, business and regulatory environment, governance, quality of life, attitudes in society, sustainability of economic development models.*

MATERIALS AND METHODS

The methodological scheme to quantify the Covid-19 crisis effects on the Romanian rural area will focus on the following elements:

-quantification of the composite index of the socio-economic development of the Romanian rural area [4], at county level, in the period 2018-2020 (2018 is considered the reference year) and the analysis of the COVID pandemic effects on the socio-economic development index of the rural area, by counties;

-all these aspects will be analysed at national, macro-regional and county level;

-quantitative and qualitative analysis of investigated phenomena.

RESULTS AND DISCUSSIONS

The rural socio-economic development index, in the present research study, aims to capture the rural development phenomenon across counties following the Covid-19 crisis, in dynamics, in the period 2018-2020. For a most clear picture of the evolution of rural development process in the territory, both the composite index (that allowed a ranking, a typology of counties by their rural development level) and its component dimensions were considered, in order to identify the factors that have influenced the rural development level.

Overall, in the investigated period, the rural development index (RDI) slightly appreciated in the year 2020, yet its evolution was different across the territory (Table 1).

Table 1. RDI evolution by degree of rurality, in the period 2018-2020

		RDI 2018	RDI 2019	RDI 2020
Total		1.36	1.36	1.40
Rurality	predominantly urban	1.99	1.98	2.34
	intermediate	1.46	1.47	1.53
	predominantly rural	1.27	1.27	1.29

Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

The territorial discrepancies reveal that the benefits of post-communist transition and of the EU membership have been unevenly distributed, with a strong polarisation between urban and rural areas and between different rural areas. This fact is also reflected in the different impact of the Covid-19 crisis at territorial level.

Thus, it can be noticed that the most obvious discrepancy in terms of the rural socio-economic development index depends on the rurality level, so that this index (RDI) is higher as the degree of rurality decreases (the predominantly urban counties have the highest values of this index (2.34), followed by the intermediate rural counties (1.53) and ultimately by the predominantly rural counties (1.29)). The increasing trend in all these categories is worth noting, yet in the case of predominantly urban areas the increase is significant, by 17.59%, as against 4.79% in the intermediate rural areas and only 1.57% in the predominantly rural areas.

The variations of the rural socio-economic development index, in the period 2018-2020, at macroregional level, reveals an increasing trend of the index in most macro-regions; decreases were found only in Macro-region 1, but this region still maintains its first position in the ranking, at considerable distance from the other macro-regions.

By development regions, the region București-Ilfov has a top position in the ranking (2.34), followed at a significant difference by the Centru Region (1.67), Vest Region (1.48), Nord-Vest Region (1.47), Nord-Est Region (1.40), while the last positions of the ranking are occupied by the regions Sud-Est (1.28), Sud (1.27) and Sud-Vest (1.08).

Table 2. RDI evolution by degree of rurality, by macro-regions and regions, in the period 2018-2020

		RDI 2018	RDI 2019	RDI 2020
Total		**1.36**	**1.36**	**1.40**
Macro-region	*Macro-region 1*	*1.60*	*1.58*	*1.57*
	Macro-region 2	*1.28*	*1.30*	*1.34*
	Macro-region 3	*1.28*	*1.28*	*1.40*
	Macro-region 4	*1.22*	*1.21*	*1.26*
Region	Nord-Vest	1.53	1.52	1.47
	Centru	1.66	1.64	1.67
	Nord-Est	1.37	1.39	1.40
	Sud-Est	1.18	1.21	1.28
	Sud	1.18	1.18	1.27
	București-Ilfov	1.99	1.98	2.34
	Sud-Vest	1.05	1.03	1.08
	Vest	1.44	1.44	1.48

Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

By county, the ranking begins with Brașov (2.45), Ilfov (2.34), Timiș (2.08), Suceava (1.70), Bihor (1.65), Maramureș (1.64), Sibiu (1.62), and ends up with Olt (0.85), Caraș-Severin (0.95), Vâlcea (0.97) and Teleorman (0.97) (Table 2).

The smaller the territorial unit we refer to, the higher the discrepancy of the development index, so that while the gap is 0.31 at macro-regional level, it is 1.26 at regional level, to reach 1.60 at county level.

The classification of counties by the rural development level results in the following ranking:

- counties with good development level: Ilfov and Brașov;
- counties with an acceptable development level: Timiș;
- counties with medium development level: Harghita, Dâmbovița, Mureș, Iași, Alba, Călărași, Sibiu, Maramureș, Bihor, Suceava;
- counties with low development level: Ialomița, Gorj, Tulcea, Brăila, Neamț, Dolj, Vrancea, Covasna, Botoșani, Bacău, Argeș, Cluj, Bistrița-Năsăud, Hunedoara, Galați, Arad, Constanța, Satu-Mare;
- counties with very low development level: Olt, Caraș-Severin, Vâlcea, Teleorman, Buzău, Giurgiu, Mehedinți, Vaslui, Prahova, Sălaj.

Even though overall, the rural development index increased in all categories of counties, the translating of counties into lower categories is worth noting. Thus, the counties with very low and low development level cumulated 39.02% in 2018, while in the year 2020 their share reached 69.29%, to the detriment of counties with medium, acceptable or good development level. This evolution highlights the different responses to the crisis caused by COVID 19 at territorial level (Fig. 1).

Depending on the evolution of the rural development index, in the period 2018-2020, three directions of evolution of rural areas can be noted at county level: *counties with a steady trend* (19 counties: Argeș, Bihor, Botoșani, Brașov, Buzău, Călărași, Dâmbovița, Dolj, Galați, Giurgiu; Hunedoara, Ialomița Iași, Ilfov; Olt, Teleorman, Tulcea Vâlcea); *counties in moderate decline* (17 counties: Alba, Arad, Bacău, Brăila, Caraș-

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Severin, Constanța, Covasna, Harghita, Maramureș, Mehedinți, Mureș, Neamț, Sibiu, Suceava, Timiș, Vaslui, Vrancea); *counties in strong decline* (5 in number: Bistrița-Năsăud; Cluj; Prahova, Sălaj, Satu Mare).

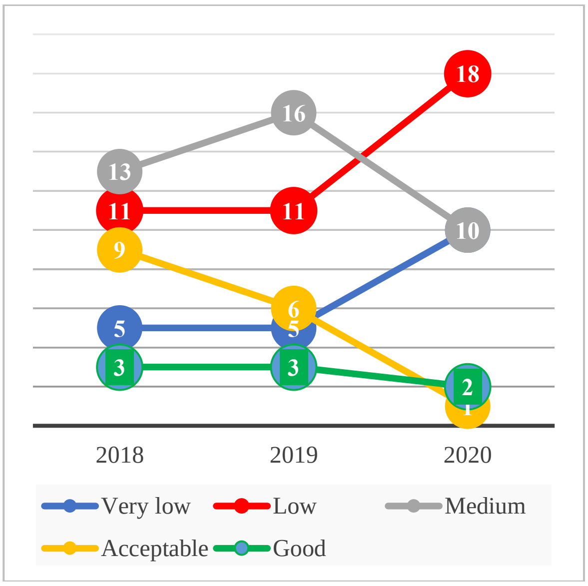

Fig. 1. Evolution of counties in number by categories according to the rural development level in the period 2018-2020
Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

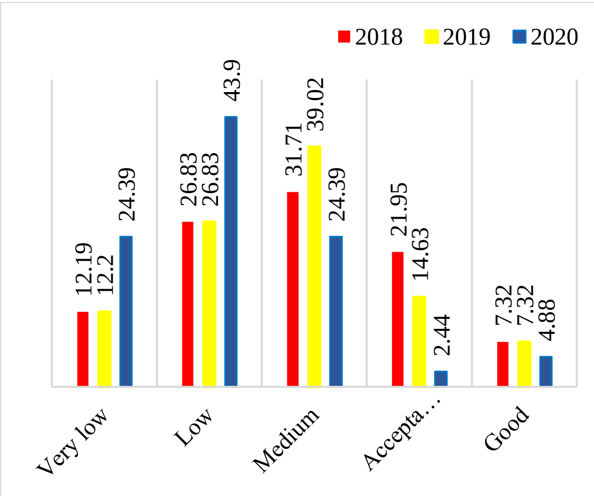

Fig. 2. Evolution of counties in percentage by categories according to the rural development level in the period 2018-2020
Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

In order to find explanations for this evolution, the analysis will start from the evolution of index for each category; the evolution of the dimensions related to the index, as well as the indicators related to each dimension will be analysed.

In the category of counties in strong decline, in the year 2020, the average rural development index was 1.33, ranging from 1.16 in Prahova County to 1.48 in Satu Mare. Out of the counties in this category, in the year 2020, 60% were counties with low development level and 40% with very low development level, these coming from the category of counties with medium and acceptable development level in the year 2018 (Table 3).

Table 3. Evolution of the RDI index and component dimensions, in the period 2018-2020, for the counties in strong decline

	RDI		Demographic dimension		Social dimension		Economic dimension		Ecological dimension	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Counties in strong decline	Decreasing trend		Decreasing trend		Oscillating trend		Oscillating trend		Decreasing trend	
Bistrita-Nasaud	1.54	1.43	0.63	0.60	0.30	0.33	0.40	0.37	0.21	0.13
Cluj	1.58	1.41	0.52	0.51	0.36	0.35	0.33	0.35	0.36	0.20
Prahova	1.29	1.16	0.46	0.36	0.39	0.36	0.34	0.28	0.11	0.16
Salaj	1.28	1.18	0.46	0.47	0.31	0.27	0.43	0.41	0.09	0.04
Satu Mare	1.55	1.48	0.67	0.65	0.32	0.30	0.31	0.25	0.25	0.27
TOTAL	1.45	1.33	0.51	0.49	0.37	0.37	0.30	0.33	0.20	0.16

Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

A decrease was noticed in the absolute values of all dimensions that make up the rural development index, for this category of counties, as follows: demographic dimension -5.47%, social dimension -4.17%, economic dimension -8.29%, ecological dimension -21.57%.

There are certain changes in the evolution of the RDI index structure, with a slight increase in the importance of demographic dimension (from 37.85% to 38.89%) and of social dimension (from 23.20% to 24.17%); the economic dimension remains at about the same level (24.93%), while the importance of the ecological dimension decreased (from 15.32% to 12.01%).

The counties with the sharpest decrease are Cluj (-10.74%) and Prahova (-10.08%). The evolution of the two counties has no common points in terms of the structural evolution of the development index; it can be noticed that in the period 2018-2020 Cluj County had a favourable evolution in economic terms, a slight decrease in the demographic and social dimension and an ecological depreciation. At the same time, Prahova County had a positive evolution only in ecological terms, and significant decreases were noticed in all the other dimensions.

In the category of counties in moderate decline, in the year 2020, the average rural development index was 1.43 and varied from 0.95 in Caraș-Severin to 2.08 in Timiș.

In the year 2020, out of the counties in this category, 41.18% were counties with low development level, 35.29% counties with medium development level, 17.65% counties with very low development level and 5.88% counties with acceptable development level.

The absolute values of all dimensions that make up the rural development index, for this category of counties, decreased in the demographic (-3.08%) and social (-12.36%) dimensions, while an increase was noticed in the economic dimension (+8.96%) and the ecological dimension (+1.67%).

Certain changes were noticed in the evolution of the RDI index structure, with an increase in importance of the economic dimension (from 21.60% to 24.05%) and of the ecological dimension (from 14.79% to 15.03%); a decrease was noticed in the social dimension (from 26.08% to 23.35%) and in the demographic dimension (from 38.01% to 37.64%) (Table 4).

Table 4. Evolution of RDI index and component dimensions, in the period 2018-2020, for the counties in moderate decline

	RDI		Demo dim.		Social dim.		Econ. dim.		Eco dim.	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Counties in moderate decline	Decreasing tend		Maintaining trend		Oscillating trend		Increasing trend		Oscillating trend	
Alba	1.63	1.59	0.41	0.40	0.46	0.45	0.36	0.36	0.41	0.38
Arad	1.46	1.45	0.51	0.49	0.52	0.49	0.30	0.27	0.13	0.21
Bacău	1.38	1.38	0.57	0.54	0.29	0.25	0.32	0.36	0.20	0.24
Brăila	1.10	1.23	0.44	0.44	0.20	0.23	0.06	0.10	0.40	0.46
Caraș-Severin	1.06	0.95	0.33	0.31	0.30	0.19	0.39	0.39	0.05	0.06
Constanța	1.43	1.47	0.74	0.72	0.52	0.44	0.07	0.17	0.10	0.14
Covasna	1.31	1.35	0.62	0.64	0.24	0.21	0.32	0.36	0.14	0.14
Harghita	1.65	1.51	0.60	0.58	0.56	0.39	0.30	0.36	0.19	0.17
Maramureș	1.76	1.64	0.58	0.54	0.35	0.30	0.64	0.65	0.20	0.15
Mehedinți	1.07	1.05	0.38	0.38	0.36	0.31	0.16	0.17	0.18	0.19
Mureș	1.54	1.51	0.59	0.56	0.35	0.41	0.36	0.34	0.24	0.20
Neamț	1.35	1.27	0.50	0.47	0.40	0.36	0.24	0.26	0.22	0.18
Sibiu	1.73	1.62	0.70	0.68	0.40	0.33	0.45	0.45	0.17	0.16
Suceava	1.77	1.70	0.78	0.72	0.28	0.28	0.38	0.40	0.32	0.30
Timiș	2.04	2.08	0.69	0.68	0.48	0.46	0.52	0.60	0.35	0.35
Vaslui	1.07	1.14	0.50	0.51	0.26	0.23	0.19	0.25	0.12	0.15
Vrancea	1.46	1.34	0.49	0.48	0.50	0.34	0.30	0.35	0.17	0.17
TOTAL	1.46	1.43	0.55	0.54	0.38	0.33	0.32	0.34	0.21	0.21

Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

Table 5. Evolution of RDI index and component dimensions, in the period 2018-2020, for the counties with a steady trend

	RDI		Demo dim.		Social dim.		Econ. dim.		Ecol. dim.	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Counties with a steady trend	Increasing trend		Decreasing trend		Oscillating trend		Increasing trend		Increasing trend	
Argeș	1.26	1.39	0.38	0.31	0.42	0.56	0.39	0.40	0.07	0.12
Bihor	1.49	1.65	0.57	0.53	0.40	0.37	0.47	0.48	0.05	0.29
Botoșani	1.14	1.35	0.49	0.49	0.28	0.32	0.20	0.29	0.17	0.25
Brașov	2.12	2.45	0.77	0.77	0.52	0.55	0.64	0.61	0.19	0.53
Buzău	0.83	0.98	0.28	0.29	0.34	0.39	0.18	0.27	0.02	0.03
Călărași	1.41	1.61	0.50	0.49	0.32	0.41	0.16	0.30	0.42	0.41
Dâmbovița	1.35	1.51	0.55	0.47	0.34	0.52	0.34	0.35	0.12	0.18
Dolj	1.21	1.30	0.27	0.29	0.52	0.50	0.11	0.11	0.30	0.40
Galați	1.23	1.45	0.58	0.57	0.30	0.37	0.03	0.08	0.31	0.43
Giurgiu	0.95	1.04	0.42	0.43	0.24	0.32	0.18	0.17	0.11	0.12
Gorj	1.27	1.22	0.43	0.41	0.42	0.37	0.38	0.41	0.03	0.04
Hunedoara	1.18	1.45	0.24	0.22	0.47	0.39	0.43	0.59	0.05	0.25
Ialomița	1.23	1.21	0.44	0.45	0.35	0.34	0.09	0.20	0.35	0.23
Iași	1.51	1.58	0.81	0.82	0.37	0.35	0.17	0.24	0.17	0.18
Ilfov	1.99	2.34	0.94	0.92	0.46	0.77	0.43	0.43	0.16	0.22
Olt	0.79	0.85	0.12	0.10	0.40	0.37	0.16	0.17	0.11	0.21
Teleorman	0.78	0.97	0.05	0.05	0.30	0.47	0.13	0.15	0.30	0.29
Tulcea	1.04	1.23	0.46	0.44	0.37	0.42	0.14	0.25	0.07	0.11
Vâlcea	0.89	0.97	0.31	0.26	0.06	0.14	0.42	0.44	0.10	0.13
TOTAL	**1.25**	**1.40**	**0.45**	**0.44**	**0.36**	**0.42**	**0.27**	**0.31**	**0.16**	**0.23**

Source: author's own processing of statistical data collected from NIS Tempo online, accessed on September 30, 2022 [11].

In the category of counties with a steady trend in the year 2020, the average rural development index was 1.40, ranging from 0.85 in Olt county, to 2.45 in Brașov county. Out of the counties in this category, in the year 2020, 42.11% were counties with low development level, 26.32% counties with very low development level, 21.05% counties with medium development level and 10.52% with good development level (Tabel 5).

The absolute values of all dimensions of the rural development index, for this category of counties, decreased only in the case of the demographic dimension (-3.48%), while significant increases were noticed in the economic dimension (+17.62%), social dimension (+15.26) and ecological dimension (+42.58%).

Certain changes were noticed in the evolution of the RDI index structure, with an increase in the importance of the social dimension (from 29.07% to 29.87%), of the economic dimension (from 21.34% to 22.37%) and of the ecological dimension (from 11.68% to 16.65%); a decrease was noticed in the demographic dimension (from 36.38% to 31.30%).

CONCLUSIONS

The territorial discrepancies reveal that the benefits of post-communist transition and of EU membership have been unevenly distributed, with a strong polarisation between the urban and rural areas, as well as between different rural areas. This fact is also reflected in the different impact of the Covid-19 crisis at territorial level.

The Covid-19 crisis also came with a series of negative effects in the short and medium term, but also with a series of opportunities for Romania's economy, as well as for agriculture and rural areas, with medium and long-term effect. The intervention of the European Union has been more prompt and more focused than ever in combating the Covid-19 pandemic and its economic effects.

The most important support instrument established at EU level, the Next Generation (NEXTGEN) Programme, allocates financial resources of exceptional magnitude (1,850 billion euros, out of which about 550 billion in non-refundable form, and the difference up to 1,850 billion, in the form of credits at an extremely low interest rate), and has ambitious goals, not only to recover from the Covid-19 pandemic, but also to build the foundation of a stronger future European Union, which is greener, more digital and more resilient.

For Romania, this instrument takes the form of a National Recovery and Resilience Plan (NRRP) that represents the greatest opportunity to fight the effects of the pandemic, especially considering that our country will benefit from some of the most substantial allocations – about 33 billion euros in non-reimbursable form and about 55 billion euros in repayable form.

In Romania, the estimated effects of NRRP should materialise in the number of jobs created, economic growth and increase of the institutional resilience. The European Commission estimates that 90,000 jobs will be created as a result of infrastructure investment projects (an important component of NRRP) and of the digitalisation and education component. NRRP represents a great opportunity for the recovery and sustainable transformation of the economy in Romania (visible through the estimated effects on GDP, cohesion, green and digital transformation, under different scenarios) that our country should not miss; otherwise, the result will be a wider gap between Romania and the rest of the EU.

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ROMANIA'S POSITION IN THE WORLDWIDE TRADE WITH SUNFLOWER AND RAPE SEEDS

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Abstract

Romania is an important agricultural producer in the Black Sea basin, which benefits from pedoclimatic conditions favourable for the cultivation of oil plants. In this context, the paper aims to identify the position occupied by Romania in the global trade of rapeseed and sunflower seeds, for the period 2018-2022. To this end, quantitative and value imports and exports were analysed for these product categories, based on the statistical data available on specialized websites such as ITC. The results of the study show that Romania was the most important exporter worldwide, both in terms of value and quantity, of sunflower seeds in the period 2018-2021. In 2022, it lost the 1st place to Ukraine. Rapeseed ranked 5th in terms of exported quantity and 6th in terms of export values, among the world's top exporters. Also, Romania registered an increasing trend in the imports of sunflower and rapeseed for the studied period, especially in 2022. Imports of sunflower seeds placed Romania on the 4th place, and those of rapeseed on the 11th place in terms of quantity and respectively 12th for value.

Key words: *exporters, importers, rapeseed, Romania, sunflower seeds, trade*

INTRODUCTION

Romania's geographical position has generated a favourable climate and a fertile soil favourable to the cultivation of oleaginous plants in general and sunflower and rapeseed in particular. Romanian farmers were not interested in cultivating rapeseed, but recent macroeconomic changes [4], the development of hybrids resistant to pests and diseases [5] and the non-reimbursable European funds that stimulated agricultural production [14, 16] or the production of biofuel have changed this aspect [18].

In this way, in the year 2022, at the level of the European Union, Romania ranked first in terms of the area cultivated with sunflowers - 1,081,790 ha, and in 3rd place for the production obtained - 2,079,010 tons. In rapeseed, Romania occupied the fourth place both in the ranking of growers and producers, with 466,800 ha cultivated and a production of 1,222,640 tons [10].

It should be noted that among the oleaginous plants cultivated in the EU, the largest areas were occupied, in order, by rapeseed (59%), sunflower and soybean.

Oilseeds have been used to produce food and fuel, as animal feed, as well as for industrial purposes [9].

In Romania, in 2022, 8,005,889 ha were sown or planted in "own fields" (in Romanian "ogor propriu") [12]. Of these, the largest area was cultivated with corn - 30%, followed by wheat - 27% and oleaginous plants: sunflower - 14% (1,093,265 ha) and rapeseed - 6% (468,870 ha) – Figure 1.

The preference of Romanian farmers to grow more sunflowers among oilseed plants is still noticeable, different from the general trend manifested at the European level, but recently rapeseed is gaining their trust [3].

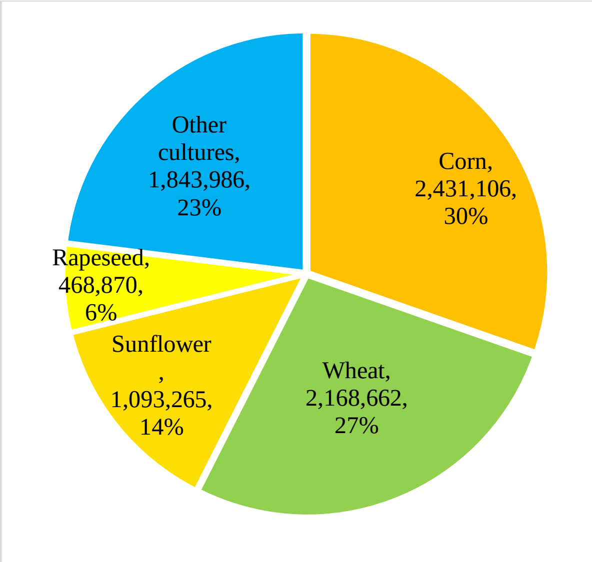

Fig. 1 The share of areas occupied by the main agricultural crops, in 2022, in Romania.
Source: own representation after [12].

In 2022, in the general ranking of Romanian exports, oleaginous plants included in the category "Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder" were ranked 13th, with a value of $2,136,739 thousand and represented 2.21% of Romania's total exports. During this time "Cereals" were in 5th place, with a value of $4,588,275 thousand, which represented 4.74%. The first place was occupied by "Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles" [13].

The analysis of the data available worldwide showed that the value exports of sunflower seeds increased in the period 2018-2022 by 64.61%, and the values recorded by the first 12 world exporters in 2022 represented 88.32% of the total. For world quantitative exports, the increase was 37.43%, and the first 12 ranked in 2022, together exported 93.42% of the total of 8,172,322 tons of sunflower seeds.

Global rapeseed exports in value terms increased by 68.82% in the analysed period. In 2022, the top 12 states together accounted for 90.85% of the total value of $17,537,480 thousand.

The value of world imports of sunflower seeds was $7,510,156 thousand in 2022, with an increase of 82.46% compared to 2018. The first 12 of the world ranking of importers accounted for 70.36% of the total.

Total value imports of rapeseed worldwide increased by 59.60% in the analysed time frame. 86.97% represents the percentage held by the imports of the first 12 world importers of the total [13].

In this context, the article will highlight the quantitative and valuable imports and exports of rapeseed and sunflower seeds of Romania and specify the place occupied by our country in the ranking of important players in this field.

MATERIALS AND METHODS

In this article the world oilseeds trade was analysed, highlighting the main importers and exporters of sunflower and rapeseed worldwide, in terms of quantity and value and the position occupied by Romania in this ranking was identified.

To obtain the data, the bibliographic method was used, and the studied period was 2018–2022. The analysed indicators were the quantities of sunflower and rapeseed exported and imported by Romania and the values of exports and imports for these categories of oleaginous plants.

The statistical data which was processed based on statistical data obtained from the International Trade Centre [13] website was processed and then represented graphically.

RESULTS AND DISCUSSIONS

Worldwide, in 2022, Ukraine was the main exporter of sunflower seeds, followed by Romania with an export value of $1,166,091 thousand and Bulgaria with an export value of $724,980 thousand (Figure 2). It is worth noting that Ukraine’s sunflower seed exports accounted for 18.67% of the world’s total sunflower seed exports, Romania’s 17.24%, and Bulgaria’s 10.72%.

As can be seen, the value exports of sunflower seeds of Ukraine increased from $28,231 thousand in 2018 to $1,263,155 thousand in

2022 (4,474.35%). Almost 80% of the total went to European Union countries and 19% to Turkey [8].

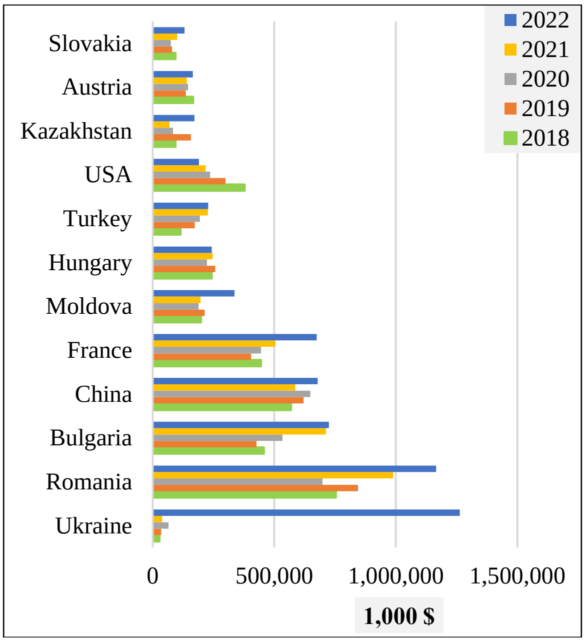

Fig. 2. Main sunflower seeds exporters worldwide* – value, 1,000 $.
* reporting to the year 2022
Source: own representation after [13].

In 2018-2021, Ukraine did not rank among the largest exporters of sunflower seeds. Since 2022, export values have increased. Compared with 2021, they increased with 3,223.49% in 2022 thanks to EU support [2].
Romania ranked first, in the period 2018-2021, in the top exporters of sunflower seeds in terms of value. In 2022, although it had an increase in the value of exports by 54.73% (meaning $1,166,091 thousand), compared to 2018, it was positioned in 2nd place, with a difference of $97,064 thousand compared to Ukraine. Although it was the world leader at that time, Romania recorded the lowest value for sunflower seeds exported in 2020, $698,733 thousand.
Other countries in the top world exporters in this category were: China, France, Moldova, Hungary, Turkey, USA, Kazakhstan, Austria and Slovakia. We can conclude that six EU member states were in this ranking and respectively five states from the Black Sea area, which is also an important cereal basin [7].

Among the main exporters in terms of value of sunflower seeds, also recorded decreases in 2022 compared to 2018: Hungary – 0.30%, USA – 49.66% and Austria – 0.62%.
From the data presented in Figure 3, it emerged that Ukraine exported the largest quantities of sunflower seeds in 2022, 2,767,006 tons, with an increase of 4,713.49% compared to 2018 (58,704 tons). Thus, Ukraine moved to first place, ahead of Romania, which held this position in the period 2018-2021. In third place was Bulgaria, which recorded a decrease in exports of 16.20%. In this ranking there were 5 EU member states and respectively 6 states from the area of the Black Sea basin.

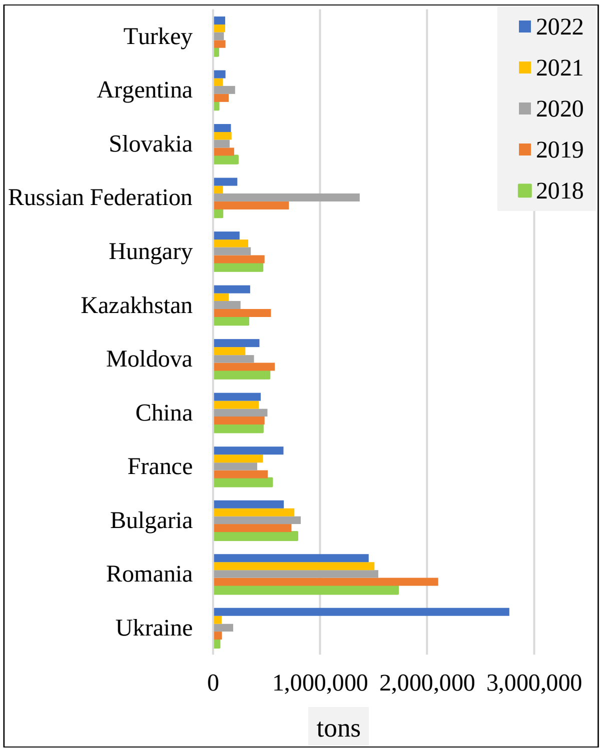

Fig. 3 Main sunflower seeds exporters worldwide* – quantitative, tons.
* reporting to the year 2022
Source: own representation after [13].

In 2022, Ukraine and Romania's sunflower seed quantitative exports account for 33.86% and 17.79% of the world's total sunflower seed exports respectively. Values in other federal states are below 8%.
From 2018 to 2021, Ukraine ranked last among the 12 largest sunflower seed exporting countries (quantitative). Instead, in

the year 2022 it was in first place, the increase recorded being 3,502.14%, compared to 2021.

Although it was the world leader, Romania's quantitative exports registered a decrease of 15.83% in 2022 (meaning 1,453,463 tons), compared to 2018, which was considered a good agricultural year for sunflower crop [15]. Also in 2019, there were favourable conditions for the development of sunflower plants [6] and the largest amount of exported sunflower seeds was recorded, 2,104,662 tons.

Due to the fact that it has limited processing capabilities, Romania exported most of its harvest. Thus, almost 2/3 of the harvest was delivered to Bulgaria (approximately 400,000 tons/year), Turkey (approximately 400,000 tons/year), Hungary (approximately 220,000 tons/year), to Western European countries or to Asian countries [1, 17].

Half of the most important 12 exporters recorded decreases in the quantities of sunflower seeds traded in the period 2018-2022 (Romania, Bulgaria, China, Moldova, Hungary and Slovakia). The biggest decrease was registered by Hungary - 46.08%.

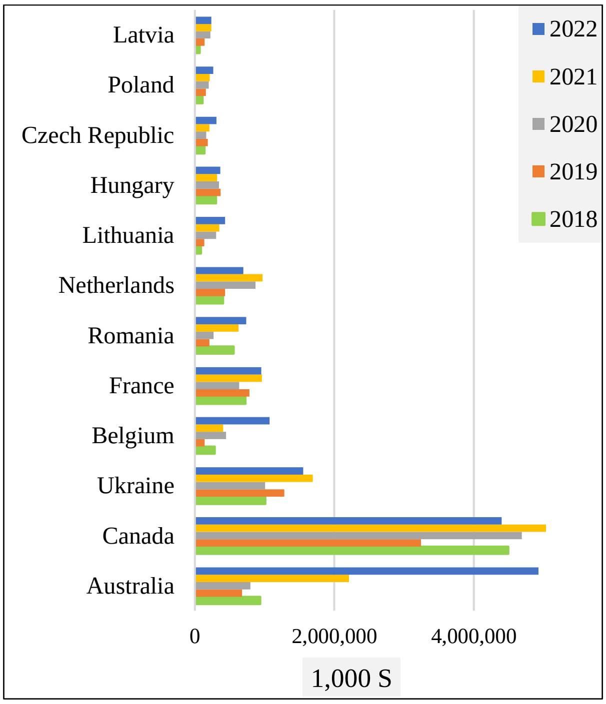

Fig. 4. Main rapeseeds exporters worldwide* – value, 1,000 $.
* reporting to the year 2022
Source: own representation after [13].

The main exporters of rapeseed for the analysed period can be found in Figure 4. It can be seen that, apart from the first 3 ranked, the other 9 states are members of the EU.

Australia ($4,927,169 thousand), Canada ($4,396,657 thousand) and Ukraine ($1,551,024 thousand) occupied the first 3 positions, and Romania took the 6th place, with $734,524 thousand in 2022. With the exception of Canada, which had a 2.24% decrease in export values, the other states in the Top 12 recorded increases. Australia (525.46%), Belgium (376.27%) and Latvia (345.21%) had the biggest increases.

Compared to 2021, in 2022 Australia doubled its export value (223.18%).

The value exports of rapeseed for Romania represented 4.19% of the total, in 2022, and the increase in the period 2018-2022 was 32.45%. Romania was the 3rd EU country, after Belgium (4th place) and France (5th place), which was among the top 12 world exporters of rapeseed. The lowest value obtained from rapeseed exports was in 2019 - $206,216 thousand.

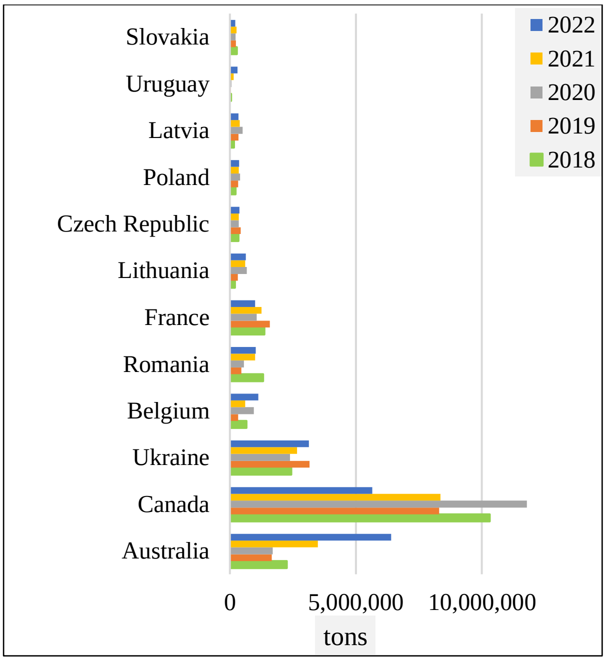

Fig. 5. Main rapeseeds exporters worldwide* – quantitative, tons.
* reporting to the year 2022
Source: own representation after [13].

On the first places in the top of the world rapeseed exporters at a quantitative level were Australia, Canada and Ukraine, which exported 6,395,425 tons, 5,651,642 tons and, respectively, 3,136,246 tons in 2022 (Figure 5). In 2022, Australia almost doubled the amount exported, compared to 2021 (183.18%).

In general, the quantitative exports of rapeseed registered increases in the period 2018-2022, with the exception of Canada, Romania, France and Slovakia. Canada had the biggest decrease - 45.19%.

Romania's quantitative rapeseed exports fluctuated during the analysed period and decreased in 2022 by 22.64%, compared to 2018. The amount of 1,021,306 tons exported in 2022 placed Romania in 5th place in the top exporters. The lowest exported quantity was recorded in 2019, 460,019 tons. At the same time, Romania was the 2nd country in the European Union, after Belgium (4th place), in the top exporters of rapeseed.

The analysis of the data on the world value imports of sunflowers (Figure 6) indicated that Bulgaria was in the first place in the top importers in 2022, with $1,012,206 thousand. Turkey ranked 2nd, with $647,689 thousand and the Netherlands – $539,683 thousand.

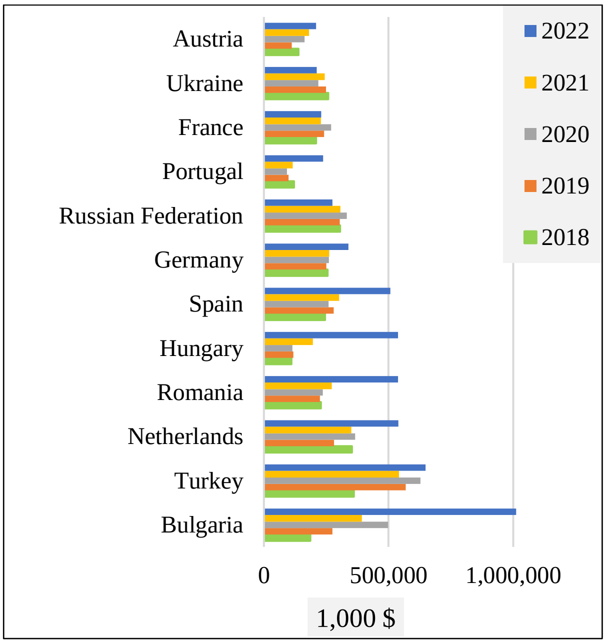

Fig. 6. Main sunflower seeds importers worldwide* - value, 1,000 $.
* reporting to the year 2022
Source: own representation after [13].

Value imports of sunflower seeds increased in 2022 compared to the values of 2018 for most of the states in the top importers. Exceptions were made by the Russian Federation and Ukraine, where decreases of 10.10% and 17.92% were recorded, respectively.

The presence of nine of the EU member states in this ranking of importers is noteworthy.

Although it was an important exporter of sunflowers, Romania found itself in the top 12 importers in position 4, registering $538,098 thousand in 2022. During the period under analysis, Romania's value imports increased in 2022, compared to 2018 (235.79%), in parallel with the increase in exports. The country from which Romania's sunflower imports mainly originated was Ukraine [8]. The lowest amount imported was in 2019, $224,795 thousand.

In 2022, Bulgaria's value imports represented 13.48%, Turkey's - 8.62%, the Netherlands' - 7.19% and Romania's - 7.16%, of the total world imports of sunflower seeds.

The analysis of the quantitative imports of sunflower seeds (Figure 7) showed that Bulgaria, Turkey and Romania kept their positions in the ranking of value imports.

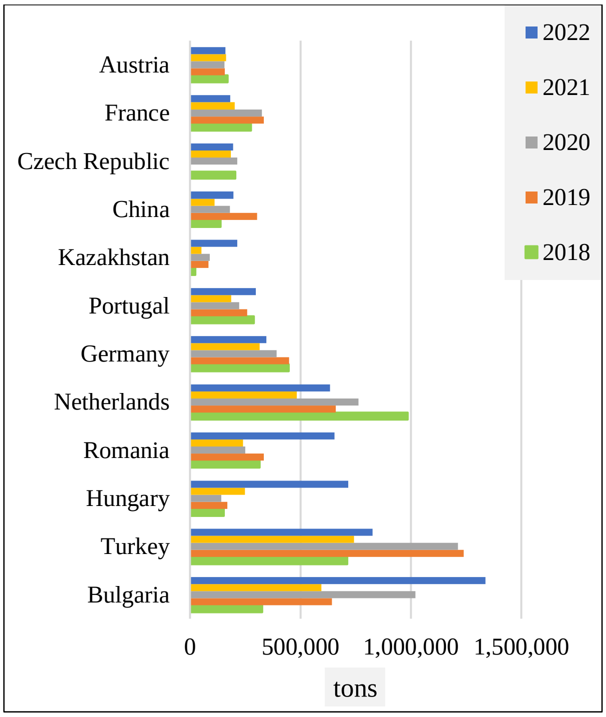

Fig. 7. Main sunflower seeds importers worldwide* - quantitative, tons.
* reporting to the year 2022
Source: own representation after [13].

Thus, in the first place was Bulgaria, which imported the largest amount of sunflower seeds, 1,337,262 tons in 2022 and doubled the amount imported compared to 2021. The increase for the period under analysis was of 408.80%.

The 2nd place was held by Turkey, with an increase of 116.05%, and on the 3rd place was Hungary, where the imported quantity increased by 468.62%.

In the 4th position, Romania reported a 207.34% increase in the amount of sunflower seeds imported in 2022 compared to 2018, i.e. 653,668 tons. Imported quantities varied from year to year, and in 2021 the lowest quantity was mentioned - 240,625 tons.

In 2022, quantitative imports of sunflower seeds increased compared to the values of 2018 for some of the states in the top importers, and for others they decreased: Netherlands, Germany, Czech Republic, France and Austria. The Netherlands had the biggest decrease - 35.67%, and the biggest increase in the imported quantity - Kazakhstan, 863.47%.

Regarding the world importers of rapeseed, from a value point of view, (Figure 8) Germany, Japan and Belgium held the first 3 places with the following values for the year 2022: $4,403,503 thousand, $1,966,880 thousand and $1,808,386 thousand, respectively.

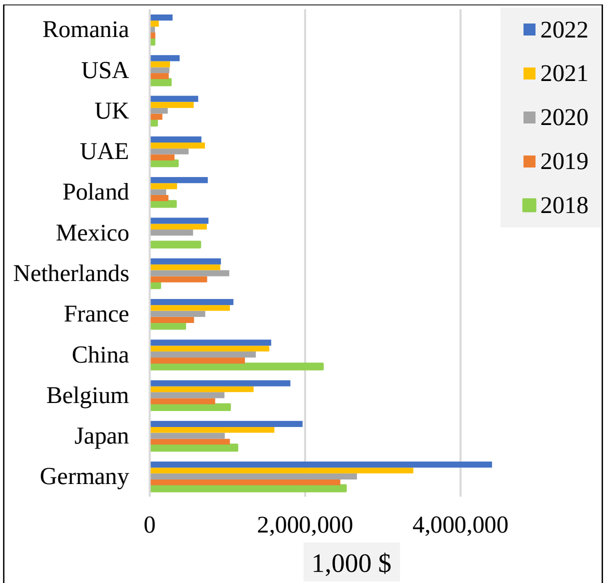

Fig. 8. Main rapeseed importers worldwide* - value, 1,000 $.
* reporting to the year 2022
Source: own representation after [13].

A total of 6 EU member states are among the most important importers. Germany's value imports in 2022 represented a quarter of the total and increased by 59.60% compared to 2018. For Japan, the increase was 74.73%, and for Belgium - 75.57%.

Also, from the analysis of the data presented by the International Trade Centre [13], it was noted the increase in the values of imports in the analysed time interval for other countries as well. The Netherlands had the biggest increase – 678.30%. China was the only one that registered a decrease in import values of 29.71%.

Romania ranked 12th in the ranking. In 2018 it imported rapeseed worth of $58,662 thousand, and in 2022 $293,698 thousand, which means an increase of 500.66%.

The analysis of the quantitative imports of rapeseed (Figure 9) showed that the first 4 countries in the ranking recorded decreases in the quantities of imported rapeseed: for Germany – 5.94%, Belgium – 3.46%, Japan – 10.12% and China – 58.78% (the biggest drop).

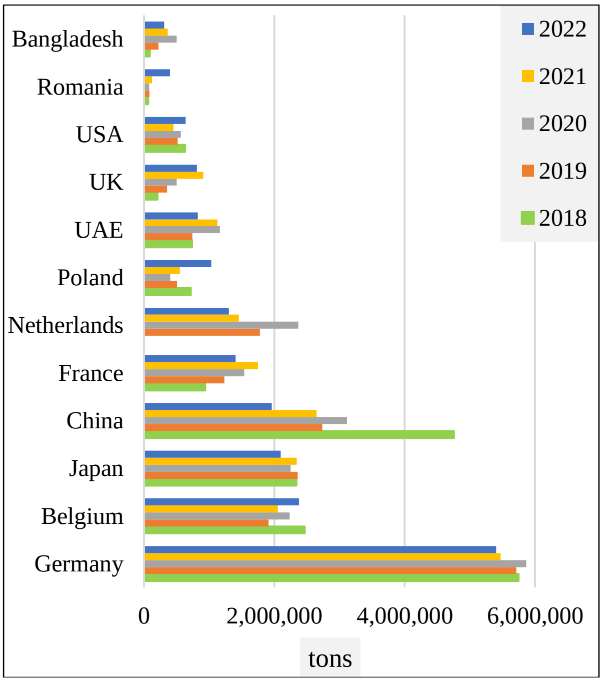

Figure 9. Main rapeseed importers worldwide* - quantitative, tons.
* reporting to the year 2022
Source: own representation after [13]

The largest amount of rapeseed was imported in 2022 by Germany – 5,405,041 tons. The

2nd place was held by Belgium, with approximately half of the quantity imported by Germany - 2,379,932 tons. Ranked 11th, Romania recorded a 498.93% increase in the amount of rapeseed imported in 2022 (398,126 tons) compared to 2018 (66,473 tons). The analysis of "The Supply Balances for the main agri-food products" [11] highlighted the fact that in 2021 Romania exported approximately half of the resources of rapeseed and sunflower seeds, meaning 40.25% for sunflower and 61.57% for rapeseed (Table 1).

Table 1 Share of imports and exports in the supply balances for sunflower and rapeseed in 2021

	Sunflower seed		Rapeseed	
	1,000 tons	%	1,000 tons	%
Total resources	3,760.20		1,634.80	
of which: - Total imports	240.9	6.41	125.4	7.67
Internal use of which:	1,290.20	34.31	396.5	24.25
- industrial use	1,283.10	99.45	391.3	98.69
- seeds	5.60	0.43	3.6	0.91
- losses	1.50	0.12	1.6	0.40
Total exports	1,513.60	40.25	1,006.60	61.57
Final stock	956.40	25.43	231.7	14.17

Source: own calculations after [11].

Domestically, 1,290.20 thousand tons of sunflower seeds were used (34.31%) and a smaller amount of rapeseed - 396.5 thousand tons (24.25%). For both categories of oleaginous plants, the highest use was in industry, 99.45% for sunflower and 98.69% for rapeseed. Losses were approximately equal in both types of seeds.

CONCLUSIONS

Following the analysis of the exports and imports of rapeseed and sunflower seeds for the period 2018-2022, the following conclusions were drawn:

• Benefiting from favourable conditions for the cultivation of oleaginous plants, Romania was the most important exporter of sunflower seeds, in terms of quantity and value, worldwide in the period 2018 – 2021. In 2022, this position was held by Ukraine;

• 2019 was the year in which Romania exported the largest amount of sunflower seeds - 2,104,662 tons;

• in the value exports category, the highest value was recorded in 2022 - 1,166,091 thousand dollars;

• Rapeseed exports placed Romania in 5th place due to the quantity and respectively 6th, due to the exported value;

• Romania exported the largest amount of rapeseed in 2018 - 1,320,200 tons;

• The highest value of rapeseed exports was obtained in 2022 - $734,524 thousand;

• In 2022, Romania doubled the value of sunflower seeds imports ($538,098 thousand) compared to 2021 and ranked 4th in the list of world importers; it also occupied the 4th place due to the imported quantity, of 634,098 tons;

• Compared to 2021, in 2022 the quantitative and value imports of rapeseed doubled, which led to Romania entering the top 12 importers in these categories.

Romania has agricultural potential both for sunflower and rapeseed cultivation, because, despite the fact that in 2022 sunflower crop occupied only 14% and rapeseed 6% of the total cultivated area and there were also problems related to drought in certain development regions, our country occupied 3rd place for the sunflower production and 4th for the rapeseed production obtained at the level of the European Union. The lack of processing units placed us, in the same year, among the first exporters of sunflower and rape seeds. By developing precision agriculture and especially irrigation systems, in order to be able to withstand climate changes, Romania will be able to continue to be an important producer of oleaginous plants, which will strengthen its status as an important player on the market in the future.

At the same time, the increase in the number of processing units will lead to an increase in exports of products from processed oilseeds.

ACKNOWLEDGEMENTS

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THE INVOLVEMENT OF THE COMMON AGRICULTURAL POLICY IN THE LIVESTOCK SECTOR AND THE CONTRIBUTION TO THE DEVELOPMENT OF MOUNTAIN RURAL AREAS

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Abstract

Animal husbandry is a traditional activity and an important source of income in the hilly and mountainous areas of Romania, which also supports secular activities in these places. In the context of the EU directives, animal husbandry must be combined with environmental protection actions without losing its importance and traditional elements. The Common Agricultural Policy 2021-2027 through the National Rural Development Programme offers broad support to the livestock sector, but also imposes certain restrictions, as manure from animal husbandry has a negative impact on soil and underground waters through nitrite and nitrate pollution. The article analyses the dynamics of cattle and sheep and goat herds from Romania's mountain area in the period 2015-2021 and the annual amounts of manure that can be obtained from these species. Some methods of using polluting products from animal husbandry are presented, such as using them in biogas plants and obtaining fertilizers from processed manure, which can contribute to the sustainable development of rural areas.

Key words: *animal husbandry, Common Agricultural Policy, environmental protection, manure, rural development*

INTRODUCTION

Livestock farming, a specific activity in the mountain area, has recently faced, in addition to economic problems, the requirements to adapt to environmental standards. Consequently, investment in farm modernization is needed in this sector, which ensure a good manure management [14].

The advantage that Romania has in terms of raising sheep and goats is due to its geographical position, with varied relief (mountains, hilly areas and plains in percentage of approximately 33% each) and large areas of pastures (3.3 million ha) and meadows (1.5 million ha), representing respectively 14% and 7% of the total of 14.6 million ha of agricultural land [19].

Sheep and goats make use of land unsuitable for cereal cultivation and other important categories of plants by grazing. At the same time, they represent an important factor for the preservation of biodiversity, the maintenance of local breeds thus avoids the "genetic erosion" caused by genetic crossings. At the same time, the manure they produce improves soil fertility and ensures plant biodiversity from the spontaneous flora [7].

With Romania's entry into the EU, a new trend appeared in the sheep sector, namely, the transition from raising sheep for milk, live lambs and wool, to the production of meat and milk for the European market [19].

At the same time, the legislative harmonization with the EU community acquis imposed compliance with the "animal welfare" requirements. In Romania this situation is slowly improving [21].

According to statistical data, in 2021, 10,087,439 sheep, 1,826,845 cattle and 1,492,544 goats were raised in Romania [17]. The production of manure obtained from these animals ranked dairy cows first, with 11,508 kg/year, followed by 1-2 years' cattle, with 7,749 kg/year and sheep in last place, with 843 kg/year [10].

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Manure from these animals is a source of pollution not to be neglected if not properly managed.

EU farmers have been affected hard by rising input prices, especially in Russia, Ukraine and Belarus, which provided 48.16% of the fertilizers used in the Member States in 2021 [9]. The European Commission considers manure to be the key that would help reduce costs and dependence on non-EU countries [22].

The article analysed how the livestock sector can contribute to the development of rural areas through the new requirements regarding manure management. Treatment and transformation through a process known as Manure Nitrogen Recovery (RENURE), agreed by the EU's Common Agricultural Policies (CAP), as well as use in biogas plants to obtain alternative heat and electricity are ways to harness the main pollutant in rural areas and an important step towards implementing the Zero-Waste concept [25].

MATERIALS AND METHODS

The purpose of this study was the analysis of how the livestock sector can contribute to the development of rural areas, taking into account the recommendations of the Common Agricultural Policies. The analysed period is 2015-2021. For the elaboration of this paper was used the information available online on the website of the National Institute of Statistics (INS), more precisely the Tempo-Online database. In order to better outline the existing situation on the Romanian animal husbandry sector, a series of indicators were analysed, such as: the number of live animals and the annual amounts of manure that can be obtained from several of the animal species. This information was processed using a quantitative analysis method and presented in the form of tables or graphs. Also, the data available on the Agency for the Financing of Rural Investments (AFIR) website was used, from which information regarding the number of selected funding applications for the Sub-measure 6.1 was extracted. In parallel, the specialty literature was studied, in order to know the current state of the information on the approved topic, in the context of support provided to this sector by the European Commission, through various specific policies.

RESULTS AND DISCUSSIONS

In Romania, the area included in the Mountain Area (ANC ZM) represents about 30% of the country's area (71,381.48 km^2) and covers 27 counties - Figure 1, 2.

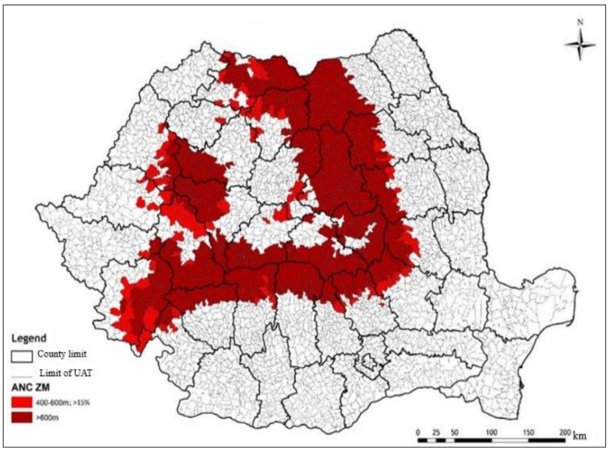

Fig. 1 Administrative-territorial units (UAT) included in the mountain area (ANC ZM) starting with 2023, Source: [14].

The locals in this area represent almost 15% of the Romanian population. At the level of 2016, the rural population of the mountainous area constituted 52.47% of the total population of the mountainous area, while the rural population of Romania represented 44.94% of the total population of the country [24].

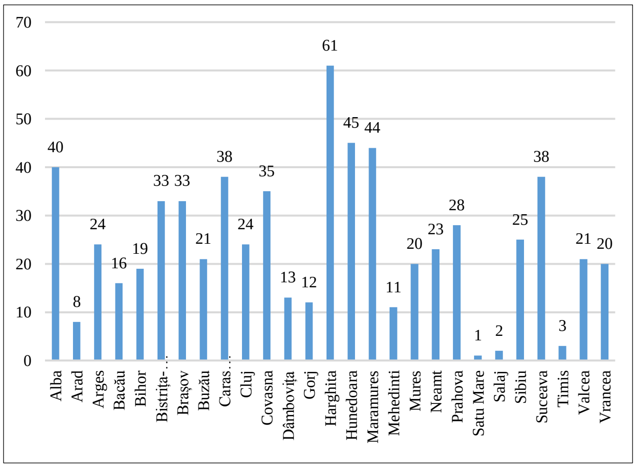

Fig. 2. Number of UATs in the Mountain Area
Source: our representation after [1].

It also includes 658 Administrative-Territorial Units (UAT) - Figure 2 - with an agricultural area of 1,828,845 ha [18].

As it can be seen, there are counties with a large number of UATs located in the mountainous area (Harghita, Hunedoara, Maramures), but also counties with only a few localities (Satu Mare, Salaj, Timis).

Livestock farming (especially cattle, sheep and goats) is an activity practiced in Romania since ancient times, especially in the mountain area, where it is the main occupation of the locals.

The breeds encountered here are bred in subsistence and semi-subsistence farms, which require low maintenance costs [19].

At the same time, these farms have less access to sources of funding and are less able to adapt to high performance technologies due to a lack of own funds [11].

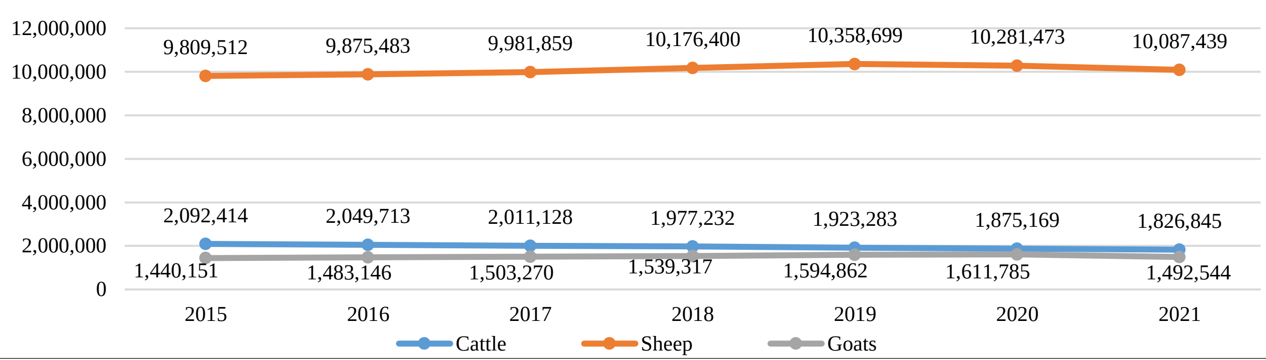

Fig. 3. Livestock dynamics of cattle, sheep and goats in Romania, from the mountain area, in the period 2015-2021
Source: our representation after [17].

Figure 3 shows the dynamics of cattle, sheep and goats in Romania, in the mountain area, in the period 2015-2021.

It is noted that the total number of cattle heads decreased by 12.7% in the analysed period, while for sheep and goats there was a slight increase by 2.83% and 3.64%, respectively. At the same time, it can be noticed that the Covid-19 pandemic had a negative impact on the livestock by about 10%.

Among the animal species raised in the analysed region, sheep predominated, being followed, at a distance, by cattle and then by goats.

The dynamics of the cattle herds from the 27 counties included in the mountain area, in the period 2015-2021 is found in Figure 4.

The share of cattle raised in the mountain area increased from 73.2% in 2015 to 75.5% in 2021. From the point of view of the territorial distribution, is necessary to mention that only 7 counties recorded an increase in the number of heads, of which can be noted Covasna, Sibiu and Bihor, by over 15%.

Suceava County remained the leader, but for the analysed period was reported a 25% decrease in cattle herds.

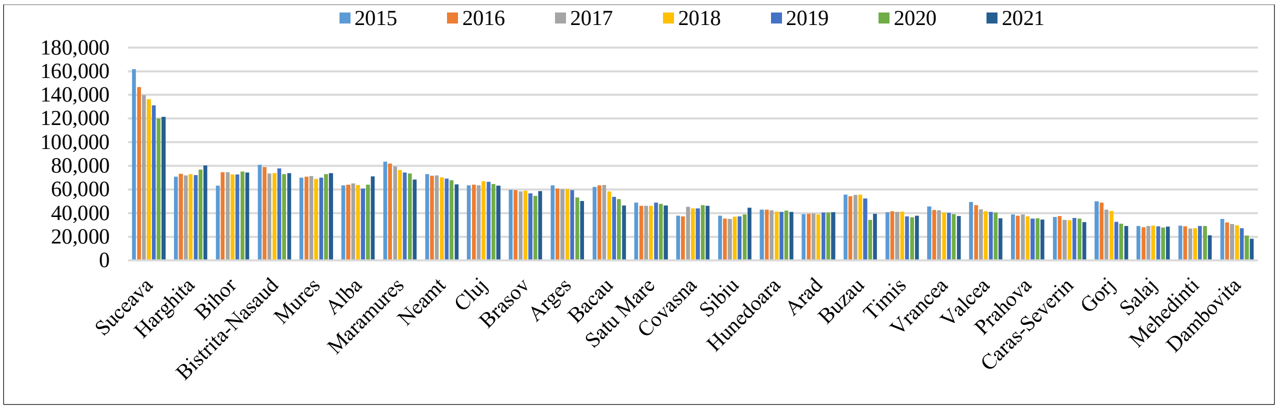

Fig. 4. Dynamics of cattle herds in the mountain area, in the period 2015-2021
Source: our representation after [17].

Despite the trend of increasing the number of sheep heads at the country level, the share of those raised in the mountain area, of the country's total, decreased from 71.8% in 2015 to 66.7% in 2021.

In 2021, the livestock grew in 13 counties, the most significant increases being recorded in Bihor – 37.6%, Alba – 29.25% and Bacau – 23.1% (Figure 5).

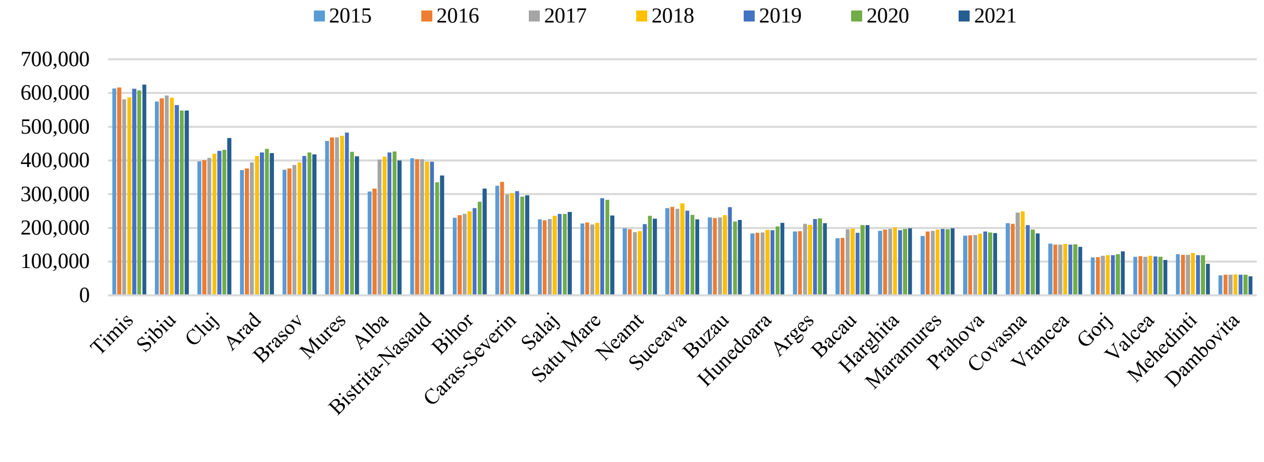

Fig. 5. Dynamics of sheep flocks in the mountain area, in the period 2015-2021
Source: our representation after [17].

The largest decrease was observed in Mehedinti and Covasna counties, with 24.25% and respectively 14.1%, Timiș and Sibiu counties, found in the first places, held about 20% of the total sheep in the country, keeping a quasi-constant trend in the analysed period. Compared to 1990, the number of sheep decreased, from 14,061,864 in 1990 to 10,087,439 in 2021, i.e. by 29.26% [5]. In the case of goats, can be noticed a situation similar to that of sheep, that is, the share of livestock in the mountain area relative to the country's total decreased from 49.1% in 2015 to 47.02% in 2021. The highest percentage of growth was recorded in Alba County (118.93%), followed by Sălaj (39.31%) – Figure 6.

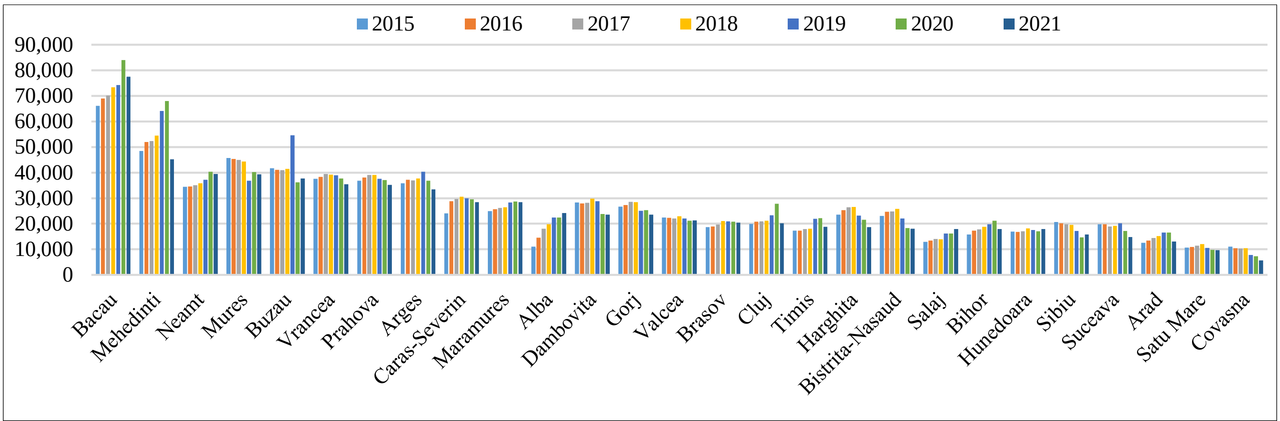

Fig. 6. Dynamics of goat herds in the mountain area, in the period 2015-2021
Source: our representation after [17].

At the opposite pole is Covasna, where the decrease was about 50%, and for the counties of Sibiu and Suceava the decreases were about 25%. Bacău County was the leader, with 11% of all Romanian goats.

Compared to 1990, the number of goats increased, from 1,004,810 in 1990 to 1,492,544 (48.54%) [5].

The annual quantities of manure (solid or semi-solid consistency) that can be obtained from some of the animal species studied are shown in Table 1.

Table 1. Manure production (kg/year)

Species	Production of manure kg/year	Nutrients (kg)
dairy cows	11,508	81 kg N 15 kg P_2O_5 54 kg K_2O
cattle 1-2 years	7,749	5 kg N 20 kg P_2O_5 43 kg K_2O
infant calves 0.3 -1 year	4,930	35 kg N 5 kg P_2O_5 26 kg K_2O
sheep	843	7 kg N 1 kg P_2O_5 5 kg K_2O

Source: [10].

In traditional agricultural practices, manure is used to fertilize crops and is applied directly to the land. But exceeding the optimal allowable amounts creates a surplus of nutrients that becomes harmful, especially because of nitrates.

Manure emits nitrogen-containing gases into the atmosphere, such as: ammonia, nitrogen oxides, nitrous oxide (which has a strong greenhouse effect). Poor manure management can lead to the loss of 50% of nitrogen and diminish the fertilizing effect of the obtained compost [15].

Because 80% of the animals are raised in individual households that are not conditioned by obtaining the environmental permit and do not have manure storage facilities, they are a risk factor for point pollution of water and for increasing the level of greenhouse gas emissions [14].

Poultry breeding is also a traditional activity in rural area, they are raised in large numbers, both in individual households and at the country level in livestock farms. Experiments to make the most efficient use of animal manure are in full development, and poultry manure is also included in this category [13, 16].

Studies show that manure is one of the raw materials from farms, which can be used for the operation of compost production complexes and biogas plants. For the purpose of determining the appropriate size of the biogas plant, account must be taken of the number of heads of animals and the type of raw material available.

Thus, in Table 2 it is presented the correlation between the number of cattle on the farm, the resulting amount of manure/day, the production of electricity and heat obtained and the estimated value of the required investment.

Table 2. Production of electricity and heat obtained from cattle farms

No. of cattle heads	Manure (kg/day)	KWh cal	KWh el	Total	Occupied area (ha)	Total estimated cost (1,000 Euro)
500	34	87	173	260	0.4	1,276
829	56.37	162	330	492	0.4	1,328
1,000	68	202	346	548	0.8	1,883
1,500	102	318	518	836	0.8	1,953
2,000	136	434	691	1,125	1.8	2,480

Source: [23].

For the production of biogas, in addition to the biogas production facility, the farmer needs animal droppings, vegetable biomass and waste resulting from agro-food activities.

The most recommended crops for obtaining biomass are: silage corn, sugar beet and fodder grasses.

Biogas obtained from manure has many advantages ecological, such as a much more bearable smell (which leads to the acceptance of animal farms, which receive complaints in this regard), reduction of emissions of methane, CO_2, particles and nitrous oxide, sanitation of liquid manure and a better capacity of nitrogen fertilization contained in the treated manure (i.e., less nitrogen is needed to achieve the same fertilization effect) [8].

In addition to biogas, following the anaerobic fermentation process, a good quality fertilizer is obtained, which contributes to maintaining soil fertility without the need for excessive use of chemical fertilizers [20].

Another way to use manure is to use it to produce organic fertilizers and fertilizers. RENURE products are a substitute for chemical fertilizers. RENURE, ‘Nitrogen recovered from manure’, is defined as any substance containing nitrogen, wholly or partly derived from manure by processing [12] (Figure 7).

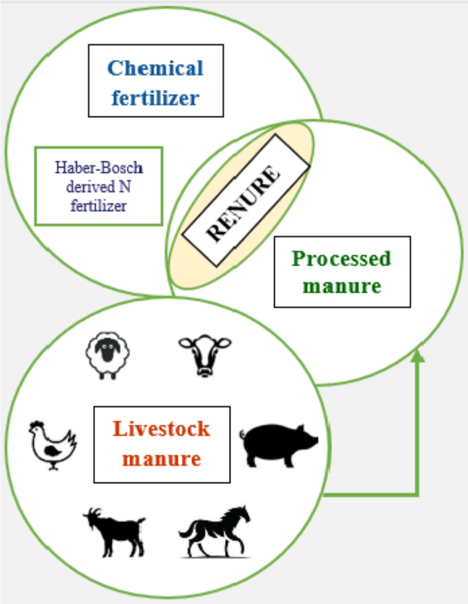

Fig. 7. Graphical representation of the product RENURE
Source: our representation after [12].

Following the model of biogas plants, it will be possible to build communal platforms for collecting manure, which will later be processed to obtain RENURE, which will provide jobs and will contribute to improving the demographic aspect of the rural space, especially in the mountain area.
This will ensure the availability and accessibility of the key input (fertilizer) amid disruptions caused by natural disasters, climate change and geopolitical instability.
Within the National Rural Development Program (PNDR) 2014-2020, financial support was granted for the projects implemented in the mountain area and for the preservation of autochthonous animal breeds, there are even special sessions for submitting funding requests for this area.
Through the requirements imposed on farmers, these projects directly or indirectly contributed to the reduction of nitrate pollution [18].
The EU considers young farmers a key element in the development of the agricultural sector and supports generational renewal through tools the common agricultural policy, such as direct payments and financial assistance through Sub-measure 6.1 "Support for the installation of young farmers" [4]. Table 3 presents the projects that were financed within the PNDR 2014-2020, in the counties that are part of the mountain area, under this Sub-measure.

Table 3. Distribution of the number of projects at the level of each county in the Mountain Area

County	Mountain Area			Mixt	
	2015	2016	2017	2018	2020
Alba	17	21	25	0	25
Arad	3	10	10	12	19
Arges	10	22	12	0	3
Bacau	4	5	7	0	2
Bihor	30	74	125	52	48
Bistrita-Nasaud	88	229	206	3	31
Brasov	11	12	13	0	2
Buzau	2	4	5	1	3
Caras-Severin	50	74	77	10	13
Covasna	17	22	45	7	0
Cluj	37	63	74	25	38
Dambovita	4	19	15	13	80
Gorj	34	28	24	0	7
Harghita	0	2	3	0	3
Hunedoara	38	128	116	3	3
Maramures	7	21	49	2	8
Mehedinti	5	6	8	0	1
Mures	0	0	3	0	13
Neamt	0	1	2	0	1
Prahova	0	0	1	0	0
Salaj	0	0	1	2	8
Satu-Mare	0	0	0	1	10
Sibiu	1	3	1	1	4
Suceava	0	10	6	4	6
Timis	0	3	2	35	54
Valcea	9	8	3	0	3
Vrancea	1	3	5	2	6

Source: [6] based on data provided by [3].

Analysed Sub-measure had as the self-evaluation criterion “Principle of indigenous breeds/varieties”, for which a maximum of 5 points were awarded and which worked as follows: a percentage score was given out of the 5 points depending on the percentage which was represented by the SO (standard output) value for native breeds/varieties from the total SO related to the dominant sector (livestock sector or vegetable).
Also, the implementation of the new projects

meant the introduction of advanced animal husbandry technologies, which required compliance with hygiene standards and ecological measures required at the EU level.

An important aspect was the obligation that, in order to obtain the financing of the PNDR 2014-2020, the investment projects in animal husbandry had to have a manure platform available.

Next, the sessions of the PNDR 2014-2020 opened under sub-measure 6.1, which contributed to the preservation of traditional activities in the mountain area, will be presented:

Session 2015: had separate fund allocations for the mountain area and non-mountain area. Funding applications for the mountain area started to be submitted only from stage 3, because in the first two stages no projects with a score above the monthly quality threshold were submitted.

Session 2016: had separate funding allocations for mountain area and non-mountain area just like 2015. Money for upland was requested in 6 stages. At the end of the session, although the entire amount was requested, not all of the commitment was allocated, largely due to ineligible projects submitted according to the allocation, but not funded.

Session 2017: for the mountain area there were a number of 3 stages with selected projects, due to the request for funds for this area in the first two months after the opening of the continuous project submission session.

The 2018 session: was characterized by the abandonment of the separate allocation for the mountain area, with projects competing according to the selection score for the same amount of money, regardless of the area. This fact is due to the small amount of money allocated, only 11 million euro, compared to 2017 where the amount of 176 million euro was allocated, of which 138 million euro for the non-mountainous area and 38 million euro for the mountainous area.

Session 2020: the first session to have a distinct allocation for the diaspora, parallel to the national allocation. Unfortunately, no project for the diaspora was declared eligible this session. The main reason argued by the evaluators in the "Eligibility criteria not met" section is the lack of the official document with an apostille according to „The Hague Convention" with which the applicant had to prove the holding of a job in the EU space [2].

With a few exceptions, can be noticed increases in the number of projects submitted both in the sessions dedicated to the mountain area 2015-2017 and in those opened at national level (mixed).

It can be observed that in the sessions with distinct submission for the mountain area, usually, there were several projects submitted for this area.

In addition to the benefits for the environment and for human nutrition, PNDR 2014-2020 projects have led to the development of family businesses, to the increase of entrepreneurs' incomes and to the economic growth of the mountain area.

CONCLUSIONS

The mountainous area is distinguished from the other regions, primarily by natural disadvantages (climate and altitude) and structural disadvantages, such as: dispersal of households within a locality, large distances from administrative centres, lack or insufficiently developed infrastructure, isolation from communication routes.

At the same time, residents face the following problems: lower incomes, reduced possibilities to access financial resources, lack of qualified human resources and high costs for the implementation of modern technologies.

Analysing the data taken from INS, it can be concluded that over 2/3 of the sheep and ¾ of the cattle are found in the mountain area. The amount of manure per capita obtained, as well as the new Community requirements for environmental protection, have changed the preferences of livestock farmers in terms of livestock structure. Thus, there was a decrease in the number of cattle and an increase in the number of sheep and goats.

Better exploitation of the products available in the rural area will lead to sustainable development. Manure is a product that has been misused but can be used to obtain green

energy and fertilizers to EU standards.
Depending on the location and distances to nearby farms, it may be proposed to develop a manure collection cluster with or without biogas production facilities in the area of interest.
In most cases specific to the mountain area, at least 2 conditions must be met:
• Cooperation of farmers to ensure the necessary number of animals to overcome the balance point (breakeven) of the investment;
• The facility to enter the electricity/heat market and RENURE products.

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DUAL EDUCATION – A VIABLE SOLUTION IN THE TRANSITION TO THE LABOUR MARKET

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Abstract

The qualification of human resources through the training of practical skills at the secondary level represents a challenge for professional and ethnic education, in the context of economic decentralization and the massification of higher education. Thus, we can ask ourselves if the gap between work and education, respectively that between professional requirements and skills, is the result of the lack of jobs or the lack of skills? Following the same line of ideas, these two overlapping crises may be the result of poor coordination between the actors interested in this problem, namely: education and training providers for the labour market, ministries and representatives of the government administration, employers, and, not lastly, the young people. The purpose of this study is to provide concise data regarding the current situation of vocational and technical education (VET) in Romania, which will serve as fundamental information for ongoing and future discussions regarding the new generation of education and training programs. The results showed that vocational education in a dual system, based on the German model, could represent an alternative for relaunching vocational education in Romania and a solution to facilitate the transition of young people to the labour market. The key factor of dual education is the practical component it emphasizes, developing the professional skills of young people directly at the workplace.

Key words: *DUAL, education, practice*

INTRODUCTION

Dual education is a tripartite form of professional and technical education organization, which is based on a partnership contract between the economic operator, the educational unit, and the administrative-territorial unit, as well as individual practical training contracts between the economic operator, student/parent - tutors and the educational unit.

The term "dual education" is widely used as an umbrella term, referring to the fact that teaching and learning in Vocational Education and Training (VET) is characterized by "duality" from two points of view: the duality of learning spaces (schools/ VET providers and training companies), who share responsibility for providing theoretical and practical training, respectively the duality of actors involved (public and private actors), who share responsibility for VET policies and practices [6], [11].

The dual nature of learning spaces is the basis of the definitions used in European and international specialized literature:

- ✓ According to the United Nations Educational, Scientific and Cultural Organization (*UNESCO*), "the dual education system is called "dual" because it combines in one course both apprenticeship in a company and vocational education in a vocational school." Within the company, the apprentice benefits from practical training, which is supplemented by theoretical training at the vocational school.
- ✓ According to the European Center for the Development of Vocational Training (CEDEFOP), dual education refers to "periods where learning or training in an educational institution or training center is combined with learning or training at the workplace". CEDEFOP also refers to dual education as work-study, emphasizing that the term "dual education" can be used as a synonym for "work-study", "apprenticeships" or "work-

based learning". There are, however, a series of small but significant differences between these terms, as they differ from the point of view of the two aspects mentioned above [6], [20], [22].

The organization of dual education is done at the request of economic agents. The organization, duration, content of the training programs, and methods of certification of the professional training are established by consulting the economic operators. Therefore, this form of professional education is complementary to those currently operating, and GEO 94/2014 provides the legal framework for its organization, allowing economic agents to be directly involved in all the components of the workforce training they need).

Work experience is highly valued by businesses and therefore the lack of such experience is a major obstacle for people looking for their first job. Many young people are caught in a vicious circle: they can't find a first job, but they also can't get a job because they don't have work experience. In some European countries, apprenticeship programs have been shown to have a significant impact on promoting youth employment and are one of the main reasons for low levels of youth unemployment [9], [10].

The education and professional training of students have as their main purpose the formation of competencies, understood as a multifunctional and transferable set of knowledge, skills, and aptitudes, necessary for:

✓ personal fulfilment and development, by achieving one's own goals in life, according to everyone's interests and aspirations and the desire to learn throughout life;

✓ social integration and active citizen participation in society;

✓ employment and participation in the operation and development of a sustainable economy;

✓ the formation of a conception of life, based on humanistic and scientific values, on national and universal culture, and on the stimulation of intercultural dialogue;

✓ education in the spirit of dignity, tolerance, and respect for fundamental human rights, and freedoms;

✓ cultivating sensitivity to human issues, moral-civic values, respect for nature, and the natural, social, and cultural environment [8], [21].

In this context, the purpose of this paper is to provide accurate information regarding the regulatory and organizational methodology of vocational and technical education (VET) in Romania. This information is intended to serve as fundamental knowledge for ongoing and future discussions concerning the new generation of education and training programs.

More specifically, the study addresses the following aspects:

- ✓ the rationale behind the implementation of dual education systems.
- ✓ establishing connections between excellence in vet, dual education, and economic growth.
- ✓ identifying trends and changes in dual education.
- ✓ innovative approaches to enhancing and increasing the attractiveness of this type of education.

MATERIALS AND METHODS

In the framework of dual education, the following notions are used during practical activities, according to the legislation in force [11], [13], [14], [15]:

✓ *the internship* represents the activity that the students carry out according to the education plan and the purpose of which is to check the applicability of the theoretical knowledge that they have acquired during the theory lessons in the school curriculum.

✓ *practice organizer* - the higher education institution that carries out instructive, educational, and formative activities, according to the Romanian legislation in force.

✓ *practice partner* - the central or local institution or any other private legal entity in Romania, which carries out an activity in correlation with the specializations contained in the nomenclature of the Ministry of

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Education and which can participate in the process of practical training of students.

✓ *the trainee (trainee)* represents the student who is enrolled in an internship and carries out the activity within the internship to consolidate theoretical knowledge as well as training and cultivating the skills and abilities to apply them according to the specialty for which he is trained.

✓ *the internship leader* is the person who ensures the planning, organization, and supervision of the internship, as well as compliance with the conditions of training and acquisition by the practitioner of the professional skills planned for the internship period.

✓ *the internship tutor* is the person designated by the internship partner, who will ensure compliance with the training conditions and acquisition by the intern of the professional skills planned for the internship period.

✓ *the internship contract* is an agreement concluded between the internship organizer - the educational institution, the internship partner - the company, and the one who carries out the internship.

✓ *the internship program* is a document developed by the relevant department, following the legislation in force, which includes the training objectives to be achieved and the skills to be obtained through the internship, as well as the modalities for its implementation

The following normative acts are the basis for the realization of this form of education:

→ National Education Law no. 1/ 2011, with subsequent amendments and additions;

→ Order of the Ministry of National Education no. 5732/ 2022 regarding the approval of the Methodology for the organization and operation of dual education;

→ Government Decision no. 918/2013 regarding the approval of the National Qualifications Framework and Government Decision no. 567/ 2015 for the amendment of Decision no. 918/2013 regarding the approval of the National Qualifications Framework;

Government Emergency Ordinance no. 49/ 2014 regarding the establishment of some measures in the field of education, scientific research and for the modification of some normative acts.

Therefore, based on the study of the legal framework and other materials on the topic, a comprehensive and logically structured material was set up emphasizing why education in a dual system is useful and efficient.

RESULTS AND DISCUSSIONS

The procedural preparation for the organization of internships is a necessary precondition for the preparation of activities supporting the practice. The students' practice is carried out following the education plan, as a way to verify the applicability of the theoretical knowledge acquired by them in the practical activity.

At the same time, the running of the internships aims to strengthen the theoretical knowledge and the training of the students' practical skills and abilities, which can be applied to the specialization that they follow. Therefore, the practice activity wants to complement in the most appropriate way the didactic activity through which the students acquired basic theoretical knowledge [4], [5].

Dual education is addressed to 8th-grade graduates of the current year or 8th-grade graduates who have interrupted their studies and whose maximum age is up to 26 years.

Length of studies:

✓ after the 8th grade, dual education is organized to acquire a job with level 3 qualification;

✓ the level 3 qualifications include the 3-year study module (the theoretical parts of compulsory and specialized education, as well as practical internships carried out at the respective economic operators) for the 9th, 10th, and 11th grades;

✓ education is completed with a level 3 professional qualification certification exam, recognized both in the country and in the European Union [23].

Characteristics of education in the dual system:

- dual education is organized as part-time education, day courses, within state, private or confessional, authorized or accredited educational units, at the national level.
- educational units in which dual education is organized are established annually by order of the Minister of Education.
- in state education units, the dual study program is free.

During the three years, combined practical training internships are organized, with a total duration of 24 weeks distributed over the 3 years [4].

The structure of practical training for dual education

IX CLASS - 20% practical training - 5 weeks internship

CLASS X - 60% practical training - 9 weeks internship

CLASS XI - 72% practical training - 10 weeks internship

After the 3 years of training in Dual, i.e. the 9^{th}, 10^{th}, and 11th grades, graduation is completed with a certification exam for level 3 trades.

Graduates from dual education (called DUAL) can be employed at the partner economic operators where they have completed their practical training during the 3 years of DUAL and, at the same time, they can continue their studies at high school, to obtain level 4 qualification, the baccalaureate diploma and, respectively, to pursue university education (level 6) or, with/without baccalaureate, to choose post-secondary education (level 5). Thus, the professional educational route can continue depending on one's choice for level 4 (high school), 5 (post-secondary), or level 6 (university studies) qualifications.

The content of pre-university education is provided by the National Curriculum, which represents the coherent set of educational framework plans (Fig. 1), school programs, and textbooks in pre-university education [12]. The curriculum corresponding to qualifications in vocational and technical education (VET) is developed based on the Vocational Training Standards (SPP).

Vocational training standards are the document that describes the learning outcomes that a participant in a vocational training program, carried out within vocational and technical education, must demonstrate at the end of it (Fig. 2). Also, the SPP is the document that is the basis of the valuation for certification [4].

CURRICULUM PLAN
11th GRADE
Vocational Education

Qualification: HOTEL WORKER
Professional Training Field: TOURISM AND CATERING
General Training Field: TOURISM

Module 1. Hotel Tourism Product			
	Total Hours/Year:		**210**
	from which:	Technological Laboratory:	120
		Practical Training	90
Module 2. Hotel Space Maintenance			
	Total Hours/Year:		**420**
	from which:	Technological Laboratory	180
		Practical Training	240
<u>Practical Training Period</u>			
Module 3. Local Development Curriculum			
	Total Hours/Year:		**300**
	OVERALL TOTAL:		**930 Hours/Year**

Fig. 1. Vocational education level curriculum, technological stream, services profile, tourism field/hotel worker specialization - 11th grade - technology curriculum area
Source: OMEN no. 3500/ 29.03.2018 [17].

The structure of the professional training standard is approved by MECS Order no. 4121/ 13.06.2016 regarding the approval of the Structure of the professional training standard in professional and technical education.

Starting with 2016, an evaluation standard corresponding to each unit of learning outcomes was developed and included in the SPP, in which the conditions under which the acquisition of the respective unit of learning outcomes is tested are specified. These conditions are described by performance criteria and indicators. Thus, the professional training standard is the regulatory document with the most important role in the design of the curriculum for professional and technical education, being elaborated based on the occupational standards in force or, in their absence, the competencies related to the occupation/occupations targeted by the respective qualification, which establish by consulting sectoral committees or economic operators and other interested factors.

#	Subject	Curriculum Framework			Timetable			Total
		TC	CD	CDL	TC	CD	CDL	
TECHNOLOGIES		2	9	30	2	9	4.2	15.2
12	Information and Communication Technology -- CEBUC M.CRISTINA MIHAELA	2			2			2
13	Specialized Culture		6					
14	Practical Training			30				
15	Weekly Practical Training		3					
16	Module I. Fundamentals of Accounting -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					2		2
17	Module II. Quality in Tourism and Catering - Theory --CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					1		1
18	Module II. Quality in Tourism and Catering - Practical Training --CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					1		1
19	Module III. Tourist Accommodation Facilities - Theory -- (m)					1		1
20	Module III. Tourist Accommodation Facilities - Practical Training -- (m)					1		1
21	Module IV. Basic Food Processes - Theory -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					2		2
22	Module IV. Basic Food Processes - Practical Training -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					1		1
23	Module V. Practical Training Period (CDL)-- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)						4.2000	4.2

Fig. 2. Timetable at the level of professional education, technological stream, services profile, tourism field/ hotel worker specialization - 9th grade - curricular area technologies
Source: own contribution.

The key competencies targeted by a qualification are formulated in terms of specific knowledge, skills, and attitudes and are integrated into the units of general, and specialized technical learning outcomes. This enables the deepening of key competence areas in vocational training contexts. In this context and in correlation with the European efforts to promote key skills (years 2004 - 2008), the National Education Law no. 1/2011 assumed the eight key skills recommended by the European Commission as the objectives of the levels of compulsory and post-compulsory education.

In the case of vocational education and technical high school education, a distinct curriculum design model is used - compared to the one used in general education - based on the concept of learning outcomes. This model is based on the European Qualifications Framework (EQF), defined in 2005. Learning outcomes are expressed in terms of knowledge, skills, and attitudes acquired through learning and are defined by qualification. The learning outcomes are described by the professional training standards which, in turn, are developed based on the occupational standards in force [18].

The categories of learning outcome units from the professional training standard are:

→ general technical learning outcome units;
→ units of results of specialized technical learning.

Units of general technical learning outcomes are common to all qualifications in a vocational training area at a given qualification level, and units of specialized technical learning outcomes are specific to each qualification.

In analysing the two types of skills approaches, for use in the development of curriculum documents and skills assessment systems, as well as for ensuring coherence between education and training routes, common relationships and approaches are considered important. The two perspectives have a history and origins that explain the differences in approach, respectively:

→ model of competencies - key in the field of education;
→ the competency model as learning outcomes from the professional field.

Both perspectives are valuable, they are not mutually exclusive, nor can they be ranked under the criterion of legitimacy. These models co-exist, have been assumed at a formal level in regulatory systems, and have been assimilated in subsequent curriculum documents. The main relationship between the 2 perspectives is the notion of the learning result, which is considered either a component of the competence or the competence itself. The difference is the level of generality, as follows: in the general education system, the learning result is considered more general (skills, in different categories, constituting different types of learning results), while in the professional training system, the learning result is a component, a partial result, a level of development of a competence, which is itself specific (professional, related to a professional occupation/qualification) [19].

Curricular components [12]:

✓ *The common core (TC)* which includes the educational subjects/modules, with the corresponding time allocations, common within a professional training profile/field and which is part of the national curriculum;

✓ *Differentiated curriculum (CD)* that includes the modules specific to the respective professional qualification and is part of the national curriculum;

✓ *Curriculum in local development (CDL),* which constitutes the specific offer of each educational unit, is aimed at adapting the professional training of students to the requirements of the local labour market. The

CDL is proposed and developed by each educational unit, following the consultation of its partner enterprises.

The curriculum design process in local development includes the following stages:

- identification of professional training needs at the local level;
- the development of the Curriculum in local development, in line with the training needs identified at the local level;
- approval of the CDL by the Board of Administration of the educational unit and by the Local Committee for the Development of Social Partnership;
- CDL approval by the county school inspectorate [1], [2], [3].

During professional and technical education, each module in the curriculum of the Technologies Curriculum Area (specialist module) is taught by one or more teaching staff (generally in cases where the specialized module has both theory hours and technological laboratory hours and practical training hours) – another examples in Fig. 3 and Fig. 4.

#	Subject	Curriculum Framework		Timetable			Total
		TC	CD	TC	CD	CDL	
TECHNOLOGIES		0	21	0	21	9.6429	30.6429
9	Specialized Culture		5				
10	Practical Training		16				
11	CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				2		2
12	Module I. Ethics and Professional Communication - Theory -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				1		1
13	Module II. General Accounting - Theory -- CIOBĂNICĂ I.FLORIN-CRISTIAN(m)				1		1
14	Module II. General Accounting - Technological Laboratory -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				2		2
15	Module III. Tourist Assets - Theory -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				2		2
16	Module III. Tourist Assets - Technological Laboratory - -CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				1		1
17	Module IV. Consolidated Practical Training (CDL) – CIOBĂNICĂ I. FLORIN-CRISTIAN(m)					9.6429	9.6429
18	Module I. Ethics and Professional Communication - Practical Training --CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				1		1
19	Module III. Tourist Assets - Practical Training -- CIOBĂNICĂ I. FLORIN-CRISTIAN(m)				11		11

Fig. 3. Timetable at professional education level, technological stream, service profile tourism field/ hotel worker specialization - 10th grade - curricular area technologies

Source: own contribution

Teaching-learning activities organized in separate groups (e.g. with a minimum of 10 students) can be organized for practical training activities at economic operators. Regarding didactic methods, the most used are the methods based on oral communication (exposition and conversation), but the methods of learning and exploration through discovery (direct and indirect exploration of objects and phenomena) are also useful. The education system promotes the use of student-centered interactive methods based on children's voluntary actions (exercises, practical activities, etc.) and stimulated action (didactic games, learning through dramatization, etc.) [7].

Curriculum Area/Subject/Module	Number of hours per week			Total number of hours per week	Number of weeks	Number of hours per school year
	TC	CD	CDL			Curriculum Areas
LANGUAGE AND COMMUNICATION	**5**	-	-	**33**	**30**	**150**
Romanian Language and Literature	2	-	-			
Modern Language 1	2	-	-			
Modern Language 2	1	-	-			
MATHEMATICS AND NATURAL SCIENCES	**3**	-	-			**90**
Mathematics	1	-	-			
Physics	2	-	-			
HUMAN AND SOCIETY	1	-	-			**30**
Social-Human Sciences / Entrepreneurial Education	1	-	-			
PHYSICAL EDUCATION AND SPORTS	**2**	-	-			**60**
Physical Education	2	-	-			
COUNSELING AND GUIDANCE	-	1	-			**30**
Counseling and Guidance	-	1	-			
TECHNOLOGIES	-	21	-			**630**
Specialized Culture	-	-	-			
Practical Training	-	21	-			
TOTAL HOURS TC/ CD	**11**	**22**	-			**990**
Internship Training Period	-		**30**	**30**	**10**	**300**
Total hours per school year	**330**	**660**	**300**			**1290**

Fig. 4. Technology curriculum area for 11th grade, three-year vocational education level curriculum, technological stream, service profile, tourism field/ hotel worker specialization

Source: OMEN no. 3152/ 24.02.2014 [16]

If the practical training takes place at the economic operator, the tutor is responsible for how the training activity is carried out, following the collaboration with the teaching staff of the school.

Practical training is a mandatory activity within professional and technical education and is provided by teacher-engineers and/or foremen in laboratories and workshops, as well as by tutors, and staff appointed by employers for the practical training of students in the enterprise [1], [2, 3].

Benefits for the duration of schooling in the dual system:

- monthly scholarship of 400 lei (200 lei paid by the state + 200 lei paid by the partner economic operators where they did the practical training);
- performance awards;
- transport/accommodation settlement;
- equipment work and protection;
- practical training and mentoring;
- diploma recognized at European level;
- priority in employment;
- the possibility of continuing studies to obtain the baccalaureate diploma.

The benefits of economic operators

From the point of view of the benefits, the economic operators who invest in the dual system have the opportunity to select the best graduates of the dual education, participating both in the selection process for admission to the dual education and the certification exam that will be organized at economic operators and with their direct involvement.

Also, employers have the opportunity to show their direct involvement in the life of the local community, maintaining a much closer contact with the school, with the parents, and, of course, with the students, contributing to a greater extent to the economic development at the local level, having representatives on the school board [23].

Last but not least, through the legislative changes, economic operators benefit from the deduction of all the expenses they make in dual education.

- ✓ Deductibility of expenses

The expenses related to the organization and conduct of dual education were included in the category of deductible expenses when calculating the fiscal result, according to Law No. 239/ 2020, which amends the Fiscal Code in this regard. Deductible expenses are those expenses incurred for the organization and conduct of dual education, in accordance with the legal regulations in the field of national education, with the exception of depreciation expenses, which are deductible according to the special regulations regarding depreciation.

- ✓ Deduction of depreciation

Regarding investments and fixed assets owned and used for the organization and development of dual education, according to the legal regulations in the field of national education, they represent depreciable fixed assets, the value of which is recovered from a tax point of view by deducting depreciation.

- ✓ Non-taxable income

They are non-taxable income: scholarships, awards, and other rights in the form of accommodation, meals, transport, work equipment/protection, and others received by students during dual education, according to the legal regulations in the field of national education

CONCLUSIONS

The values promoted in the Romanian educational system are an integrated part of the response that education offers to the challenges of the contemporary world and reflect, equally, the culture and spirituality of the Romanian people and the values promoted at the European and global level. These values are intended to guide the management of personal life (health, fulfilment, and personal development), and to promote a sustainable lifestyle, oriented towards success, active citizenship, social inclusion, entrepreneurship, and integration into the labour market.

Vocational and technical education in the dual system combines learning at the workplace with that at school. The dual system works for and in agreement with the labour market, providing the economy with a well-qualified workforce. Within this system, educational institutions and their employers or organizations share responsibility for:

- ✓ the set of general and specific skills that must be developed for acquiring a specific job;
- ✓ learning contents;
- ✓ the preparation methods and the material base necessary to achieve the proposed objectives;
- ✓ training costs, with the government covering the cost of school training and employers financing company training.

The advantages of dual education are the following:

- ✓ a large number of students benefit from the advantages of professional training in real working conditions;
- ✓ this type of education facilitates the transition from the school environment to the one specific to work in the enterprise, thus leading to a high level of employability for the graduates;
- ✓ the strong involvement of employers guarantees the up-to-date nature of the qualifications, and alignment with the needs of the labour market, while also increasing the notoriety and attractiveness of the system;
- ✓ the system is regulated by solid quality assurance mechanisms;

✓ it is a very popular and widely accepted system in the countries that practice it;

✓ the diploma obtained at the end of the studies has a high value in the labour market and is recognized in the European Union.

In conclusion, dual education is not only a technical issue, but also has an important social component. Thus, it assumes a type of society in which the interested actors - essentially economic agents and government institutions - are willing to share their responsibility for the professional training of young people and to invest in this process, on the one hand at the school level, on the other party to that of the enterprise.

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MODELING THE FACTORS OF IMPLEMENTATION AND ADOPTION OF RICE TECHNOLOGY AMONG 4-H CLUB YOUTH

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Abstract

The study aimed to pave an argument that exposes the causal factors of rice technology implementation and adoption among the members of 4-H club youth in Southern Leyte, Philippines. Primary data were gathered from 118 4-H club youth members selected at complete enumeration. Descriptive statistical measures were used to summarize the collected data and ordered regression models were constructed to determine the predictors of implementation and adoption of rice technology. Results portrayed that there are still more members who do not implement and adopt the rice technologies introduced by the 4-H club in their respective places. And very few of them have fully implemented and adopted the rice technologies. The first regression model revealed that the significant causal factors of implementation of rice technologies are attended training (at a 5% level), economically viable characteristics of rice innovative and new technology (at a 10% level), and minimal risk characteristics of rice technology (at a 10% level). Plus, the second-ordered logistic model represented that the only significant causal determinant of the adoption of rice innovative and new technologies among 4-H club youth is the training attended (at a 5% level). In conclusion, the youth members of the 4-H club must be trained and educated concerning the different functions, features, and benefits of adopting innovative rice technology. Furthermore, proper training will give them sufficient knowledge and information in implementing and adopting rice technology to improve their productivity as well as increase their economic profitability.

Key words: *rice technology, youth members of the 4-H club, implementation and adoption, regression analysis*

INTRODUCTION

It is worth noting that youth is the stage in life where it begins to formulate ideas and meaning of life and question different aspects of daily happenings. According to Lee et al. [13], youth are expressing an ability to envision and think about the progress of the future. In that case, youth is the suitable stage to educate and impart the importance of sustainability in the aspect of agriculture which is vital in the economy [6], [10], [19].

One of the innovative programs in agriculture that provide educational perspective and training for youth is the 4-H club. The said program originatedin the United States (US) where it centered on educating and guiding the youth on how to make grow crops and care for livestock as well as skillful in various food production processes [11], [12]. The abbreviation name 4-H pertains to the following: 1-head, 2-heart, 3-hands, and 4-health [11]. Whence, the 4-H club program represents the four personal parts of the association that needs to focus on sustainable development. In the country of the Philippines, the 4-H club program is encouraging the youth members to adopt new and innovative rice technologies which improve productivity in the country. In fact, rice production must be economically improved since rice is the main staple food on every Filipino's table and is considered the main source of income for local farmers in the country, especially, for poor farmers in rural areas [4], [5], [7]. The primary content of the 4-H club is to educate the youth to implement innovative and new technologies in rice production. Also, to inform and train them that every effort of rice farmers in the country is valuable and that it is the life of the Philippine economy. According to Botangen et al. [3], it is necessary to conduct training and educational seminars to introduce the importance of new technologies in progressing food production in the country. This is to impart knowledge of the different characteristics of the technologies and innovations so that the 4-H members will be convinced to implement and adopt them. Plus, the program has provided financial and technical support to Filipino youth in establishing livelihood projects [22].

In addition, 4-H attempts to progress the youth's, leadership, responsibility, citizenship, and life skills through cognitive content learning programs and an optimistic youth modification strategy [8]. Hence, with the implementation of the 4-H club livelihood inaugural, the Department of Agriculture (DA) and Agricultural Training Institute (ATI) in the Philippines, in conjunction with local government units (LGUs), hoped to strengthen the extension delivery system in selected municipalities in Southern Leyte, developing the lives of the youth regarding food production.

The investigation of the factors affecting the implementation and adoption of rice innovative technologies among 4-H youth club associates is very few in the body of literature. Henceforth, the article initiated to do a research survey that looks at the causal factors that governed the rate at which 4-H youth club membersare implementing and adopting rice technologies in Southern Leyte, Philippines. In particular, the study identifies the causal determinants that could serve as a groundwork for conceptualizing the extension delivery projects in rice production. The main purpose of this survey study was to infer the experiences of the youth members of the 4-H clubin the discourse of the implementation and adoption of the variousrice innovative technologies in the 4-H Club initiatives in the province. Plus, the findings of the survey may serve as a basis for collaborating agencies in agriculture to develop and improve the 4-HClub program components and promote them to other municipalities. Furthermore, this study may help other researchers in agriculture to improve the well-being of rice farmers and youth members of the 4-H club, and results may impart to the body of knowledge as a global contribution.

MATERIALS AND METHODS

Research Design

This research study utilized a descriptive-correlation survey design that seeks the significant factors affecting the implementation and adoption of rice innovative technologies among the members 4-H club members. The study used standard descriptive measures and regression modeling in analyzing the gathered cross-sectional data.

Locale of the Survey and Participants

The research survey took place in the selected municipalities in Southern Leyte, Philippines which include Tomas Oppus, Macrohon, Saint Bernard, Hinunangan, and Maasin City where 4-H club programs are active and well-organized to influence the youth. Since there are only a few members of the 4-H club youth, this study considered a complete enumeration process to choose respondents for the said survey.

It is worth noting that complete enumeration as a sampling procedure will give a holistic view of the information needed for the survey. In that case, all active 4-H club youth members were included in the survey where they have a recipient role in the government's livelihood programs. Hence, a total of 118 members participated in the said survey which there are 20 members in Tomas Oppus, 25 members in Macrohon, 25 members in Saint Bernard, 23 members in Hinunangan, and 25 members in Maasin City.

Research Instrument, Data Collection, and Ethics

The research instrument of this study was a developed semi-structured questionnaire that consists of four parts such as socio-demographic profile, 4-H Club influence, rice technology characteristics, and implementation and adoption of rice technology. For the respondents' socio-demographic profile, they were asked about the following: age, sex, educational status, and family income. As for the second part, they were asked about who influences them which includes the 4-H coordinator (yes or no), and family (yes or no).

In addition, they were also asked if they attended training (yes or no) concerning rice technology and they were requested to rate the 4-H club coordinator's effectiveness with the following categories: highly ineffective - 1, ineffective - 2, uncertain - 3, effective - 4, and highly effective - 5). Plus, the youth members were also asked to rate (1 to 5 scaling: 1 is the lowest and 5 is the highest)the following characteristics of new rice technology introduced by the 4-H Club organizer: (1) complexity; (2) economically viable ; (3) compatibility; (4) environmentally safe; and (5) minimal risk. Table 1 portrayed the range of perception scores for rice technology characteristics and their linguistic description.

Table 1. Members' perception scores for the various rice technology characteristics

Interval of scores	Response
4.21 – 5.00	Strongly agree
3.41 – 4.20	Agree
2.61 – 3.40	Neutral
1.81 – 2.60	disagree
1.00 – 1.80	Strongly disagree

Source: Authors' guidelines (2023).

Lastly, participants were asked how the implement (0-not implemented, 1-implemented but not continued, 3-continued but modified some processes, 4-fully continued) and adopt (0-not adopted, 2-adopted in average time and scale, 3-fully adopted in larger scale and shared to others to adopt) the rice technologies introduced by the 4-H club.

A formal letter of permission was sent to the head of the Southern Leyte before the conduct of the said survey. In addition, permits to execute the survey research were also obtained from the agencies of 4-H Clubs in the places where the study is conducted. After that, respondents were informed that participation in the data collection is voluntary and they are also told that the data gathered were solely used for the research article only. Primary data were gathered from the respondents with the aid of a developed questionnaire in the form of a face-to-face interview. Moreover, the information gathered from interviews was validated via focus group discussion (FGD).

Data Management and Analysis

In summarizing the gathered survey data, statistical measures include mean average (M), standard deviation (SD), frequency counts (n), and percentages (%). To determine the factors affecting the implementation and adoption of rice technologies, an ordered logistic regression analysis was employed. To perform the post-estimation technique for the regression model, the ordinary least square (OLS) regression was generated first followed by the diagnostic tests using the STATA command. After that, necessary adjustments in the ordered logistic model were employed to obtain statistically reliable results [15]. Furthermore, all calculations were accomplished with the aid of Microsoft Excel and STATA version 14.0.

RESULTS AND DISCUSSIONS

Members' Profile and Influence

As seen in Table 2, the mean average age of the youth members of the 4-H club in Southern Leyte, Philippines is close to 20.77 (SD=6.07). About 53% of them are male members and 47% are female members. On average, dominant of them (63%) are in-school youth, which indicates that they have attended school at the average age interval of 15-24 years old or at least they have attended college level. And about 37% of them are out-of-school youth, which means they have not finished any college degree or post-high school degree. Approximately, their mean average monthly income is close to PHP 6,370.34 (SD=PHP 3,812.49). Their monthly income is relatively low since most of them do not have a higher-income job. About 94% of the respondents said that the 4-H coordinator is influencing them to implement and adopt the current rice technology.

The remaining 6% said that they are not influenced by the 4-H coordinator. Most (84%) of the respondents said that their family members are the ones who influence them to join the 4-H club and to implement and adopt the rice technology. And about 16% of them said that their family does not influence them in regard to 4-H activities. About 78% of the members are having attended training programs in rice technology implementation and adoption and 22% of them do not have experience in training. From 1 to 5 rating, the

4-H coordinator is rated at 4.55 (SD=0.64), which can be interpreted as highly effective in terms of influencing the members to adopt the rice technology in their respective areas.

Table 2. 4-H club members' profile and influence

Variables	M	SD
Age (in years)	20.77	6.07
Male[a]	0.53	0.55
Education status[a]	0.63	0.50
Monthly family income[b]	6,370.34	3,812.49
4-H coordinator influence[a]	0.94	0.24
Family influence[a]	0.84	0.36
Attended training[a]	0.78	0.42
Effectiveness of 4-H Coordinator[c]	4.55	0.64

Note: a - dummy variable; b - Philippine Peso (PHP); c-scale from 1 to 5.
Source: Own calculation (2022).

Rice Technology Characteristics

Table 3 portrays that the members of the 4-H club are "neutral" (M=3.39, SD=0.88) in the "complexity" characteristics of rice technology. This implies that the youth perceived that the innovations of rice technology are moderately difficult to implement and adopt in their respective areas. In fact, innovative technology in agriculture is challenging to apply in an actual scenario if it involves complex structures and procedures which is difficult to follow [16]. In addition, rice technology as "economically viable" is rated as "neutral" (M=3.38, SD=1.34) by 4-H club members. This means that they perceived that the economic benefits of rice technology moderately exceed its economic expense. It is vital in rice production that a long-term economically viable technology must be integrated into rice farming to maximize profit and attain the expected sustainability [1], [18]. The 4-H club members "agree" (M=3.94, SD=0.87) that the rice technology introduced to them is "compatible". This goes to infer that the new innovative rice technology is consistent and does not conflict with the existing technologies and needs of adopters. The compatibility of rice technology is vital in further enhancement and productivity as well as improving the income and well-being of farmers [20]. Rice technology as "environmentally safe" is rated as "neutral" (M=3.10, SD=1.16). This means that the 4-H club members perceived that the new rice technologies are moderately safe for the environment. In fact, it is important that the application of technologies is eco-friendly and safe to preserve other helpful microorganisms in the paddy field while improving its productivity [17]. Moreover, rice technology as a "minimal risk" is also rated as "neutral" (M=3.36, SD=0.94) by the youth members. In that case, it is perceived that rice technology is moderately a minimal risk where its likelihood of harm or discomfort is lesser compared to the usual harm of existing technologies. Farmers are more likely to adopt a rice technology that is safe and does not harm their health, and does not contaminate the paddy soil which may cause a decrease in yield [14][16].

Table 3. The 4-H club members' rating of rice technology characteristics

Characteristics	M	SD	Description[e]
Complexity[d]	3.39	0.88	Neutral
Economically viable[d]	3.38	1.34	Neutral
Compatibility[d]	3.94	0.87	Agree
Environmentally safe[d]	3.10	1.16	Neutral
Minimal risk[d]	3.36	0.94	Neutral

Note: d - Scale from 1 to 5; e - See Table 1 for details.
Source: Own calculation (2023).

Rice Technology Implementation and Adoption

Table 4 depicts that the dominant (55.08%) of the youth 4-H club members have not implemented the rice technologies introduced to them. About 36.44% of them had implemented but not continued and 5.93% of them had modified some processes of it. Only 2.54% of the members have full and continually implemented the rice technologies in their places.

Table 4. Level of implementation of rice technology

Level of Implementation	n	%
Not implemented	65	55.08
Implemented but not continued	43	36.44
Continued but modified some processes	7	5.93
Fully continued	3	2.54

Source: Own calculation (2023).

Likewise, Table 5 shows that the dominant (68.64%) of the youth members do not adopt the new rice technologies introduced to them. About 25.42% of them have adopted in average time and scale in their respective places. And only 5.93% of them have fully adopted them on a larger scale and shared the said technologies with other farmers in their places.

Table 5. Level of adoption of rice technology

Level of Implementation	N	%
Not adopted	81	68.64
Adopted in average time and scale	30	25.42
Fully adopted on a larger scale and shared with others to adopt	7	5.93

Source: Own calculation (2023).

Ordered Logistic Models

Table 6 presents the post-estimation (diagnostic tests) for the regression model to ensure the credibility of devising a statistical inference and interpretation of the parameter results. So, the two models are found heteroscedastic (*p*-value=0.001) based on the Breusch-Pagan test and an adjustment of the models was done using a robust command in STATA [15]. In addition, the two models were found to have no omitted variable (*p*-value>0.05) bias based on the Ramsey RESET test which indicates that the variables incorporated into the models were befitting [9].

Table 6. Post-estimation (diagnostics) for the models

Model	Test Statistic		p-value	Interpretation
I	The Breusch-Pagan	χ^2=10.60	0.001	Heteroscedasticity
	The Ramsey RESET	F=0.95	0.417	Absence of omitted variables bias
	Variance inflation factor (VIF)	VIF=1.39	-	Safe from Multicollinearity
	The Shapiro-Wilk	Z=4.46	<0.01	Residuals are not normally distributed
II	The Breusch-Pagan	χ^2=11.93	0.001	Heteroscedasticity
	The Ramsey RESET	F=0.62	0.606	Absence of variables bias
	Variance inflation factor (VIF)	VIF=1.39	-	Safe from Multicollinearity
	The Shapiro-Wilk	Z=5.22	<0.01	Residuals are not normally distributed

Source: Own calculation (2023).

Moreover, the models are found to have no problem concerning multicollinearity between independent variables since the mean average variance inflation factor (VIF) is lesser than 10 [2]. Furthermore, the two models found that their residuals are not normally distributed (p-value<0.01) based on the Shapiro-Wilk test, however, the k-density estimate graphs are close to normality [15]. Hence, the two ordered logistic models are valid and statistically reliable for extracting inferential information.

Table 7. Ordered logistic regression models for 4-H youths' implementation (Model I) and adoption (Model II) of rice technology and its factors

FACTORS	Ordered Logit Models	
	Implementation	*Adoption*
Profile and Influence		
Age (in years)	-0.064^{ns} (0.042)	-0.041^{ns} (0.044)
Male[a]	0.237^{ns} (0.375)	0.383^{ns} (0.396)
Education status[a]	-0.208^{ns} (0.444)	-0.462^{ns} (0.351)
log (Monthly family income[b]+1)	0.768^{ns} (0.767)	-0.229^{ns} (0.939)
4-H coordinator influence[a]	-0.238^{ns} (1.210)	-0.109^{ns} (1.314)
Family influence[a]	-0.309^{ns} (0.613)	-0.520^{ns} (0.627)
Attended training[a]	1.205** (0.013)	1.228** (0.593)
Effectiveness of 4-H Coordinator[c]	-0.151^{ns} (0.429)	-0.073^{ns} (0.408)
Rice technology Characteristics		
Complexity[c]	-0.203^{ns} (0.254)	-0.216^{ns} (0.270)
Economically viable[c]	0.353* (0.186)	0.317^{ns} (0.216)
Compatibility[c]	-0.257^{ns} (0.286)	-0.162^{ns} (0.305)
Environmentally safe[c]	-0.105^{ns} (0.162)	-0.007^{ns} (0.209)
Minimal risk[c]	-0.415* (0.245)	-0.153^{ns} (0.254)
Participants	118	118
χ^2	32.70***	20.84*
p-value	0.002	0.076
Pseudo R²	0.120	0.089

Note: a - dummy (indicator) variable; b - Philippine Peso (PHP); c - 1 to 5 scaling; standard errors are enclosed with parenthesis; ns- not significant; *p<0.10;**p<0.05; ***p<0.01.
Source: Own calculation (2023).

As seen in Table 7, Model I (X^2=32.70, *p*-value=0.002) is highly significant at a 1% level. This goes to infer that there are statistically significant predictors that governed the level of implementation of new rice technologies among the youth members of the 4-H Club. In addition to that, the coefficient of determination (Model fit: R^2=0.120) also shows that there are independent variables that explain the variation in the level of implementation.

In that case, Table 7 reveals that the significant influencing predictors of implementation of rice technology include attended training (at a 5% level), economically viable characteristic of new rice technology (at a 10% level), and minimal risk feature of new rice technology (at a 10% level). At the same time, the second regression model (II) (X^2=20.84, *p*-value=0.076) is statistically significant at a 10% level that has a coefficient of determination (goodness-of-fit) of 0.089 (R^2). Further, the only statistically significant factor in the adoption of new rice technologiesis the attended training (at a 10% level). It is worth noting that training and development in farming are educational activities that involve innovation and new technologies designed to improve the efficiency of farmers and the productivity of economic income.

Training in agriculture is vital in knowledge development concerning farm technologies and new techniques which are necessary for production growth and sustainability [3], [5], [21], [23]. On the face of it, youth members of the 4-H club are more likely to implement and adopt rice technologies if they are rigorously educated about the functions, features, and benefits. In addition, if rice technology is perceived to be economically viable, then youth members are encouraged to implement the technology in their respective places to maximize its profitability [17]. In fact, farmers are more satisfied if they can take advantage of the technology and exceed their economic profitability over the economic cost of rice production [7]. However, the negative sign of the coefficient of minimal risk characteristics indicates that if the youth members perceived that the rice technology is riskier, they are more convinced to implement it. This result is not parallel to the findings in the literature that farmers are more encouraged to adopt the technology if no risk is involved [14], [17].

CONCLUSIONS

The study's main aim is to model the factors influencing the implementation and adoption of rice technologies among 4-H club youth members. Results showed that youth members are influenced by the 4-H coordinator and their families. In addition, it is revealed that most of the youth members in the 4-H club have attended training concerning innovative rice technologies. Moreover, the youth members perceived that 4-H coordinators are doing their job well. However, it is found that most of the members do not implement and adopt the rice technologies and that there are only a few youth members who fully implement (2.54%) and adopt (5.93%) the rice technologies in their respective places.

The statistical model revealed that the significant factors of implementation of rice technologies are the following attended training, economically viable characteristics of rice technology, and minimal risk characteristics of rice technology. Moreover, the second statistical model portrayed that the significant determinant of the adoption of rice technologies among 4-H club youth is the training attended. Conclusively, it is necessary that the youth members of the 4-H club must be trained and oriented in regard to the different functions, features, and benefits of implementing and adopting the newly introduce innovative rice technologies in their respective areas. In fact, proper training and seminars will give them sufficient knowledge and information in implementing and adopting rice technologies to amend their productivity and increase their economic profitability.

In that case, the Philippine government must provide enough budget for supporting the 4-H club program to conduct rigorous training and seminars for their members. Plus, the government must provide subsidies for agricultural inputs in relation to rice technologies to support the youth members and farmers' production process. As for further studies, a similar study must be conducted in other areas in the Philippines where there are 4-H club programs exists to gather richer details and arguments to improve the current program. It is also suggested that one may incorporate variables of well-being (happiness level) or satisfaction of being a member of the 4-H club as possible limitations of the current article.

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MANAGEMENT OF PERSONAL DATA PROCESSING AND PROTECTION

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Abstract

This article emphasizes the crucial significance of personal data and the potential dangers arising from its unauthorized processing, which can violate an individual's basic rights and freedoms. To address these worries, the European Union has implemented a comprehensive regulatory structure, widely recognized as the General Data Protection Regulation (GDPR). In the domain of data privacy and security, personal data is defined as encompassing any information with the capacity to identify an individual, whether it be anonymized, encrypted, or pseudonymized data. The regulatory purview of GDPR spans all modes of data processing, automated or manual, and remains indifferent to the storage medium or technology employed. Illustrative examples of personal data comprise an individual's name, identification number (like a CNP), location data (such as GPS coordinates), online identifiers (for instance, specific types of cookies), and a diverse array of attributes pertaining to an individual's physical, physiological, genetic, psychological, economic, cultural, or social identity. This classification also encompasses information such as IP addresses, email addresses, or residential addresses. It is of utmost importance to acknowledge that personal data, whether examined in isolation or in conjunction with other data elements, retains the potential to unveil the identity of an individual. This paper expands the scope of analysis to critically assess the multifaceted implications of GDPR within the contemporary landscape of data privacy and security, with a specific focus on its relevance within the realm of management practices. The examination encompasses an in-depth exploration of the foundational principles of GDPR, its legal framework, and its global impact across businesses, individuals, and regulatory bodies. Additionally, the study delves into the complexities associated with GDPR compliance, illuminating the evolving dynamics of data protection within an increasingly digitized world. It emphasizes the essential role played by effective management strategies in addressing these challenges.

Key words: *personal data, GDPR, organization, legality*

INTRODUCTION

The safeguarding of natural persons' personal data processing is a fundamental right protected by Articles 7 and 8 of the Charter of Fundamental Rights of the European Union [1], Article 16 of the Treaty on the Functioning of the European Union (TFEU) [14], and Article 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms [4]. A significant milestone in European data protection regulations occurred in 2016 when the European Parliament and the Council adopted the General Data Protection Regulation (GDPR), which became directly applicable in all European Union member states from May 25, 2018. This regulation was complemented by the Directive on the protection of natural persons in the context of criminal offense prevention, investigation, detection, prosecution, or execution of criminal penalties, ensuring the free movement of such data [3]. In the digital age, the protection of personal data is a serious topic on the agenda of every organization (institution or entity). GDPR, the European regulation that came into effect in Romania on May 25, 2018, provides citizens with increased control over their identifiable data. Since its implementation, several organizations have faced sanctions for illegally processing personal data of natural persons. The National Authority for the Supervision of the Processing of Personal Data (ANSPDCP), as an autonomous central public authority with general competence in the field of personal data protection, represents the guarantor of respect for the fundamental rights to private life and the protection of personal data, stipulated by the articles mentioned in the first paragraph [9]. Thus, people dissatisfied with the way an organization processes their data have the right to file a complaint with the ANSPDCP (which can also be filed ex officio) and to go to court to obtain compensation.

Protecting personal data is one of the most important responsibilities of an organization or entity, there are many reasons why this responsibility must be taken seriously, including:

✓ *people's trust* – if their data is not properly protected, trust can be lost;

✓ *reputation* – failure to protect personal data can damage the organization's reputation and lead to unpleasant situations for both parties;

✓ *increasing opportunities* – excellent data protection is a way to stand out from the competition;

✓ *prevention of harm* – the misuse of personal data can harm the people involved, this situation can also lead to identity theft or fraud;

✓ *legal compliance* – compliance with privacy and data protection laws is essential in every jurisdiction. Such laws exist globally, but the European Union's General Data Protection Regulation (GDPR) stands out as the most rigorous and intricate regulation in this domain. Neglecting data protection could lead to investigations from regulatory bodies, sanctions (including criminal penalties), or legal action.

✓ *compliance with contractual conditions* – when organizations receive personal data from others, the contracts they have in place may obligate them to ensure the protection of that data.

The primary objective of this academic paper is to conduct a comprehensive and critical analysis of the GDPR concerning contemporary data privacy and security, with a particular emphasis on its relevance within the field of management practices. Enacted in 2018, the GDPR has triggered a significant shift in how organizations gather, process, and safeguard the personal data of European Union citizens.

At the same time, this paper aims to provide a comprehensive grasp of the fundamental principles and legal framework underpinning GDPR, along with its global ramifications for businesses, individuals, and regulatory entities, while underscoring the pivotal role that effective management plays in ensuring compliance and robust data protection. Furthermore, this analysis sheds light on the evolving landscape of data protection in an increasingly digitized world and underscores the essential nature of proficient management strategies in addressing these challenges. By delving into the nuances of GDPR and its implications for management, this paper seeks to offer valuable insights contributing to the ongoing discourse surrounding data privacy, regulation, and the governance of organizations.

MATERIALS AND METHODS

As the General Data Protection Regulation (GDPR) continues to exert its profound influence on the intricate domain of data privacy, it becomes increasingly imperative to embark upon rigorous academic inquiries aimed at comprehending its multifaceted dimensions and rigorously assessing its tangible real-world ramifications.

This scholarly paper endeavors to furnish an exhaustive scrutiny of GDPR compliance, delving into the regulatory framework and its pragmatic consequences. In the pursuit of this scholarly goal, a systematic approach has been embraced, which encompasses a diverse spectrum of sources and research methodologies. The bedrock of this research endeavor resides in the triangulation of primary and secondary sources, thereby ensuring a holistic and comprehensive exploration of the intricate facets inherent to the GDPR.

The following sources were used for the creation of this article:

✓ *Primary sources: this study rests the authoritative text* of the GDPR itself, which is complemented by official documents and guidelines disseminated by data protection authorities and regulatory bodies operating within the European Union. These primary sources serve as the fundamental cornerstone for the analysis of this framework, presenting an unadulterated reflection of the legislative intent and the operational intricacies underpinning the GDPR.

✓ *Secondary sources*: These sources include academic journals and scholarly volumes authored by experts in the field of data protection law, and reports from esteemed institutions and consulting firms. The insights garnered from these secondary sources, along with the varied perspectives and nuanced interpretations of the GDPR, enhanced the analysis by providing contextual depth to the GDPR's impact across a spectrum of stakeholders.

Moreover, in order to remain attuned to the evolving nature of GDPR and to glean real-time insights, websites have been consistently monitored. Reputable websites, including those maintained by the European Commission, data protection authorities, and reputable news sources, have been regularly consulted for updates, case studies, and relevant reports. These online sources provided critical information to contextualize the analysis within the dynamic landscape of GDPR compliance.

The methodology employed in this study is grounded in the amalgamation of legal analysis and ethical dimensions, thereby establishing a comprehensive framework for the examination of compliance with the General Data Protection Regulation (GDPR).

The management-oriented methodology for GDPR offering pragmatic strategies for organizations to harmonize data management practices with the stipulations of the GDPR. The ethical considerations are intricately interwoven throughout the research process, engaging with salient inquiries pertaining to data privacy, transparency, and societal ethics.

RESULTS AND DISCUSSIONS

A. The fundamental terms of personal data

Personal data can be classified into two categories [10]:

→ ***Personal identification data*** - is information that is related to an identified person or that can be identified with a person, being also called "personal identifiable information”. Some examples of personal data are the name and surname of a person, date of birth, home address, e-mail address, telephone number, marital status, photo of the face (image), voice, profession, habits and preferences, identifiers online and any other data related to the physical, physiological, economic, financial, cultural or social identity, which can be used for the direct or indirect identification of a natural person.

→ ***Sensitive data*** - is information that is much more protected than other types of data, which must benefit from special protection.

Sensitive data includes personal information that discloses one's racial or ethnic background, political affiliations, religious or philosophical beliefs, membership in trade unions, genetic details, biometric data for human identification, health-related information, and details about an individual's sexual life or orientation.

In general, the processing of this type of data is prohibited, but it is allowed only in certain exceptional situations, strictly provided by law (for example, when the data is necessary for the conclusion of an employment contract or the provision of medical services).

The following list contains the GDPR - compliant [6] definitions of the phrases used in this paper:

- “personal data” refers to any information related to a natural person, whether identified or identifiable. An identifiable individual is someone who can be directly or indirectly recognized, typically through elements such as a name, identification number, location data, online identifier, or specific physical, physiological, genetic, psychological, economic, cultural, or social characteristics;
- “processing” encompasses any activity conducted on personal data, whether automated or not. This includes actions like gathering, recording, organizing, storing, adapting, modifying, extracting, consulting, using, transmitting, sharing, disseminating, aligning, combining, restricting, deleting, or destroying the data.;
- “*data subject”* is any natural person whose data may be processed;
- “*special categories of data”* are data about the racial and ethnic origin, political opinions, religious or philosophical beliefs, membership in certain organizations, data about criminal

record, or the health and sexual orientation of the data subject;

- "*restriction of processing"* means the marking of stored personal data so as to limit their future processing;
- "*data record system"* means any structured set of personal data accessible according to specific criteria, be they centralized, decentralized, or distributed according to functional or geographical criteria;
- "*data controller*" refers to an individual or legal entity, public authority, agency, or any other organization that, either independently or in collaboration with others, defines the objectives and methods of processing personal data. This term also includes organizations and entities engaged in processing personal data;
- "*data processor*" is an individual or legal entity, public authority, agency, or any other organization that handles personal data on behalf of the data controller;
- "*data protection officer* (DPO)" is the person appointed by the data controller to ensure that the organization complies with relevant data protection laws and regulations;
- "*recipient*" refers to the individual or legal entity, public authority, agency, or any other organization to whom personal data is revealed, regardless of whether they are a third party or not;
- "*third party*" denotes an individual or legal entity, public authority, agency, or organization apart from the data subject, the data controller, the data processor, and individuals authorized by the data controller or data processor to handle personal data under their direct supervision;
- "*transmission*" refers to the disclosure of safeguarded personal data from the accountable entity to a third party;
- "*consent*" from the data subject implies any clear, specific, informed, and voluntary expression of the individual's will, either through a statement or a clear action, indicating acceptance for the processing of their personal data;
- "*breach of personal data security"* means a breach of security that leads, accidentally or unlawfully, to the destruction, loss, alteration, or unauthorized disclosure of personal data transmitted, stored or otherwise processed, or to unauthorized access to them;
- "*genetic data"* means the personal data relating to the inherited or acquired genetic characteristics of a natural person, which provide unique information regarding the physiology or health of that person and which results in particular from an analysis of a sample of biological material collected from the data subject;
- "*biometric data*" refers to personal information obtained through specialized processing methods concerning the physical, physiological, or behavioural traits of an individual. These traits enable or confirm the distinct identification of that person, such as facial images or fingerprint data;
- "*health data*" includes personal information pertaining to the physical or mental well-being of an individual, encompassing the provision of healthcare services. It reveals details about a person's health condition;
- "*enterprise"* means a natural or legal person carrying out an economic activity, regardless of its legal form, including partnerships or associations that regularly carry out an economic activity;
- "*data protection authority (DPA)"* means an independent public body established by a member state that has the responsibility to conduct investigations and take corrective action as necessary to ensure that the data protection rules are being followed.

B. Management of personal data

The management of personal data includes all information related to the rights of data subjects, the principles of the GDPR and the legal grounds on which all operations on personal data must be based.

(a) Rights

GDPR offers the data subject several rights, which can be exercised in relation to the data controller, by submitting a request in this regard [13]. The data controller cannot ignore this request, and it must be solved and answered within the legal term established by GDPR - one month from the receipt of the request, but it can be extended by another two months when the request is complex.

The rights that the data subject has according to GDPR are the following:

the right to be informed which requires individuals to receive information about the data being processed, including details such as what data is involved, the reasons for processing, the intended purposes, recipients of the data, and the individual's rights;

→ *the right of access* which grants individuals the ability to access their data, with the data controller obligated to provide the data subject with this access;

→ *the right to rectification* which enables individuals to correct incomplete or inaccurate information related to them;

→ *the right to erasure ("to be forgotten") which* allows individuals to request the deletion of personal data in certain situations;

→ *the right to restriction of processing* which grants the data subject the ability to request and obtain limitations on personal data processing in specific cases;

→ *the right to data portability* which enables individuals, in certain instances, to request and obtain the transfer of their personal data;

→ *the right to object* which gives individuals the authority to oppose processing when valid grounds exist;

→ *the right not to be subject to an automated decision, including profiling* which allows individuals to avoid being subjected to automated decisions, including profiling. If such a decision significantly affects them, they have the right to challenge it and request human intervention;

→ *the right to lodge a complaint with the national Data Protection Authority* which offers the data subject the possibility to file a complaint with the National Data Protection Authority if they are unhappy with how their data is being processed or if their rights have not been upheld.

→ *the right to take legal action against a company/organisation* where an individual has the right to initiate legal proceedings to seek compensation, both material and moral, for damages incurred due to the unlawful processing of personal data.

(b) GDPR principles

Any organization that processes personal data must comply with the key principles introduced by the GDPR [5]:

The principle of legality, fairness and transparency

This principle dictates that personal data should be processed in a lawful, just, and transparent manner concerning the data subject.

- the principle of legality assumes that the data must be processed in accordance with the law and fall under at least one of the legal grounds for processing from Art. 6 GDPR (consent, contract, legal obligation, vital interest, public interest and legitimate interest). The legality of the processing of special data must comply with certain additional requirements.

- the principle of fairness means that personal data cannot be processed in unfair, immoral ways or in ways that could harm data subjects.

-the principle of transparency means that individuals must know how an organization processes their data. Thus, the data controllers must optimally inform the data subject about how they process his data - prior to data collection - and facilitate the exercise of his rights.

The principle of purpose limitation

The purposes of data collection and processing must be determined, explicit and legitimate. The GDPR prohibits personal data from being processed for other purposes incompatible with the original purposes. In such a situation, being an incompatible purpose, the processing of personal data for the new purpose will not be legal.

The principle of data minimization

This principle assumes that the data controller processes only the minimum amount of data to achieve their goals, i.e. no more data than they need. Indeed, the data should be sufficient, pertinent, and restricted to what is necessary for the intended processing purposes.

The principle of accuracy

Personal data must be precise, comprehensive, and current. Any inaccurate data must be promptly deleted or corrected.

The principle of storage limitations

The data must be stored in a format that permits the identification of data subjects for a duration not surpassing the period required to fulfill the processing purposes. Any subsequent storage or archiving of this data must comply with legislation, ensuring compatibility with the initial collection purpose and incorporating technical security measures to prevent unauthorized processing.

The principle of integrity and confidentiality

The data must be processed in a way that ensures adequate security of personal data, including protection against unauthorized or unlawful processing and accidental loss, destruction or damage, by taking appropriate technical or organizational measures (for example to put in place measures and protocols to safeguard personal information).

The principle of accountability

The data controller is solely responsible for complying with the above principles and implementing appropriate measures for the protection of personal data, and who can demonstrate this compliance. This implies that the data controller must not only adhere to the GDPR's guiding principles but also be able to prove that he does so. The documentation of these processes is accomplished, for instance, through the implementation of appropriate policies and procedures, such as registers, analyses, agreements, written consents, information notes on the processing of the personal data, etc.

(c) The legal basis

According to Article 6 of the GDPR, personal data can be processed if at least one of the legal grounds is identified and properly documented before processing. All data operations must be lawful, i.e. based on at least one of the following grounds [7]:

- ✓ *vital interest,*
- ✓ *legal obligation,*
- ✓ *the contract,*
- ✓ *legitimate interest,*
- ✓ *consent and*
- ✓ *the public interest.*

The six grounds listed above are on equal footing. Regardless of the basis, the data controller must comply with the GDPR and implement appropriate data protection policies. In most cases, legal grounds require processing to be "necessary" for a particular and specified purpose. It must be defined before data processing begins, with great care as it will have a significant impact on the processing implementation [2], [11], [12].

Within data processing records, each legal basis should be justified with the proper information. As a result, a compact personal data management system is proposed, presented as an informative decision-making circuit of the logical type, offering YES or NO options [8]. This system aims to facilitate the selection of appropriate legal bases and, in particular, to aid data controllers in making informed choices.

The procedures that are conducted in this informational circuit and that, ultimately, can provide the compliant version concerning the legal grounds, are presented in the following sections.

(1) Vital interest: the processing is necessary in an effort to protect the vital interests of a person (the life or health of the person is protected).

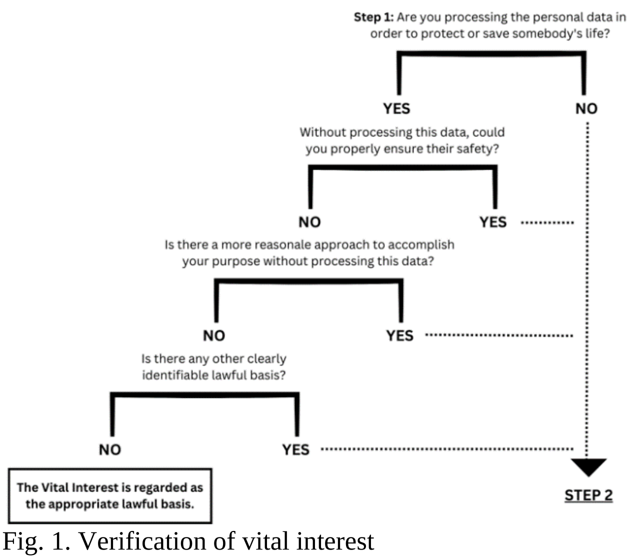

Fig. 1. Verification of vital interest
Source: own contribution.

(2) Legal obligation: the processing is required to uphold the legal responsabilities to which a data controller is subject; the information note must include the applicable legislation, the date and the name of the data subject.

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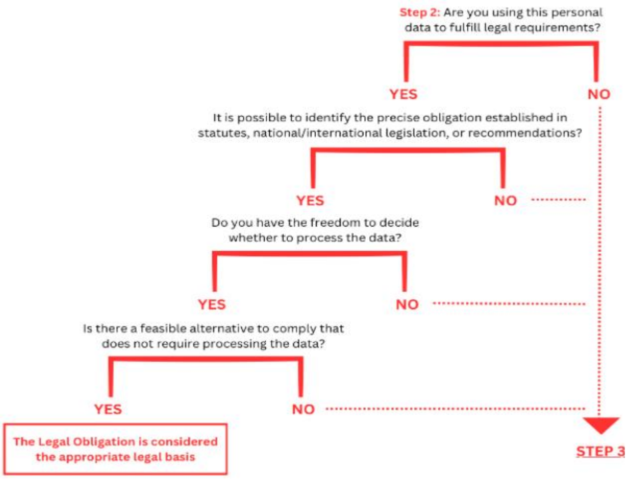

Fig. 2. Verification of legal interest
Source: own contribution

(3) The Contract: processing personal data is considered essential for fulfilling a contract in which the data subject is involved or for carrying out specific measures requested by the data subject before the contract is finalized. In general, in order to draft a contract that is going to be signed by the client, the data controller must handle the personal information of the future client. Such data may only be utilized throughout the duration of the agreement.

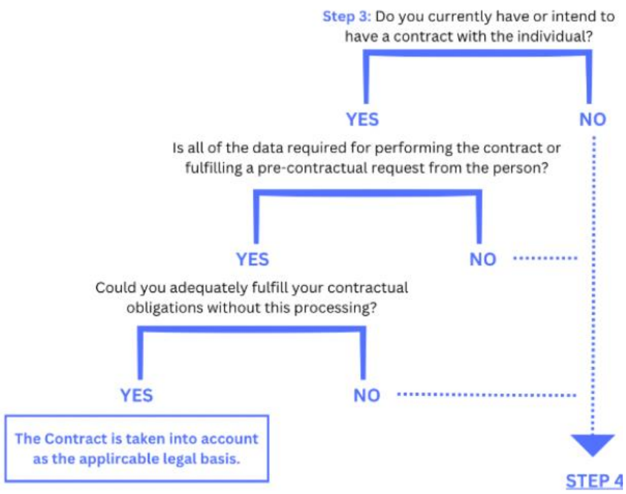

Fig. 3. Verification of the contract
Source: own contribution.

(4) Legitimate interest: can be used with caution as a legal basis following a detailed and well-documented analysis, as long as it does not conflict with the interest of the data subject. In particular, the controller must check that the data subjects' fundamental rights and freedoms are not violated, while ensuring that the reasonable expectations of the data subjects, based on their relationship with the controller, are considered, while also assuring thorough information in regard to this legal basis.

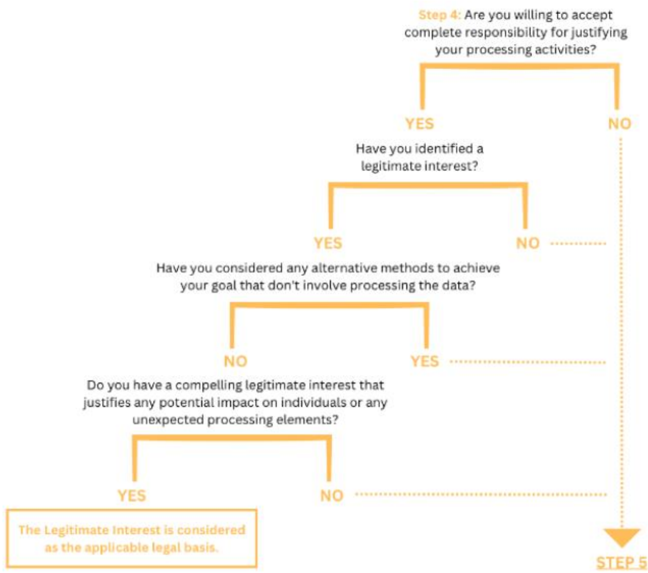

Fig. 4. Verification of the legitimate interest
Source: own contribution.

Additionally, the organisation must demonstrate in writing that their interest outweighs the rights and freedoms of the data subject before using the legitimate interest as a legal basis.

This is typically done through a Legitimate Interest Assessment (LIA), which may be followed by a Data Protection Impact Assessment (DPIA).

(5) Consent: When no other applicable legal basis exists or is mandated by the Regulation, the establishment of this legal foundation is necessary. A comprehensive information note must be provided to the individual, detailing the terms of the permission.

The individual's agreement must be clear, well-informed, and definite to be considered valid. It should be freely given and expressed through a tangible action, like checking a box, signing a document, or verbally confirming agreement. Additionally, the person should have the same ease in withdrawing their consent as they did while giving it, although not necessarily through the same method. According to EU law, the personal data of children under 16 can only be collected and processed with the consent of a parent or legal guardian.

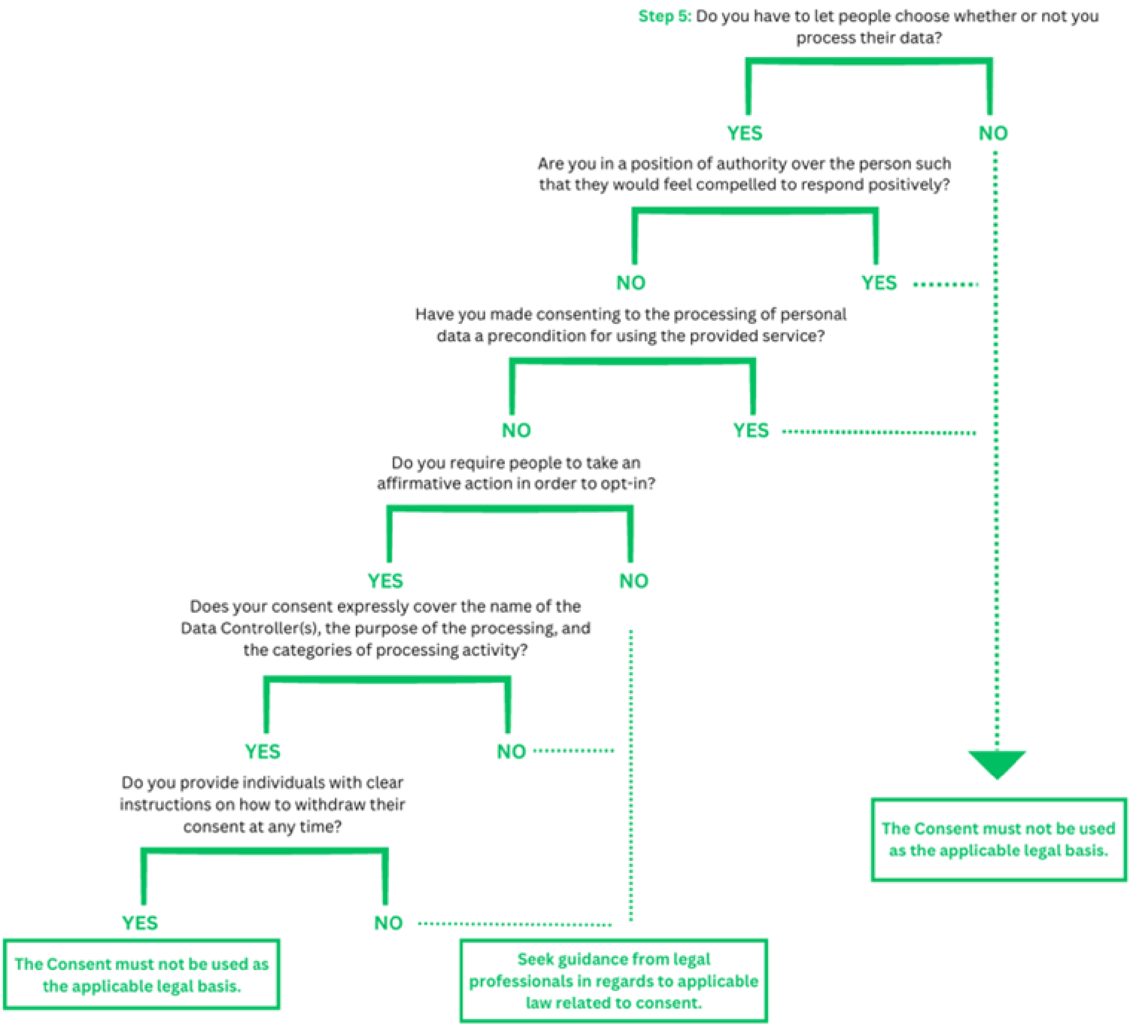

Fig. 5. Verification of consent
Source: own contribution

(6)Public interest: the processing is necessary for the performance of a task carried out in the public interest or the exercise of the official authority vested in the data controller. The use of public interest/task as a legal basis is so specific that it does not require further explanation as to when it applies. This multifaceted approach it was expressly designed to assist institutions/ companies/ organisations in fulfilling legal obligations and realizing efficacious and efficient data protection management that aligns harmoniously with overarching strategic objectives.

The agricultural sector, particularly in rural regions, contends with a distinctive labour landscape characterized by a substantial presence of unregistered or informally employed workers. These individuals, despite constituting an essential component of the agricultural workforce, often lack formal legal recognition, rendering them vulnerable to various forms of labour exploitation and infringements upon their rights and freedoms. In this intricate context, the significance of the General Data Protection Regulation (GDPR) cannot be overstated, due to the fact that it serves as a formidable legal framework with the potential to substantially augment the safeguarding of the rights and liberties of these workers.

Central to GDPR's relevance in this setting is the imperative to establish and maintain comprehensive databases and records that accurately encapsulate the employment status, wage structures, and prevailing working conditions of agricultural labourers. In aligning with the GDPR's foundational principles of data protection and privacy, the meticulous handling and administration of this data can profoundly ameliorate the predicaments faced by these labourers. This data not only acts as a bulwark against their potential exploitation but also provides a mechanism for effecting equitable remuneration, ensuring occupational safety, and promoting fair labour practices.

The exigency of GDPR becomes more pronounced when contemplating the predicament of Romanian day labourers who seek employment opportunities in other European Union member states, notably Spain and Italy. These migrant labourers, often grappling with linguistic barriers, limited access to legal resources, and susceptibility to discrimination, find themselves ensnared in a particularly precarious position. Within this framework, GDPR-compliant databases emerge as a lifeline for these itinerant labourers. They serve as a conduit for their prospective employers to adhere to the requisite labour norms, thereby effectuating the protection of rights encapsulated within GDPR.

For example, these databases facilitate the meticulous monitoring of work hours, wage disbursements, and the stipulations of employment contracts for Romanian day labourers, thereby ensuring equitable remuneration and lawful safeguarding of their interests while working abroad. Moreover, the steadfast commitment of GDPR to data protection and privacy guarantees the judicious handling of the personal information associated with these labourers, mitigating the risks associated with data breaches and unauthorized data usage.

Therefore, GDPR plays a crucial role in addressing the complex issues faced by the agricultural sector, especially in rural areas where unregistered labour is common. By consistently upholding principles of transparency, accountability, and fairness through compliant databases, GDPR serves as a protector of the rights and liberties of both local and migrant agricultural workers. As a result, it contributes to creating a fairer and more just working environment in Europe and elsewhere, establishing itself as a fundamental element in advancing the principles of social justice and inclusivity within the agricultural sector.

CONCLUSIONS

Personal information, regardless of whether it's in physical form, digital databases, or other formats, must be gathered and managed responsibly. Specific measures are in place to adhere to the Regulation governing the processing and free movement of personal data. In our increasingly data-driven world, where information holds immense value, GDPR's aim is to uphold the confidentiality of personal data.

In adhering to EU privacy regulations for the collection and processing of personal data, it is imperative to establish a robust legal foundation. Consequently, several legal bases underpinning the aforementioned operations encompass:

- the presence of the person’s consent;
- the necessity of executing a contract;
- public interest;
- compliance with legal obligations.

security is everyone's responsibility, as there are dangerous threats that could easily cause damage. It is the role of each individual to implement data security best practices. Thus, it is recommended to:

- lock computers and devices when they are left unattended;
- select strong, long and complex passwords;
- keep data where it belongs;
- dispose of the data properly.

Phishing also involves attempts to trick you into clicking on email links or attachments that contain viruses that might harm your computer system. Beware to never give out your password in response to an email or phone call, and be cautious about the websites you visit and the links you click. One individual making a mistake is all it takes for a hacker to gain access to your computer system or for your data to be lost or stolen. As such, accountability is crucial when it comes to protecting data confidentiality. The management and usage of personal data can greatly impact an individual's life, which is why it's essential to understand the significance, value, and safeguarding of data in all your actions!

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STATISTICAL ANALYSIS MODEL FOR IDENTIFYING THE DYNAMICS OF HOTEL TOURISM

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Abstract

Data analysis is a process of inspecting, transforming, cleaning, and modeling information with the purpose of uncovering useful insights, providing conclusions, and supporting decisions. The results obtained from processing statistical data are presented as specific statistical models (series, graphs, tables), and the relationships for observed phenomena emerge in a sequence that corresponds to the existing relationships. These make it possible to interpret patterns, enabling the correct selection of methodologies for calculating statistical indicators. Statistical data in tourism provide the opportunity for the development of strategies within this sector, where evaluated indicators serve as a source for monitoring and refining situations in tourism. The assessed information allows for analyses across various periods, integrating tourism into the national statistical system. The purpose of this study is to present an analytical model through a phased realization of statistical analysis regarding tourist arrivals in hotel-type accommodation establishments. Essentially, this analysis includes: the statistical study of frequency distributions through the calculation of variation and asymmetry indicators, the statistical study of frequency distributions through the calculation of central tendency indicators, and the establishment of statistical relationships between the two characteristics – the number of hotels and the number of tourists arriving in hotels.

Key words: *hotel tourism, dynamics, statistical analysis model, Romania*

INTRODUCTION

Tourism stands as a pivotal and substantial industry in a country's economy. Romania's wealth of natural, climatic, and historical attributes bestows considerable advantages upon tourism compared to other sectors of the economy. Fostering the growth of the tourism sector should take precedence on both a national level and among entrepreneurs within this domain. It is imperative to promote important decisions and escalate efforts towards developing regions with pronounced tourism potential. Presently, the tourism industry is experiencing a robust upswing following the easing of restrictions post the SARS-CoV-2 pandemic, as the population eagerly seeks to resume their ordinary lives.

The primary objective of statistics is to provide high-quality data and information that embody accuracy, relevance, accessibility, timeliness, coherence, and clarity. Statisticians' provided data offers the capacity to evaluate decision-making factors more broadly. Many accommodation proprietors remain unaware of the opportunities that statistical data can unlock. Statistical data within the tourism realm extend the potential for devising strategies within this sector, with evaluated indicators serving as a resource for monitoring and refining the tourism landscape.

The assessed information enables the execution of analyses across diverse timeframes, effectively integrating the tourism sector into the national statistical framework.

In summary, the significance of statistics in tourism encompasses [2]:

-understanding society as a whole and the level of economic development;

-establishing directions and development objectives;

-formulating prospective and developmental programs;

-determining measures to be taken within the decision-making process;

-monitoring the achievement of established objectives;
-disseminating the obtained data;
-conducting international comparisons.
In this context, the purpose of this research was to develop an analytical model through a phased realization of statistical analysis regarding tourist arrivals in hotel-type accommodation establishments in Romania.

MATERIALS AND METHODS

A tourist accommodation facility is any permanent or seasonal construction or arrangement that provides accommodation services and other specific amenities for tourists.
In statistical research, tourist accommodation facilities with an accommodation capacity of fewer than 5 places are not included.
A hotel is a type of tourist accommodation facility set up in buildings or building structures that offers properly equipped rooms, studios, or apartments to tourists.
It provides specialized services, has a reception area, and may include dining spaces.
Tourist arrivals in tourist accommodation facilities refer to the number of tourists staying in tourist accommodation establishments and encompass all individuals (both domestic and foreign) travelling outside their permanent place of residence and spending at least one night in a tourist accommodation facility in visited areas within the country.
In practice, this study utilizes two sets of data covering the period from 2005 to 2022 (Table 1):

1. tourist accommodation capacity (the first analyzed characteristic being the *number of hotels*) and
2. the utilization of tourist accommodation facilities, measured by the number of tourist arrivals in hotels (the second analyzed characteristic being the *number of tourists*).

The presented data constitutes an information set concerning the number of hotels (Xi) and the number of tourists/ arrivals in hotels (Yi) on a national level spanning the period from 2005 to 2022. These data (Xi and Yi characteristics) can be subjected to statistical analysis to identify trends and patterns in tourism dynamics within this region.

Table 1. Statistically analyzed characteristics

Year	Number of hotels (Xi)	Number of tourists/ arrivals in hotels (Yi)
2005	989	4,477,936
2006	1,059	4,725,448
2007	1,075	5,212,170
2008	1,104	5,245,292
2009	1,159	4,539,858
2010	1,233	4,585,211
2011	1,308	5,357,763
2012	1,384	5,740,304
2013	1,429	5,908,649
2014	1,456	6,314,865
2015	1,522	7,214,613
2016	1,530	7,927,540
2017	1,577	8,565,979
2018	1,616	9,004,486
2019	1,608	9,274,954
2020	1,581	4,116,681
2021	1,583	6,203,693
2022	1,602	7,943,950

Source: NIS, 2023, http://statistici.insse.ro:8077/tempo-online/[8].

Based on these two datasets, the following analyses can be conducted:

- ✓ statistical analysis of frequency distributions through the calculation of ***variation indicators*** (absolute range of variation, relative range of variation, absolute individual deviations, relative individual deviations, mean absolute deviation, variance, standard deviation, coefficient of variation) and ***skewness indicators*** (absolute skewness, relative skewness, skewness coefficient);
- ✓ statistical analysis of frequency distributions through the calculation of ***central tendency indicators*** (measures of central tendency - arithmetic mean, harmonic mean, geometric mean, quadratic mean, as well as positional average indicators - median and mode);
- ✓ establishing statistical relationships between variables (the two characteristics), both through simple methods (graphical method, correlation table method, grouping method, method of interdependent parallel series) and through analytical methods

(regression method, covariance method, correlation ratio method, correlation coefficient method, analysis of variance method):

→ *The grouping method* is a technique for organizing data whereby statistical relationships can be investigated. Simple grouping involves organizing statistical units based on a primary grouping characteristic and calculating and interpreting partial means or partial relative values for the resultant characteristic. Combined grouping involves dividing statistical units into groups based on variations of two grouping characteristics, and the results of the grouping are presented in a two-way combined table.

Depending on the type of grouping variable (discrete or continuous) and the range of characteristic values, grouping can be done by categories (when data is grouped according to a discrete variable with a relatively small range of values) or by intervals (when data is organized according to a continuous variable with a wide range of values). This method should be employed only when dealing with a large number of statistical observations, where applying analytical calculation methods is not feasible without prior data grouping.

→ *The graphical method* involves constructing a correlation graph (known as a scatterplot) where the values of the primary grouping characteristic (x) and the values of the secondary grouping characteristic (y) are plotted. Based on the distribution pattern of points on the graph, a line or curve is visually drawn, the equations of which are known. If the curve or line is drawn on the first diagonal, the relationship is direct, and if it's drawn on the second diagonal, the relationship is inverse.

→ *The regression method* is an approach to analyzing relationships between variables using regression functions. Regression functions are selected empirically using correlation graphs and significance tests. Based on the number of variables used in the model, two types are distinguished: single-factor regression (one predictor variable xi and one response variable yi) and multiple-factor regression (multiple predictor variables and a single response variable).

→ *The correlation coefficient method* revolves around the "correlation coefficient," which serves as a synthetic indicator used to measure relationships between two variables with a normal distribution.

→ *The correlation ratio method* is used to determine the strength of relationships between the considered influencing factor (xi) and the resultant characteristic (yi), regardless of the form of the relationship—whether linear or nonlinear—by calculating a synthetic correlation indicator called the "correlation ratio" (Rx/y). By measuring the degree of intensity, the link between the characteristics considered as influencing factors and the resulting characteristics is established, without concerning whether the relationships are linear or nonlinear.

→ *The analysis of variance method* can be employed in several cases, namely: to verify the independence of a commercial or tourism-related phenomenon, to assess the stability of means and variances across multiple successive samples, and to examine the dependence of a commercial or tourism-related phenomenon on its influencing factors.

All statistical processing and calculations were conducted using the statistical analysis software ANOVA and the Excel function library, ensuring easy and accurate results generation.

RESULTS AND DISCUSSIONS

To characterize the relationship between phenomena, several approaches fall under the category of simple methods for characterizing connections. These methods are easy to apply and rely on qualitative analysis of correlated variables, offering insights into the nature and essential traits of the investigated relationship. Utilizing graphical methods, a quick visual analysis of the trend of the two analyzed characteristics can be achieved, as shown in the following two graphs. In Figure 1, the evolution of the total number of major accommodation establishments in Romania is depicted. It is evident that agrotourism guesthouses are leading by a significant margin, followed by hotels and tourist guesthouses. Agrotourism guesthouses and hostels have become increasingly popular and appreciated in recent years, with a doubling of accommodation spaces between 2005 and 2022. Hotels and tourist guesthouses have also experienced modest growth, while cabins and vacation villas have not expanded their accommodation capacity. The general trend regarding the number of hotels has been a gradual annual increase, relatively stable over time, with small fluctuations in certain periods.

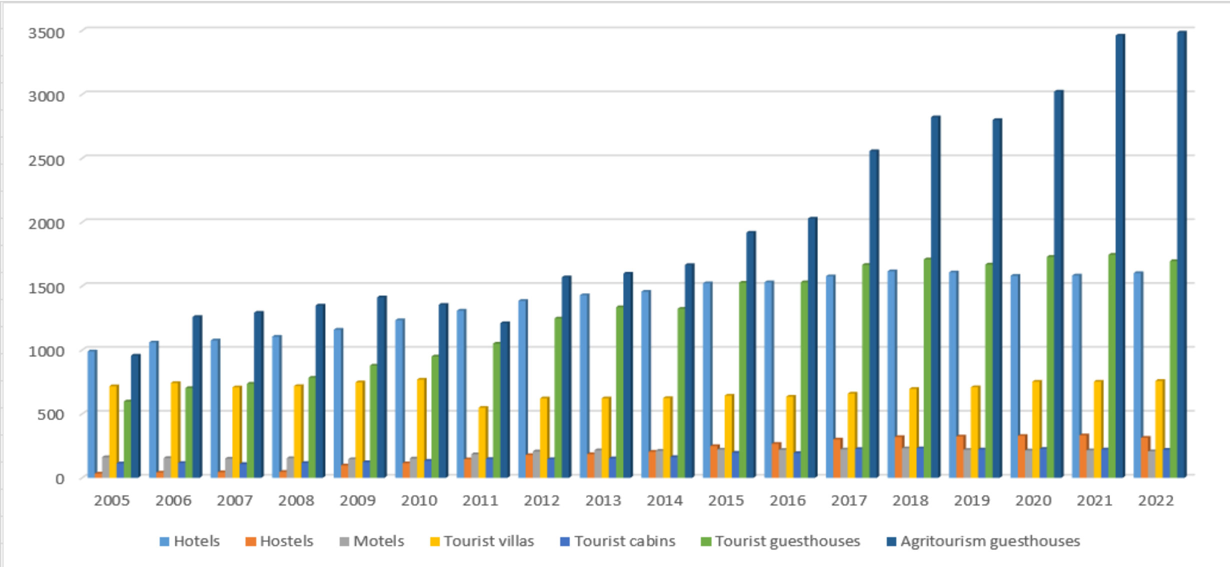

Fig. 1. The total number of accommodation spaces for the main lodging establishments during the period 2005-2021
Source: NIS, 2023, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table [8].

In Fig. 2, it's evident that the largest number of tourists prefer to stay in hotels, with numbers increasing from over 4.4 million in 2005 to a peak of 9.2 million in 2019. The second preferred accommodation choice is tourist guesthouses, accommodating over 580 thousand people in 2012, with the peak being in 2019 at 1.2 million. There are two notable points of reference when a decline in tourist numbers occurred, namely during the global economic crisis (2008-2010) and during the SARS-Cov-2 pandemic, which resulted in severe travel restrictions (2020-2021). These restrictions started to ease in 2022, allowing for a resumption of travel and vacations, and consequently, a significant increase in the number of tourists (some of the 2022 data might not be updated, which is why this year is missing from the graph representation).

In actuality, the number of tourists experienced a 17% upswing from 2005 to 2008, followed by a remarkable surge of 202% between 2010 and 2019, culminating in a peak in 2019. The onset of the SARS-CoV-2 pandemic and the subsequent travel bans led to a stark plummet of 207% in tourist numbers in just one year. However, commencing from 2021, as travel restrictions eased, there was a noteworthy resurgence, with a 68% upswing in tourist numbers. This trend has remained consistent and is ongoing.

In Figure 3, the two characteristics are depicted in the form of a scatterplot, aiming to observe and potentially establish a connection between them. The relationships that can emerge are stochastic relationships, where one phenomenon acts as an influencing factor and the other as an effect.

Statistical dependence is characterized by the fact that when an influencing factor changes, the influenced factor responds with a distribution of values. As apparent from the parallelism of the two trends, the connection between variables is direct.

However, since there isn't a concrete manifestation of a relationship between the two variables (xi and yi) that can be quantitatively expressed to measure the intensity of their occurrence, a statistical analysis using specific analytical methods is necessary.

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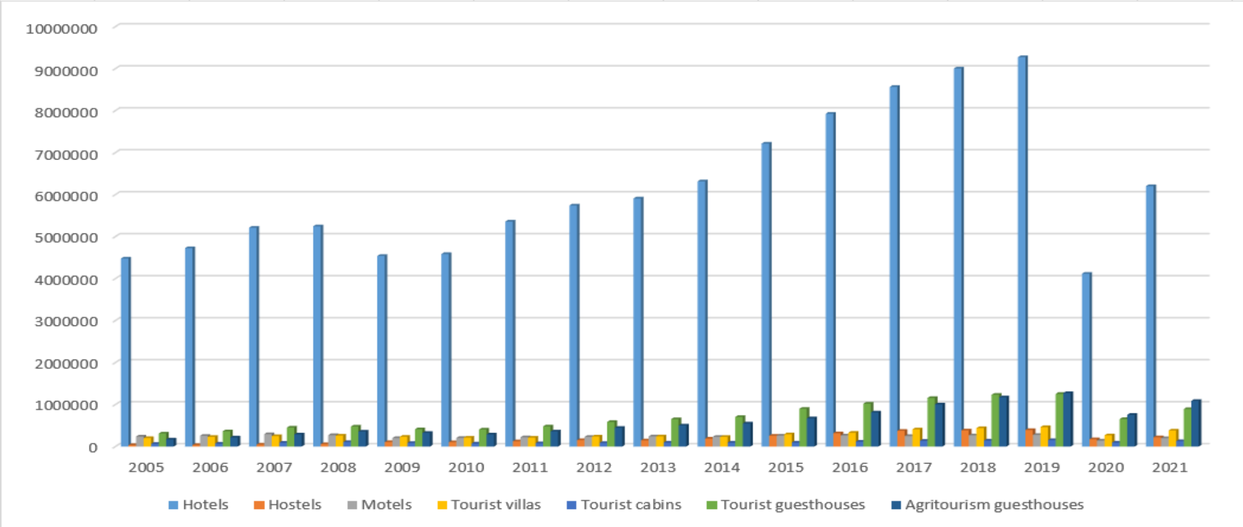

Fig. 2. The total number of tourists during the period 2005-2021, categorized by the main lodging establishments
Source: NIS, 2023, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table [8].

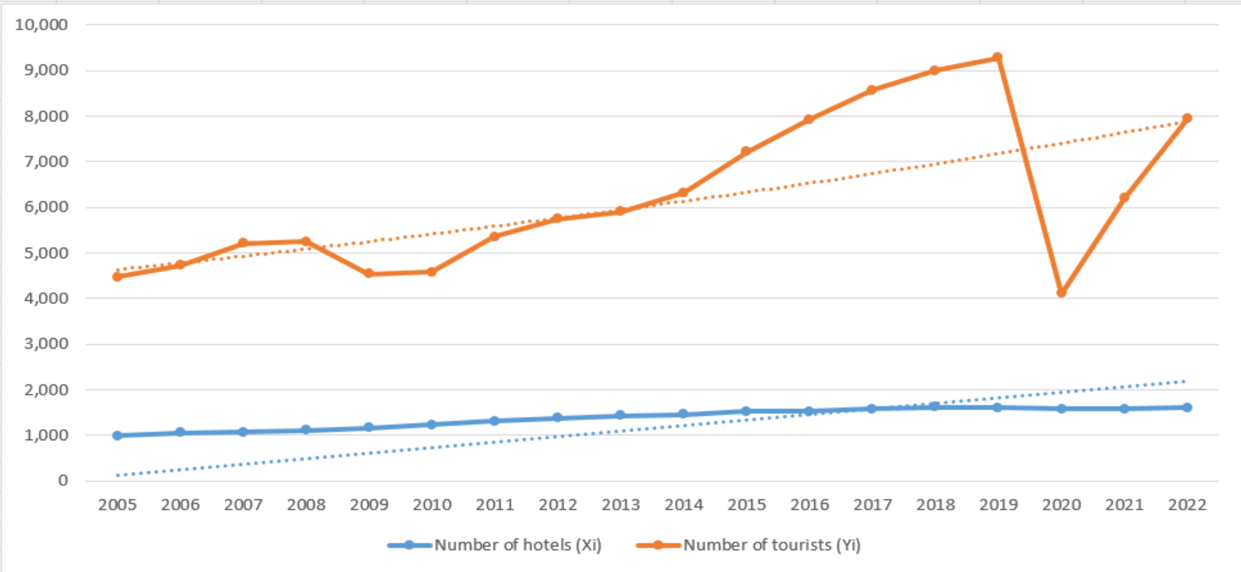

Fig. 3. The graphical representation of the two characteristics
Source: NIS, 2023, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table [8].

To facilitate the comparison of the two one-dimensional distributions organized into interval groups, we calculated *central tendency indicators* (mean, median, mode), *variability indicators* (variance, squared mean deviation, coefficient of variation), and *skewness indicators* (absolute skewness, relative skewness, interquartile range, skewness coefficient). To assess the strength of the relationship between the two variables (Xi, Yi), we computed the Pearson correlation coefficient, a measure suitable for data with an asymptotic normal or normal distribution.

a. Statistical analysis of frequency distributions - central tendency indicators

Central tendency indicators are a highly significant category of statistical measures employed in the analysis of numerical variables, succinctly capturing what is typical, essential, characteristic, objective, and stable for a set of numerical data. These indicators become more informative about central tendencies as the underlying data becomes more homogeneous [5].

→ ***Mean:*** It is the most commonly used indicator to characterize central tendency and represents the value that, when replacing all terms in a series, does not change their cumulative level. The mean is a typical or central value within a distribution (most

frequently used is the arithmetic mean). It is sensitive to extreme values, which can impact the meaning and representativeness of the mean as a central value. For the mean to be representative, the data from which it's calculated should be as homogeneous as possible. When the number of characteristic values coincides with the number of units, the simple arithmetic mean is used. In cases where the same value of the characteristic is recorded for multiple units, the mean is calculated as a weighted arithmetic mean [1].
Since the data from the two analyzed series are not redundant, we have used the simple arithmetic mean:

- for the X_i characteristic:

$$\bar{x} = \frac{\Sigma x_i}{n} = \frac{24{,}815}{18} = 1{,}379$$

- for the Y_i characteristic:

$$\bar{y} = \frac{\Sigma y_i}{n} = \frac{112{,}359{,}392}{18} = 6{,}242{,}188$$

Positional average indicators highlight central tendencies or concentrations of units. Among the positional average indicators, the most commonly used ones are the median and the mode.

→ ***Median:*** It is the central value in an ordered distribution of data, essentially representing the value in an ordered series (ascending/descending) that divides the series into two equal parts, such that 50% of the terms have values lower than the median, and 50% have values higher than the median. The median considers only the position of the terms in the series, remaining unaffected by the magnitude of these values. The median is equal to the central term of the ordered series (ascending/descending) if the series has an odd number of terms. If the series has an even number of terms, the median is equal to the simple arithmetic mean of the two central terms of the ordered series (ascending/ descending) [4].
For the two analyzed series, we have n=18, so the position of the median will be calculated using the formula: (n+1)/2 = 9.5, which means the median lies between the ninth and tenth elements of each series, after they have been arranged in ascending (or descending) order.

- for the X_i characteristic: Me ≈ (1,429 + 1,456)/2 =1,443
- for the Y_i characteristic: Me ≈ (5,908,649 + 6,314,865)/2 = 6,111,757

→ ***Mode (mode of a series):*** It is the value that appears most frequently in a distribution or corresponds to the highest frequency of occurrence.
It can be observed that for both characteristics, the data is not redundant, meaning each value has a single occurrence. However, to determine this indicator, we will use the method of grouping by variation intervals for a frequency distribution series:

Table 2. Data Grouped by Frequency of Occurrence

Xi Characteristic		Yi Characteristic	
Intervals	Frequency of occurrence	Intervals	Frequency of occurrence
989 - 1,149	4	4,116,681-5,406,250	8
1,149 - 1,306	2	5,406,249-6,695,818	4
1,306 - 1,463	4	6,695,818-7,985,386	3
1,463 - 1,619	8	7,985,386-9,274,954	3

Source: own contribution.

For characteristic X_i, the median interval size was determined as h_x = 157, and for characteristic Y_i, it was found as h_y = 1,289,568, calculated as the ratio between the absolute amplitude and the number of grouping intervals, which is equal to 4, as shown in Table 2.
The absolute frequency of the median interval for X_i is 4, and the same holds for Y_i. Subsequently, the values for the mode were calculated using the lower limit of the modal interval, the size of the modal interval, the difference between the frequency of the modal interval (Δ_1) and the one before it, and the difference between the frequency of the modal interval and the subsequent one (Δ_2) [3].

- for the X_i characteristic:

$$Mox = x_0 + h_x * \frac{\Delta_1}{\Delta_1 + \Delta_2} =$$

$$= 1{,}306 + 157 * \frac{2}{2+4} \approx 1{,}149$$

- for the Y_i characteristic:

$$Moy = y_0 + h_y * \frac{\Delta_1}{\Delta_1 + \Delta_2} =$$
$$= 5{,}406{,}249 + 1{,}289{,}568 * \frac{4}{4+1} \approx$$
$$\approx 6{,}437{,}905$$

b. Statistical analysis of frequency distributions - variation and skewness indicators

With the help of variation indicators, we can [4], [10]:

-study the representativeness of the mean for a data series;

-assess the degree of homogeneity of the series;

-characterize the degree of variation in a series;

-compare over time and space multiple distribution series for the same characteristic or different characteristics recorded for the same population;

-understand the degree of influence of the grouping factors;

-understand the shape of the frequency distribution through comparison with the normal distribution.

The verification of ***data homogeneity*** involves calculating simple variation indicators (absolute range of variation and relative range of variation), as well as synthetic variation indicators (variance, mean squared deviation, and coefficient of variation).

→ ***The absolute range of variation*** is determined as the difference between the maximum value (x_{max}) and the minimum value (x_{min}) of the characteristic, indicating the widest range of dispersion of characteristic values:

- for the X_i characteristic:

$$A_{abs} = x_{max} - x_{min} = 1{,}616 - 989 = 627$$

- for the Y_i characteristic:

$$A_{abs} = y_{max} - y_{min} = 5{,}158{,}273$$

→ ***The relative range of variation*** is obtained by dividing the absolute range by the mean:

- for the X_i characteristic:

$$A_{rel}{}^{\%} = \frac{x_{max} - x_{min}}{\bar{x}} * 100 = 45.48\%$$

- for the Y_i characteristic:

$$A_{rel}{}^{\%} = \frac{y_{max} - y_{min}}{\bar{y}} * 100 = 82.64\%$$

→ ***The variance*** is calculated as the simple arithmetic mean (for simple series) or weighted mean (for frequency distribution series) of the squared deviations of the series terms from the central tendency (most commonly the arithmetic mean). It is an extremely useful indicator in statistical studies, being used in calculating skewness, kurtosis, and other statistical indicators.

- for the X_i characteristic:

$$\sigma_x{}^2 = \frac{\sum (x_i - \bar{x})^2}{n} = 46{,}053$$

- for the Y_i characteristic:

$$\sigma_y{}^2 = \frac{\sum (y_i - \bar{y})^2}{n} = 2{,}649{,}510{,}644{,}172$$

→ ***Mean squared deviation (standard deviation)*** is calculated as the square root of the arithmetic mean of the squared deviations of the series terms from their mean or as the square root of the variance. The mean squared deviation indicates on average how much the terms of a series deviate from the central tendency (usually the mean).

- for the X_i characteristic:

$$\sigma_x = \sqrt{\sigma_x{}^2} \approx 214.6$$

- for the Y_i characteristic:

$$\sigma_y = \sqrt{\sigma_y{}^2} \approx 1{,}627{,}731.75$$

A notable observation is the high standard deviation for the number of tourists, suggesting a substantial dispersion around the mean.

→ ***The coefficient of variation*** is the most widely used and significant indicator for analyzing variation. It is calculated as the ratio between the standard deviation (either squared or linear) and the mean.

- for the X_i characteristic:

$$v = \frac{\sigma_x}{\bar{x}} * 100 \approx 13.8\%$$

- for the Y_i characteristic:

$$v = \frac{\sigma_y}{\bar{y}} * 100 \approx 26.\%$$

It is noticeable that for both characteristics, the two values indicate a homogeneous dataset. This is evident as both the relative amplitude is below 100%, and the coefficient of variation is under 35%. Nevertheless, the dataset demonstrates greater homogeneity concerning the first characteristic (number of hotels), as indicated by a smaller spread around the mean (45.48%) and a lower intensity of variation (13.8%) compared to the second characteristic (number of tourists).

Determining the **asymmetry** of an empirical distribution series can be done through both graphical methods and by calculating asymmetry indicators. The most commonly used graphical representation for assessing asymmetry is the frequency polygon. However, graphical representations provide only a suggestive insight into the degree of asymmetry, without yielding an exact value to measure it. Evaluating asymmetry involves understanding the standard deviation, the interquartile range, and the coefficient of asymmetry [9].

→ ***The interquartile range (IQR)*** measures the spread of the middle half of the data and is used to assess the dispersion around the median. IQR is calculated as the difference between the third quartile (Q3) and the first quartile (Q1) in a dataset (IQR = Q3 - Q1). Quartiles are values that divide the dataset into four equal parts, with Q1 dividing the lower portion (25% of data) and Q3 dividing the upper portion (75% of data) [11].

To calculate the IQR, the data is first arranged in ascending order, then the positions of the quartiles are identified as follows:

(I)The first quartile (Q1): (n+1)/4 = (18+1)/4 = 4.75, so it falls between the fourth and fifth element,

(II)The second quartile (Q2 or median): (n+1)/2 = (18+1)/2 = 9.5, so it falls between the ninth and tenth element,

(III)The third quartile (Q3): 3*(n+1)/4 = 3*(18 +1)/4 = 14.25, so it falls between the fourteenth and fifteenth element.

- for the X_i characteristic:
  Q1 = 1,196 and Q3 = 1,582,
  so IQR = Q3 - Q1 = 386
- for the Y_i characteristic:
  Q1 = 4,725,448 and Q3 = 8,565,979,
  so IQR = 3,840,531

For the first characteristic, the interquartile range is 386, which means that 50% of the data in the distribution lies within this interval. The relatively large value of the interquartile range for the number of tourists indicates significant variability in the data of this series.

→ ***The skewness coefficient***: measures the asymmetry of data distribution or the deviation from the symmetry of data distribution and can be calculated using Pearson's formula, which involves indicators such as the mean, median, and standard deviation. A positive value of the skewness coefficient indicates positive skewness, to the right, meaning the data is skewed to the left, while a negative value indicates negative skewness, to the left, meaning the data is skewed to the right. A coefficient close to zero indicates an approximately symmetric distribution, meaning perfect symmetry.

- X_i characteristic: $C_{as} = \frac{\bar{x} - Mo}{\sigma_x} \approx 1.15$
- Y_i characteristic: $C_{as} = \frac{\bar{y} - Mo}{\sigma_y} \approx -0.19$

For the first characteristic, the skewness coefficient is approximately 1.15, which suggests a positive asymmetry of the data distribution, meaning there is a longer tail on the left side of the distribution. For the other characteristic, the skewness coefficient has a relatively small, negative value (-0.19), which suggests a slight negative asymmetry. This indicates that the distribution has a longer tail on the left side and is moderately more concentrated on the right side.

All these results provide a more detailed picture of the dispersion and asymmetry in the data concerning the number of hotels and the number of tourists for the analyzed period.

c. Establishing the statistical relationships between variables

To perform a correlation analysis between the two characteristics - the number of hotels (X_i) and the number of tourists (Y_i) - we can calculate the Pearson correlation coefficient as an average of the normalized products of deviations. The correlation coefficient can vary between -1 and 1, where a value of 1 indicates a perfect positive correlation (when an increase in one variable is associated with a proportional increase in the other variable), a value of -1 indicates a perfect negative correlation (when an increase in one variable is associated with a proportional decrease in the other variable), and a value of 0 indicates a lack of linear correlation between variables or that there is no significant linear correlation [6]. The value of the correlation coefficient depends on the shape of the regression line, which is why this indicator is significant for linear correlations and less meaningful for nonlinear correlations (in the latter case, the correlation ratio is used).

For calculating the Pearson correlation coefficient (r), we use the values of the mean ($\bar{x}$, $\bar{y}$) and the standard deviation (σ_X, σ_Y) for each variable [7]:

$$r = \frac{\sum[(x_i - \bar{x})*(y_i - \bar{y})]}{[(n-1)*\sigma_x*\sigma_y]} \approx 0.854$$

The obtained value for the correlation coefficient indicates a strong positive correlation between the number of hotels and the number of tourists. In other words, there is a strong tendency that when the number of hotels increases, the number of tourists also increases significantly. However, it's important to note that correlation does not necessarily imply a causal relationship. While there is a strong correlation between the number of hotels and the number of tourists, it doesn't necessarily mean that an increase in the number of hotels directly causes an increase in the number of tourists, or vice versa. There are many additional factors and variables that can influence this complex relationship, such as tourism promotion, regional economy, and local events can also influence both variables.

CONCLUSIONS

Current economic theory, which characterizes and analyzes the functioning of economic mechanisms, highlights the multiple interdependencies present in economic activity. Numerous factors, both primary and secondary, essential and non-essential, quantifiable and non-quantifiable, or quantifiable with approximation, influence socioeconomic phenomena and are interconnected in a reciprocal relationship. Tourism represents an important and significant sector within a country's economy, and as such statistical data in tourism provide the opportunity to develop strategies for this sector, and the evaluated indicators serve as sources for monitoring and refining situations and decisions.

Upon examining the two data series in our analysis, it becomes clear that both the global economic crisis spanning from 2008 to 2010 and the SARS-CoV-2 pandemic from 2020 to 2022 exerted significant impacts on the tourism industry. In the short term, events of this nature can lead to substantial disruptions across the broader economy. What holds significance is that the tourism sector holds the potential to rebound and expand following the stabilization of these respective situations. Looking at the longer term, an overarching trend of growth is evident, albeit with yearly fluctuations in the number of tourists arriving at existing lodging establishments. The continuous rise in tourist numbers serves as an impetus for the establishment of new accommodation options, with hotels being the favored choice for lodging structures.

The statistical analysis conducted in this study represents a specific interpretation of the data. A comprehensive and detailed data analysis involves employing multiple statistical methods to arrive at more precise conclusions and predict future trends in the tourism industry. However, as a conclusion from the case study on the number of hotels and tourists accommodated in these lodging structures, a positive correlation can be observed. This suggests a linear relationship, where the growth of accommodation infrastructure (number of hotels) is associated with a significant increase in tourist flow. While causal linkage is not a necessity in statistical correlation, in simpler terms, it can be said that when the number of hotels increases, there is a strong tendency for the number of tourists to also increase.

A crucial aspect for the tourism sector is to embrace the assistance provided by qualified professionals in the field of statistics. These experts can help popularize the need for statistical methodologies and their utility, offering solutions and evidence based on reliable information that supports stakeholders in the sector, including managers who might not naturally perceive these intricacies.

In conclusion, statistics should play a pivotal role in making significant decisions that can influence businesses over both the short and long terms.

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THE ROLE OF BIG DATA IN DIGITALIZING INFORMATION

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Abstract

In a world increasingly shaped by data, its exponential growth demands global organizations to swiftly embrace and synchronize with the prompt evolution of our lives. Innovations in storage technology, the advent of IoT (Internet of Things), and the emerging regulations of the European Union, such as the General Data Protection Regulation (GDPR), all underscore how "Big Data" propels economic transformation. Amid the rapid proliferation of artificial intelligence and technology, Europe's digital overhaul assumes paramount importance, as recent crises underscore the urgency for more effective alternatives that fuel the imperative shift towards sustainability. The concept of "Big Data" has been integrated as a central pillar in the EU's digital transformation strategy, set for 2030, and consequently, within the ambit of its green strategy. This sector's inherent opportunities contribute to the EU's pursuit of climate neutrality by 2050. At its core, "Big Data" involves the amalgamation of extensive and diverse information, subjected to algorithmic analysis to drive decision-making. The data's significance extends beyond economic implications, permeating diverse domains such as safety, health, agriculture, environment, law, and even individual contexts, thereby accentuating the intrinsic essence of "Big Data". This paper addresses the intricate demands posed by the rapid expansion of this type of data, which is experiencing exponential growth in terms of accessibility and automated integration within digital landscapes. Its efficacy is contingent upon not merely the escalating capabilities of technology to facilitate the accumulation and retention of substantial data quantities, but also on its proficiency to conduct thorough analysis, comprehension, and effective utilization of the data's complete worth.

Key words: *"Big Data", analysis, cloud, cluster*

INTRODUCTION

The end of the last decade finds us at a juncture where technological advancement, the internet, and interconnected networks have seamlessly woven themselves into the fabric of our existence. The influence of digitization and the importance of cyberspace have witnessed an exponential surge in the recent years. A substantial portion of the world's population, businesses, and nations have tapped into this realm, progressively depending on increasingly intricate information and communication technology systems. The unrestricted dissemination of information transcends geographical limits, and the magnitude of data and information has experienced a substantial expansion.

In broad terms, the concept of "Big Data" is defined as "large volumes of data rapidly produced by a diverse array of sources" [6]. Furthermore, it pertains to the exponential growth, both in availability and automated utilization of diverse digital information, as well as their analysis through algorithms to underpin decision-making. Definitions concerning "Big Data" exhibit a degree of subjectivity due to the lack of a clear method for quantifying the size of a dataset. The exponential increase in data generated and collected by interconnected technologies, alongside the influx of information from sensors, voice, multimedia, and more, holds a pivotal role in the digital transformation processes across all fields. Simultaneously, beyond the collection and storage of vast data volumes, understanding the potential for analysis and comprehending the value of this data are equally significant [14].

At the heart of the EU's digital transition strategy lies the foundational concept of "Big Data," coinciding with the establishment of a unified European data market through the introduction of the "European Data Act" in February 2022 [24]. The overarching goal of the EU's single data market is to cultivate a thriving data-driven economy, which is going to be:

- **dynamic,** by allowing the free flow of data within the EU, accessible to all, aimed at fostering a technology-based future and enhancing regional cooperation. Each EU member state can contribute to this realm by establishing what are known as common and interoperable “data spaces”, ensuring that the essential data collected within these spaces is collaboratively exchanged;
- **attractive,** through investments in new data storage and processing tools and infrastructures, especially in cloud technology, which will facilitate European convergence in terms of research and the modernization of key sectors of activity;
- **steady**, being backed by well-defined regulatory norms concerning data privacy and protection, as well as in the field of competition law. Additionally, measures are in place to empower data subjects to retain complete authority over their own data;
- **cyclical**, in order to support the goals of the Green Deal. It is also essential to filter data for processing and storage, with an emphasis on data that truly holds value within these innovation and research processes. Similarly, GDPR underscores the importance of setting retention periods for data, enabling the reclamation of storage space and relieving the burden on servers and services that are responsible for their management.

It's worth noting that the European Union already houses vast quantities of qualitative, non-personal data that remain untapped, and this volume is continually expanding. In 2018, the European region stored 33 Zettabytes (Zb) of data (with 1 Zb equivalent to 1 trillion Gigabytes (Gb)). It's estimated that by 2025, this figure will escalate to 175 Zb. This scenario prompts the need to find ways to unlock the value of these data and grant access to European businesses and researchers, all within the boundaries of the law.

In this context, the aim of this research addresses the intricate demands posed by the rapid expansion of this type of data, which is experiencing exponential growth in terms of accessibility and automated integration within digital landscapes.

MATERIALS AND METHODS

Within the data processing and analysis process, "Big Data" combines the subsequent data types:

→ ***structured data*** (possess definitive properties, such as size and format, and can be processed using relational databases),

→ ***semi-structured data*** (do not adhere to formal data standards yet are not entirely disorganized), and

→ ***unstructured data*** (completely disorganized and cannot be stored or processed using relational databases).

Unstructured data is most commonly encountered in the form of audio files, images, video files, social media updates, as well as other textual formats like log files, interaction data, machine and sensor data. Graph databases are becoming increasingly significant due to their ability to display massive amounts of data in a manner that expedites and streamlines the analysis process [15]. "Big Data" encompasses large and intricate datasets that are so voluminous that traditional data processing software simply cannot manage them. Due to the exponential growth of "Big Data" volume (generated not only by human users but also by various sources), new strategies and technologies are needed to analyze "Big Data" sets at terabyte or even petabyte scale. With the advent of the *Internet of Things* (IoT), more and more objects and devices are connected to the internet, gathering data about customer usage patterns and product performance. The emergence of machine learning has further augmented the data generation. Cloud computing technology has greatly expanded the possibilities offered by "Big Data" [5].

A dataset becomes a cluster when data sharing the same properties are grouped together. The cloud storage system provides efficient scalability, enabling developers to create clusters for testing a subset of data (Fig. 1). As integration progresses, the data requires inputting, processing, formatting, and rendering it accessible in a practical format.

Following this, vital insights can be derived, serving the purposes of advancing *machine learning*, crafting *predictive models*, and identifying *behavioral patterns*.

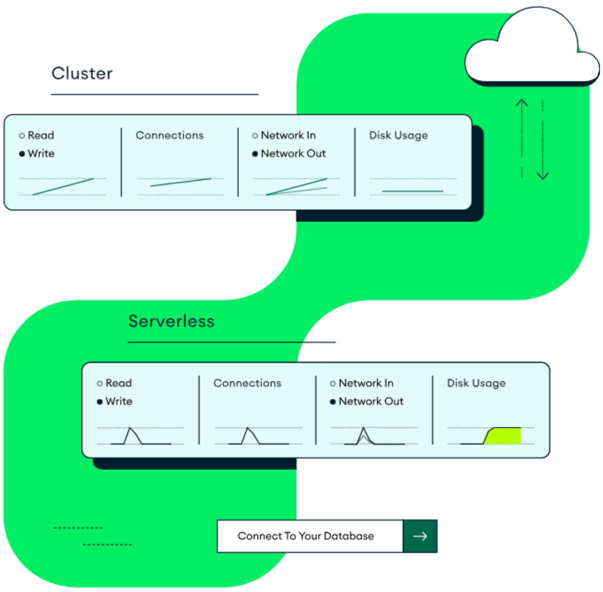

Fig. 1. Management of "Big Data" within the cloud environment
Source: https://www.mongodb.com/cloud/atlas.

In order to fully harness the potential of "Big Data," companies require the appropriate tools to process, analyze, and store the vital information they produce and gather on a daily basis for real-time outcomes. The four core components of any Big Data project include data storage (big data storage), data extraction (data mining), analysis, and visualization, with each element featuring innovative and high-tech instruments:

- **Data storage**: The storage of "Big Data" requires appropriate space, with storage solutions available in the form of cloud, on-site, or hybrid configurations. Data can be stored in diverse formats and integrated as needed, aligning with desired processing requirements and the essential processing engines within specific datasets. Cloud-based storage alternatives are progressively gaining favor due to their capacity to meet present computational needs, allowing flexible resource utilization, and ensuring secure and easily accessible data storage. As such they are essential to optimize the volume of information that can be stored, and it's worth noting that there already exist certain solutions specifically designed for this purpose, such as:

a)*HBase/Hadoop* - is an open-source platform that accommodates both structured and unstructured data, designed specifically for storing very large datasets using clusters [8].

b)*MongoDB* – proves to be highly beneficial for organizations employing a blend of semi-structured and unstructured data. For instance, it caters to businesses developing mobile applications or those requiring storage for product catalogs or data essential for real-time personalization [13].

- **Data mining**: Once the data is stored, tools need to be added to facilitate the discovery of information intended for analysis or visualization. The tools listed below aid in extracting relevant data without requiring manual tracing - a task that becomes impractical for humans, especially when dealing with thousands of records:

a)*IBM SPSS Modeler* can be employed to build predictive models using a visual interface, encompassing text analysis, entity analysis, decision management, and optimization. It enables the extraction of both structured and unstructured data within a comprehensive dataset [10].

b)*KNIME* is a scalable, open-source solution that provides an extensive array of algorithms and community contributions for data extraction and analysis, predictions, and key insights discovery. Text files, databases, documents, images, networks, and even Hadoop based data can be ingested, making it an ideal solution when dealing with combined data types [11].

c)*RapidMiner* is an open-source tool that empowers users to leverage templates instead of writing programming code, at the same time providing machine learning, data mining, predictive analytics, and business intelligence in order to support the entire process [18].

- **Data analysis**: Leveraging machine learning and artificial intelligence through visual analysis of diverse datasets enables the construction of data models, meaning that data can be thoroughly explored to make new discoveries and practically applied to each client's needs. The most powerful tools to

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facilitate data analysis for obtaining essential business, customer, or global insights include:

a)Apache Spark - is one of the most well-known tools for data analysis, with users ranging from small businesses to government agencies and tech behemoths like Apple, Meta (Facebook), IBM, and Microsoft. It functions as a quick, effective, and open-source tool that is compatible with the main Big Data programming languages, such as Java, Scala, Python, R, and SQL. This tool also enables developers to extensively employ SQL, batch processing, stream processing, and machine learning all within a single location, alongside graph processing. Impressively versatile, it operates on platforms such as Hadoop (for which it was initially developed), Apache Mesos, Kubernetes, both as an independent framework and in the cloud [1].

b)*Presto* - is an open-source tool that employs distributed SQL queries, designed to function as a robust engine for interactive data analysis. This tool supports both non-relational sources like Hadoop Distributed File System (HDFS), Amazon S3, Cassandra, MongoDB, and HBase, as well as relational data sources including MySQL, PostgreSQL, Amazon Redshift, Microsoft SQL Server, and Teradata. It finds utility in massive corporations such as Meta, Netflix, Airbnb, and Groupon [16].

c)*SAP HANA* – is typically utilized to aid businesses in making prompt decisions, drawing upon extensive sets of data [19].

d)*Tableau* - combines data analysis and visualization tools, and can be used on a desktop, through a server, or online [23].

e)*Splunk Hunk* (*Analytics for Hadoop*) - serves as a comprehensive analysis tool capable of generating queries, charts, and visual representations of fed data, all manageable through a dashboard, swiftly created and shared via the Hunk interface. It also operates on other databases and stores, including Amazon EMR, Cloudera CDH, and the Hortonworks Data Platform [22].

- **Data visualization:** To ensure easy comprehension during presentations, data is transformed into data visualizations. The top visualization tools include:

a)*Plotly* supports the creation of charts, presentations, and dashboards from analyzed data, using JavaScript, Python, Matlab, Jupyter, or Excel. Utilizing a graphical user interface (GUI) for importing and analyzing data, along with an extensive visualization library and an online chart-building tool, it becomes incredibly easy for it to generate excellent graphics [15].

b)*DataHero* is a user-friendly visualization tool that can extract data from various cloud services and input them into charts and dashboards [4].

c)*QlikView* enables the creation of data visualizations from all data sources using self-service tools that eliminate the need for complex data models and can be shared with others, allowing collaborative decision-making based on revealed trends and data. Advanced capabilities allow visual analyses to be embedded in applications, while dashboards can guide individuals through the production of analytical reports without requiring an understanding of data science [17].

RESULTS AND DISCUSSIONS

a. Attributes of “Big Data”

Although the concept of "Big Data" is relatively recent, the origins of large datasets trace back to the 1960s and 1970s, during the nascent stage of the data universe, marked by the emergence of early data centers and the development of relational database systems. Around the year 2005, an increasing awareness emerged regarding the substantial volume of data being generated by users through platforms like Facebook, YouTube, and other online services. The advancement of open-source frameworks, such as Hadoop and more recently Spark, has played a pivotal role in the burgeoning of "Big Data," as they facilitate the more streamlined processing of massive data volumes and alleviate the cost burden of storage.

The etymology of the term "Big Data" dates back to the mid-1990s and pertained to the manipulation and analysis of extensive datasets. It was first introduced into discourse in 1998 by John R. Mashey, an IT specialist, in his seminal work "Big Data and the Next Wave of Infrastress." Subsequently, in the year 2000, Peter Lyman and Hal Varian published the ground-breaking study "How Much Information?", representing the first endeavour to quantify the annual generation of new information on a global scale. In 2001, Douglas Laney elaborated on the distinct characteristics of "Big Data," which were later recognized and encapsulated as the "3 Vs."[12]:

- ***volume*** - pertains to size, likely the most widely recognized characteristic of "Big Data", especially considering that over 90% of all contemporary data has been generated in recent years; this aspect encompasses vast quantities of data, influenced by the proliferation of sources from which the data originates;
- ***velocity*** - refers to the speed at which data is generated, collected, updated, and processed in real-time, playing a significant role in determining the usefulness and potential of the data; typically, the highest data speed is achieved through direct in-memory transmission, as compared to disk writes; and
- ***variety*** - signifies the diversity of digital data, as data is acquired in a growing number of different formats, ranging from structured data (such as numeric data stored in databases) to unstructured data (such as text documents, emails, videos, audios, or financial transactions, depending on the specific nature of each company's activities, objectives, and strategies). In essence, data can be categorised based on its origin, source, and format (structured, semi-structured, or unstructured data).

The complexity of huge datasets has been demonstrated in practice throughout time, which has led to the discovery of additional features beyond the three previously mentioned, leading to the emergence of the "10 Vs", which are as follows [2], [3]:

- ***variability*** - refers to:

- the inconsistency of typically unstructured data sequences, which need to be identified through anomaly detection methods, thus requiring data filtering and flow control.
- the fact that "Big Data" is also variable due to the multitude of data dimensions resulting from various types and sources of data;
- the inconsistent speed at which "Big Data" is loaded into the database.

- ***veracity*** (***accuracy)*** - refers to the quality of data and their sources ("trusted sources"), as well as the integrity and comprehensiveness of the data set. Essentially, it describes the discrepancies, inconsistencies, and uncertainties that come with data collection, and the quality and quantity of the data determine whether they can be effectively used to generate useful information.
- ***validity*** - similarly to veracity, it refers to how accurate and correct the data are for the intended use. According to Forbes, an estimated 60% of data scientists' time is spent on data cleaning before any analysis can take place. The effectiveness of "Big Data" analysis relies heavily on the quality of the underlying data, underscoring the importance of implementing appropriate practices to ensure consistent data quality, standardized definitions, and comprehensive metadata.
- ***vulnerability*** - "Big Data" poses new security concerns, a breach of their security constituting a significant violation.
- ***volatility*** - Before the emergence of the "Big Data" concept, organizations tended to store data indefinitely. It could even be kept in the live database without causing performance issues, but due to the speed and volume of "Big Data", its volatility needs to be carefully taken into consideration.
- ***visualization*** - entails presentations aimed at interpreting data and providing context. Current data visualization tools face technical challenges due to limitations in memory technology and reduced scalability, functionality, and response time. For instance, traditional charts cannot be relied upon when dealing with a billion data points, necessitating different data representation methods such as data clustering or using tree maps, parallel coordinates, circular network diagrams, or cones. Coupled with the multitude of variables stemming from data variety and high velocity, as well as the intricate relationships among them, it becomes

evident that crafting meaningful visualizations is no simple task.

- ***value*** – the most crucial characteristic is deriving value from data, rendering other aspects of "Big Data" meaningless without it. This encompasses how data analysis and processing can lead to their quantification, allowing for the correlation of these insights through processes that manage data accumulation.

All this parameters demonstrate that the significance of "Big Data" extends beyond the sheer volume of information that it covers, equally important being the speed at which it can be reached, as well as the numerous different categories of data involved. "Big Data" manifests in various formats including text analysis, social network analysis, web analysis, mobile analysis, multimedia analysis (including images, audio, and video), and data collected from the Internet of Things (IoT). However, despite the substantial data quantity, its intrinsic value to data holders is not guaranteed. Contemporary advanced technology operates within remarkably brief periods, processing an immense volume of data, often numbering in the millions. This process iteratively adjusts variables to discern patterns that can lead not only to problem resolution but also to a competitive edge. Consequently, a requisite technology is one that can adeptly collect, store, and process data through real-time analysis. In the context of a company's operations, it becomes imperative to consider aspects such as customer behavior, the inherent risks tied to the company's activities, its performance metrics, productivity levels, and its market valuation.

As depicted in Fig. 2, in order for Big Data utilization to hold relevance for an organization, it is imperative that relevant information is first extracted from data sources (with Big Data encompassing these storage sources). This entails employing appropriate data management techniques, while the data could be given in real-time or as archived information. Subsequently, depending on the type of data, dedicated software programs for analysis must be employed. This facilitates the straightforward determination of whether a specific process yields benefits for the respective company or if existing ones can be enhanced. Moreover, this study might present brand-new strategies for dealing with certain problems, favouring the organization's constant adaptation to its operational environment.

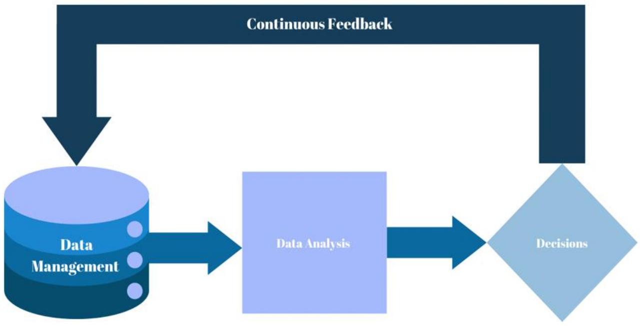

Fig. 2. The “Big Data” concept
Source: own contribution.

b. The importance of “Big Data”

Modern technology, particularly IoT, machine learning, and cloud computing, has significantly facilitated the exponential growth of data and has reshaped how companies comprehend the concept of "Big Data" and employ it to formulate development strategies. The advantages of "Big Data" are most apparent when a company takes the initiative to analyse the collected data and utilizes the insights to generate enhanced business outcomes. "Big Data" provides fresh perspectives that unveil new opportunities and propose novel business models [21].

The potential advantages of “Big Data” [20] are:

- ✓ it assists businesses in comprehending the market and consumer behaviours, providing them with a clearer insight into the products that can be marketed in specific regions or demographic areas and, consequently, enabling them to outperform their competition.
- ✓ contributes to customer satisfaction and loyalty by discerning consumer patterns, enabling businesses to attract new customers and discover effective ways to meet customer expectations and maintain their loyalty.
- ✓ it helps in developing a results-oriented marketing strategy - data analysis streamlines marketing campaigns, allowing companies to

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better understand their audience and implement more precise marketing tactics.

✓ it fosters innovation - prudent companies utilize insights from "Big Data" analysis to uncover weaknesses in their production process, aiding in the creation of superior quality products compared to their competitors.

✓ reduces operational costs and time - "Big Data" technologies, especially cloud-based mechanisms, store large volumes of data, which streamlines operational costs and enables faster business operations.

✓ equips companies with the capacity to develop competitive pricing strategies - In the past, conducting competitive analysis presented difficulties, but this is no longer the scenario. "Big Data" presents the chance to scrutinize competitors' approaches and can offer recommendations regarding actions to take or avoid while shaping your unique business strategy. Moreover, aided by "Big Data," it can be easier to identify price fluctuations, aiding in the creation of the most efficient pricing strategy. Ultimately, this grants a greater opportunity to establish a more balanced price in alignment with consumer purchasing behaviour and industry trends.

✓ assists companies in uncovering new revenue streams - an analysis of both consumers and competitors can lead to the discovery of untapped investment opportunities.

✓ serves as a risk analysis tool - "Big Data" analysis can aid in striking a balance between social and economic factors, alongside other external elements, by harnessing predictive insights.

The functioning of information technologies, critical information structures, and the security of data availability, integrity, and confidentiality are crucial for various aspects of modern society such as the business environment, government institutions, transportation, public safety, healthcare, communications, the banking and financial system, emergency services, utilities, and national defence. Even the largest organizations find "Big Data" to be a significant challenge that they cannot overlook. Its enormous potential to improve business decisions, achieve higher precision in customer targeting, and streamline internal processes is undeniable.

Applications of "Big Data"

"Big Data" presents significant opportunities across multiple domains (Fig. 3):

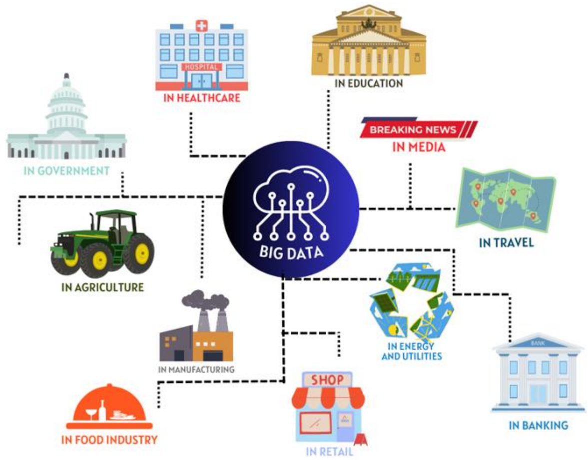

Fig. 3. "Big Data" Applicability in the society
Source: own contribution.

In Government/ public sectors:

Governments across the globe deal with vast amounts of data on a daily basis. This is largely due to the comprehensive updates and records they must maintain regarding their citizens, economic growth, energy resources, and more. This data necessitates thorough examination and analysis, serving as a valuable tool for government operations, primarily in two areas - welfare schemes and cyber security.

Figure 4 shows the fields of the public sector where BigData application is used.

Fig. 4. "Big Data" application in the public sector
Source: own contribution.

In the realm of welfare programs, this data is instrumental in expediting and informed decision-making for political initiatives, identifying areas requiring attention, monitoring agricultural landscapes, and tracking livestock. It also plays a crucial role in addressing national challenges such as terrorism, unemployment, and poverty. When it comes to cybersecurity, analytical tools are employed for tasks such as detecting fraud and apprehending tax evaders.

In agriculture: The utilization of "Big Data" analytics drives advancements in smart farming and precision agriculture practices, leading to cost savings and the emergence of new business opportunities. Crucial domains where big data is applied encompass facilitating the fulfilment of food demand by providing farmers with real-time updates on changes in rainfall, weather patterns, and factors influencing crop yield. It also contributes to enhancing the intelligent and precise utilization of pesticides, aiding farmers in making well-informed decisions about pesticide usage. Moreover, big data aids in efficiently managing farm equipment, optimizing supply chain operations, strategically planning seed planting and chemical application, and ensuring food safety through the collection of data on humidity, temperature, and chemical levels to monitor the health of growing plants.

In education: "Big Data" has revolutionized the education sector by harnessing vast amounts of data encompassing students, faculty, courses, and results. Analysing this data offers valuable insights that enhance educational institutions' operations and effectiveness. This ranges from personalized learning programs, redesigned course materials, and dynamic grading systems to predicting students' career paths. By scrutinizing individual student records, strengths, weaknesses, and interests can be understood, aiding in tailored guidance and suitable career predictions. "Big Data" has overcome the limitation of one-size-fits-all education through e-learning solutions, empowering administrators with analytics and data visualization to optimize university operations, recruitment, and student retention strategies (Fig. 5).

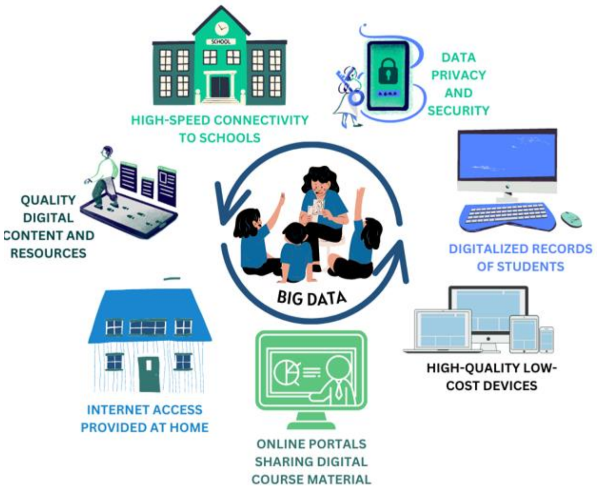

Fig. 5. “Big Data” Application in education
Source: own contribution.

In healthcare: “Big Data” has a pivotal role in advancing contemporary healthcare practices. It has transformed the healthcare sector comprehensively, encompassing cost reduction in treatments, anticipation of epidemic outbreaks, prevention of avoidable illnesses, improvement of overall quality of life, projection of daily patient income for staffing management, integration of electronic health records, implementation of real-time alerts for immediate care, utilization of health data for strategic planning enhancement, and mitigation of fraud and errors within this essential sector.

In media: The enthusiasm surrounding conventional methods of media consumption is gradually waning, giving way to contemporary practices of accessing online content through smart devices, which have emerged as the prevailing trend. These modern approaches are not only instrumental in predicting audience preferences, including genre, music, and content tailored to specific age groups, but also provide valuable insights into customer churn, as they manage to optimize the timing and cost-effectiveness of media streaming schedules, enhance the efficiency of product updates, and significantly contribute to precision in advertising targeting

In travel: Reduced wait times are the consequence of route planning that is customised to the needs of each individual user thanks to the use of "Big Data". Tools like Google Maps, which provide routes with the least amount of traffic congestion, are examples of how it also helps with congestion management and traffic control. Additionally, "Big Data" data plays a crucial role in identifying accident-prone areas and consequently improving general traffic safety.

In financial institution/ banking: Covering a wide spectrum of functions including fraud detection, streamlining transaction processing, gaining deeper customer insights, optimizing trade execution, and delivering enhanced customer experiences, "Big Data" presents a diverse array of applications. At the same time, banks can use "Big Data" Analytics to gain valuable insights into customer trends, which can be shared with clients, along with the ability to conduct personalized assessments and swiftly generate comprehensive reports (Fig. 6).

Fig. 6. "Big Data" application in financial institution
Source: own contribution.

In manufacturing: "Big Data" has effectively contributed to the improvement of manufacturing processes, enabling tailored product design, ensuring robust quality maintenance, orchestrating efficient supply chain management, and conducting assessments to monitor potential risks.

In retail: Big Data presents an extensive array of uses, participating in forecasting emerging trends, pinpointing relevant customers with precision timing, reducing marketing costs, and elevating the caliber of customer service. It encompasses maintaining holistic consumer perspectives, enabling personalized interactions, refining pricing strategies for optimal trend leverage, streamlining backend operations, and amplifying customer service excellence.

In energy and utilities: Energy and utility systems leverage a variety of Big Data sources, encompassing smart meters, grid infrastructure, weather information, power system metrics, storm data, and Geographic Information System (GIS) data. These platforms make use of this data to achieve cost reduction, enhance operational efficiency, minimize carbon emissions, and effectively manage the energy demand originating from end consumers.

In food industry: Big data assists food platforms in elevating their marketing strategies, curating innovative and highly desirable products, and empowering businesses to monitor competitors' growth rates while maintaining quality control and scrutinizing procurement and pricing choices.

This data is also proving valuable for owners by enabling them to monitor factors such as product quality. It allows them to discern whether the product has undergone modifications, such as ingredient substitutions or adjustments in measurements, as well as determine if changes are minor, significant, or influenced by external factors such as seasonal variations or shifts in storage methods.

d. The risks of "Big Data"

While the potential of these datasets is immeasurable, "Big Data" poses risks concerning the protection of personal data and the right to privacy of individuals concerned; among these, we can mention:

➢ the extent of data collection, tracking, and profiling, considering that data is typically aggregated from various sources, leading to an increased level of detail;

➢ data protection embedded in products and services (privacy by design/by default), aiming to integrate confidentiality and data protection into the design specifications and architecture of information systems. Innovative and responsible engineering can enable individuals' rights (such as access, objection, restriction, rectification, and data portability) to be exercised effectively;

- data security faces obstacles due to the swift expansion of dataset volume, which can be effectively managed by developing adaptable systems at the data level, where filtering plays a vital role in this context;
- transparency, which may diminish in the absence of proper informing of the individuals subject to automated decisions, as they lack comprehension of the process they are exposed to and have limited control over their data. Individuals should receive clear information about what data is processed, including observed or inferred data about them, how and for what purposes their information is used, including the logic used in algorithms to determine assumptions and predictions. The National Supervisory Authority for Personal Data Processing (ANSPDCP) should have access to details about these automated mechanisms and the potential impact they may have on the rights of the individuals concerned;
- the absence of internal standards/ procedures in accordance with the current legislation regarding personal data protection. Data controllers/data processors are accountable for the decisions they were supposed to make, considering the prevailing legal regulations in this field;
- heightened possibilities of government surveillance and their potential abuses, such as blatant violations of fundamental human rights. Additionally, the volumes of generated data contain extensive and diverse quantities of information about our personal lives, a situation that can clearly lead to deducing behavioral tendencies as well as other individual details, including sensitive data (information about health, sexual orientation, religious beliefs, political affiliations, etc.).;
- discrimination based on data, which is evidently linked to the previously mentioned issues, highlights the inequalities that can arise if this field is not well regulated. When all aspects about an individual are known, legislators must ensure that this will not negatively impact the lives of the individuals concerned.

Companies rely on the data they collect about their customers, so how efficiently employees utilize this data is of paramount importance. The modern era of "digital" companies (such as Google, Facebook, Uber, and Airbnb), centers more around how they use the data they collect rather than what they sell or produce [7]. A significant debate surrounds the relationship between these types of companies and their users. Regulatory frameworks like General Data Protection Regulation (GDPR) have emerged as a recognition of the value users' data holds when accessing such services. However, many users are unaware of the extent of personal data they provide. Most companies collect information about their customers, and whether users feel uneasy about this depends on how that data is used and what they receive in return.

Therefore, "Big Data" must be used in a responsible and sustainable manner, safeguarding the fundamental rights and freedoms of individuals, while also applying and adhering to data protection legislation. Within the European Union, efforts are directed towards regulating and documenting "Big Data" in a fair and ethical manner, ensuring the attainment of maximum value from this dataset while respecting human rights [9]. Data related legislation aims to establish clear rules regarding the utilization of data generated by Internet of Things (IoT) devices, as well as how products are designed ("privacy by design"), enabling the facilitation of rights concerning the processing of personal data on a large scale, and fostering the creation of data value.

CONCLUSIONS

In broad and concise terms, "Big Data" embodies a wide-ranging effort to optimize our interconnected world by grasping and anticipating influential factors simultaneously. it delves into understanding humans reasoning, which, though unique from individual to individual, still exhibits certain patterns. The presence of high-quality and interoperable data from various domains enhances competitiveness and innovation, ensuring sustainable economic growth. The same dataset can be endlessly utilized and reused for a multitude of purposes without any degradation its quality or quantity.

Moreover, "Big Data" pertains to data that involves greater *variety*, received in increasingly larger *volumes* and at higher *velocity* (“the three Vs”). This type of data is subject to exponential growth, both in its availability and in the automated utilization of digital information. It doesn’t rely only on technology's increasing capability to support the collection and storage of vast data volumes but also on its capacity to analyse, comprehend, and harness the entire value of the data. Despite their potential to address the previously mentioned challenges that may arise, these massive data volumes are entirely unstructured and cannot be stored or processed using relational databases. Analysing "Big Data" contributes positively to organizational performance. The power centers of global companies remain at the forefront of their respective industries by harnessing the potential of "Big Data".

For efficient data collection, processing, and application of specialized analysis methods, organizations need advanced technological infrastructure encompassing hardware and software. In addition, they must engage analytical professionals ("data scientists") who blend programming and statistics expertise, while also possessing advanced domain-specific knowledge pertinent to the organization's sector. These experts must adeptly communicate and present information, often utilizing graphs and reports to provide context to the results.

In the realm of evolving technological advancements, "Big Data" has emerged as an invaluable asset, offering a myriad of benefits and opportunities. The world's most competitive companies harness insights from data analytics to maintain their competitive edge, setting a precedent that businesses of all sizes can emulate for expeditious growth and heightened customer satisfaction. As we navigate this era of information-driven progress, embracing the power of "Big Data" stands as a strategic imperative, propelling organizations toward a future characterized by innovation, efficiency, and strategic advantage.

Hence, datasets have the potential to:

- foster innovation and research by providing real-time access to data that would otherwise have been much harder to obtain and analyze, facilitating comparative processes;
- enable easy adaptation of the service sector to ever-changing customer preferences and needs, through the development of systems capable of analyzing multiple factors regarding consumer patterns over specific intervals of time;
- liberalize the economic sector and enhance productivity by making improved and up-to-date operational business information available to all. This will particularly benefit small and medium-sized enterprises, reducing their costs and helping them tailor their services and products to market demands;
- streamline activities in the public sector through process and communication digitalization;
- simplify people's lives in a digitally advancing world, with each passing day.

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STRATEGIC ASSESSMENT MODEL OF THE RURAL SPACE IN THE COUNTY OF VALCEA, ROMANIA

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Abstract

The development of rural space is a basic concern of today's society dominated by the trend of modernization and the need to preserve identity. The current context highlights numerous elements favorable to the development of the rural space, but also elements that inhibit this process. Favorability for the development of the rural area is given by the availability of endogenous resources, and the elements that slow down the development process are generally related to the inability of the local responsibility factors to implement policies, programs and strategies adapted to the territorial specificity that lead to the development of agriculture as a basic activity but and to a diversification of economic activities and implicitly to the development of the rural economy. The paper briefly presents a model of strategic evaluation of the rural space that highlights the territorial specificity and allows the elaboration of sustainable development options adapted to it. From the secondary analysis of the statistical data and the relevant specialized literature and through the application of the PESTEL and SWOT strategic analysis models, sufficient specificity elements were identified that led to the development of relevant strategic options for sustainable rural development in Vâlcea county.

Key words**:** *sustainable development, rural space, strategic management, strategic evaluation, strategic options*

INTRODUCTION

The rural area, in the current economic and social context, constitutes an objective of relevant importance for the development of society and is represented by the sum of available endogenous resources and the ability to capitalize on them in a sustainable way. If in the past the valorization of endogenous resources in the rural area was limited to obtaining renewable biological productions, currently this valorization is focused on the diversification of economic activities [11] and ensuring their sustainability based on the consideration that the rural area is represented not only by "the fertility of the soils but also the geographical extent, respectively the allure of the surrounding environment" [2].

A series of advances in the development of rural space are known: the modernization of rural infrastructure, the development and diversification of agricultural activities, the diversification of the rural economy, still without the necessary consistency to eliminate the existing gaps compared to states in the Eastern European bloc, such as the Czech Republic, Hungary, Poland [18]. This signals the need for studies at the level of rural areas that allow the characterization from the point of view of the structure of the rural economy, the territorial specificity (given by the diversity of endogenous resources) and the social structure [23] basis for the development of relevant strategic options for the promotion of sustainable rural development [9]. What is expected from these studies is the highlighting of the most relevant measures that lead in a relatively short time to the achievement of "living conditions comparable to those in urban areas in accordance with the functions of the rural space, especially those of conservation and development of the landscape" [20]. At the level of the European Union, the adoption of rural development as a strategic policy of the European Union (EU) at the end of the 1980 is noteworthy, therefore a priority of the Common Agricultural Policy,

the emphasis being placed on the restructuring of agriculture, solving environmental problems and understanding the extensive needs of the countryside. The certification of this status takes place through "Regulation (EC) no. 1698/2005 of the Council of September 20, 2005 regarding the support for rural development granted from the European Agricultural Fund for Development [5, 21]".
The existing debates in the current period lead to the promotion of economic recovery actions on a sustainable basis because it allows a better reporting on the current challenges caused by climate changes caused by economic activity capable of leading to the manifestation of extreme climate phenomena [16], in areas in which they were not present.
Romania has adopted the rural development strategy and "is part of the context of reform and development that the EU proposes through the Europe 2020 strategy" [4]. The objectives of the Europe 2020 strategy are oriented towards a "smart, sustainable and inclusive economy with ambitious targets for each member state in the fields of education, innovation, energy/ environment, employment and social inclusion and improving competitiveness in general". Rural development, according to those indicated, is based on change, but also involves ensuring its sustainability [15]. Sustainable rural development, as it results from the bibliographic study, represents an objective of strategic importance, and the current context dominated by numerical population growth, climate change and the economic crisis generated by the COVID 19 pandemic and the Russian-Ukrainian conflict highlights the reality of the existence of limited resources and imposes adopting relevant measures to ensure food safety. We understand that in order to ensure food security, the agri-food sector must find relevant solutions, so the pressure on it is high, and its almost total overlap with the rural area determines the orientation of research from this point of view towards the sustainable development of the rural environment. The realization of this ideal requires the dynamic, concrete, concurrent and integral research of the influences of external and internal components on this process using strategic management. Thus, the possibility of establishing long-term development directions, specific performance objectives and the elaboration of strategic options to ensure the achievement of these objectives is created. The strategic approach is complex, it takes place in stages and coherently through procedures that are carried out in a certain sequence according to the methodology specific to the strategic management process.
For this, a field research was organized, the purpose of which is the strategic evaluation of the development of the economy in the rural area of Vâlcea county in order to develop strategic options relevant to achieving sustainable rural development.
Vâlcea County is located "from a geographical point of view in the south-central part of Romania, belongs to the South-West Oltenia Development Region of Romania and is located between the parallels of $48^0 28''$ and $48^0 36''$ north latitude and between the meridians $23^0 37''$ and $24^0 30''$ east longitude in the Getici Subcarpathians, at the confluence of the Olt and Olănești rivers" [13]. The area of the county is 5,764.77 km^2, representing 2.4% of the country's surface and 19.73% of the South-West Oltenia Region.

MATERIALS AND METHODS

In choosing the research methods, we took into account the fact that to capture the socio-economic reality at the community level, it is recommended to use quantitative and qualitative methods to obtain more knowledge [14]. The methods used are the secondary analysis of statistical data and relevant literature (reports, strategies, studies, monographs) for the identification of critical factors and some practices, the PESTEL analysis model, respectively the SWOT analysis (Fig. 1).
The PESTEL model assumed the realization of a diagnosis of the studied area following six criteria: political, economic, social, technological, natural (environmental) and legislative contributing to the elaboration of the strategy because it sets the framework in which to operate and make decisions [8].

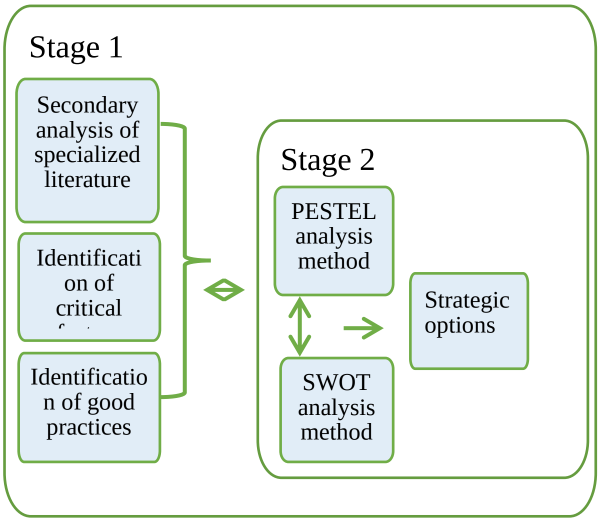

Fig. 1. Schematic structure of the research
Source: Own conception.

The SWOT model highlights the strengths and weaknesses of the researched area, respectively the opportunities and threats, representing the premise of the preparation of sustainable development strategies for sustainable development.

The role of these methods is to allow the responsible factors of sustainable rural development to obtain the most realistic overview from a socio-economic point of view, to identify critical factors with an impact on development and to elaborate strategic options relevant to sustainable rural development. At the same time, this highlights the specific elements of the researched area [10, 3] and the activities carried out [12].

RESULTS AND DISCUSSIONS

At the base of the diagnosis of the rural space in order to develop development strategies is the statement of Mateoc and Ungureanu (2010) "the problem of rural development and planning is one of the most complex themes of contemporaneity, due to the fact that, in its essence, it involves achieving a balance between the requirement to preserve the rural space from an economic, ecological and socio-cultural point of view, on the one hand, and the tendency to modernize rural life, on the other hand" [17].

The first stage sought to obtain information relevant to the research and materialized through the application of a questionnaire for the collection of quantitative information at the level of territorial administrative unit (UAT), respectively through the secondary analysis of statistical data and relevant literature. The result obtained improved through participatory observation (qualitative method of information collection) allowed the formation of a realistic picture and the identification of critical factors, respectively good practices. In the second stage, the strategic evaluation of the rural space in Vâlcea county was carried out with the help of the PESTEL and SWOT strategic analysis models. The use of the PESTEL analysis model took place on six criteria that define the life framework of the countryside in Vâlcea county (political, economic, social, technological, environmental and legislative) to identify specific characteristics of the community/area studied. Next, the SWOT model was used to combine the specific internal and external characteristics of the studied community.

Results of using the PESTEL model

The analysis of the political criterion highlights the creation at the level of the European Union of a legislative framework dedicated to the development of the rural area dominated by the Common Agricultural Policy. Over time, this has gone through numerous transformations that determined the shift from exclusively subsidizing agriculture to addressing complex issues circumscribed to the multifunctional role held by rural areas [6]. Thus, through the CAP, targets were set related to the diversification of agricultural activities, the sustainability of rural development, the preservation of the natural environment and the improvement of the living conditions of the population living in rural areas [22]. The current CAP highlights "better flexibility and a new green architecture with mandatory standards aimed at promoting green practices by farmers. Changes have been introduced to contribute to the achievement of the objectives of the European Green Deal and the strategy From farm to consumer" [1]. The farm-to-consumer strategy brings as a novelty "modern and sustainable methods of agricultural production and management that will be financed through the eco-schemes within the CAP: precision agriculture, agro-ecology (integrated pest management, organic agriculture), agriculture with low carbon footprint and agroforestry" [7].

The development of the rural space in Vâlcea county is a strategic objective and assumed by the factors of local responsibility. The rural area of Vâlcea county identifies in 2014 a number of 78 communes and 560 villages. The development of the rural area is positively correlated with the development and diversification of economic activities, and the existence of inequalities in the field of road infrastructure and public utilities makes it difficult to achieve. Added to this is the low ability to access European funds for the reduction/disappearance of these inequalities against the background of a low level of education and involvement. Local Action Groups (LAGs) formed through the LEADER axis of the National Rural Development Program (PNDR), are numerically reduced in Vâlcea county, proving a disinterest of the inhabitants of the rural environment in attracting funds specific to local needs (Integrated Sustainable Development Strategy Vâlcea, 2015 - 2020). Through PNDR in Vâlcea county in 2019, 59 projects with a total value of approximately 110 million lei were completed and in the process of completion [32].

The analysis of the economic criterion highlights that the countryside of Vâlcea county is generally characterized by a poor diversification of economic activities dominated by agriculture. Industry is a little developed economic sector in rural Vâlcean. Tourist and agro-tourism activities in the favorable areas register an effervescence, which represents an important alternative source of income and employment for the Valcean countryside. The diagnosis included all the elements that make up the economic life of the studied rural area and aims at: the level of GDP, the branch structure of the national economy, the level of development of each branch, the evolution of the economy and the population, the evolution and distribution of income by social category, the degree employment etc.

The gross domestic product had a sinusoidal path in the period 2019-2022, so according to Table 1, it recorded lower values in 2020 than in 2019 and then increased in 2021 and 2022. The gross domestic product per capita shows the same trend with an evolution index above the national average.

Table 1. Gross domestic product

	2019	**2020**	**2021**	**2022**
Total GDP per economy	1,059.8	1,040.8	1,116.8	1,204.2
The South-West region of Oltenia	81.3	79.7	86.4	93.4
Vâlcea county	15.4	15.3	16.6	18
Gross domestic product per inhabitant				
Total	11,527	11,162	11,904	12,794
The South West region of Oltenia	8,927	8,669	9,380	10,159
Vâlcea county	9,300	9,104	9,838	10,682
The evolution of the gross domestic product				
Total economy	4.1	-4.4	4.3	4.7
The South West region of Oltenia	3.7	-4.5	5.4	5.1
Vâlcea county	5.7	-3.4	5.6	5.7

Source: Own calculation based on NIS data [19].

The contribution of Vâlcea county to the formation of the regional GDP registers an average (2005-2016) of 18.39% and 1.33% to the formation of the national GDP [24]. The gross domestic product by sectors of activity, in 2011, reveals the fact that the largest contribution to its formation is made by industry, respectively the processing industry, whose weight is 30.1%, compared to 28.8%, which is the contribution to national level, followed by trade with 13.7%, public administration with 10.7%, construction with 8.9% and agriculture with 8.6% [13].

The performance of the agricultural sector in Vâlcea county does not rise to the level of the agricultural potential, although there are concerns of the group of specialists and the competent bodies in this regard. One of the factors that hinders performance in agriculture

is the fragmentation of property into small plots (3.4 - 5.82 ha), which imposes the need to merge them into holdings with larger areas, in order to be able to switch to a high-performance agriculture.
With an area of 576,477 ha, Vâlcea County is the second largest county within the Southwest Oltenia Development Region of Romania, occupying 20% of its area. Of the total area owned by Vâlcea county, 42.12% is agricultural area, i.e. 242,856 ha with the following types of use: 35.76% arable, 44.01% pastures, 13.39% hayfields, 1.49% vineyards and wine nurseries, 5.33% fruit orchards and nurseries. To these areas are added the non-agricultural lands in the area of 333,621 ha, respectively 57.88% of which forests and other forest vegetation 88.09%, area occupied by waters and ponds 3.74%, area occupied by constructions 3.49% , roads and railways 2.05%, degraded and unproductive land 2.6% (Table 2).

Table 2. The land fund in Vâlcea county by categories of use

No	The mode of use for the agricultural area of Vâlcea county	Ha	%
1.	Total	**576,477**	**100**
1.1.	Agricultural	242,856	421.2
1.1.1.	Arable	86,857	35.76
1.1.2.	Grassland	106,894	44.01
1.1.3.	Rough	32,531	13.39
1.1.4.	Vineyards and wine nurseries	3,622	1.49
1.1.5.	Fruit orchards and nurseries	12,952	5.33
1.2.	Toal non-agricultural land	333,621	57.88
1.2.1.	Forests and other forest vegetation	293,915	88.09
1.2.2.	Busy with puddles	12,497	3.74
1.2.3.	Busy with construction	11,650	3.49
1.2.4.	Roads and railways	6,857	2.05
1.2.5.	Degraded and unproductive land	8,702	2.6

Source: Own calculation based on NIS data [19].

The analysis of the mode of agricultural use highlights the large weight held by the pasture category 44.01%, which shows the favorability of the area for animal breeding, Vâlcea county being in first place in the region in this chapter.

The areas occupied by the main crop plants highlight the following (Fig. 2): the area cultivated in Vâlcea county with the main crop plants decreased from 85,950 ha (1990) to 78,356 ha (2007), respectively to 69,326 ha (2019).

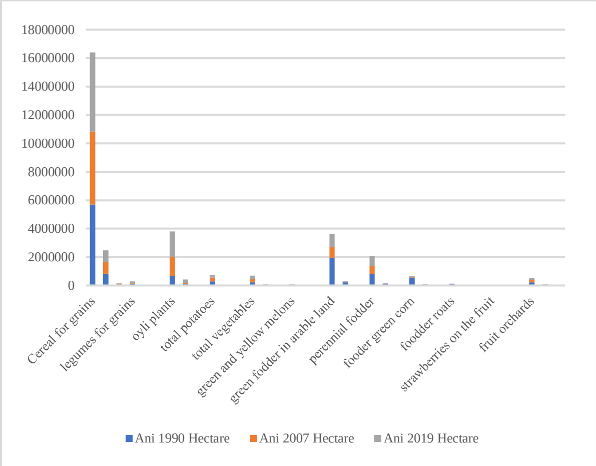

Fig. 2. The evolution of the areas occupied with the main crops in Vâlcea county
Source: NIS data Tempo online [19].

The situation for each main category of crop plants is as follows: cereal for grains occupy an area of 54,820 ha (2019) compared to 69,199 (2007) and 60,412 (1990); grain legumes occupy an area of 115 ha (2019) more than 61 ha (2007) and less than 580 ha (1990); oil plants occupy an area of 2,301 ha (2019), much larger than 251 ha (2007), respectively 30 ha (1990); potato occupies an area of 2,984 ha (2019) more than 2,131 ha (2007) and less than 3,651 ha (1990); area occupied with vegetables reaches 4,289 ha (2019) lower than 4,376 ha (2007) and higher than 3,278 ha (1990); green fodder obtained in arable land occupies an area of 6,492 ha (2019) greater than 4,673 ha (2007) but less than 16,817 ha (1990); perennial fodder occupies an area of 5,926 ha (2019) greater than 4,550 ha (2007), but less than 9,573 ha (1990); fodder roots occupy an area of 160 ha (2019) more than 52 ha (2007), but less than 1,292 ha (1990); strawberries on fruit are found on an area of 185 ha (2019) more than 129 ha (2007), but less than 392 ha (1990); fruit orchards occupy an area of 10,845 ha (2019) more than 8,551 ha (2007) but less than 16,459 (1990).

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Livestock breeding is a traditional occupation in Vâlcea County, as can be seen from the land fund through the large proportion of areas occupied by pastures.

The numbers of animals registered at the level of Vâlcea county (Figure 3) show in 2018 a decrease compared to 1990, respectively 2007 for cattle (41,519); pigs (75,043); horses (5,648); poultry (1,482,416).

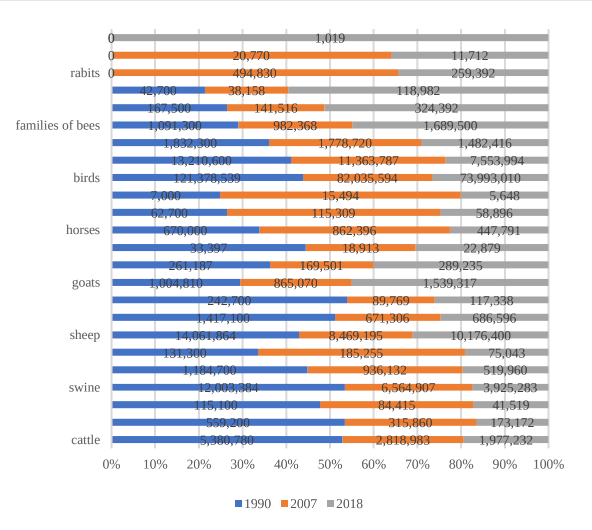

Fig. 3. Evolution of the number of animals in the main species in Vâlcea county
Source: NIS data Tempo online [19].

Regarding the increase of sheep, the analysis shows that their number has increased significantly, recording in 2018 a herd of 117,338 compared to 89,769 (2007), but lower than in 1990 (242,700).

Goats number 22,879 in 2018, increasing compared to 2007 (18,913), but decreasing compared to 1990 (33,397).

Bee families represent the category that registers the biggest increases, recording in 2018 a number of 118,982 bee families, increasing compared to 2007 (38,518) and compared to 1990 (42,700).

There is also a new category of rabbits that registered in 2018 a herd of 1019.

Forests represent an important wealth of Vâlcea county. Forest vegetation covers 50.98% of the county's surface, constitutes one of the main resources of the economy of the county's localities and ensures a good ecological balance.

The total area occupied by forest in the year 2020 registers in Vâlcea county the value of 267,200 ha, insignificantly higher compared to the year 207 (262,400 ha) and insignificantly lower compared to the year 1990 (267,900 ha), following the same existing trend at the regional and national level.

In 2020, the area of coniferous forests is 88,800 ha less compared to 207 (92,200 ha) and higher than in 1990 (82,000 ha). Deciduous forests occupy an area of 178,400 ha in 2020, more than in 2007 (170,200 ha) and less than in 1990 (185,900 ha). It is noted that deciduous forests predominate, their share being 66.76% (Table 3).

Table 3. Evolution of forested areas in Vâlcea county

		Anul		
		1990	2007	2020
		thousands of hectares		
Forest surface	Total	6,252.3	6,314.9	6,449.4
	The South West region of Oltenia	790.1	784.4	790.1
	Vâlcea county	267.9	262.4	267.2
Softwood	Total	1,928.8	1,920.2	1,916
	The South West region of Oltenia	123.7	124.4	122.3
	Vâlcea county	82	92.2	88.8
Hardwood	Total	4,323.5	4,394.7	4,533.4
	The South West region of Oltenia	666.4	660	667.8
	Vâlcea county	185.9	170,2	178.4
Other lands	Total	118.8	169.6	154.8
	The South West region of Oltenia	16.3	20.4	23.8
	Vâlcea county	3.5	5	5.3

Source: Own calculation based on NIS data [19].

Table 4. The evolution of agriculture, forestry and fishing enterprises in Vâlcea county

CAEN Rev. 2 (activities of the national economy - sections)	**Size classes**	**Years**	
		2008	2020
		number	
A Agriculture, forestry and fishing	0-9 people	148	190
	10-49 people	19	35
	50-249 people	1	6
	250 people and more	1	:

Source: NIS data Tempo online [19].

Enterprises in the agricultural sector register an increase for all categories, such as micro-enterprises from 148 (2008) to 190 (2020), small enterprises from 19 (2008) to 35 (2020), and medium-sized enterprises from 1 (2008) to 6 (2020). These are suggestively presented in Table 4.

The rural industry includes units or sub-units of production and provision of productive services, located in the rural area and belonging to the craft cooperative, agricultural commercial companies, private producers, etc. Food industry companies are well represented in Vâlcea County by the canning company from Râureni.

This is one of the well-known Romanian brands with a tradition of over 4 decades in the production of canned vegetables, fruits, and natural juices. The company went through several transformations and in 2008 was taken over by the Annabella company which invested 5 million Euro in the modernization and re-technological of the production processes as well as in the distribution of the products. Today the company distributes production both on the domestic and foreign markets. Exports have a share of 10% of the entire production and are oriented towards the markets of Germany, Austria, Italy, Spain, England, Canada. Other enterprises with national recognition operate in the bakery sector – SC Velpitar SRL; SC Boromor SRL, meat processing – SC Diana SRL.

Tourism is a well-represented activity in the rural area of Vâlcea county, totaling a number of places/day of 3,555,564 (2021), increasing compared to 2007 (2,625,499), as shown in Table 5.

We note the contribution of agritourism guesthouses to the development of the rural area by contributing to the increase in the incomes of rural households and the increased number of accommodation places for the days they operate by 380,926 (2021) higher than 27,133 (2007) as can be seen in Table 6.

The localities with the largest number of accommodation places are Voineasa (124,905 in 2021, more than 10 times higher than in 2007); Malaia (92,853 in 2021, about 20 times more than in 2007), Costești (36,224 in 2021, about 6 times more than in 2007).

Table 5. Tourist accommodation capacity in the rural area of Vâlcea county

Types of tourist reception structures	places	2007	2021
		Places:days	
Total	Total	2,625,499	3,555,564
	Barbatesti	496	3,450
	Budesti	328	1,070
	Bujoreni	:	5,110
	Caineni	6,850	13,464
	Costesti	552	36,224
	Daesti	988	2,000
	Fartatesti	:	4,728
	Golesti	8,480	15,308
	Ionesti	:	1,464
	Lungesti	:	3,996
	Maciuca	:	13,300
	Malaia	9,443	118,301
	Maldaresti	:	11,645
	Mateesti	:	180
	Mihaesti	6,570	8,736
	Milcoiu	19,772	20,775
	Racovita	6,570	10,864
	Salatrucel	5,520	16,226
	Slatioara	:	10,222
	Tetoiu	:	6,344
	Tomsani	:	1,440
	Vaideeni	:	12,538
	Vladesti	2,534	4,270
	Voineasa	214,247	204,767

Source: NISdata Tempo online [19].

Table 6. Accommodation capacity in agritourism guesthouses in the rural area of Vâlcea county

Types of tourist reception structures	places	2007	2021
		Places:days	
Agritourism guesthouses	TOTAL	27,133	380,926
	Barbatesti	496	3,450
	Budesti	328	1,070
	Bujoreni	:	5,110
	Caineni	:	13,464
	Costesti	552	36,224
	Daesti	988	2,000
	Fartatesti	:	4,728
	Golesti	896	9,940
	Ionesti	:	1,464
	Lungesti	:	3,996
	Maciuca	:	13,300
	Malaia	5,792	92,853
	Maldaresti	:	11,645
	Mateesti	:	180
	Racovita	:	10,864
	Slatioara	:	10,222
	Tetoiu	:	6,344
	Tomsani	:	1,440
	Vaideeni	:	12,538
	Vladesti	2,534	1,240
	Voineasa	11,056	124,905

Source: NIS data Tempo online [19].

The analysis of the labor force at the level of Vâlcea county highlights a constant evolution of the labor resource around 128 thousand people (127.4 in 1990 and 128.6 in 2007), after which this number drops to 108.8 thousand people in 2018 (Table 7).

Table 7. The labor resource in Vâlcea county

Gender	Years		
	1990	2007	2018
	thousands of people		
Male	127.4	128.6	108.8
Female	119.5	115.8	99.1

Source: NIS data Tempo online [19].

The study of the activity rate by age groups, residence environments South West Oltenia Region (Table 8) highlights a decrease in it for all age groups, as follows: age group 15-24 years (from 29.5% to 24.3%), 25-34 years (from 80.5% to 72.5%), 35-54 years (from 82.4% to 77%), 55-64 years (52.1% to 45.3%).

Table 8. Activity rate by age groups and residence environments in the south-west Oltenia region

Age groups	Residential environments	Years	
		2007	2021
		%	
15-24 years	Total	29.5	24.3
	Urban	18.8	13.2
	rural	42.1	33.1
25-34 years	Total	80.5	72.5
	Urban	79.3	79
	rural	81.8	66.5
35-54 years	Total	82.4	77
	Urban	80.9	85.5
	rural	84.2	68.7
55-64 years	Total	52.1	45.3
	Urban	31.1	49.7
	rural	65.9	40.9
16-65 years	Total	66	61.4
	Urban	60.6	66.3
	rural	71.7	56.7

Source: NIS data Tempo online [19].

The analysis of the average number of employees in the rural area of Vâlcea county for the period 2007-2018 shows a decrease from 18,271 (2007) to 17,369 (2018) with the following evolution by locality (NIS, online Tempo data): Alunu locality from 685 to 756, Amarăști from 177 to 49, Bărăți from 316 to 159, Berislăvești from 350 to 330, Boișoara from 76 to 55, Budești from 568 to 470, Bjoreni from 274 to 360, Bunești from 220 to 100, Caineni from 314 to 225, Cernișoara from 235 to 210, Dăesti from 400 to 455, etc. This shows the predominance of the decreasing rate for most localities, but also the existence of some localities with very significant increases in the number of employees ex Mihăesti from 684 to 2,240.

The analysis of the social criterion reinforces the idea that the social environment, together with the economic one, represents the foundation of the analyzes regarding the sustainable development of the rule and is the basis of the strategic orientation. Knowing the evolution of the population in the rural area of Vâlcea county constitutes the pivot of the analysis, because the population has an impact on the economic environment and implicitly on the sustainable rural development, being a factor of action and consumption, respectively the beneficiary of the development. Numerically, it records a downward trend from 411,576 inhabitants (2007) to 354,535 (2014), respectively to 351,728 (2018). The share of the rural population is 54.6% (2007), 55.4% (2014), respectively 55.2% (2018). The population density was 71.4 inhabitants per kmp in 2007, 63.2 inhabitants per kmp in 2014, respectively 61.0 inhabitants per kmp in 2018 (Table 9).

Table 9. Resident population by means and density

Per i od	Number of inhabitants			% of total		Density
	Total	urban	rural	urban	rural	
2007	411,576	186,838	224,738	45.4	54.6	71.4
2014	364,535	162,555	201,980	44.6	55.4	63.2
2018	351,728	157,469	194,259	44.8	55.2	61.0

Source: NIS data Tempo online [19].

Mass education highlights a school network for the rural area of Vâlcea county represented in the 2021-2022 school year by 3 high schools, 1 vocational school, 87 secondary schools, 149 kindergartens and 32 primary schools. The health infrastructure highlights in 2018 6 publicly owned hospitals and 5 privately owned hospitals, 1 public polyclinic and 10 private polyclinics, 3 medical dispensaries, 1 health center, 1 mental health center, 1 medical and sanitary unit, 1 medical center of specialty, 83 private medical offices of general medicine, 17, school medical offices, 204 privately owned family medical offices, 7 privately owned civil medical society units, 233 privately owned dental offices, 18 privately owned civil dental society units, 326 medical offices privately owned specialized medical companies, 3 privately owned specialty medical civil societies, 7 publicly owned pharmacies, 173 privately owned pharmacies, 52 privately owned pharmaceutical points, 1 publicly owned pharmaceutical warehouse, 36 publicly owned medical laboratories, privately owned medical laboratories, 19 laboratories of technique d entare privately owned, 1 transfusion center publicly owned, and other types of medical offices, of which 1 is public and 12 private [24]. The existing homes in Vâlcea county show an increasing trend from 182,412 homes in 2014 to 184,721 homes in 2018 [26]. The localities in which there is sewerage total a number of 43 (2014) whose evolution is positive and reaches 48 in 2018. Among them, a number of 32 localities belong to the rural environment (2014), respectively 37 (2018) [27]. The network and the volume of distributed drinking water highlight the existence of 67 localities with a water distribution network in 2014, which is evolving positively to 76 localities in 2018. Of these, a number of 65 are rural localities with 9 localities more than in 2014. They record a total length of 2,448.3 km (2018) of which 1,733.6 km in rural localities [28].

The natural gas network is present in 17 localities, 9 of which belong to rural areas, with a length of 582.2 km (2018) [29]. The railway lines total 163 km. Public roads total 2,321 km in 2018 compared to 2,325 km in 2014 [30]. Of the 2321 km, 876 km are modernized roads, 835 km with light road surfaces, 470 km paved roads and 140 km dirt roads [31].

The analysis of the technological criterion highlights its influence on the competitive advantage. This process is enhanced, moreover, by the need to integrate the Romanian economy into the European Union economy, a process that is taking place below expectations, but which must be accelerated, and a significant contribution to this is also made by the following three institutions of the county: The National Research - Development Institute for Cryogenic and Isotopic Technologies (ICSI), whose object of activity is scientific research, technological development and innovation, with the capitalization of results through technological transfer and specialized services; The Research and Development Station for Fruit Cultivation, which aims to relaunch and modernize fruit growing in the Oltenia region and align this field, scientifically and economically, with community requirements, while ensuring the competitiveness of fruit products on international markets; The Drăgășani Winery Research - Development Station was established in 1,936 under the name of the Drăgășani Oenological Station, as a unit of the Ministry of Agriculture and Domains [13]". The total research and development expenses in Vâlcea county are increasing from 24,849 thousand lei (2007) to 54,516 thousand lei (2018) (NIS, Tempo online).

Table 10. The park of tractors and main agricultural machines in Vâlcea county

Categories of tractors and agricultural machines	Years / number		
	1990	2007	2018
Agricultural tractors	1,701	2,003	5,040
Plows	992	1,741	3,001
Cultivators	152	102	172
Seed drills	286	577	1,323
Machines for spreading chemical fertilizers	105	:	:
Spraying and dusting machines	272	15	8
Self-propelled combines for grain harvesting	276	191	317
Self-propelled combines for harvesting fodder	59	3	5
Combines and machines for harvesting potatoes	17	:	1
Presses for baling straw and hay	184	5	101
Windrowers for fodder	47	2	1

Source: NIS data Tempo online [19].

The agricultural field shows an increase in the level of technological endowment (Table 10) as follows: at the level of tractors (1,701 in 1990 to 5,040 in 2018), plows (992 in 1990 and 3,001 in 2018), mechanical seeders (286 in 1990 and 1,323 in 2018), but also their

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decreases in the case of balers from 184 (1990) to 101 (2018) and windrowers for fodder from 47 (1990) to 1 (2018) which shows a series of changes at the level of technologies, but also at the level of land use.
The data attest to the low level of receptivity to technological innovations and the degree of endowment with such goods, but an increase in the orientation towards the identification of funds to attract them. The collaboration between higher education institutions and the business environment in the rural area is timid even if it is noted that there are partnerships regarding research, innovation and business development in the rural area.
The analysis of the natural criterion highlights the need to adopt immediate measures to restore its quality because: a fifth of the 832 km of the length of the Olt River within Vâlcea County has a moderate ecological condition, the water quality of the reservoirs on the territory of Vâlcea County shows a ecological moderate/good, the quality of the fields is affected by the administration of chemical fertilizers, zootechnical residues (development strategy of Vâlcea county, 2016). Waste management is carried out in accordance with the County Waste Management Plan (PJGD, Vâlcea, 2019-2025) developed on the basis of the National Waste Management Plan, in force from 01.05.2018, and the Methodology for the development, monitoring, evaluation and the revision of the county waste management plans and the waste management plan for the municipality of Bucharest by means of Order no. 140/2019, in force since April 17, 2019.
At the level of 2018, a deficient degree of coverage with sanitation services is highlighted (Table 11).

Table 11. Degree of coverage with sanitation services

residential environments	**Degree of coverage with sanitation services**	
	2014	2018
Total	40	46
Urban	54	73
Rural	28	24

Source: NIS data Tempo online [19].

This was due to the need to build a legal framework specific to the market economy, respectively Romania's alignment with European legislation. The impact of this situation on rural development was a negative one, because it generated enough reasons for insecurity in making investments, especially those of an external nature. Another negative characteristic of the legislative framework is the lack of permanence, i.e. the durability of some normative regulations on the grounds that with the alternation of governing parties every four years, different visions were also manifested, which implicitly attracted legislative changes.

Synthesis of the use of the PESTEL model

The results obtained following the application of the diagnosis of the rural area using the PESTEL model are presented centrally in Table 12 and include both the major diagnosis criteria (Political, Economic, Social, Technological, Environmental and Legal) and the main sub-criteria.

Table 12 Results of the macroenvironment diagnosis according to the PESTEL model

Macro Environment Analysis Criteria	
Political	Economic
Change in order to adapt to the requirements of the Community market, Promoting coherent policies Promoting environmentally friendly policies, Appropriate social policies.	Economic, fiscal and budgetary policies, Workforce, standard of living, Activity rate, Employment rate,
Social	Tehnological
Demography (number of population, density, evolution, birth rate, mortality rate), social laws, Level of education, Image and attitude towards work,	The level of technological endowment State expenditures in research and development Receptivity to technological innovations Collaboration between higher education institutions and the economic environment.
Environment	Legal
Environmental protection policies Waste management and recycling,	Regulations on: environment protection, work legislation, taxation.

Source: Own processing.

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Next, within each major field of diagnosis, of the PESTEL model, those sub-criteria of diagnosis considered relevant for the approach regarding the development of the rural area were selected and are presented in Table 13. This selection is carried out by working groups made up of local actors and specialists in the issue of rural development.

Table 13 The relevance of some criteria of the PESTEL model for rural development

Field of diagnosis	Sub criterion	Impact				
		1	2	3	4	5
Political	Promoting coherent policies					
	Promotion of environmentally friendly policies					
	Adapting and updating policies to community policies.					
Economic	Economic policies in favor of the environment					
	Fiscal policies					
	Workforce					
	Inflation index					
Social	Population evolution					
	Activity rate					
	Occupancy rate					
Tehnolo-gical	ICT infrastructure					
	State expenditures in research and development					
	Intensity and technological creation					
Environ ment	Environmental protection policies					
	Waste management					
Legal	Regulations regarding:					
	protect the environment					
	Work legislation					
	Taxation					

Source: Own processing.

Results of using the SWOT model

The information collected with the help of the PESTEL analysis model is relevant, but for the most complete knowledge of the socio-economic characteristics of the countryside in Vâlcea county, the SWOT analysis model was used. With the help of the SWOT analysis model, the strong and weak points were identified, respectively the opportunities and external threats of the researched area, which presents the following layout (Table 14):

The information presented in the SWOT analysis leads to the establishment of the following:

- the advantages of the sustainable development of the rural area in Vâlcea county are: high potential for the development of agricultural and non-agricultural activities (tourism, agritourism, etc.); support from local authorities for harmonious development through the development of sustainable development strategies
- The weaknesses of the sustainable development of the rural area in Vâlcea county are: the decrease in the number of the population, the poor educational infrastructure, the share of small agricultural holdings, respectively the lack of the necessary knowledge, regarding the attraction of national and European funds, for a high percentage of farmers.
- The opportunities for the sustainable development of the rural area in Vâlcea county are: the multiple possibilities of diversifying agricultural activities, developing agricultural and non-agricultural activities, improving the physical infrastructure, sustainable capitalization of renewable resources, respectively the European legislative framework favorable to sustainable development (CE, 2019);
- The threats to the sustainable development of the rural area in Vâlcea county are: the degradation of the natural environment, the shyness of the measures of subordinating the economic to the ecological, the lack of sustainable consumption models, the lack of clear strategies to promote and support the products obtained in the rural area, the predisposition for an exaggerated consumption of resources.

The synthesis of the information acquired as a result of the implementation of the methodology used leads to the elaboration of the following strategic options for the sustainable development of the rural space in Vâlcea county:

1. Supporting investments in the field of agritourism and rural tourism

Table 14. SWOT analysis

	Strong points		*Weaknesses*
1	Tourist potential favorable to agritourism and rural tourism	1	Population decrease due to migration
2	Good agricultural potential and the diversification of the land fund by categories of use	2	Weak reaction of political forces vis-à-vis the updating of the national legislation on sustainable development
3	Climatic conditions favorable to a harmonious economic development in conditions of increased biodiversity	3	Poor educational infrastructure, accentuated in small villages.
4	Support from local authorities to achieve a balance between socio-economic interests and their impact on the environment	4	Significant share of individual agricultural holdings that determine the non-alignment of agricultural production with European standards.
5	Development of a sustainable development strategy at the Vâlcea county level	5	Lack of the necessary knowledge, regarding the attraction of national and European funds, for a high percentage of farmers.
	Oportunities		***Threats***
1	The possibility of developing and diversifying economic activities	1	Degradation of the natural environment due to both agricultural and non-agricultural activities
2	The possibility of accessing European and national funds to improve the physical infrastructure	2	The shyness of the measures of subordinating the economic to the ecological and the integration of production and processing activities
3	The possibility of accessing European funds for the development of the agricultural and non-agricultural sector in the countryside	3	Lack of funds for innovation and infrastructure in the process of transition to the sustainable economy
4	The existence of an increasing trend for rural tourism and agritourism	4	Low degree of awareness on the part of the population for the need to adopt sustainable consumption patterns
5	The existence of interest in the sustainable exploitation of renewable resources	5	Lack of clear policies and strategies to promote and support products obtained in rural areas.
6	The existence of a European legislative framework favorable to sustainable development (European Green Deal)	6	The predisposition towards an exaggerated consumption of resources

Source: Own processing.

2. Adapting the legislative framework to the requirements of the European Green Deal strategy
3. Developing strategies and programs for harmonious local development
4. Development and promotion of information and consulting services offered to staff from the rural area and from the local public administration in order to access funds for rural development.
5. Attracting investment funds and creating jobs
6. Supporting the process of initiating and implementing sustainable business models with the help of the post-2020 financing framework
7. The promotion and superior valorization of specific products, of the traditions of the rural area of Vâlcea county
8. Developing integrated agricultural systems by encouraging partnerships in redesigning the current supply chain (farm to fork).

CONCLUSIONS

The development of relevant strategic options for the sustainable development of the countryside in Vâlcea county is based on the realization of a diagnosis at the level of its component elements.

The research methodology used included methods and techniques belonging to strategic management and consisted of the secondary analysis of specialized literature, the identification of critical factors and successful initiatives, the application of PESTEL and SWOT analysis models.

The study highlights the existence at the level of the studied area of the premises necessary for the sustainable development of the countryside in Vâlcea county as a result of the natural potential favorable to agricultural and non-agricultural activities that can be exploited to its true potential through the development of information and consulting services in order to access funds for rural development;

For rural areas at the European Union level, there are intense concerns about sustainable rural development. The key elements of this development are partnership and innovation, which creates the appropriate framework for sharing knowledge and experiences in the direction of redesigning rural economic activities towards the sustainable exploitation of available resources.

The diagnosis of the area using the PESTEL and SWOT analysis models led to the identification of the specific elements of the studied area and gave the possibility to the responsible factors and those interested as forces of the development of the rural space to better guide the process of elaboration and implementation of strategic options for obtaining sustainable rural development.

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AGRICULTURAL COOPERATIVE – VIABLE ALTERNATIVE FOR THE ECONOMIC-SOCIAL DEVELOPMENT OF SMALL AND MEDIUM FARMERS. CASE STUDY CĂLĂRAȘI COUNTY, ROMANIA

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Abstract

Romania has an agriculture in which approximately 37% of the population carries out their activity, with approximately 3 million plots, whose average surface is 1.5 ha, a fact that acutely requires the organization of farmers in associative forms, in order to modernize this important economic branch. Starting from these considerations, we analyszed, using the survey method based on a questionnaire, in 3 communes from Călărași county, the situation of farmers, on a structured sample based on the information taken from the Agricultural Register of the town halls, with a number of 238 respondents, having as its main objective the identification and drawing of development directions for small farmers, starting from the situation highlighted by means of processed and analyzed statistical data, but also by applying the opinion survey among small farmers. In order to evaluate the correlation of two important variables in the questionnaire, respectively, the farmer age and the farm size, the chi-square test was used, a test of statistical significance, through which we analyzed the frequencies for the measurable variables, on a nominal or ordinal scale. The possibility of association with other owners of farms in order to develop was analyzed: for the use of the land, the possibility of association being accepted by 46.2% of the respondents; for the association for the purpose of joint use of agricultural machinery, more than 33% support this possibility; for the valorization of agricultural products, over 30% want association with other farmers; 37% would associate for the joint rearing of animals; 34.5% want an association for the processing of agricultura products, 34.5% are followers of this association. We conclude that the organization of agricultural producers in associative forms opens new opportunities for economic development, by attracting local, zonal or regional advantages, and through collective bargaining power to increase the prosperity of the associated members and the communities they belong to. We also appreciate that among the factors of progress for the sustainable development of agriculture and the rural environment, an important place is occupied by the establishment and development of efficient associative structures, which contribute to the socio-economic stabilization of rural areas by favoring the development of agrarian structures integrated with market flows and economically efficient.

Key words: *association, cooperative, development, farmer, rural area*

INTRODUCTION

Agriculture is a field in which association and cooperation were and are more necessary than in any other field of human activity, the isolated farmer feeling practically powerless in the face of the circumstances that arise in a market economy [1, 7].

In the recent years, worldwide, due to the strategies of concentration or development, farmers farmers must choose the best action strategy, because in these uncertain conditions, only farms that have a secured market and are able to access and manage funds can be viable, profitable and competitive [4,14]. As an alternative and opportunity, farmers should consider the possibility of some form of association, among which cooperatives, groups of producers and associations of producers stand out [3,7].

In this approach, the market economy is perceived as a place of cooperation where people organize themselves in order to obtain economic advantages, which individually could not have been achieved or would have required much greater efforts [2, 6].

They can benefit from the advantages resulting from the practice of cooperation only if their own entity is worth more in combination than separately [10, 17].

Cooperation, and by extension, its practical form of manifestation-cooperative, is an inexhaustible source of solutions both for it (as an institutional structure) and for the community in which it functions/manifests itself [2, 26].

It is obvious that Romanian agriculture takes place on two levels: - farms with legal personality, non-cooperative, commercial, with development and consolidation tendencies, adapted to the entrepreneurial sector; - the traditional peasant household, autonomous, poorly performing, with little mechanization, focused on self-consumption and with reduced commercial functions [4, 25, 28].

In this context, if the first category of farms operates exclusively on the basis of the rules established by the market economy, in which the competitive sector regulates the entire process, the second category of farms subscribes to the subsistence farm, in which the social function precedes its economic function, covering - self-consumption with own agricultural and food products, with fodder products for household livestock and only partially with availability for commercialization, not capitalized but properly [5, 11, 29].

In Romania, the problem related to the establishment of associations/cooperatives lies mostly in the ignorance of these terms. This notion is completely excluded in the view of the older farmers who confuse these forms of association with the CAPs, through which their properties were confiscated. The current awareness of young farmers regarding the advantages that the association brings remains, most likely, the most sustainable solution in this sense [29, 21].

Small and medium-sized producers have a low profitability compared to large producers, whose high productions ensure the possibility of selling their products in large food chains. This is also one of the reasons why small and medium producers are not allowed to sell the products obtained in these stores, due to the inability to offer a large quantity all year round [8, 12].

Through cooperatives, a reduction in product trading costs is achieved, and a reduction in opportunistic behaviors is achieved, as well as limiting the risks deriving from these behaviors [9,29].

The acceptance of cooperative property must be done not in alternative or substitution relations to the other two forms of property in the economy (individual private property and public property), but in active partnership relations [11, 17].

The cooperative principles must be applied in their totality and unity to give personality and stability to the system, but also comparability with existing systems in other countries. Registering in a cooperative group must be done based on the use of scientifically based procedures and criteria, which take into account the profile and size of the activity, but also the entrepreneurial spirit, future projects, innovative spirit, professional and personal aspirations, etc. [13, 21]. Cohesion of the group represented by the cooperating members is a condition that guarantees the good functioning of these entities. As such, a cooperative that wants to be functional must be made up of similar entities or legal structures [8, 11].

In this context, the purpose of this study is the identification and drawing of development directions for small farmers, starting from the situation revealed through the processed and analyzed statistical data, but also by applying the opinion survey among small farmers from three communes of Călărași county.

MATERIALS AND METHODS

The specific objectives of the research consisted in: analysis of the current situation of small farmers; the structure of farms according to legal status and seniority; the share of farms distributed by surface size; the method of marketing the products; the possibility of association with other farm owners in order to develop.

A number of 238 farmers from Independenţa, Borcea and Dorobanţu communes were selected in the study sample, respectively, 90 from Independenţa commune, 80 from Borcea commune and 68 from Dorobanțu commune. The research was based on the survey method based on a questionnaire, physically applied, at the farmer's residence, between February and April 2023, and the correlation of the information was verified by the χ2 test.

The questions were structured on 2 levels, respectively, 4 filter questions, related to the age of the respondents, the age of the farm, the size and legal form of the farm and 4 groups of questions with predetermined answers, to simplify the process of completing and analyzing the answers, but also so that the respondents can choose the one that best reflects the situation pursued by the questions in the questionnaire. The age groups were structured in five levels, as follows: up to 30 years, between 31-40 years, between 41-50 years, between 51-60 years, over 60 years. Regarding the criterion on the structure of farm, according to the number of years since the establishment of the farm7 groups of categories were used, and regarding the structure of farms distributed by surface size, 5 categories were determined.

In order to determine the cumulative distribution function that applies to statistical distributions we used the χ 2 (“hi-square”) test of concordance, a general test that is applied to grouped data or frequency data by associating the columns and rows of a two-entry table, cross frequencies, in which the data are classified according to one, two, or more segmentation variables being calculated after the compilation of contingency tables [18,19]. The significance threshold was chosen and the number of degrees of freedom of the table was calculated to the formula (r-1)*(c-1); then, to take the value of χ2 from the distribution table, theoretical χ2, to compare the obtained results and to determine if there to check the association between variables or the existence of a null hypothesis.[27]. The calculated χ2 is compared with the theoretical χ2 for different probability thresholds.

RESULTS AND DISCUSSIONS

A number of 238 persons answered the questions, of which, 90 from Independenţa commune, 80 from Borcea commune and 68 from Dorobanțu commune. Regarding their age, the largest percentage is occupied by those in the 41-50 age group, namely 29.4% of the total, as it can be seen in Table 1.

Table 1. Structure and share of respndents depending on age, on the 3 communes studied in Călăraşi county

Commune / Age category	Independența	Borcea	Dorobanțu	Total	
UM	No	No	No	No	%
< 30 years	6	14	6	26	10.9
31-40 years	32	20	18	70	29.4
41-50 years	14	12	20	46	19.3
51-60 years	12	22	14	48	20.2
>60 years	26	12	10	48	20.2
Total	90	80	68	238	100

Source: Own determinations, based on questionnaire.

Table 2. Structure and share of farms belonging to respondents, according to the number of years from the farm establishment, in the three studied communes

Specification	Independenţa		Borcea		Dorobanțu		Total	
	no	%	no	%	no	%	No.	%
< 10 years	22	*24.4*	8	*10.0*	12	*17.6*	42	*17.65*
11 to 15 years	10	*11.1*	12	*15.0*	22	*32.4*	44	*18.49*
16 to 20 years	6	*6.7*	16	*20.0*	10	*14.7*	32	*13.45*
21 to 25 years	14	*15.6*	3	*7.5*	6	*8.8*	26	*10.92*
26 to 30 years	14	*15.6*	24	*30.0*	6	*8.8*	42	*18.49*
31 to 35 years	18	*20.0*	10	*12.5*	6	*8.8*	34	*14.29*
> 35 years	6	*6.7*	4	*5.0*	6	*8.8*	16	*6.72*
Total	90	*100.0*	80	*100.0*	68	*100.0*	238	*100.0*

Source:Own determinations, based on questionnaire.

Respondents over 51 years old also have an important percentage, 40.4%, this percentage being stratified by two age groups, and respondents under 30 years old, registered only 10.9%, these data demonstrating the population's aging trend from the countryside.

According to FAO, the farm is an economic unit of agricultural production, subject to a single management and which includes all the animals that are found and and the land used totally or partially for agricultural production, regardless of the form of ownership, area or legal aspect.

From the analysis of the age of the farm (Table 2), it is found that over a third of the farms are less than 15 years old, so that 21 farms are less than 10 years old (more than half of them are part of the Independenţa commune) and 22 farms with age between 11 and 15 years (half are part of Dorobanțu commune).

An important percentage is held by farms established 26-30 years ago, respectively, 18,49% of the total. As it can be seen from Table 2, in our case study we also have farms with a long history of 35 years, and of course, with a vast experience in agriculture, which proves once again the agricultural profile of the three communes studied.

According to the data of the National Institute of Statistics, in Romania, there were 2.887 million farms using 12.8 million hectares of agricultural land, at the level of 2020 [24]. In only 10 years, the number of farms decreased by 25.2%, while the agricultural area used decreased by 4.1%. From a legal point of view, the number of farms without legal personality in the same year was 25.3% lower than in 2010, and those with legal personality decreased by approximately 17% [24]. This reduction in the number of farms made ca the average agricultural area per farm to increase from 3.45 ha in 2010 to 4.42 ha in 2020. This tendency to reduce the number of farms also had implications on the structure of farms, by reducing the share of those with smaller used agricultural area of 0.1 ha from 10.3% to 4.3% in the same period and the increase in the share of those who used areas larger than 10 ha from 2.2% in 2010 to 4.2% in 2020 [24].

By category of farms: the used agricultural surface that returned on average to a farm without legal personality was 2.73 ha, compared to 1.95 ha in 2010; the used agricultural surface that returned on average to a farm with legal status was 194.78 ha, compared to 190.78 ha in 2010 [23].

Still, the size of 2.73 ha is considered far too small for the sustainability of a family as well as for the practice of a rational agricultural system both from a phytotechnical point of view and the use of modern work equipment. The production profile, however, allows small farm to produce much more, in the case of vegetable cultivation, of vineyards and orchards. Moreover, the small peasant farms are mostly mixed, they raise animals and practice either the cultivation of plants, field crops or fruit trees.

Table 3. Structure of farms according to legal status of respondents farm

Specification	UM	Independenta	Borcea	Dorobanțu	Total	
					No.	%
family farm without legal status	no	34	23	29	86	36.13
	%	39.53	26.74	33.73	100	x
authorised natural person (PFA/I.I.)	no	56	57	39	152	63.87
	%	36.84	37.5	23.66	100	x
Total	no	90	80	68	238	100
	%	37.8	33.6	28.6	100	x

Source: Own determinations, based on questionnaire.

Regarding the legal status of the farms studied, as shown in Table 3, 36.13% are part of the group of family farms without legal status and 63.87% are registered as Authorized Natural Persons or as Individual Enterprises, an encouraging aspect regarding the ability to understand small farmers regarding the advantages of association and cooperation in agriculture.

Table 4. Structure and share of respondents farms, distributed by surface dimensions

Specification	UM	Independenţa	Borcea	Dorobanțu	Total	
					No.	%
< 5 ha	no	26	8	10	42	*18.49*
	%	59.09	18.18	22.73	100	*x*
5,1 -10 ha	no	40	24	18	82	*34.45*
	%	48.78	29.27	21.95	100	*x*
10,1 ha-20 ha	no	14	14	12	20	*16.81*
	%	35	35	30	100	*x*
20,1 ha -30 ha	or	4	22	14	20	*16.81*
	%	10	55	35	100	*x*
>30 ha	no	6	12	14	16	*13.45*
	%	18.75	37.5	43.75	100	*x*
Total	no	90	80	68	238	*100.0*

Source: Own determinations, based on questionnaire.

Table 5. Correlation between respondents age and farms size

Age	UM	Farm size(ha)					al	
		< 5	5.1 -10	10.1 -20	20,1 -30	>30	No.	%
< 30 years	Nr.	8	10	2	x	6	26	10.92
31-40 years	Nr.	24	16	12	8	10	70	29.41
41-50 years	Nr.	6	14	10	6	10	46	19.33
51-60 years	Nr.	6	20	2	16	4	48	20.17
>60 years	Nr.	x	22	14	10	2	48	20.17
Total	Nr.	44	82	40	40	32	238	100
	%	18.49	34.45	16.81	16.81	13.45	100	x
Indicators	Test χ2	Significance threshold						
	≤	0.2	0.1	0.05	0.01	0.001		
CHIINV (Chi theoretical)	≥	20.47*	23.54	26.3	32	39.25	N	
CHIINV (Chi calculated)	21.82							

Source: Own determinations, based on questionnaire.

From Table 4, it emerges that the farms studied, in most of them, subscribe to the national statistics: 34.45% are part of the 5.1-10 ha category, of which almost half are from Independenţa commune; 18.49% have an area of less than 5 ha, more than half being part of Independenţa commune; farms in the 20.1-30 ha and 10.1-20 ha categories are with a percentage of 16.8%; in the second category, 55% of the farms are from Borcea commune; with an area larger than 30 ha, 16 farms are registered, 13.45% of the total, the majority being from Dorobanțu commune.

As the national statistics highlights, young farmers (under 30 years old) represent only 7% of the total population of farmers, exploiting a percentage of 7% of the SAU [4, 3].

At the other extreme, farmers who have passed the retirement age (over 65 years old) represent 40% of the total number of farmers and exploit 30% of the SAU.

From the data presented in Table 5, in the communes studied, as in the national statistics, only a percentage of 10.9 are under 30 years of age, and almost all of them have farms with an area of up to 5 ha. Among those aged between 31-40, a third own farms with an area between 5.1 and 10 ha. Farms with an area between 5.1-10 ha are owned by respondents over 50 years old, which confirms the data above, and for those who have farms larger than 10 ha, the majority are respondents from the same age category. Thus, an insignificant correlation between the size of the farm and the age of the holder is found.

In the rural area, in the vast majority of cases, products are sold through direct sales. The direct sale of agricultural products has always existed, but it holds a small proportion (6-8%)

of the total activities of selling agricultural products, depending on the type of agricultural product and the producing region. [21]. Thus, approximately 70% of the domestic agricultural harvest is sold directly even if there are much more profitable options for producers [24].

Table 6. Structure of forms of selling vegetal products in respondents farms

Specification	UM	Independenţa		Borcea		Dorobanțu		Total	
		No	%	no	%	No	%	No	%
Direct sell	No.	71	*85.5.*	62	*87.3*	53	*84.1*	186	*85.7*
Contract sell	No.	12	*14.5*	9	*12.7*	10	*15.9*	31	*14.3*
Total	No.	83	*100.0*	71	*100.0*	63	*100.0*	217	*100.0*
Persons surveyed	No.	90	*100.0*	80	*100.0*	68	*100.0*	238	*100.0*
Persons who do not sell	No.	7	7.77	9	11.25	5	7.35	21	8.82

Source: Own determinations, based on questionnaire.

As it results from the data presented in Table 6, more than 85% of the analyzed farms capitalized the production directly at the time of harvesting, a situation distributed almost symmetrically among the 3 municipalities, with a percentage between 84.1% and 87.3% of the total of those who sold the obtained production.

Only 14.3% of the respondents who sold the obtained production had distribution contracts, a situation distributed almost identically among the 3 communes, with percentages between 12.7% and 15.9%. We note the fact that there is also a percentage of approximately 9% of the respondents, who did not sell the obtained production but used it for their own consumption and for animal feed.

At the level of the agricultural farm, a specific aspect can be observed in terms of the consumption of agricultural products, because, according to the statistics, at the national level, in the year 2020, the elderly participate in the maintenance of the farmers, but also the relatives who live in the city - 3,259 people/household returned to the rural environment, and 3,016 people returned to the South-Muntenia Development Region [23,24].

From the analysis of the distribution of the products obtained, in the communes studied, it is found that out of the total of those surveyed, 232 persons consume products from the farm but also actively participate in the activity in the farm and a number of 152 people are the persons who are part of the category of children and old persons who consume but do not help in the agricultural activity (Table 7).

The ratio of 0.66 between the number of adults and the number of children, the old, etc., indicates that there are many dependents, especially the old.

This number of persons who do not participate in production is very high, unlike other countries of the European Union, where almost all family members are involved in agricultural activity.

As it results from the centralized information in Table 8, it is interesting that for the use of the land, the possibility of association is accepted by 46.2% of the respondents, almost half of them being from Dorobanțu commune; for the association for the purpose of joint exploitation of agricultural machinery, more than 34% agree, 80% being from the communes of Independenta and Borcea and 17% from the commune of Dorobanțu; for the joint sale of agricultural products, over 31% would like to associate with other farmers; 38% of the total consider an association for animal breeding; and an association with the purpose of processing agricultural products, is desired by 35.34% are followers of this association, almost half of those who answered affirmatively are from Independenţa commune.

Table 7. Correlation between people who worked on the farm and the number of people who consumed agricultural products

Specification	No./farm.	Independenţa	Borcea	Dorobanțu	Total	
		No.	No.	No.	No.	%
Number of adults who consumed, but also worked in the farm	1	12	2	8	22	*9.5*
	2	44	30	36	110	*47.4*
	3	14	26	12	52	*22.4*
	4	12	14	6	32	*13.8*
	5	4	6	4	14	*6.0*
	6	x	x	2	2	*0.9*
Total	no	86	78	68	232	*100.0*
	%	*37.1*	*33.6*	*29.3*	*100.0*	X
Number of children, old, other relatives who live in the farm and who only consumed in the farm	1	28	20	18	66	*43.4*
	2	20	20	26	66	*43.4*
	3	2	10	0	12	*7.9*
	4	2	x	2	4	*2.6*
	5	x	x	2	2	*1.3*
	6	x	x	2	2	*1.3*
Total		52	50	50	152	*100.0*
Relation No of children, the old etc/No of adults	*%*	***0.60***	***0.64***	***0.74***	***0.66***	***X***

Source: Own determinations, based on questionnaire.

We consider that the desire for association should be used for the creation of agricultural cooperatives in the directions given by the respondents, because one of the great challenges facing the agricultural sector at European level is the increase in the number and variety of viable and sustainable agricultural enterprises economically speaking.

In this sense, agricultural cooperatives can be considered preferred vehicles through which farmers join forces, create organizational structures that take over functions related to production, both upstream (financing, credit, input purchases, etc.) and downstream - especially through commercialization of production, which ensures a better future for them [15,16]. Cooperatives and groups of producers benefit from access to subsidies and European Funds with the role of support and development of agriculture in Romania [21, 22].

PNDR support granted within s.M 4.1. “Investments in agricultural holdings” open to it is also addressed to farmers from the categories of natural persons, individual and family businesses, but also to legal entities, with the aim of increasing the performance of farms, in terms of the competitiveness of the activity, the diversification of production and the increase of product quality, the transformation of small and medium-sized units into commercial units, compliance with standards community.

The final objective is to increase the added value of agricultural products by processing them at the farm level and selling them directly to consumers, respectively, the promotion of integrated agri-food businesses.

These facilities can be divided into two categories: cooperative facilities and facilities for cooperative members. If the cooperative carries out product processing activities and/or obtaining of genetic material the production of genetic material, animal breeding, are exempt from paying the profit tax in the first 5 years from the date of entry into production. In Călăraşi county, according to the data provided on MADR website, in the National Register of Agricultural Cooperatives (RNCA), in 2021, 57 cooperatives were established, of which only half had submitted a balance sheet a year ago [20].

Table 8. Structure of activities desired, for the association with other farm owners

Specification		Independența		Borcea		Dorobanțu		Total	
		No.	%	No.	%	No.	%	No.	%
1. for joint use of land use	yes	38	*42.2*	28	*35*	44	*64.7*	110	*46.22*
	no	52	*57.8*	52	*65*	24	*35.3*	128	*53.78*
2. for the joint operation of agricultural machinery	yes	36	*40*	32	*40*	12	*17.6*	80	*34.48*
	no	54	*60*	48	*60*	56	*82.4*	158	*65.52*
3. for the sale of agricultural products	yes	34	*37.8*	16	*20*	22	*32.4*	72	*31.03*
	no	56	*62.2*	64	*80*	46	*67.6*	166	*69.97*
4. for the animal breeding	yes	36	*40*	12	*15*	40	*58.8*	88	*37.93*
	no	54	*60*	68	*85*	28	*31.2*	150	*62.07*
5. for processing of agricultural products	yes	40	*44.4*	24	*30*	18	*26.5*	82	*35.34*
	no	50	*55.6*	56	*70*	50	*73.5*	156	*64.66*
6. in other fields	yes	12	*13.3*	8	*10*	10	*14.7*	30	*10,35*
	no	78	*86.7*	72	*90*	58	*85.3*	208	*89.65*
Total		90	*100*	80	*100*	68	*100*	238	*100.00*

Source: Own determinations, based on questionnaire.

CONCLUSIONS

Regarding the cooperation, the European experience, with special reference to the developed countries in the west of the continent, is rich, effective and can be considered a reference model, a context in which an analysis of all social relations and effects, of national and European legislation, is required. of the factors and economic levers that can contribute to the development of cooperation, to find the ways, methods and means to increase the efficiency of the added value, for the sustainable and efficient development of agriculture.

From our study, it results that there are activities for which the desire of the respondents to associate is found in about 50% of those surveyed, who are aware that if they are part of associative forms, new opportunities for economic development will be opened to them, by attracting local zonal or regional advantages, and they can use the collective power to increase personal prosperity, their families and the communities they belong to, because they have democratically established rights, and this represents one of the greatest benefits.

However, you should be informed that the strength of the cooperative does not result from the size of its property or the associated members, but from the intensity of the relations between the cooperative and its members, respectively its market partners, that the success of these structures is given by the unity of interests of the cooperative members and not by the work in common, because many claim that they have too small farms to enter into a form of association.

The cooperative must not be tied to the land, especially when it is addressed to persons with small and very small properties, and its activity must be found, with priority, in the sphere of covering the markets, especially the agri-food ones, as well as in the collection area, processing, storage, etc., aspects that our respondents do not master but consider as constraints rather than opportunities.

The idea must be promoted that the homogeneity of the group represented by the cooperative members is a condition that guarantees the good functioning of these entities and, as such, a cooperative that wants to be functional must be made up of similar entities or legal structures.

We appreciate that among the factors of progress for the sustainable development of agriculture and the rural environment, an important place is occupied by the establishment and development of efficient associative structures, which contribute to the establishment of value-added creative sectors in Romanian agriculture, predictable and perennial.

We need the promotion of agricultural cooperatives as a model of success in structuring a better governance of Romanian agriculture to ensure the security, sovereignty, food safety of the population and increase the competitiveness of Romanian farmers on the single European market, cooperatives being alternatives for economic-social balancing, with a major impact in balancing the trade balance, increasing the value added to primary production and strengthening the role of farmers in the agricultural and food chain. It should be noted that by joining to agricultural cooperatives, small and medium farmers have the most to gain, but this does not exclude that among them there are also above-average farmers who joined the cooperative and worked in the cooperative since many years. In order for cooperative members, small and medium farmers to have results, it is necessary for that cooperative to have a high negotiating capacity, to be consolidated or to be stimulated to consolidate. Otherwise, experience shows us that they will have the same results and fate as the small farmers who compose them.

As it also results from our study, beyond the advantages offered by belonging to an associative form, in Romania, appropriate legislation is important, but also the removal of psychological obstacles that stand in the way of the establishment and operation of agricultural cooperatives, barriers that relate to the existence of certain behavioral traits of small farmers, who have a certain level of training and professional training, and who hardly give up their individual convictions to think collectively and in the interest of all members of the associative structure.

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COMPARATIVE ANALYSIS OF BLACK TOURISM IN ROMANIA AND WORLDWIDE

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Abstract

Dark tourism (or black tourism, or grief tourism), is the tourism associated with death or tragedy. Well known dark tourism attractions are: Auschwitz, Ground Zero or Chernobyl. Dark tourism is controversial with some viewing it as an act of respect and others as unethical practice. This study was carried out during February 24-25, 2023, on the occasion of the Romanian Tourism Fair. We wanted to make a comparative analysis regarding the popularity of black tourism in the world; the opinion of Romanian tourism consumers is presented. For the external part of the research, we used the data provided by Passport Photo Online, a specialized company from the United States. For Romania, the authors of the article, together with master's students from the University of Agronomic Sciences and Veterinary Medicine - Bucharest, Faculty of M.R.D., specialization in Management in agritourism and public catering, applied 1121 questionnaires to possible tourists who visited the fair. The questionnaire purpose was to find out the opinion of the visitors regarding black tourism, if this form of tourism is popular and which are the tourist areas in Romania where this tourism is practiced. The answers were analysed and interpreted, the conclusions being very interesting and useful for the new National Strategy of Romania for the development of tourism, which is under public debate.

Key words: *dark tourism, national strategy for tourism, questionnaire*

INTRODUCTION

Black tourism involves visiting places associated with death and suffering. The traces of the bombings of Hiroshima and Nagasaki, the field of Chernobyl and the Nazi or communist camps are today objects visited by millions of people every year. Are you wondering what "black tourism" is? Well, he is as black as his name [2]. This type of gloomy tourism involves thrills, new experiences, visiting places generally associated with death or related to famous characters. Among the most interesting and visited places that are part of black tourism, we list: • the cities where the nuclear bomb fell in Hiroshima and Nagasaki • the radioactive city of Chernobyl • Nazi concentration camps • Genocide Museum in Murambi, Rwanda • Catacombs in Paris Black tourism, although it is something strange, is also sought after [12]. Moreover, even appreciated. It has been defined as tourism involving historical places associated with death and tragedy. Thanatotourism is a term derived from the word "thanatos", the word "death" in Greek and the god of death in Greek mythology, and "tourism" [11]. People are attracted to different places due to the historical value, but also the association with suffering. There is a long world tradition, recent but also ancient, of those who visit places related to death and tragedies, such as: • gladiator games in ancient Rome at the Coliseum, • participation in public executions by beheading in France of Robespierre • punishment by being shot at the stake or on the wheel in the public square in the Middle Ages • the burning of witches or the trials of the Templars • visiting the catacombs. Academic attention on the subject was found in Glasgow, Scotland. The term "black tourism" was invented in 1996 by Lennon and Foley, two professors from Glasgow Caledonian University [10] [13]. The term "thanatotourism" was first mentioned by A.V. Seaton in 1996, professor of tourism marketing at the University of Strathclyde [20] [21]. Since 2014, various studies, definitions, labels and categories have appeared: • holocaust-related tourism • tourism related to the legacy of African slaves [22]. There is no longer a question of tastes, trends or economy. But that thirst for the gloomy, searching for the supernatural. In England, there were even studies on this topic. In 2005, the Institute for Black Tourism was founded. Death and suffering become a tourist product. Stone even divided the sites according to typology from the most "white" to the most "black": • funny "black" factories • "black" galleries • "black" prisons • "black" burial places • "black" altars • "black" places related to conflicts • "black" places related to genocides In 2008, Stone and Sharpley concluded that the association with suffering and death in black tourism represents immorality, precisely to communicate morality. On the other hand, critics of this type of tourism were also brought. Namely the exploitation of the deceased for profit. But reexamining tragedies can lead us to avoid others in the future. The most visited and interesting destinations include: • castles and battlefields such as Culloden in Scotland and Bran Castle in Romania • former prisons such as Beaumaris Prison in Anglesey, Wales • Places of natural or man-made disasters such as Hiroshima Memorial Park in Japan, Chernobyl in Ukraine on the site of the former nuclear power plant, Ground Zero - what remained after the attack of September 11, 2001 [19]• Jack the Ripper exhibition in London • places related to human atrocities and genocide, Auschwitz concentration camp, Poland, [5] Tuol Sleng Genocide Museum in Cambodia, Nanjing Massacre Memorial Hall, China, Spirit Lake Internment Camp Center near La Ferme, Quebec, Jeyu Uprising sites in South Korea,. • the hills of Culloden Moor, in Scotland, where the British troops, led by the Duke of Cumberland, nicknamed "the butcher", crushed the Jacobites in 1746. • a tour following Hurricane Katrina in New-Orleans, • tour in Rwanda following the genocide Assassinated famous personalities and places of pilgrimage: • Ford's Theater, in Washington D.C. On April 14, 1865, Abraham Lincoln was assassinated here, over 700,000 visitors a year • President Kennedy, at Dealey Plaza, and the museum has over 350,000 visitors a year • Pompeii Theatre, from Rome. Julius Caesar was assassinated here in 44 BC • Birla House, New Delhi. Here on January 30, 1948, Mohandas K. Gandhi was shot • The Dakota Building, in New York. In front of this building, on December 8, 1980, John Lennon was shot • Lorraine Motel, Memphis, Tennessee. In April 1968, Martin Luther King Jr. was shot here • Yusupov Palace, St. Petersburg. In December 1916, Grigory Rasputin was assassinated here • Sarajevo, Bosnia. On June 28, 1914, Archduke Franz Ferdinand was shot here [1] • Audubon Hall, New York. On February 21, 1965, Malcolm X was shot here. Although Romania does not excel in many aspects, we find it on the map of black tourism [14]. Foreigners are very interested in the legend of Dracula and Bran Castle [7]. Passionate about the horrors of the past, fictional or real, foreigners come to Romania especially for these places. If you can believe it, the Carpathians, Transylvania, Dracula, Bran or Poienari are discussed intensively on foreign forums [3]. But few foreigners know about Sighet and the Memorial to the Victims of Communism and the Resistance. The memorial was founded in 1993 by Ana Blandiana and Romulus Rusan. Here we find photos, documents, objects, letters, newspapers, textbooks, albums and over 5,000 hours of audio recordings from that period [24].

We have museums about kitsch communism, but also the Sighet Museum and black cells of communism. Massacres, catastrophes, battles, attract Romanian tourists.

Places of black tourism visited in Romania:

• Sighet Memorial Museum and former communist prison.

• Bran Castle [18].

• Ceausescu's palaces and, of course, the People's House [25].

In this context, this study aimed to make a comparative analysis regarding the popularity of black tourism in the world and to test the opinion of the Romanian tourism consumers on this topic.

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MATERIALS AND METHODS

This study was carried out during February 24-25, 2023, on the occasion of the Romanian Tourism Fair. We wanted to do a comparative analysis regarding the popularity of black tourism in the world, compared to the opinion of Romanian tourism consumers [9]. For the external part of the research, we used the data provided by Passport Photo Online, a specialized company from the United States. For Romania, the authors of the article, together with master's students from the University of Agronomic Sciences and Veterinary Medicine - Bucharest, Faculty of M.R.D., specialization in Management in agritourism and public catering, applied 1121 questionnaires to possible tourists who visited the fair. The questionnaire purpose was to find out the opinion of the visitors regarding black tourism, if this form of tourism is popular and which are the tourist areas in Romania where this tourism is practiced [6].

RESULTS AND DISCUSSIONS

Passport Photo Online surveyed 900 Americans to find out what their motivations are and what are the most popular for "black tourism." A revealing statistic: 82% have already visited at least one black tourism destination and, of those who have not, 63% are interested [15].

Eight out of ten respondents have already visited a black destination in their lifetime, although for Gen Z this percentage rises to 91% and among baby boomers it drops to 71%.

The main reason why they visit destinations marked by death or disasters is related to the educational aspect (52%), but also to the desire to pay tribute to the affected people (47%) or because they want to discover a place with history and not just a fashionable destination.

Concerning the most attractive sort of dark tourism, war or battlefield tourism are on the first places.

Ecological disaster tourism is also very important by a great deal of morbid curiosity and, to a lesser extent, travel for the exploitation of cemeteries, for their artistic, architectural, historical or landscape heritage [4].

At the same time, there are tourists who want to meet or learn about ghosts or enchantments, travel to places associated with the deliberate killing of a nation or an ethnic act, and even prisons, Passport Photo Online explains. Nuclear tourism is another category of interest; the Chernobyl series of events had a lot to do with it, and today the nuclear power plant is the ninth most popular destination visited by tourists. In Bali, funeral rites have become tourism. Balinese customs show us the traditional discovery and exhumation of corpses after a certain period. And even keeping them in the houses. All these customs became the occasion for black tourism. Other American citizens visit the Holocaust Museum in Washington [23]. We note with surprise, but also with pride, the fact that Bran Castle is in 8th place [16] [17] (Table 1).

Table 1. The 15 most popular destinations in the world

PLACE	DESTINATION	COUNTRY/ AREA	%
1.	PEARL HARBOUR NATIONAL MEMORIAL	HAWAII	45
2.	GROUND ZERO	NEW YORK	44
3.	CATACOMBS OF PARIS	FRANCE	43
4.	HIROSHIMA AND NAGASAKI	JAPAN	42
5.	WRECK OF THE TITANIC	NORTH ATLANTIC	41
6.	ALCATRAZ FEDERAL PENITENTIARY	CALIFORNIA	40
7.	AUSCHWITZ CONCENTRATION CAMPS	POLAND	39
8.	BRAN CASTLE	ROMANIA	39
9.	CHERNOBYL NUCLEAR POWER PLANT	UKRAINE	37
10.	FUKUSHIMA	JAPAN	35
11.	WUHAN	CHINA	34
12.	CHOEUNG EK	CAMBODIA	32
13.	KIGALI GENOCIDE MEMORIAL CENTRE	RWANDA	32
14.	AOKIGAHARA FOREST	JAPAN	32
15.	AZOVSTAL PLANT IN MARIUPOL	UKRAINE	31

Source: Passport Photo Online [15].

We also tried to find out the opinion of the tourists from Romania, through the 1,121 questionnaires applied to the tourists who came to the tourism fair [8]. To begin with, we analysed the distribution of respondents based on age and gender (Table 2).

Table 2. Distribution of respondents by age depending on gender

	under 18 years	18-25 Years	26-35 Years	36-45 years	46-55 years	56-65 Years	Total
Female	1.2%	15.2%	15.3%	7.9%	5.2%	2.4%	47.2%
Male	2.2%	23.6%	15.7%	7.2%	2.8%	1.2%	52.8%
Total	**3.4%**	**38.8%**	**31.0%**	**15.2%**	**8%**	**3.6%**	**100.0%**

Source: Own calculation.

From the analysis carried out, it follows that 47.2 of the respondents are female and 52.8 are male. Among women, the largest share is

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those aged between 18 and 35, respectively 30.5%. The situation is similar for men, where the two categories add up to 39.3%. As the educational level of the respondents is concerned it was found that the majority of those with secondary education (high school) with a ratio of 61.4%, followed by those with graduate studies (college/university) with a ratio of 29.8%, finding at the opposite pole respondents having postgraduate studies, 7.4%, as well as those with primary education (middle school) with 1.2% (Table 3).

Table 3. Distribution of respondents by age depending on educational level

	Middle school	High School	College / University	Postgraduate studies	Total
under 18 years	0.2%	0.0%	0.0%	0.0%	0.2%
18-25 years	0.4%	35.9%	8.4%	1.1%	45.8%
26-35 years	0.2%	16.6%	13.2%	0.9%	35.9%
36-45 years	0.2%	6.7%	7.1%	1.6%	13.3%
46-55 years	0.2%	2.2%	0.9%	0.9%	4.0%
56-65 years	0.0%	0.0%	0.2%	0.4%	0.7%
Total	**1.2%**	**61.4%**	**29.8%**	**7.4%**	**100.0%**

Source: Own calculation.

Regarding the occupation of the respondents it was observed that 60.3% are represented by employed/self-employed individuals, followed at a great distance by students, with a ratio of 28.8% (Table 4).

In terms of declared income of the respondents it was found that 41.97% of them have an income situated between 1,000 LEI and 2,000 LEI, followed by those with an income below 1,000 LEI in the share of 21.73%, and the others with an income in the range of LEI 2,001-3,000 in the share of 12.99%, while at the opposite pole there are those with income exceeding LEI 4,000 in the share of 8.79% (Table 5).

Table 4. Distribution of respondents by age depending on occupation

	Employee / Self-employed	Student	Unemployed	Other	Total
Under 18 years	0.0%	0.0%	0.0%	0.2%	0.2%
18-25 years	26.4%	25.5%	0.9%	3.1%	55.8%
26-35 years	18.3%	2.2%	0.2%	4.2%	24.9%
36-45 years	11.5%	0.7%	0.4%	1.6%	13.2%
46-55 years	3.5%	0.4%	0.0%	0.2%	4.0%
56-65 years	0.6%	0.0%	0.0%	0.0%	0.7%
Total	**60.3%**	**28.8%**	**1.6%**	**9.3%**	**100.0%**

Source: Own calculation.

Table 5. Distribution of respondents by age depending on income

	< LEI 1,000	LEI 1,000-2,000	LEI 2,001-3,000	LEI 3,001-4,000	> LEI 4,000	Total
under 18 years	0.23%	0.25%	0.26%	0.02%	0.12%	0.79%
18-25 years	16.25%	24.35%	8.90%	1.81%	4.48%	44.28%
26-35 years	4.87%	11.75%	5.60%	3.80%	2.22%	29.96%
36-45 years	2.04%	5.36%	4.21%	12.18%	2.32%	15.30%
46-55 years	0.66%	3.52%	1.92%	1.23%	1.00%	8.35%
56-65 years	1.28%	2.20%	2.23%	0.92%	0.88%	7.89%
Total	**21.73%**	**43.97%**	**12.99%**	**7.56%**	**8.79%**	**100.0%**

Source: Own calculation.

To the question related to knowledge of the concept of black tourism, 44% of those surveyed replied that they have little information about this type of tourism, 22.0% responding that they have enough information, while only 24.4% admitted to having insufficient information, 5.5% have a lot of information and 3.4% said they know nothing about this type of product (Table 6).

Table 6. Distribution of respondents' opinion on the information held about black tourism depending on age

	A lot	Many	Few	Very few	Nothing	Total
under 18 years	0.5%	0.4%	0.2%	0.2%	0.2%	0.3%
18-25 years	2.8%	18.6%	24.6%	6.8	1.6%	55.8%
26-35 years	2.4%	7.7%	13.5%	3.7%	0.7%	25.9%
36-45 years	0.6%	5.4%	6.8%	0.9%	0.2%	15.3%
46-55 years	1.4%	0.7%	1.4%	0.8%	0.3%	6.0%
56-65 years	0.2%	0.6%	0.2%	0.2%	0.4%	0.8%
Total	**5.5%**	**24.4%**	**44.0%**	**22.0%**	**3.4%**	**100.0%**

Source: Own calculation.

The most important question in the questionnaire was whether the respondents had visited a black tourism destination at least once (Table 7).

Table 7. Distribution of respondents' opinions on the visited black tourism destination

	Yes	No
Under 18 years	2.2%	7.0%
18-25 years	11.0%	5.8%
26-35 years	23.1%	1.9%
36-45 years	25.1%	1.2%
46-55 years	30.5%	1.4%
56-65 years	1.4%	1.2%
Total	83.3 %	16.7%

Source: Own calculation.

Another important question was whether tourists who have not yet visited a black tourism destination would be willing to go to such a location? (Table 8). The results are very interesting and show that tourists who have not yet visited a black tourism destination want to do so in the near future. The most willing are those over 18 years old and the younger ones and those over 56 years old are less determined.

Table 8. Tourists' willingness to go to a black tourism location.

	YES	NOT	MAYBE
under 18 years	50%	20%	30%
18-25 years	60.0%	15%	25%
26-35 years	70%	10%	20%
36-45 years	75%	5%	20%
46-55 years	78%	2%	20%
56-65 years	55%	15%	30%

Source: Own results.

Table 9. The 10 most popular black tourism destinations in Romania

Rank	DESTINATION	%
1.	BRAN CASTLE	85
2.	THE PEOPLE'S HOUSE.	74
3.	SIGHET MEMORIAL MUSEUM	53
4.	POENARI FORTRESS	42
5.	THE MERRY CEMETERY OF SAPANTA	41
6.	MAUSOLEUM OF MĂRĂȘEȘTI	38
7.	THE SULINA CEMETERY	35
8.	PITESTI PRISON MEMORIAL	32
9.	NICOLAE CEAUSESCU MEMORIAL HOUSE FROM SCORNICESTI	31
10.	"PRISON OF SILENCE" FROM RÂMNICU SĂRAT	28

Source: Own calculation.

Following the analysis of our questionnaires, regarding the opinion of Romanian tourists regarding black tourism, we can conclude that the 10 most popular black tourism destinations in Romania are the following: (Table 9).

CONCLUSIONS

Regarding the opinions of tourists surveyed by Passport Photo Online, it was found that of the 900 respondents, 82% have already visited at least one black tourism destination and, of those who have not, 63% are interested. Eight out of ten respondents have already visited a black destination in their lifetime, although for Gen Z this percentage rises to 91% and among baby boomers, it drops to 71%. The main reason why they visit destinations marked by death or disasters is related to the educational aspect (52%), but also to the desire to pay tribute to the affected people (47%) or because they want to discover a place with history and not just a fashionable destination.

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LEADER FUNDING IN ROMANIA – COMPARATIVE ANALYSIS OF TWO PROGRAMMING PERIODS

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Abstract

Since its accession to the European Union, Romania has been working to strengthen its support for area-based approaches in local development, including the implementation of the LEADER approach. This has been made possible through increased financial support and the establishment of Local Action Groups (LAGs) throughout the country. The growing number of LAGs in Romania indicates an increasing recognition of the importance of bottom-up approaches and local empowerment. LAGs serve as platforms for collaboration and coordination among various stakeholders, including local authorities, civil society organizations, and businesses. They enable communities to take ownership of their development processes and design strategies that are tailored to their specific contexts. This paper presents a comparative analysis of LEADER programme implementation in Romania in two programming periods (2007 – 2013 and 2014 – 2020), from the point of view of territorial distribution of funds, type of projects and beneficiaries, using choropleth maps with data at NUTS3 and LAU2 level. The results of the analysis show a modification of the behaviour of public and private beneficiaries, willing to involve their own funds in the realization of their projects, and the LAGs maturity in financing innovative projects and projects that develop existing businesses. The article proposes future research of LEADER impact at national and regional levels from the social return perspective.

Key words: *LEADER approach, Local Action Group, rural development*

INTRODUCTION

Until the 1970s the exogenous approach of development has been the dominant model for establishing rural development policies. The exogenous approaches to development have been heavily criticised for promoting the following [6]:

- *"dependent development*, reliant on continued subsidies and the policy decision of distant agencies or boardrooms;
- *distorted development*, which boosts single sectors, selected settlements and certain types of business, but leaves others behind and neglects non-economic aspects of rural life;
- *destructive development*, as it erases the cultural and environmental differences of rural areas; and,
- *dictated development*, as it is devised by external experts and planners".

Starting with the 1980s, once the rural development policies' exogenous model proves its limits in terms of sustainability "the emphasis shifted to rural diversification, to bottom-up rather than top-down approaches, to support for indigenous businesses, to the encouragement of local initiative and enterprise and, where these were weak, to the provision of suitable training" [6].

A European Commission paper, The Future of Rural Society [2], was the first official document re-thinking rural policy, acknowledging the diversity of the European rural space and the need of place-based approaches. The paper argued that: "If the endogenous potential of rural regions is to be properly developed, local initiatives must be stimulated and mobilised" [2]. This new perspective led the European Commission to launch in 1991 the LEADER Initiative – a pilot experiment "which, though involving minimal funding, has introduced a crucial 'bottom-up', community-based approach to EU support for rural development and (…) has had a huge symbolic impact and has proved its effectiveness in countries such as

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Finland" [11]. The term "LEADER" originally came from the French acronym for "Liaison Entre Actions de Développement de l'Économie Rurale", meaning "Links between the rural economy and development actions".

In the last 30 years various stages of LEADER have been launched in European rural areas: LEADER I, from 1991 to 1994, LEADER II from 1995 to 1999, LEADER+, from 2000 to 2006 followed by the programming period 2007–2013 in which the LEADER Approach has become known as an own Axis (Axis 4) of the Rural Development Programme (RDP) and the current programming period (2014–2020) when LEADER has transformed into CLLD (Community-led local development), being financed not only through one fund (EAFRD - European Agricultural Fund for Rural Development), but also through EMFF (European Maritime and Fisheries Fund), ERDF (European Regional Development Fund) and ESF (European Social Fund), "enabling the Local Action Groups (LAGs) to integrate local needs and solutions and to help to reinforce the links between rural urban and fisheries areas" [4].

LEADER has the merit of providing support to rural communities in finding the way to sustainable development [1], but without indicating what actions need to be taken to achieve this goal; therefore, LEADER program responds to "how we should act" rather than "what should be done" for the sustainable development of rural areas [3, 8].

"The LAG is a coagulation factor between local actors: public authorities, entrepreneurs, farmers and civil society, strengthening local governance. Applying the bottom-up approach, it manages to identify the common problems of a territory and to find solutions for them, by involving the population. Access to non-reimbursable funding is an advantage that the LAG leverages for the benefit of the community" [12].

In Romania, LEADER programme was implemented starting with the 2007 – 2013 programming period once it became a Member State of the European Union. After a rather long period of administrative establishment, the first 82 LAGs were selected in 2011, followed by another 81 LAGs selected at the end of 2012. The 163 LAGs covered 78% of the eligible surface (communes and cities with less than 20.000 inhabitants) and 72% of the population [10, 13].

The second programming period had only one stage of LAG selection, and in 2016 there were 239 LAGs authorised by the Ministry of Agriculture and Rural Development, covering 92% of the eligible area and 86% of the population.

For the next programming period, Romania has foreseen selecting 206 LAGs, according to the Strategic Plan 2023 – 2027 [7].

Specifically, the purpose of this study is to analyse the distribution of rural development aids in Romania in relation to LEADER financing.

MATERIALS AND METHODS

In this work, the first methodological step has been the construction of 2 databases, one for each programming period.

The first database contains all the projects LEADER has financed for the period 2013 (the year of the first projects selected by the LAGs) the end of the programming period (2015) with information related to the type of beneficiary, the type of action financed, amount of the contract and amount paid at county level (NUTS3).

The second database contains the projects financed under LEADER during the second programming period, i.e. from 2017 (the date of the first contract) until 1st March 2023. Although we analysed the programming period 2014–2020, it is important to bear in mind that implementation of the approved projects will continue until the end of 2025 (due to the transition period of 2021-2022 and the N + 3 rule), which means that the first comprehensive data for this period will not be recorded until the following year, in late 2026 or early 2027. This second database is more elaborate including information regarding the LAU2 codification useful to create a proper territorial distribution of LEADER funds to the communes' level.

The information has been processed and the graphic outputs were created with Data wrapper, correlating the information with the keys of the maps. The stepped scale of each map was created using the Jenks optimization method, also called the Jenks natural breaks classification method, „in order to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other classes" [5].

RESULTS AND DISCUSSIONS

In the first programming period, 7,578 projects selected by the LAGs were contracted by the Paying Agency totalling approximately Euro 385 million. 13% of them (1,017 contracts with a total value of 40.5 Euro million) were terminated due to different reasons among which: 80% at the beneficiaries' request and the rest for noncompliance with the contractual clauses.
Therefore, at the end of the Programme, with a total of over Euro 297 million in payments, the financial execution the LEADER projects was 86.3%.
When studying LEADER, most authors analyze the creation and improvement of employment, investment in tourism (one of the most favoured sectors by LEADER) or the incorporation of young people and women into the labour market.
An important conclusion can be drawn from these studies: there is an unequal distribution of LEADER funding in several areas of study, indicating the existence of a positive discrimination towards the most developed areas, as well as more solvent sectors and entrepreneurs [9].
The many differences existing in the Romanian rural territory, such as the place of agriculture in rural economy, was confirmed also when considering the interest in absorbing LEADER funds. The mapping of LEADER contracts per 10,000 inhabitants is presented in Figure 1.
It shows that there is no homogenous distribution of contracts, the minimum being 0.16 contracts/10,000 inhabitants (Vrancea) and the maximum of 17.44 contracts/10,000 inhabitants (Covasna), with an average of 4.7 contracts/10,000 inhabitants (38% of the counties being above the average).

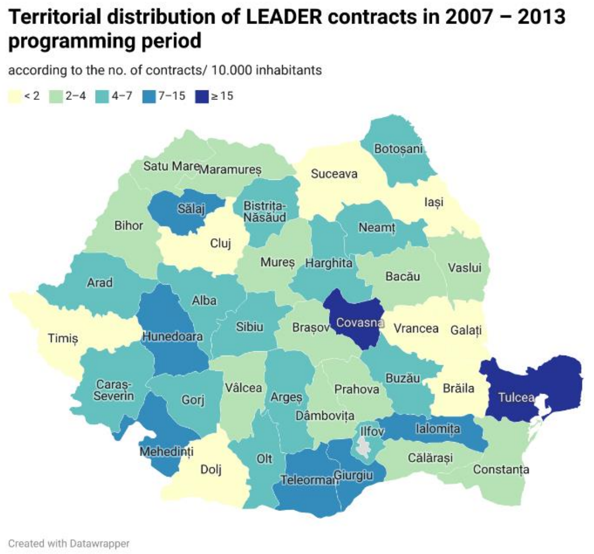

Fig. 1. Territorial distribution of LEADER contracts according to the number of contracts per 10.000 inhabitants in 2007 – 2013 programming period, using Jenks natural breaks classification method
Source: own elaboration.

In analysing the GDP per capita of the 42 counties and the territorial distribution of LEADER contracts, we observe that two counties from the 42, managed to absorb over 12% of the funds (e.g. Covasna and Mehedinți). In 2015, both counties were among the poorest counties in Romania having the highest gap related to the other counties, of 7:1, considering the GDP per capita (Figure 2).
On the other side, counties like Cluj, Timiș and Iași were among the most powerful counties, but the interest shown in LEADER projects was rather small (less than 2 contracts/ 10,000 inhabitants with less than 8 euro/capita absorbed), thus confirming Nieto's conclusion.
The average value of a project at national level in this period was Euro 50,913.95, at the county level, registering a minimum average value of Euro 32,218.72 per contract (Giurgiu) and a maximum average value of Euro 145,441.67 per contract (Vrancea) (Fig. 2).

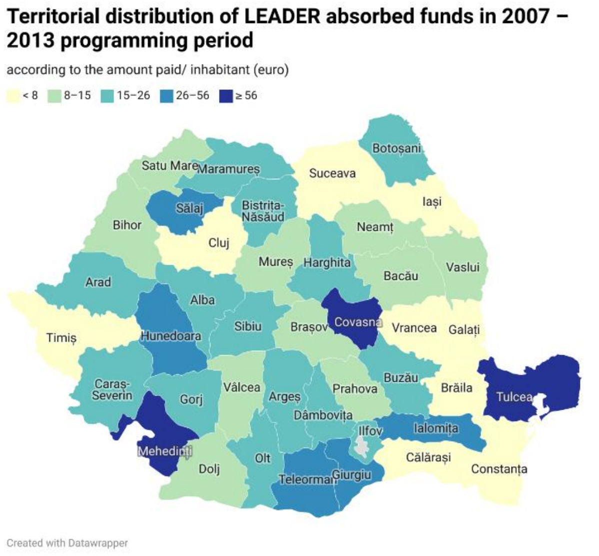

Fig. 2. Territorial distribution of LEADER absorbed funds according to the amount paid/ inhabitant (euro) in 2007 – 2013 programming period, using Jenks natural breaks classification method
Source: own elaboration.

During the second programming period, until March 2023, 8,509 projects selected by the LAGs were contracted by the Paying Agency totalling approximately Euro 463 million.

5% of them (422 contracts with a total value of Euro 26.4 million) were terminated due to different reasons among which: 62% at the beneficiaries' request due to COVID-19 related causes and the rest for noncompliance with the contractual clauses.

The financial allocation for supporting the projects selected by LAGs has increased in the second programming period, reaching over Euro 495 million. To support the transition period 2021-2022, in 2022 another Euro 100 million were distributed to the LAGs to select more projects. Therefore, with a total of over Euro 358 million in payments, the financial execution for the LEADER projects at 1st March 2023 is 60.20%.

From the point of view of the territorial distribution of the funds (Figure 3) and of the interest of the beneficiaries, reflected by the number of contracts per 10,000 inhabitants (Figure 4), there are differences compared to the previous period:

- although the much higher financial allocation, the „champion" counties of the first period (Covasna and Mehedinți) managed to absorb up to now less than 4% of the funds.
- If during the first period, Iași county, the most developed county in North-East region, managed to attract less than 100 beneficiaries with less than 5 million absorbed, during the second phase of LEADER it has over 300 contracts with almost 20 million euros absorbed, in absolute value being the champion of the second period.
- Ilfov county has the lowest number of contracts and of amounts paid; this is due also to the fact that two of the functioning LAGs had their authorisation withdrawn in 2021.

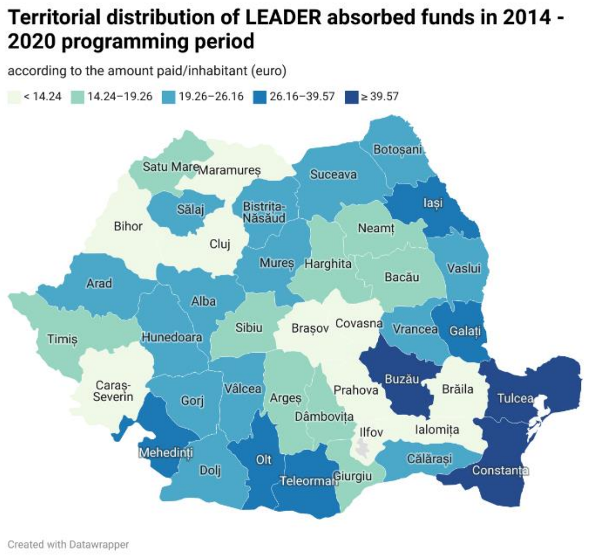

Fig. 3. Territorial distribution of LEADER absorbed funds according to the amount paid/ inhabitant (euro) in 2014 – 2020 programming period, using Jenks natural breaks classification method
Source: own elaboration.

Comparing the maps of the two programming periods in terms of the amount paid/inhabitant, considering also the Jenks breaks, it is noted a balancing at the county level with a decrease from 7 to 2.7 in terms of the ratio between the classes of values (in the first programming period the range was from 8 to 56 euro/inhabitants, while in the second programming period the range is from 14.24 to 39.57 euro/inhabitant).

This proves a higher interest in LEADER funds and a more homogenous distribution of funds at national level.

Fig. 4. Territorial distribution of LEADER contracts according to the number of contracts per 10,000 inhabitants in 2014 – 2020 programming period, using Jenks natural breaks classification method
Source: own elaboration.

This balanced distribution can be noticed also when comparing the number of contracts per 10,000 inhabitants.

It is interesting to notice that the poorest regions in Romania, South-West and North-East have the highest number of contracts and the highest values in payment.

Besides the gross analysis of general data, the two programming periods can be analysed according to the type of beneficiaries and to the type of projects. The summary of the information is presented in Table 1.

In the first programming period more than 64% of the beneficiaries were private entities interested in setting-up in agriculture as young farmers (1,884 contracts), in setting-up new non-agricultural businesses (933 contracts), in developing small and semi-subsistence farms (809 contracts) or modernising their agricultural holdings (662 contracts).

Table 1. Comparison between programming periods, according to the type of beneficiaries and measures implemented

	2007 – 2013			2014 – 2020		
	No. of contracts	Amount of contracts (euro)	% paid	No. of contracts	Amount of contracts (euro)	% paid
PRIVATE BENEFICIARIES	**4,918**	**201,450,032.02**	**47.05%**	**4,235**	**211,486,420.28**	**80.73%**
Training	151	3,127,280.15	43.66%	93	1,881,372.81	57.36%
Young farmers	1,884	63,291,221.00	77.22%	636	23,435,603.98	97.21%
Modernising agricultural farms	662	34,829,096.00	91.42%	724	53,805,263.95	91.01%
Processing	67	5,879,234.00	55.98%	17	1,455,568.96	65.44%
Small and semi-subsistance farms	809	6,067,500.00	53.60%	597	8,611,043.05	95.39%
Producers' groups	2	55,903.87	56.08%	1	41,025.00	0.00%
Consultancy	5	147,235.00	65.67%	18	386,221.36	43.02%
Setting up non-agricultural businesses	933	55,889,511.00	72.64%	1,158	49,978,634.80	88.53%
Developing non-agricultural businesses	405	32,163,051.00	55.32%	991	71,891,686.38	61.67%
PUBLIC BENEFICIARIES	**2,660**	**184,375,886.00**	**84.18%**	**4,159**	**246,422,400.88**	**75.99%**
INNOVATIVE				**115**	**5,777,045.37**	**51.11%**
TOTAL	**7,578**	**385,825,918.02**	**53.02%**	**8,509**	**463,685,866.53**	**50.45%**

Source: own elaboration.

During the second period, only 49,77% of the beneficiaries represented private entities; the focus for investments changed to setting-up new non-agricultural businesses (27% of the total number of private beneficiaries' contracts), developing the existing non-agricultural businesses (23%), modernising their agricultural holdings (17%) and setting-up in agriculture as young farmers (15%).

This distribution contrasts with the previous period, showing the growing importance of community services, characteristic of crisis years in which public sector budgets are squeezed.

During the first period, the public beneficiaries were limited to access LEADER only for the actions financed also through the national programme, i.e. projects related to increasing the economic value of forests and to improve the agricultural and forestry infrastructure, as well as projects for modernising the physical infrastructure of villages, developing the basic services for the population (e.g. recreation spaces, renovation of public buildings, construction of new kindergartens, acquisition of equipment for new public services etc), or protecting the local cultural heritage. The value of such projects is usually higher than 200,000 euro (the maximum value of a LEADER project), and most of the projects financed consisted in procurement of equipment for setting up public services for snow removal and maintenance of communal roads.

In the second period, the LAGs have selected the actions considered appropriate according to the specific needs, and although the share of public beneficiaries was more than 50%, the local communities have obtained an increase in their life quality by means of LEADER projects such as: improvement or creation of leisure and sports infrastructures (10% of contracts), creation of social infrastructures (5% of contracts) or investments in energy efficiency (3% of projects). 25% of the public beneficiaries have developed their local emergency services. In most of the cases, there were no other sources to finance such projects, so LEADER was seen as a complementary financing source to improve the quality of life. According to the European Court of Auditors' Special Report "LEADER and community-led local development facilitates local engagement, but additional benefits still not sufficiently demonstrated" issued in 2022, more than a decade after the 2010 special report on LEADER, "some Member States and local action groups used LEADER to fund statutory tasks of national, regional or municipal authorities or other activities for which other specific EU and national funding programmes existed".

Analysing the evolution of the share of contract's value in the total amount contracted according to the type of project, the main conclusion to be drawn is that both LAGs and the beneficiaries have shown a greater maturity regarding the themes approached and a better understanding of LEADER spirit.

As shown in Figure 5, we observe that:

-As regards the *training and consultancy* projects, they have maintained a relative low share, since there was a greater amount of projects in the national programme.

-As regards the *start-up measures* (both for young farmers and for non-agricultural activities), since in both programming periods at national level there was a great amount allocated in the national programme (over 6% of the financial allocation), covering all the counties, in the second programming period LEADER funds were directed more to projects of development and/ or modernisation of existing businesses. Therefore, since the national allocation of European funds was more equilibrated distributed, LEADER funds were used as complementary resources, passing from financing start-up businesses to existing one, proving a maturity of the Programme and of the LAGs.

- Projects regarding *processing of agricultural products* – since those are high value projects, that found financing in the national programme, the amount allocated through LEADER has been decreased by 5 times.

- Since the *public beneficiaries* have understood that with LEADER funding, they can finance also other projects that had no other financing sources, the projects of public interest transitioned from infrastructure to more specifically located projects, as described above.

- Another important feature is the appearance of *innovative projects*, showing that a series of LAGs has understood that LEADER philosophy means also discovering and finance those projects that have no other European financing schemes (e.g. projects of promoting the adherence to quality schemes for different types of products).

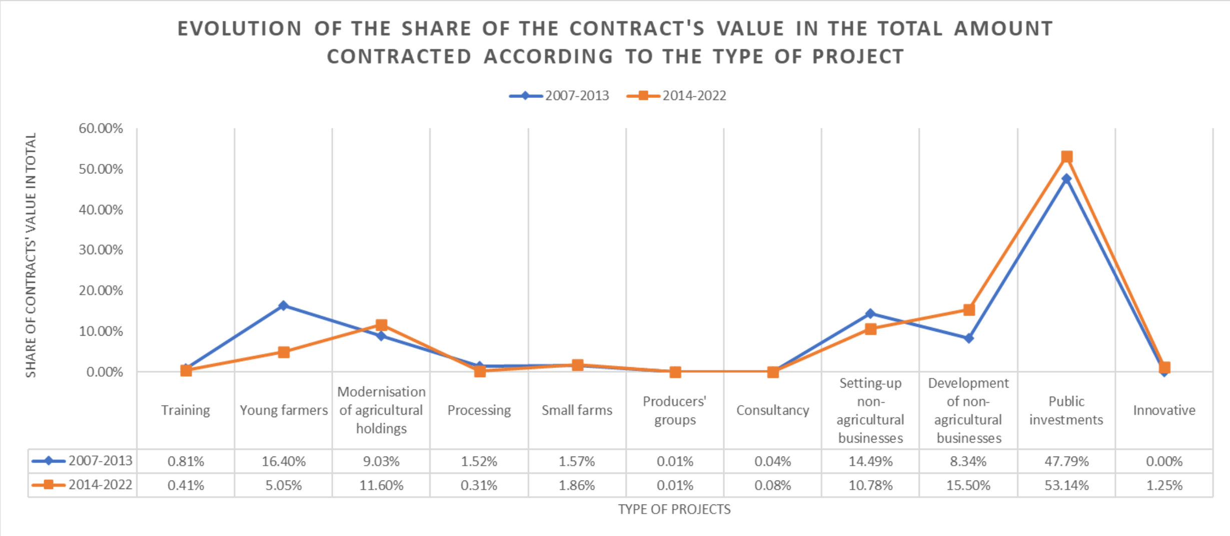

Fig. 5. Evolution of the share of the contract's value in the total amount contracted according to the type of project
Source: own elaboration.

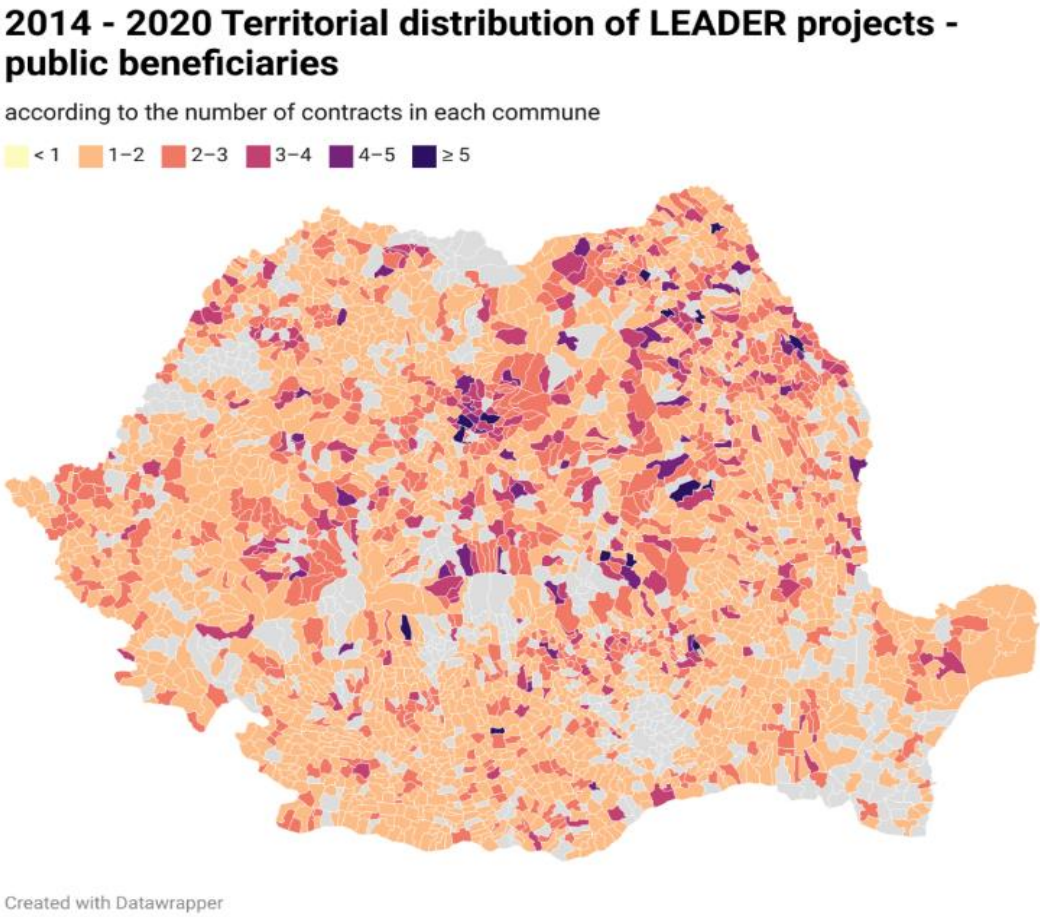

Fig. 6. Territorial distribution of LEADER contracts of public beneficiaries according to the number of contracts in each commune
Source: own elaboration.

From the point of view of territorial distribution of public contracts at commune level, most of the local authorities (65%) contracted 1 project with an average value

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attracted per commune of almost 70,000 euro (Figure 6 and 7).

The increase of 17% of the total contracted amount was distributed mainly to the projects of public beneficiaries. The average value of a project has increased from 50,193 euro to 54,493 euro, with an increase of 18% for private projects (from 40,961 euro to 49,937 euro) and a decrease of 17% for public projects (from 69,314 euro to 59,250 euro).

Besides the increase of 48% of the average value of small farms' projects, the highest increase in value was for the projects regarding modernisation of agricultural holdings (29.21%).

It is worth mentioning that the number of contracts involving private co-financing had an increase of 34.53% compared to the previous period, comprising more than 40% of the private contracts from the second programming period. The total amount of the private co-financing was over 85 million euros, representing almost 19% of the contracted amount, as shown in Figure 8.

LAGs in the second programming period covered 2,861 territorial units (2,729 communes and 132 small cities – under 20,000 inhabitants).

Correlating the territorial distribution of public (Figure 6) and private contracts (Figure 9) at commune level, of the 2781 communes receiving LEADER financing, 36% of them had only public beneficiaries (1006 communes), while 4% had only private beneficiaries (121 communes). 80 territorial units received no LEADER funds, showing that LAGs should continue to animate those territories to identify project ideas responding to local needs.

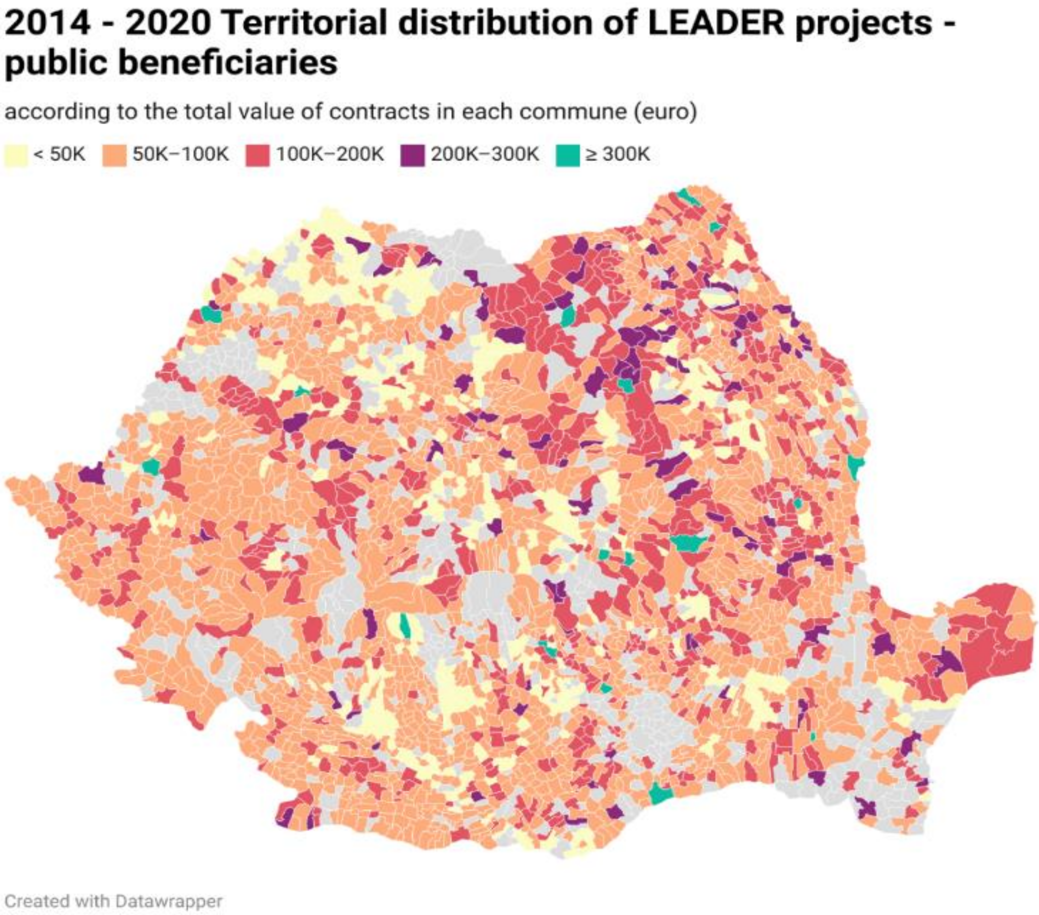

Fig. 7. Territorial distribution of LEADER contracts of public beneficiaries according to total contracted amount in each commune
Source: own elaboration.

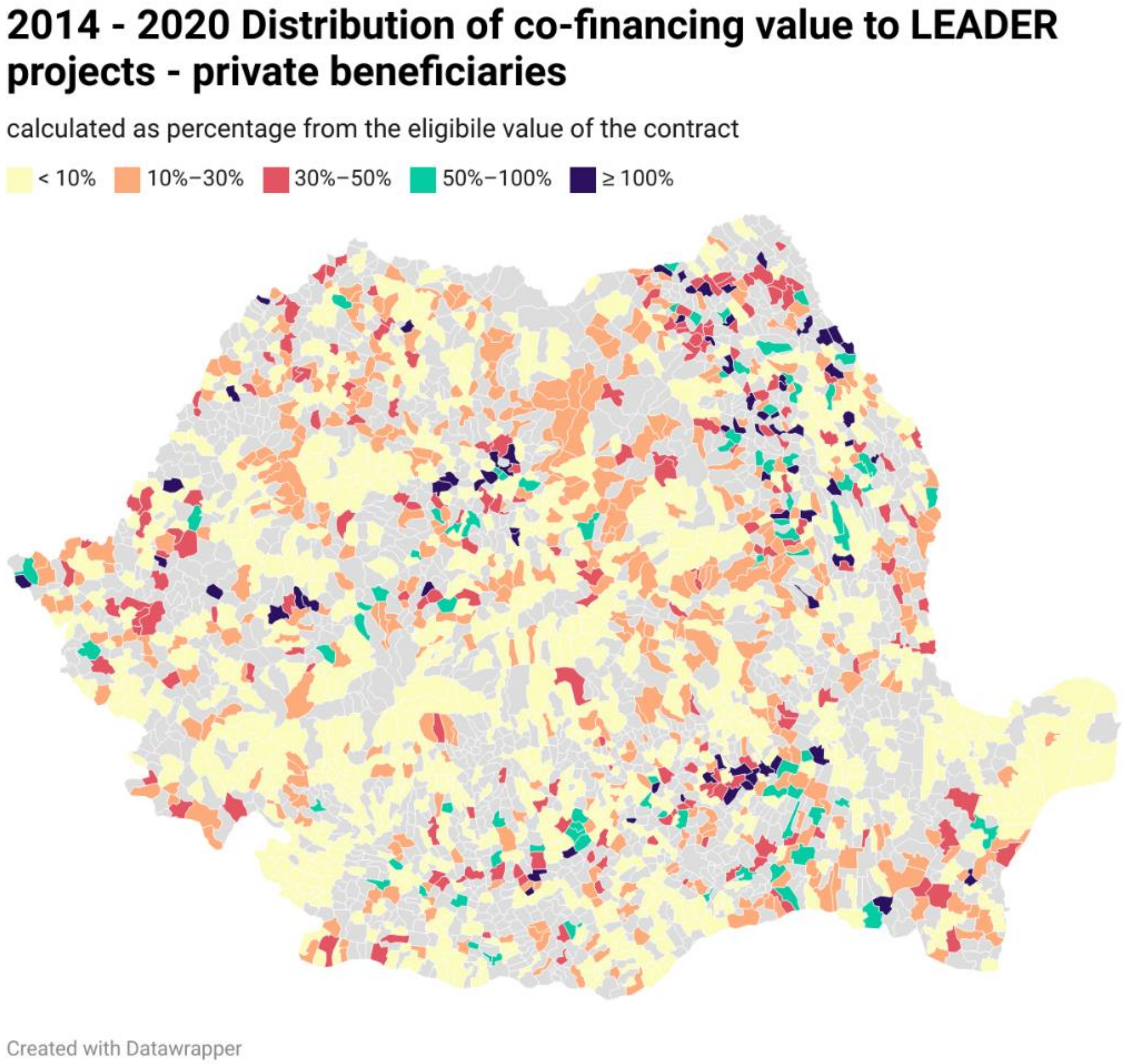

Fig. 8. Territorial distribution of private co-financing value to LEADER projects
Source: own elaboration

Another important feature of LEADER funding in the current programming period refers to the involvement of own funds.

In Figures 8 and 10, there has been mapped the distribution of co-financing value, calculated as percentage of the eligible value of the contract both for private and public beneficiaries.

This shows the amount of funding the beneficiaries have contributed to the projects submitted. If in the first programming period, most of the projects were 100% financed through LEADER, at this point the value of projects submitted is 42% higher than the value of LEADER funds.

So, the beneficiaries of LEADER funds have contributed to the programme with over 193 million euros.

For a series of territories, the private beneficiaries have submitted and implemented projects with a private contribution of more than 50% of the funds, even 100%. As a conclusion, for a great number of beneficiaries LEADER has contributed to a consistent, sustainable, and resilient development.

A significant characteristic for the second programming period for LEADER is that public beneficiaries have contributed to their community’s development with own resources: thus, they involved over 110 million euros in LEADER projects.

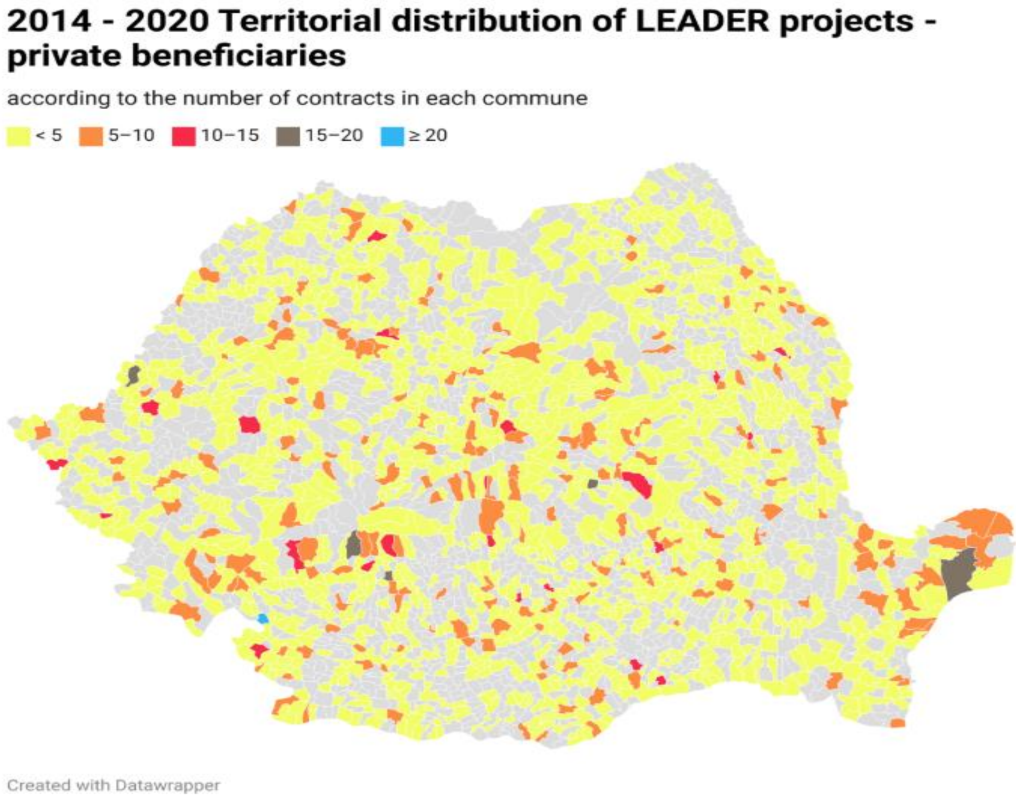

Fig. 9. Territorial distribution of LEADER contracts of private beneficiaries according to the number of contracts in each commune
Source: own elaboration.

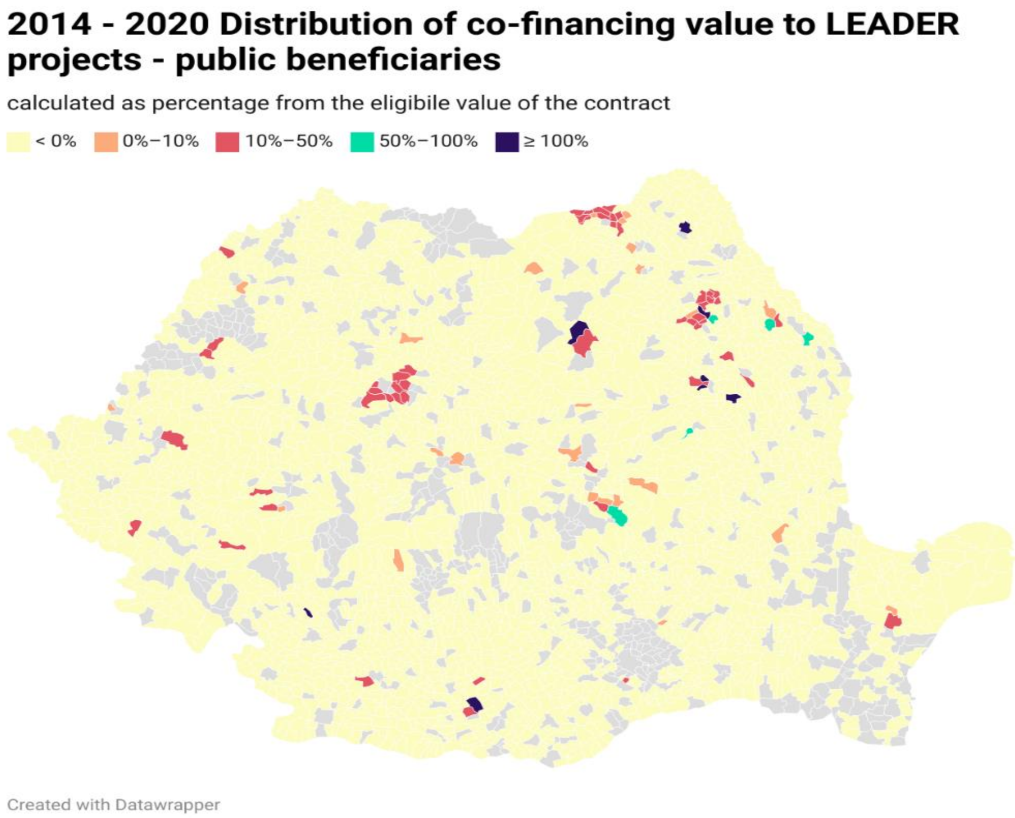

Fig. 10. Territorial distribution of public co-financing value to LEADER projects
Source: own elaboration.

CONCLUSIONS

The analysis developed in the present article presents some important features of LEADER implementation in Romania, such as:

- The highest interest in submitting projects in both programming period were in less developed counties belonging to Southwest and Northeast of Romania.

-The increase in the second programming period of the LEADER funds by public beneficiaries, characteristic of crisis years in which public sector budgets are squeezed.

-The maturity of LAGs, switching from financing start-up businesses (agricultural and non-agricultural) to supporting development and modernisation of existing businesses.

-The modification of the behaviour of public and private beneficiaries as regards their personal involvement, which lead to a contribution of over 42% to LEADER funding.

In future research, it may be interesting to explore the question of the social return of LEADER in more depth to draw more detailed conclusions that offer a better understanding of the impact of LEADER and its innovative approach when compared to other more traditional strategies adopted by the administration in rural territories.

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INCREASING THE EFFICIENCY OF INSTITUTIONAL INTERACTION DURING THE TRANSFER OF INNOVATIONS IN THE AGRO-INDUSTRIAL COMPLEX

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Abstract

In order to form a new model of economic growth that ensures food security and sustainability of the agro-food complex, it is necessary to improve the institutional conditions for the development of digital technologies and high-tech products in agricultural production. The purpose of the article is to develop theoretical and methodological aspects of the institutional interaction of participants in the innovation process, as well as to create mechanisms for systemic innovation mediation that stimulates innovation activity. The article develops conceptual provisions for regulating the development of institutional interaction, assesses the innovative activity of some European countries and assesses the dynamics of indicators of the volume of state support for the agro-industrial complex in 2013-2020. Measures are proposed to increase the efficiency of communication interaction between the participants of the innovation process using the mechanism of innovation system mediation. The practical value of the results lies in the possibility of forming an innovative development strategy in the context of the introduction of digital technologies and science-intensive products as a vector of sustainable socio-economic development of Russia.

Key words: *agro-food complex, sustainability, science-intensive products, actors of the innovation process, institutional interaction, mechanism, systemic innovation mediation*

INTRODUCTION

In order to form a new model of economic growth that ensures food security and sustainability of the agro-food complex, it is necessary to improve the institutional conditions for the development of digital technologies and high-tech products in agricultural production. In achieving sustainable development and a balanced combination of its economic, social and environmental components, the decisive role belongs to public policy [1]. Innovations are a fundamental factor in increasing the competitiveness of the agricultural sector of the economy. Sustainable development on an innovative basis is implemented through a set of technological, managerial and socio-economic tools aimed at improving the economy and the standard of living of society [15]. The reform of the CAP (Common Agricultural Policy) substantiates the importance of the innovation component in the development of scientific research in the agricultural sector of the economy [16, 17]. The Agricultural Knowledge and Innovation System (AKIS) has been established, which aims to connect agricultural production with the end consumer in order to ensure a more competitive and sustainable development of agriculture. Access to knowledge is provided by state programs of agricultural policy, which unite diversified research centers [5]. The key elements of support for farmers are advisory services (PRO-AKIS), related to social and environmental issues, which are integrated into AKIS. According to Labarthe, the purpose of AKIS is to provide knowledge transfer services to agricultural producers [11]. The stakeholders of the system are research organizations, universities, intermediary structures for the dissemination of knowledge, farmers, non-governmental organizations. AIS defines the importance of innovative solutions and emphasizes their social status. AIS, unlike AKIS, brings together a wider range of participants, the entire network of public and private stakeholders [12].

According to the World Bank, the goal (NARS) is the creation and transfer of technologies that unite organizations for the development of agriculture [27]. The definitions of AKIS, AIS, PRO-AKIS and other research systems are not clear, and several public research systems coexist [18, 19].

Dockes et al. emphasize that differences in the functioning of agricultural systems in different countries hinder effective scientific research [3]. The political concept of innovation policy is controversial. Smits considers two approaches to innovation: the innovation approach and the macroeconomic approach. According to the macroeconomic approach, innovations are considered as a set of research and development works for further commercialization and obtaining material benefits. [23].The innovative approach is based on interaction between stakeholders [6]. Edler, Fagerberg defines the innovation process as the generation of new ideas and their practical implementation [4]. The OECD in its regulations defines various forms of innovation: the development of high technology products, the modernization of old ones, service maintenance, new marketing and organizational approaches [14]. Gault used a systematic approach to statistically evaluate and measure innovation [8]. The institutional interaction of science, business, state, society is given much attention in foreign and domestic literature. The concept of an innovation spiral is widely used to study the stages of the innovation process, from the development of an idea to the implementation of innovations, taking into account the existing knowledge potential and the existing education system. Thus, in [22], a theoretical approach was applied to identify the features of the interaction of stakeholders in the process of introducing innovations in agriculture in North Macedonia. The authors presented the results of focus group discussions to assess the innovative potential of agriculture and identified such key factors of technological development as policy, legislation, knowledge, innovation infrastructure. The authors noted that the education system in North Macedonia is not sufficiently adapted to effectively organize the transfer of knowledge and technology.

The predominance of small-scale agriculture with limited financial resources also hinders the transfer of knowledge and technology, as well as the production of innovative products on farms. From the point of view of agricultural producers, the development of strategies to support innovative production and technology transfer is urgently needed.

Summarizing domestic and foreign developments in the field of formation and functioning of agro-innovation systems, we can conclude that voluntary cooperation of all stakeholders of the innovation process is necessary: the state, universities, research institutes, venture enterprises, enterprises of the real sector of the economy. One of the fundamental factors in the creation of these collaborations is the issue of legal regulation. It is extremely important to create an appropriate regulatory framework that regulates this interaction at the federal, regional and sectoral levels [24,25]. The purpose of the article is to develop theoretical and methodological aspects of the institutional interaction of participants in the innovation process, as well as to create mechanisms for systemic innovation mediation that stimulates innovation activity.

MATERIALS AND METHODS

The methodological basis of the study was state legislative acts, regulatory documents, works of foreign and Russian authors on the subject of innovative development of the agro-food complex. In the course of the study, monographic, abstract-logical, analytical, economic-statistical, expert research methods were used. Regulatory and legislative acts, information from OECD, INSEAD, Global Innovation Index, Rosstat, National Research University Higher School of Economics, Deloitte Research Center and other sources were used as the information base of the study.

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RESULTS AND DISCUSSIONS

The most authoritative ratings of innovative activity of the countries of the world are the Global Innovation Index of the consortium of Cornell University (USA), INSEAD Business School (France) and the World Intellectual Property Organization (Global Innovation Index, hereinafter referred to as the GII). Switzerland topped the list. Together with it, Sweden, the USA, Great Britain, the Netherlands, Denmark, Finland, Singapore, Germany and the Republic of Korea entered the top ten [20].

Figure 1 shows the dynamics of innovative activity in some European countries.

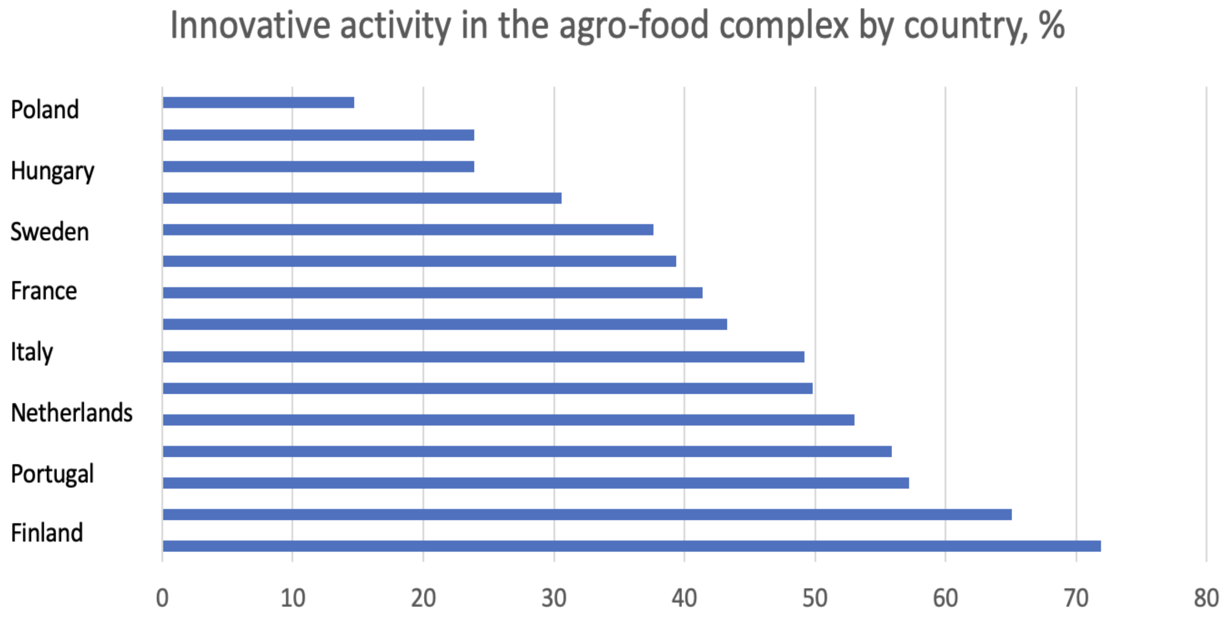

Fig. 1. Innovative activity in the agro-food complex by country
Source: Own calculations based on data [9].

The analysis shows significant differences in the level of innovative activity of different countries. For example, the Netherlands, Portugal, Finland have a value 3-4 higher compared to Poland, Hungary and Sweden.

In foreign countries, up to 90% of GDP growth is achieved through the development of innovative and digital technologies and the formed mechanisms for bringing and implementing innovations to specific agricultural producers with an assessment of the corresponding effect.

According to Table 1, it can be seen that the index of crop production (in comparable prices) in farms of all categories amounted to 98.8% compared to the previous year.

The index of livestock production (in comparable prices) in farms of all categories in 2021 amounted to 99.6% compared to the previous year, compared to the level of 2017 - 104.8% (plan for 2021 - 105.5% compared to 2017).

According to Rosstat, in 2021, the index of agricultural production (in comparable prices) in farms of all categories amounted to 99.1% compared to the previous year, to the level of 2017 -104.5% (in 2020 - 105.4% to the level of 2017), which indicates a gradual increase in pace.

The data in the table testify to the positive dynamics and increase in the pace of agricultural production.

The paper proposes a mechanism for innovative systemic mediation, which makes it possible to increase the efficiency of interaction between institutions of government, science, business, marketing in the process of creating, implementing, distributing and commercializing domestic innovative solutions at a higher systemic level - federal, regional, industry [2].

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Table 1. Dynamics of the main most important indicators of the State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials and Food Markets of the Russian Federation, million rubles

	2018	2019	2020	2021
Production index agricultural products farms in agricultural organizations, peasant (farming) farms, including individual entrepreneurs	99.6	106.9	110.3	109.8
Production index crop production on farms all categories (in comparable prices) by 2017, %	98.5	105	105.7	104.3
Index of livestock production in farms of all categories (in comparable prices) by 2017, %	101.1	103	105	104.8
Production index food products (in comparable prices) by 2017, %	103.6	107.8	111.2	114.7
Production index drinks (in comparable prices) by 2017, %	101.7	106.8	108.4	117.7
Profitability of Agricultural associations(including subsidies), %	12.5	13.3	21	25.6
Labor productivity index in % to the previous year	103.3	106.6	99.9	100

Source: Own calculations based on the data from [13].

According to Howells, an intermediary is “an organization or body that acts as an agent or broker in several aspects of the innovation process between two or more parties” [10]. There is a large body of research on how external forms of intermediation drive innovation. Insufficiently high innovative activity of the region implies poorly developed institutional networks, low innovative susceptibility of agricultural enterprises, agricultural producers, the ability to evaluate new external knowledge, accumulate it and apply it to commercialization processes. The key management tools in the course of the digital transformation of the agro-food complex are the processes of knowledge accumulation in the course of interactions between the stakeholders of the innovation process [21, 26]. Collaborations of stakeholders of the innovation process at the regional level are a form of systemic innovation mediation. The main functions of this structure are monitoring the evaluation of the effectiveness of the functioning of stakeholders, searching for reserves for increasing efficiency, developing organizational, economic and social methods for stimulating innovative activity, planning and coordinating interaction between stakeholders of different levels, marketing support for the process of introducing finished package products into agricultural production.

The transition to digital transformation predetermined the emergence of virtual innovation intermediaries in the format of bilateral platforms linking science and agricultural production. Systemic mediation in the agro-food complex will allow the formation of a certain innovative culture of the agricultural market - collaboration, the formation of which will increase the level of interpersonal and institutional trust in society.

The key mechanisms for such development are: lending, issuing loans, leasing, issuing guarantees and sureties, and providing guarantees to export-oriented companies.

To improve the institutional environment, it is proposed to search for innovative mechanisms that reduce the level of transaction costs of economic agents for interaction.

To reduce transaction costs, the stakeholders of the innovation process in the agro-food complex should interact freely and safely. An example of a mechanism for secure interaction between participants and a reduction in transaction costs can be a blockchain platform for the synthesis and operation of smart contracts in the process of managing innovative developments and patents. Blockchain is a continuous sequential chain of blocks built according to certain algorithms and containing complete information about the stakeholders of the process, as well as about the available technological solutions. The data storage system ensures the security and transparency of ongoing transactions, openness to all involved stakeholders, as well as with other interested participants. The data storage system on the network nodes of users of the blockchain system makes the system practically invulnerable to various information threats [7]. The generated registry will also allow tracking the life cycle of a packaged innovative solution in various sectors of agriculture. Smart contracts based on the blockchain platform can reduce the level of transaction costs of the subjects of innovation and are aimed at creating digital innovation assets and cryptocurrencies; identify stakeholders; confirm the authenticity of files, documents; to form databanks of innovative developments ready for implementation.

CONCLUSIONS

Increasing the efficiency of interaction between the stakeholders of the innovation process in the process of implementing the results of scientific activity is a fundamental factor in the formation of a new model of sustainable development of the agri-food complex in Russia. Measures are proposed to increase the efficiency of communication interaction between the participants of the innovation process using the mechanism of innovation system mediation. To reduce transaction costs, a mechanism for the safe interaction of stakeholders based on a blockchain platform for the synthesis and operation of smart contracts in the process of creating and implementing package solutions of finished innovative products is proposed.
The development of innovative mediation in the region makes it possible to reduce the cost of innovation, set up sustainable innovation processes, connect these processes within a single chain of production, distribution, exchange and consumption of innovations in the region. The practical value of the results lies in the possibility of forming an innovative development strategy in the context of the introduction of digital technologies and science-intensive products as a vector of sustainable socio-economic development of Russia

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STIMULATION OF DEMAND FOR INNOVATION IN AGRICULTURE BASED ON NEW MODELS OF COLLABORATION OF VALUES

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Abstract

The need to increase the volume of domestic agricultural production and overcome the import dependence of high-tech intermediate products actualizes the task of creating mechanisms to support and stimulate demand for innovative products of the agro-industrial complex. The purpose of the article is to develop theoretical and methodological foundations for the formation of scientific and technological policy to stimulate demand for innovative products in the agro-industrial complex. The theoretical foundations of the institutional interaction between the state, universities, academic institutions, agribusiness based on marketing and co-creation of values have been developed. taking into account the needs for innovation in the context of industries and regions. The study analyzes the innovative activity of some European countries, reveals disproportions between the costs of innovation and the volume of shipped products in various countries. The calculation of the index of marketing potential on the basis of a database for 83 regions was carried out and a comparison was made of the index of the country as a whole and a typical region in order to develop targeted strategies for state support. The practical significance of the research results lies in the possibility of their use in the development of mechanisms for state support of demand for innovations and digital technologies in the agro-industrial complex.

Key words: *agro-industrial complex, innovations demand, co-creation of values, multilateral platforms, marketing potential, demand stimulation mechanisms*

INTRODUCTION

High scientific potential is one of the most important conditions for the mass introduction of domestic science-intensive products in agricultural production, as evidenced by the increase in exports of information and communication technologies and agricultural products. However, the dependence of Russian agricultural producers on the import of science-intensive intermediate products is quite large. The problem of effective development, transfer and promotion of innovations remains unresolved, which is explained by the insufficient susceptibility to innovations of partner organizations in the value chain. This situation is associated with the imperfection of the institutional innovation structure of the Russian agro-industrial complex, the insufficient degree of communication between science and production in the process of creation, implementation, distribution and application of innovative solutions, imperfect mechanisms for stimulating demand in the implementation of domestic innovations, low efficiency in the use of innovative potential in the sectoral and regional context. In most cases, the main barrier to the promotion of innovative goods and technologies is the low demand of enterprises for innovation in the creation of both intermediate and final products [25]. The need to develop effective mechanisms for the interaction of organizations at all stages of the innovation cycle is explained by the low innovation culture, as well as the lack of necessary competencies in the field of innovative marketing and management, designed to intensify the process of dissemination of innovations in the agricultural sector. Close interaction of innovation centers and R&D departments with potential consumers of innovations in value chains is possible with the active use of fundamentally new innovative marketing tools [5]. The elimination of disproportions between the existing innovation potential and the efficiency of its use will stimulate the introduction of innovations in agricultural production and the formation of a model of an export-oriented agrarian economy. The problem of activating and stimulating demand for innovations is reflected in the works of domestic and foreign scientists, among whom the concepts of co-creation of value, marketing of creating consumer experience based on the organization of multilateral platforms are widely used [20]. Sawhney, M., Gianmario, V. & Prandelli, E. explored the possibilities of developing products together with consumers of innovation at different stages and using appropriate Internet mechanisms. Different levels of customer involvement were also taken into account [21]. A significant number of authors paid attention to studying the problems of marketing high-tech products, focusing on the role of marketing in the innovation process, including in the production of high-tech products [14, 15, 22]. Bansod, A.V. has been developing effective marketing strategies to increase purchases of high-tech products in retail stores in the face of a short product life cycle [3]. Venkatesh V, Bala H. paid attention to the innovative behavior of buyers and their acceptance of innovations [28]. The active participation of consumers in the innovation process served as the basis for the emergence of a new category - "consumer innovations"[30]. Theoretical and methodological approaches to the consideration of the above forms are presented mainly in the works of foreign researchers [23]. The above authors explored the trends in the development of co-creation between corporations and startups based on a systematic literature review and the presentation of the First Build case. Theoretically substantiated and successfully proven in practice are such forms of cooperation in innovation as Co-working (joint workspaces), Co-Location (placement of equipment in a territorial business center), Co-creation (joint creativity), Collaboration (collaboration), Co-innovation (joint innovation).

In particular, such a form of cooperation as Co-working is recommended for small innovative enterprises and start-ups [4, 6, 9]. Some authors consider co-creation as a management initiative [7], others characterize this form of cooperation as certain structural elements [8]. The corresponding criteria of co-creation are substantiated in the works [16]. One of the options for the form of cooperation Co-Location is the interaction of Co-working. Sverker Alänge, Annika Steiber proposed to allocate such a type of Co-Location form as Corporate-Startup, based on the partnership of large corporations, small businesses and representatives of regional authorities using various business models [1, 11]. Network technologies and multilateral platforms form the basis of fundamentally new models of cooperation. A distinctive feature of such cooperation is to attract consumers to participate in the development and improvement of new products [18, 19]. In this way, consumers become co-creators of value. To achieve mutually beneficial cooperation, it is imperative to use fundamentally new mechanisms for cooperation between customers, partners and suppliers in the value chain, the value network, including the mechanism of co-competition. New mechanisms allow customers and end users to create specific value chain constellations that take into account needs, tastes and preferences. Researchers distinguish the following models of co-creation of values: seminars on co-creation; crowd sourcing; platform for open innovation; mass customization; content activated by the user; insight communities and forums.

Increasing demand for innovative products is one of the main conditions for increasing innovative activity. According to expert surveys, about 60% of agricultural specialists assessed its importance for innovative development [12].

However, at present, the demand for innovative products in the agricultural sector of the economy does not have sufficient sustainable growth, which is due to the need to develop new methods and mechanisms to stimulate it.

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In this context, the purpose of the article is to develop theoretical and methodological foundations for the formation of scientific and technological policy to stimulate demand for innovative products in the agro-industrial complex.

MATERIALSANDMETHODS

The methodological basis of the research is legal, legislative acts, works of foreign and Russian authors on the subject of innovative development of the agro-food complex. In the process of research, monographic, abstract-logical, analytical, research methods were used. Regulatory and legislative acts, information from OECD, INSEAD, Global Innovation Index, Rosstat, National Research University Higher School of Economics were used as the information base of the study.

RESULTS AND DISCUSSIONS

The study analyzes and evaluates the level of innovative activity of some European countries, the level of shipped products in comparison with the level of costs for innovative activities.

Figure 1 shows the structure of innovation spending in some European countries.

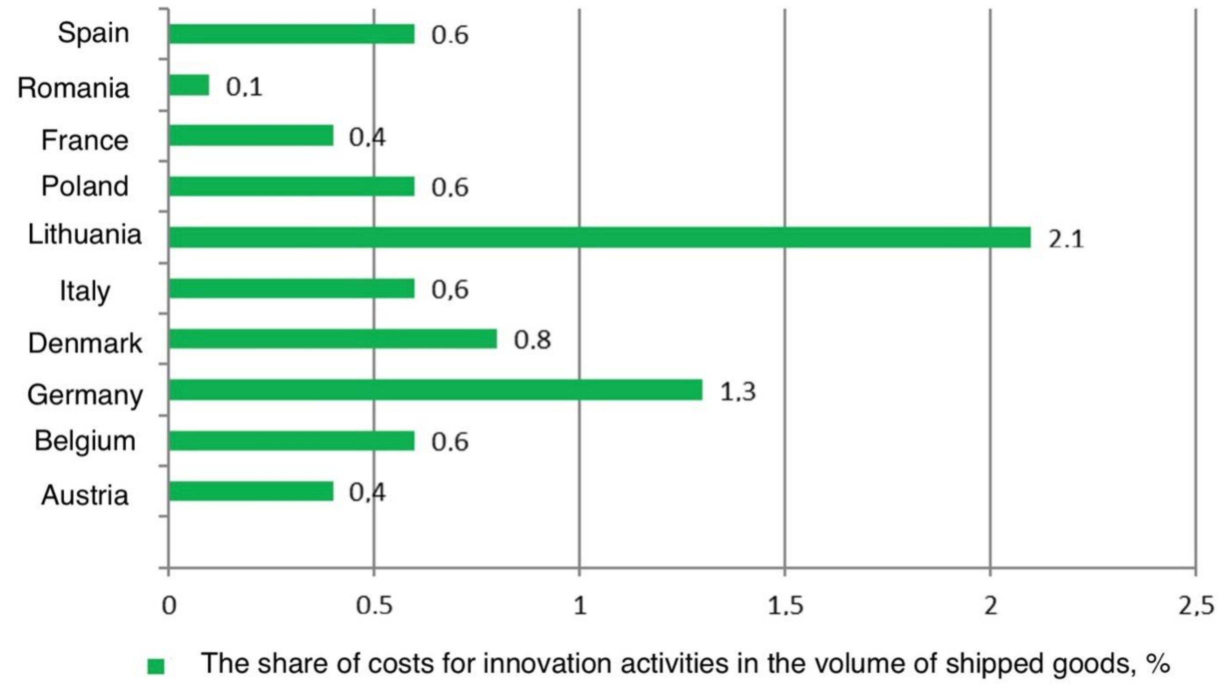

Fig. 1. The share of costs for innovation activities in the total volume of shipped goods, work performed, services, % (2021)
Source: Own calculations based on the data from [29].

From Figure 1, it can be seen that the highest values of innovation spending indicators are typical for Lithuania, Germany, and Denmark. A possible reason for the lower costs of innovation in some European countries is the fact that some countries have not sufficiently exploited the benefits of Internet innovation [2].

Figures 2-3 show indicators of the level of innovative activity and the share of innovative goods and works.

A study of the features of innovative development in individual EU countries also showed a significant cross-country differentiation in the level of innovative activity, the costs of innovative activities and the scale of production of innovative goods, works and services. In terms of innovative activity, the leaders are Belgium (71.3%); Germany (68.8%); Denmark (57.7%). Regarding the scale of the production of innovative products: the highest share of innovative goods, works and services in the total volume of shipped goods, works and services in 2021 was achieved in Spain (21.7%),

Fig. 2. The level of innovative activity of organizations in European countries, % (2021)
Source: Own calculations based on the data from [29].

Fig. 3. The share of innovative goods, works, services in the total volume of shipped goods, works, implemented services (2021)
Source: Own calculations based on the data from [29].

According to research by the National Research University Higher School of Economics, the indicator of the share of costs for innovation activity in Russia is 2%. In turn, despite the increase in costs, the level of innovative activity is only 11.9%, and the share of shipped innovative products is 5%,

This circumstance can be explained by the need to solve the problems of digital transformation of economy, which requires additional investment in the development, production and sale of innovative products, as well as the development of mechanisms to stimulate innovative activity [17, 27].

Organizations of the agrarian sector of Russia are characterized by a lower level of innovation.

Despite the fact that the innovative activity of agricultural organizations increased from 4.6% in 2017 to 8.1% in 2021, this is significantly lower than in industrial production (17.4%) and manufacturing industries (23.1%).

The intensity of spending on innovation in agriculture was only 1.1%; the volume of innovative goods, works and services as a percentage of the total volume of shipped goods, work performed, services in 2021 was equal to 2.3% (in high-tech industries - 18.4%.

Export of innovative agricultural products amounted to only slightly more than 2% of the total volume of innovative goods produced (16.5% in the economy as a whole, and 21.3% in high-tech industries).

A fairly high share of imports of science-intensive intermediate products for the livestock sector remains. .5% (generally in the economy - 23%) [29].

In order to monitor the demand for innovative products and technologies, both at the regional and sectoral levels of government, methodological approaches have been developed to assess the marketing potential of Russia and the regions-subjects of the Russian Federation.

The methodology for the formation of the system of indicators was based on the Oslo Guide, Rosstat data, the results of research by research teams and expert groups, and author's developments.

To calculate the marketing potential index, a database was compiled for 83 regions of Russia using the following indicators: the coefficient of inventive activity (the number of domestic patent applications for inventions filed in Russia per 10,000 people; the number of advanced production technologies developed per 1 million people of the labor force Number of advanced production technologies used per 1 million people of the labor force, units.

In the absence of indicators in the context of the relevant types of activity, the author's approach was applied to adjust in relation to agriculture using the appropriate coefficients as shown in Figure 4.

The analysis showed that the marketing potential of Russian agriculture is higher than in the Saratov region (5.26 units and 4.67 units).

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The backlog of the Saratov region was traced in terms of inventive activity (0.2 units and 0.4 units) and the number of developed advanced production technologies (5 units and 6.8 units).

On the contrary, the level of use of advanced production technologies was higher in the Saratov region (13.5 units and 8.6 units, respectively).

Such a methodological approach makes it possible to assess the marketing potential at the interregional level in order to develop models of state support for the demand for innovation and substantiate the mechanisms and algorithms for the interaction of participants in innovative value chains.

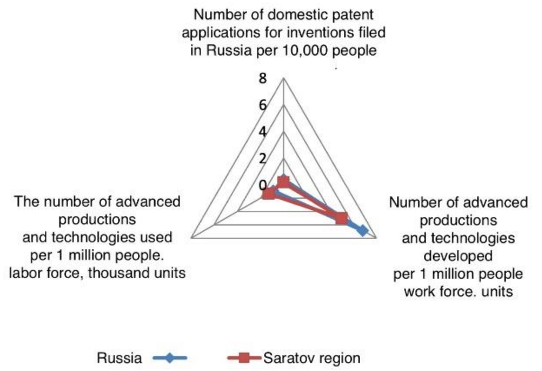

Fig. 4. Marketing potential of Russia and the Saratov region (2021)The level of innovative activity of organizations in European countries, % (2021)
Source: Own calculations based on the data from [29].

In Russia, to support innovation activities, mechanisms are used to stimulate the increase in investments, the creation of technology parks and business incubators. increasing investment [26].

In a number of constituent entities of the Russian Federation, programs are in place to subsidize manufacturers of agricultural machinery and equipment, in accordance with which part of the costs of purchasing agricultural machinery and equipment is compensated. In 2017, such programs operated in 56 regions Russia.

Starting from 2022, manufacturers of agricultural machinery and equipment will receive subsidies from the federal budget in the amount of 60% of the costs for the development, production of new types of products, as well as for the modernization of existing industries. Subsidies are also provided to compensate for the costs of research and development, production of prototypes, equipment rental. Priorities are given to the development and production of the most popular types of small-scale machinery and equipment (beet harvesters, potato harvesters and flax harvesters), which to a certain extent affect the interests of agricultural consumers. Subsidies are provided within the framework of the state program "Industrial Development and Increasing its Competitiveness" [24].

Preferential loans for the purchase of equipment are provided to small and medium-sized businesses that process agricultural products; at a rate of 2.5% -4%, and for agricultural enterprises for the same purposes - at a rate of 8.5%.

In 2023, 3 federal programs of concessional lending are available for agricultural producers [10].

The increase in demand for innovation is largely determined by the degree of interaction between actors in value chains. In the long-term forecast of scientific and technological development of the Russian Federation until 2030, one of the options is the creation of companies that integrate package solutions using advanced technologies, subject to the specifics of demand for scientific and technical products. Long-term forecast of scientific and technological development of the Russian Federation until 2030 [13].

CONCLUSIONS

The article proposes an approach to solving the problem of increasing the efficiency of mastering innovations based on the co-creation of values and the formation of multilateral platforms. The theoretical foundations of the institutional interaction between the state, universities, academic institutions, agribusiness based on marketing and co-creation of values have been developed. taking into account the needs for innovation in the context of industries and regions. The paper assesses the innovative activity of some European countries, reveals disproportions between the costs of innovation and the volume of shipped products in various countries. To calculate the marketing potential index, a database was created for 83 regions of Russia. Methodological approaches have been developed to assess the marketing potential of Russia and the regions-subjects of the Russian Federation, which makes it possible to assess the marketing potential at the interregional level in order to develop models of state support for the demand for innovation and substantiate the mechanisms and algorithms for the interaction of participants in innovative value chains. It is concluded that the involvement of consumers in co-creation models can significantly increase the innovative activity of Russian enterprises and expand the scope of development and implementation of innovative technologies, which is in line with global trends in the development of the agro-industrial complex. The practical significance of the research results lies in the possibility of their use in the development of mechanisms for state support of demand for innovations and digital technologies in the agro-industrial complex.

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STATISTICAL ANALYSIS APPLIED TO THE DATA ON CONSUMER MONETARY EXPENDITURE IN BULGARIA

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Abstract

The current paper studies data concerning consumer monetary expenditure in Bulgaria. They are structured and saved in several tables of a built data base. The considered objects are 10 different expenditures. A statistical analysis applied to these data on consumer monetary expenditure in Bulgaria is presented for the time period 2012-2021.The necessary information is searched and extracted from the indicated data base. As a result of the performed analysis of variance and Tukey's test four groups with statistically proven differences are obtained for the examined expenditures, average per household. A similar conclusion can be formed about the considered expenditures, average per person. As a whole, consumer monetary expenditure, average per household, increased in eight of the listed ten years. A quite small decline is found during 2016 as well as 2020. It is 1.36% for the first of the listed years and 1.32% for the second one. Approximately the same results are established for the consumer monetary expenditure average per person, where an insignificant decrease is calculated only for 2020.

Key words*: *consumer monetary expenditure, database, statistical analysis.

INTRODUCTION

Household expenditures have always been of interest and have been the subject of research in a number of scientific studies [15]. According to Dimitrova T., (2012) [4] “Households play a specific role in the financial system and also have specific features which distinguish them from the state and corporations as economic agents” [4]. The study of Kurshumov and Radev, (2022) [10] notes that consumers reallocate their costs to certain specific foods and beverages. The same authors point outthat “In pandemic conditions, Covid-19 was not found to pose a serious risk to food and beverage safety, which is essential for consumers” [10].

The data concerning household expenditures are presented in electronic form. The choice of information sources largely depends on whether they contain the necessary data [2], [9]. The sources that contain data related to the consumer monetary expenditure in Bulgaria are mostly structured. They are published by the Bulgarian National Statistical Institute [13]. The mentioned data are extracted from xls files [13] and are presentedin a relational database [5], [6].

The aim of this article is to present a statistical analysis applied to the data on consumer monetary expenditure in Bulgaria for the period from 2012 to 2021. The necessary information is searched and extracted from the indicated database.

MATERIALS AND METHODS

The investigatedobjects in the current work are related to the following types of expenditures:
- for foods and non-alcoholic beverages;
- for clothing and footwear;
- for housing, water, electricity, gas and other fuels;
- for furnishing and maintenance of the house;
- for alcoholic beverages and tobacco;
- for health;
- for transport;
- for communication;
- for recreation, culture and education;
- for miscellaneous goods and services.

These listedexpenditures are included in the consumer monetary expenditure. The characteristics of the above-mentioned elements are searched from the corresponding fields of the database tables (Fig. 1). Some

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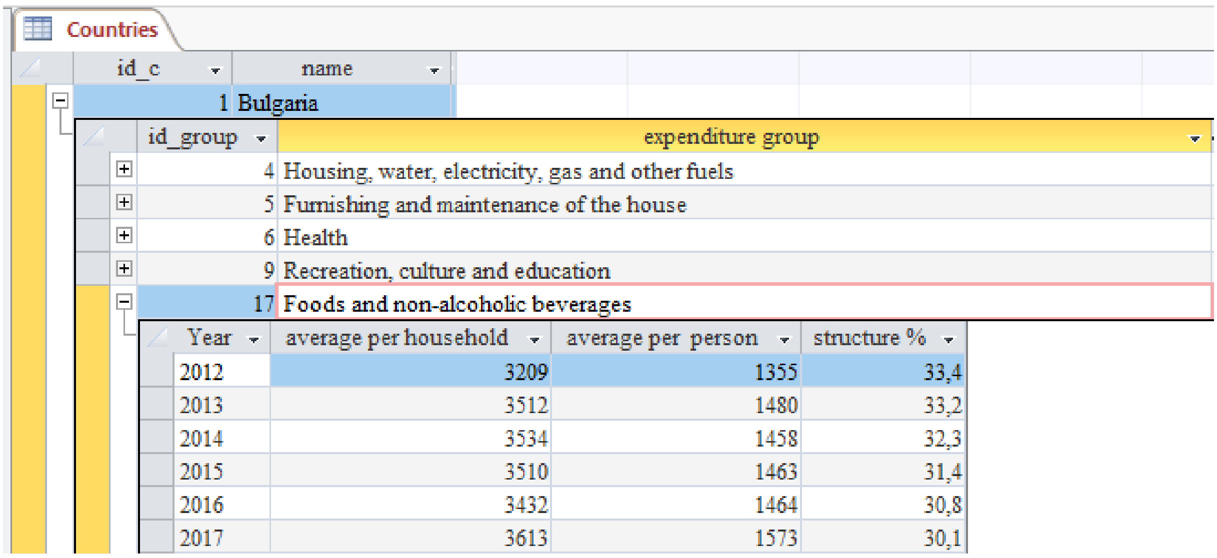
selected fields from these tables can be integrated and then certain queries can be created. Records from these queries may also be limited. In this case, certain parameters must be defined. They may include:
- chosen expenditure in the researchedperiod;
- time interval where the indicated set of expenditures is displayed;
- selection of indicators that are related to the examined group of expenditures.

The considered database is intended for use primarily by economists and statisticians. Searching the relevant elements from several tables can sometimes be a quite difficult task [3]. In this case, certain types of queries could be used. The information from them is studied and analysed during this ten-years period. The obtained data about the listed expenditures, average per household and person are summarized.

The method ofanalysis of variance [11], [14] is applied to the investigated data in the current work. The study of Adeniran, A. T., et al., (2021) [1] notes that “Analysis of variance (Anova) test has long been an essential tool for researchers conducting studies on multiple experimental groups with or without one or more control groups” [1]. Separately, the information about each one from the listed expenditures is also examined and assessed in the mentioned time segment. Software products such as Microsoft Excel [17], [12]and R Commander [7], [8] are used for the data processing. The obtained results are presented in anxlsx file format.


Countries

id_c	name
1	Bulgaria

id_group	expenditure group
4	Housing, water, electricity, gas and other fuels
5	Furnishing and maintenance of the house
6	Health
9	Recreation, culture and education
17	Foods and non-alcoholic beverages

Year	average per household	average per person	structure %
2012	3209	1355	33,4
2013	3512	1480	33,2
2014	3534	1458	32,3
2015	3510	1463	31,4
2016	3432	1464	30,8
2017	3613	1573	30,1

Fig. 1. Examined elements from the database tables
Source: Data from [13].

RESULTS AND DISCUSSIONS

The expenditures concerning the considered elements are investigated in the years 2012-2021.In this connection, analysis of variance was applied to the listed data included in the consumer monetary expenditure. The results of the calculations are presented in Table 1. As can be seen from it, the value in the column P-value is less than α=0.05. In the case, there are statistically significant differences between the studied expenditures, average per household. According to Tukey's test [16], results from the performed comparative analysis are shown in Table 2. The obtained four groups are as follows:
- The expenditures for clothing and footwear, furnishing and maintenance of the house, communication, alcoholic beverages and tobacco, miscellaneous goods and services, as well as the expenditures for recreation, culture and education are presented in an individual group. Their values are the lowest;
- The next group includes the expenditures concerning health and transport;
- The examined expenditures about housing, water, electricity, gas and other fuels are

presented in one group. The obtained values of these expenditures are comparatively high.

Table 1. Visualization of the results from theanalysis

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	94051953	9	10450217	464.920	0.00	1.986
Within Groups	2022973	90	22477.478			
Total	96074926	99				

Source: Own calculations on the basis of data from [13].

- The considered expenditures, average per household concerning foods and non-alcoholic beverages form a separate group. Their values are the highest, as can be seen from Table 2.

Table 2. Results about the studied expenditures, average per household

Consumer monetary expenditure	Assessment of the expenditures (BGN)	
Clothing and footwear	412.50	a
Furnishing and maintenance of the house	467.10	ab
Alcoholic beverages and tobacco	504.80	ab
Miscellaneous goods and services	524.80	ab
Communication	525.71	ab
Recreation, culture and education	550.70	ab
Health	677.90	bc
Transport	837.40	c
Housing, water, electricity, gas and other fuels	1,687.60	de
Foods and non-alcoholic beverages	3,697.50	e
means with the same letter are not significantly different		

Source: Own calculations on the basis of data from [13].

The processed information for the listed expenditures, average per person showed similar results. The calculated value in the column P-value is less than α (α=0.05) (Table 4). Therefore, the performed analysis of variance displayed statistically significant differences between the indicated data for the examined elements.

As a result of applying Tukey's test, four groups are obtained. One of these mentioned groups contains the first seven types of expenditures, which are visualized in Table 3.

Table 3. Assessment of theexpenditures (BGN), average per person

Expenditures	**Assessment**	
Clothing and footwear	181.60	a
Furnishing and maintenance of the house	206.80	a
Alcoholic beverages and tobacco	222.40	a
Communication	231.70	ab
Miscellaneous goods and services	231.70	ab
Recreation, culture and education	242.60	ab
Health	300.00	ab
Transport	369.30	b
Housing, water, electricity, gas and other fuels	743.40	c
Foods and non-alcoholic beverages	1,626.90	d
means with the same letter are not significantly different		

Source: Own calculations on the basis of data from [13].

The next two groups include the expenditures, average per person,concerning transport as well ashousing, water, electricity, gas and other fuels, respectively.

Quite naturally, the expenditures, average per person, about foods and non-alcoholic beverages are also included in an individual group. In the case, the values of the mentioned elements are the highest.

The change of 6 from the listed ten expenditures, average per household was studied and analysed, as can be seen from the diagram in Fig. 2.

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Table 4. Presentation of the performed calculations related to the examined expenditures, average per person

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18194386.64	9	2021598.52	218.58	0.00	1.9856
Within Groups	832392.4	90	9248.80			
Total	19026779.04	99				

Source: Own calculations on the basis of data from [13].

As a result, the following dependencies are established. An increasing tendency for the expenditures concerning communication is observed. At the end of the considered time segment the values of the indicated element are about 1.5 times higher in comparison with these ones for the first year of the examined period. Only these considered expenditures increased constantly in the years between 2012 and 2021. A different process is observed in 2019 with the expenditures for recreation, culture and education. They are quite higher for the listed year. The other five types of expenditures are comparatively lower during this period. The COVID-19 pandemic did not have a significant impact in the change of the examined elements. Certain reduction is obtained for two of themin 2020. Here, the decrease of the expenditures for clothing and footwear is about 8.18%. As can be seen from Fig. 2, the reduction of the expenditures concerning recreation, culture and education is more than 1.3 times. In addition, there has been a growth in the listed six expenditures for the last year of the considered time segment.

The largest increase is calculated for the expenditures, average per household, for furnishing and maintenance of the house in the period from 2012 to 2021. It is more than 2.2 times. It should also be noted that, the expenditures for alcoholic beverages and tobaccoare reduced only for 2016. Here, the decline is very small. In this case, it is about 1.02%.

The next two investigated elements are expenditures for health and transport. The calculations showed a decrease from 0.71% for the first of them in 2020, while for the second studied element the found decrease was 0.87% during 2015, 3.78% in 2017 and 12.19% in 2020 (Fig. 3). The expenditures, average per household, for foods and non-alcoholic beverages reduced in 2015 and 2016, while those for housing, water, electricity, gas and other fuels during2014, 2016 as well as 2018.

The present work also analyzes and estimates the indicated expenditures, average per person. The results of the analysis of variance showed that seven of the considered expenditures were presented in one group (Table 3). A continuous growth of four of these expenditures was established during the examined period. In the case, they are the following:

- expenditures for furnishing and maintenance of the house;
- expenditures for alcoholic beverages and tobacco;
- expenditures for communication;
- expenditures forhealth.

The largest change is observed in the expenditures for furnishing and maintenance over the considered time segment. Here, the increase is almost 2.5 times. The other two expenditures from this group reduced only for 2016.

The expenditures for miscellaneous goods and services decreased by 3.50% and thosefor recreation, culture and educationby 4.44%.The decline for the expenditures about clothing and footwear was 3.51% during 2015.

An increasing tendency was presented for the rest three expenditures. In addition, there was a slight decrease of about 1.49% in the expenditures for foods and non-alcoholic beveragesduring 2014.In the same year, a reduction of about 4.11% in the expenditures for housing, water, electricity, gas and other fuelswas calculated.

A higher decline (about 11.13%) in the expenditures for transport was obtained during 2020.

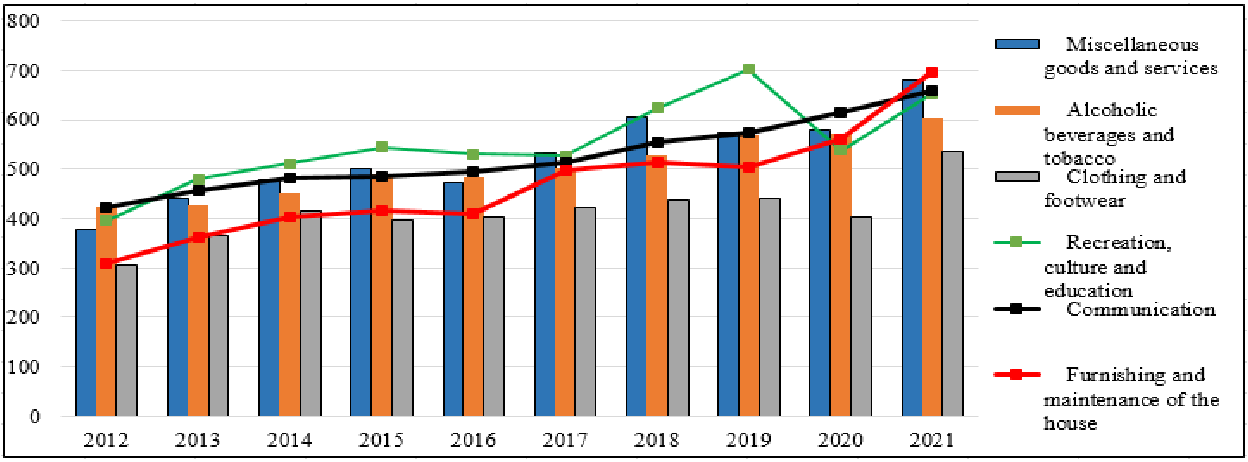

Fig. 2. The change of the listed expenditures (BGN), average per household
Source: Data from [13].

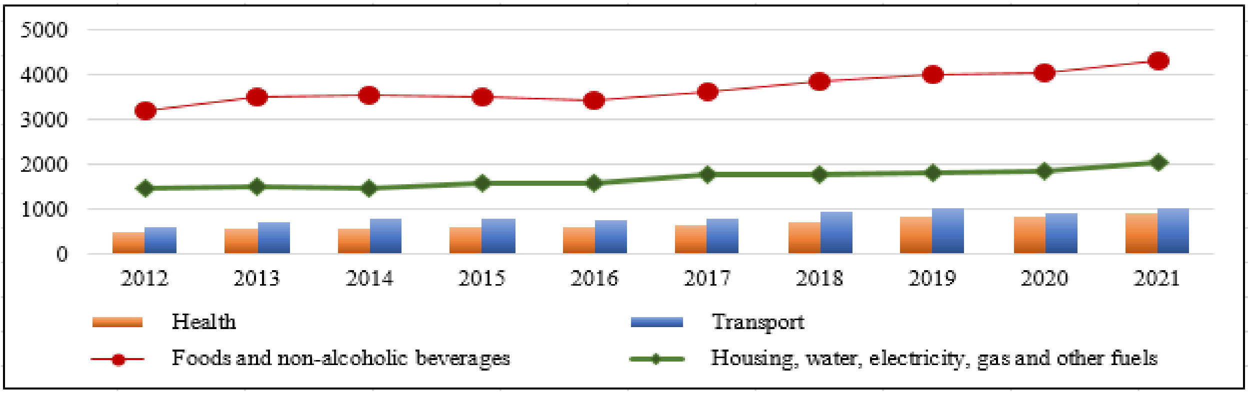

Fig. 3. The change of the other four expenditures (BGN), average per household
Source: Data from [13].

It can be summarized thatthe consumer monetary expenditure, average per household,increases for almost wholeinvestigated time period, with an exception for 2016 and 2020 (Fig. 4). In the indicated two years, the reduction is very small. It is 1.36% for the first of the listed yearsand 1.32% for the second one.

Approximately the same results are obtained for the consumer monetary expenditure, average per person for this studied time period. In the case, the calculated decrease is about 0.22% during 2020, as can be seen from Fig.4.

Moreover, in the conditions of the COVID-19 pandemic, the investigated expenditures have changed insignificantly.

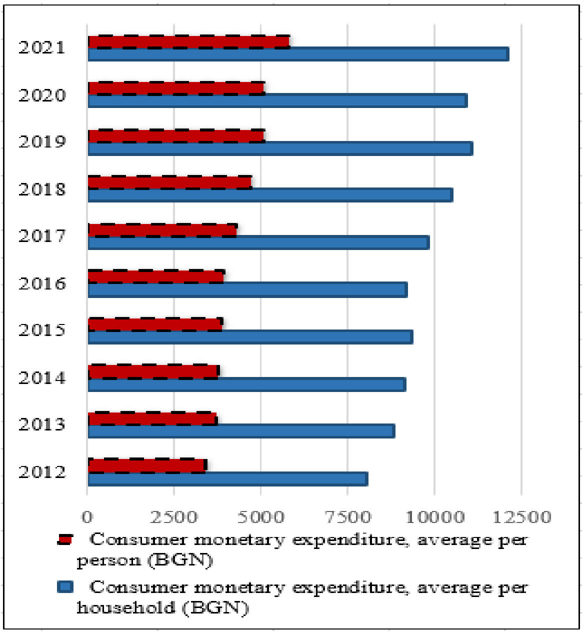

Fig. 4. Results for the consumer monetary expenditure
Source:Data from [13].

CONCLUSIONS

The present paper studies ten types of expenditures concerning:
- foods and non-alcoholic beverages;
- clothing and footwear;
- housing, water, electricity, gas and other fuels;
- furnishing and maintenance of the house;
- alcoholic beverages and tobacco;
- health;
- transport;
- communication;
- recreation, culture and education;
- miscellaneous goods and services.

They are included in the consumer monetary expenditure. The considered elements are organized and saved in a built relational database.

Statistical analysis applied to the data on consumer monetary expenditure in Bulgaria is presented for the time period from 2012 to 2021. This examined information is searched from the mentioned database.

As a result of the performed analysis of variance and Tukey's test four groups with statistically proven differences are obtained for the considered expenditures, average per household. A similar conclusion is drawn for the indicated expenditures, average per person.

As a whole, consumer monetary expenditure, average per household increased in eight of the listed ten years. Approximately the same results are also established for the consumer monetary expenditure, average per person, where an insignificant decrease is calculated only for 2020.

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SUSTAINABLE DEVELOPMENT AND TRANDISCIPLINARITY IN KNOWLEDGE SOCIETY – AIMING TO INCREASE THE QUALITY OF LIFE IN RURAL AREAS

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Abstract

The study pays attention on both the concept of sustainable development and the concept of transdisciplinarity. We analyze the impact over the quality of life in rural areas in today's Knowledge Society via SDG 4: Quality Education. The study clarifies the concept of transdisciplinarity, through concepts easier to understand such as: disciplinarity, multidisciplinarity and interdisciplinarity, from the very author of the concept, Basarab Nicolescu. It also clarifies the concept of Knowledgde Society and its demands, focusing the analysis on the general impact of Knowledge Society on sustainable development with references on the quality of life and along with SDGs perspective. This analysis is needed to fill a gap that exists in understanding the concept of transdisciplinarity itself and the transdisciplinarity approach in general. The topic is an extensive one and by bring in it to analyses, it is destined to raise the awareness to the scientific community interests in order to encourage alternative analysis.

Key words: *sustainable development, transdisciplinarity, quality of life, quality education, Knowledge Society*

INTRODUCTION

The perspective in which we look towards „*our common future*" [1] must be built in the sense of the awareness of the fact that change must be achieved both at the microsocial and macrosocial level, calling on all the resources that make up the ecosystems, the biosphere as a whole. The ancient maxim according to which „*Man is the measure of all things*" (Protagoras) contains itself that deep wisdom that places *MAN - as humanity* - in the foreground of this vast picture that includes the „*whole common living*" [10]. This makes him simultaneously the manager, the administrator, the direct responsible of all the transformations - positive or negative - that take place on Earth. There is a functionally, organic interdependence between human life, non-human life, created life - people, families, communities, organizations and the environment, say the authors of the "common living whole" paradigm.

The different perspectives in which human thought approaches the complexity of the relationships in the ecosystems, the ways in which different scientists conceptualize nature and the relationships that humanity establishes with it, give rise to a plethora of viewpoints and comprehensive paradigms. Sometimes the different approach can bring us to the point of convergence, cohesion, tradition and multiculturalism necessary to achieve common goals and objectives.

This research has a transdisciplinary documentation base with a transdisciplinary methodology, using data and information from education [4, 5, 6], economy, statistics [9, 13, 14, 15, 17], official reports [1, 2, 5, 17, 11] and specialized literature [2, 3, 7, 8, 12].

Fortunately, the concept of transdisciplinarity was popularized in academic, scientific environments by its creator. We owe the concept of transdisciplinarity to the Romanian scientist Basarab Nicolescu who created it, describe it and launched it in the academic circles. As it was stated before, the authors consider that this analysis is needed to fill a gap that exists in understanding the concept of transdisciplinarity itself and the transdisciplinarity approach in general. Also, they believe that it could be useful to wide range of researchers, PhD students from all fields of expertise.

MATERIALS AND METHODS

This research is based on the study of literature on the topic as listed at the end and from which the main ideas were systematized, structured approached in the authors' vision.
The main ideas have been pointed out and illustrated in tables and graphics.
Important data were picked up from the National Institute of Statistics regarding the situation of poverty and social exclusion rate living standard in the rural areas as well as regarding the education level of the population by age at the country level and by region of development.
Finally it was emphasized the analysis of Romania's progress in SDG4.

RESULTS AND DISCUSSIONS

The scientist Basarab Nicolescu, whose name is inextricably linked to the concept of transdisciplinarity, in his scientific paper „Transdisciplinarity" [7] clarifies the problem of confusion that can be created with close concepts, such as disciplinarity, pluridisciplinarity and interdisciplinarity, „the four arrows of one and the same bow: that of knowledge".
Another valuable scientific paper mandatory to facilitate a better understanding of the concept is „Science, Meaning and Evolution – The Cosmology of Jakob Bohme" [8].
Punctually, our contribution consists into synthesize the concepts by clarifying each one separately and then explain them with the concept of sustainable (durable) development.
Disciplinarity refers to the mono-approach, through the perspective of a single science. For example, as a research topic, quanta, in quantum physics. Interdisciplinarity and pluridisciplinarity rise at the intersection of several sciences as ways to approach knowledge.
The analysis of an object or a phenomenon from the perspective of more than two sciences is called a multidisciplinary approach.
For example, explains the author, quanta from a philosophical, psycho-social, cultural perspective. However, the extra knowledge will be attributed to the disciplinary field of which the researched object is a part, i.e. quantum physics.
Through interdisciplinarity are created bridges that make possible the transfer of methods from one discipline to another, from an applicative, epistemological aspect and as the production of new courses, independent, autonomous sciences, with their own scientific methodology and with their own language.
Sciences do not have a universal character, because the formalism in the ontological interpretation of its own results "escapes" the science itself. Examples of the transfer of methods that led to the creation of new sciences: mathematical methods in the field of physics, led to the creation of mathematical physics, methods from particle physics in astrophysics led to the creation of quantum cosmology, informatics in art led to computer art, etc. However, the value of knowledge remains in the field of research of the science that initiated the transfer of knowledge. Transdisciplinarity approach is both a scientific and a cultural approach simultaneous. Transdisciplinarity, involves cooperation with all branches of knowledge, both the exact sciences (physics, chemistry, mathematics, biology, etc. having their own autonomy) and the human ones, Art and Tradition - (Christian traditions, Hebrew, Islamic, etc.)
Transdisciplinarity is the bridge that makes possible the meeting between science and Tradition (with a big T), the meeting between the different levels of Reality (horizontal and vertical), by studying the isomorphism between the different fields of knowledge.
Transdisciplinary research goes beyond the classical, continuous level, and simultaneously enters the dynamic realm of tree-like, discontinuous structures of several levels of Reality. The net advantage of transdiciplinarity is that this approach passes through disciplinary knowledge, which makes the approaches complementary, similar to a „win-win situation".
The main methodology of the transdisciplinary research is based on *three pillars*: the levels of Reality, the logic of the

third included (and/and), complexity. Nature has a dual nature: Science and Tradition, says Nicolescu.
These two domains claim a dynamic that takes us from the Reality of a universe to the Realities of the most diverse universes, in the multi-verses.
In conclusion, as we understand it, transdisciplinarity is all the blended knowledge included in both: the real Reality and the ideal Reality.
It is not, one or another. (such as: black **or** white). It is one and the other, both, united, as One. (black **and** white). This is the principle of the third included, as Nicolescu states.
The concept of sustainable (durable) development is increasingly congruent with in all fields of human activity, as an imperative process that remind us that everything we do, think, feel, must have the attribute of being sustainable and therefore lead to durable development.
While may appear to be synonymous, the concepts of sustainable/durable development and sustainability, nevertheless have specific nuances that differentiate them.
Durable development is a *process* that involves continuous change in which the resources involved – human resources, investments, institutional changes, exploitation of resources - change themselves, being at the same time interdependent with each other, and with the political will also.
Thus, require a medium to long term process.
The concept of sustainability, states that for something to be sustainable, to have this *attribute*, one must act, behave, think, in a certain way. Sustainable is ”*to act in such a way as to meet the needs of the present without compromising the ability of future generations to meet their own needs*" [1, 2].
So, is mandatory to exists an interdependency between these concepts.
Sustainability involves actions here and now, which make sustainable development possible, in a future with a high quality of life for all. In the table below we exemplify through a model of sustainable actions that can lead, in long terms, to sustainable development (Table 1).

Table 1. 16 ways to a sustainable living

16 ways to live a sustainable life day by day	
Go paperless	**Eliminate single-use plastics**
Do not print unless absolutely necessary. Use technology, digital tools to make payments, bills, plane tickets, etc	Say NO to single-use plastic items .By 2050, unless we act sustainably, there will be more plastic in the oceans than fish.
Use natural cleaning products	**Bring Your Reusable Bags**
Cleaning products can be very harmful due to the chemical composition of the ingredients. Use ecofriendly and eco environment alternatives that contain lemon or vinegar.	More and more countries, cities have banned the use of plastic bags in shops. Buy reusable bags and use them whenever you go shopping.
Go thrift shopping buy smart	**Eat Local, Buy Local**
Avoid cheap "fast fashion", due to the materials used (polyester, microfiber, processed leather, chemical dyes), and exploitation by labor is used for their manufacture.	By acting in this way, you will be able to reduce the carbon pollution resulting from the transport of goods. You will also help support and supporting entrepreneurs and local producers.
Monitor your electronics	**Air Dry Your Laundry**
Conserve energy use with economical and fast ways, for example, charging your phone in airplane mode and shutting down your computer when you are not using it.	Let Mother Nature and the Sun air and dry your clothes. If we used dryers at least once a week, enough energy would be saved from coal or nuclear power plants.
Eat Less Meat	**Monitor Your Taps**
This has a significant effect of reducing environmental, water pollution, protecting ecosystems, the biosphere. It has a special role in creating a healthy, plant-based, vegetable-based lifestyle.	When you brush your teeth, when you shower or wash the dishes, don't let the water run and waste.Remember that in some countries of the world, children walk even 10 km/day to bring water to their homes.
Plant a Tree	**Volunteer**
Trees provide oxygen and food. It helps to save energy, to clean the air.	Get involved in volunteering in your community.
Drive Less, Bike More	**Educate yourself and others**
Reduce, Reuse, Recycle – **3R**	The more you educate yourself, the more you become aware of the positive impact of sustainability and can teach others too.
Selective collection of waste	

Source: own processing.

Therefore, sustainability refers to concrete, consistent, day-to-day actions, without whom sustainable development in the future is not possible. So the difference is between two stages: **Now& Here = sustainability** and **Now & Future = durable development.**

Furthermore, we put together the concept of the Knowledge Society to the concepts of transdisciplinarity and durable development, unitarily. As defined in National Law of Education, updated in 2022, also in the Educated Romania Project [7]. ***„The Knowledge Society*** *is a society in which* ***Knowledge*** *is the main resource, being created, shared and used to generate prosperity and well-being for its members*" [5].

Based on what we analyzed so far, we can observe that the Knowledge Society is a transdisciplinary society because involves the an isomorphism of action and conception both at the macro and microsocial levels. At the macrosocio-cultural level, the requirements stated in the given definition above, involve a somewhat difficult process, due to the profile and mentality of the dominant culture and subcultures, in competition for resources, and also due to legislative incongruities. However, we must note that the Knowledge Society is a necessity imposed by the very world in which we live.

We enlighten to our analysis a particularly important point among the 17 objectives of sustainable development, namely SDG4: Quality Education: „*to ensure inclusive and equitable quality education and promote lifelong learning opportunities to all*". [14].

SDG 4 - Quality Education, refers to that percentage of the total population enrolled in primary and secondary education, regardless of age and gender. Students over or under school entry age, due to late registration or grade repetition, are also considered. The target is 100% enrolment, regardless of age and gender. Globally, sub-Saharan Africa has the lowest percentage, 7.9%, South Asia 8.8%, the rest of the continents exceeding 9.4%, Europe and Central Asia with an average of 9.9%, North America 10 %.

As we stated, our analyze brings to attention the Quality Education indicator, mainly related to the rural areas from Romania.

Quality education is a very important indicator for increasing the quality of life, and it indicates the prospective trends in terms of the professional orientation of the generations that will join the labor market in the coming decades - Generation 2050.

Certainly at least two generations – Generation Z also known as the Zoomers, those born between 1997-2012, as well as Generation Alpha, the children born after 2010, would no longer have the same digital skills nor the same perspective and attitude towards some of the main human activities: playing, learning, working.

Fig 1. The20s: Really the best age to be?
Source: UNESCO, 2023, https://www.unesco.org/en/articles/20s-really-best-age-be, 2021, Accessed on July 20, 2023 [16].

From the statistical data provided by the National Institute of Statistics, at the national level, in 2019 a slight upward trend is observed towards *special vocational schools-secondary cycle 2*, meaning those schools that allow graduates to integrate directly into the labor market according to the qualification for which the student applied the practical test and the oral test to support the project.

In a recent draft law 2022, these special vocational schools will be integrated into the existing high schools, with the title of vocational high schools, on four profiles: *technical, services, natural resources and environmental protection*. Students can obtain, after 3 years of study, a level 3 certificate for the qualification in the chosen specialization and, if the students choose to take the full exam, grade XII, they can also obtain the Baccalaureate diploma.

Table 2. Graduate rate by education cycle

Years	2016	2017	2018	2019	2020	2021	2021/2016 %
Professional schools cycle 2	1,862	22,404	21,991	22,787	2,3491	29,953	1,608.6
Special Profesional schools cycle2	803,00	923,00	1,069	1,164	1,186	1,101	137.11
Secondary schools	29,272	28,599	27,271	29,016	30,658	27,915	96.36
Foreman schools	2,566	2,253	2,043	2,265	2,406	2,111	82.26
Special secondary schools	144,00	133,00	119,00	105,00	110,00	132,00	91.66

Source: Own processing. based on the data from INSSE, Tempo Online [13].

The advantage of professional education (and dual education where it exists) is that students are engaged, during their schooling, with a training contract, in internships in the field of future qualifications, specializations, the educational unit having signed partnership contracts with various public economic agents and private (Table. 2).

Combined with the pandemic period in which the school dropout rate increased, mainly due to the change in the educational paradigm, the current conditions and requirements, not only the educational ones, necessarily require adaptation to the new informational and technical methods. One of the purposes is to achieve the conditions - social, economic, cultural, environmental - which in the future will allow and ensure an increasing quality of life as a whole, prosperity and well-being for all.

Closely related to the low percentage recorded in the education quality index, the AROPE index is an indicator that shows the procent of the total population of people at risk of poverty or social exclusion. This social category is characterized by at least one of the following situations: a disposable income lower or on the poverty line; a severe state of material deprivation; a very low work intensity per household [3].

At the national level, according to the data from the National Strategy for Social Inclusion and Poverty Reduction 2015-2020, there are 992 marginalized rural communities - 35% of the total communes in the country - and 1,605 villages - 12% of the total villages.

On the map of poverty and social exclusion, the highest percent of the population living in marginalized rural areas, generally small, non-Roma communities, is in the North-East region, with the rural marginalization average twice as high as the average national: 11.3% compared to 6.2% nationally [17].

Also, the Center region is above the national average, with an average of 8%, the South-East has an average of 6.8, South-Mountain 4, South-West 4.5, North-West 4.4, and the region of Vest and Bucharest-Ilfov are at the opposite pole, with a marginalization rate of 1.2% and 0.6%, respectively.

In these regions, the communities are mixed – both Roma and non-Roma (Fig. 3).

Macroregion 2 and the North-East Development Region have the highest AROPE index at the national level. At the county level, Vaslui has the highest rate of marginalization in the country, with approximately 23%, which is four times higher than the national average. Rural poverty is at its highest level in the Northeast-Moldova region, where there is the largest number of villages with extreme poverty levels.

Well-being, increasing the quality of life, both in urban and rural environments, depend and are largely the result of joint efforts of the family or the community: These efforts are made not only to carry out economic activities that lead to ensuring - at least a standard of living decent, but they can also create the conditions for the manifestation of the socio-psycho-spiritual potential necessary for the harmonious development of the personality of individuals. These are prerequisites and determining factors in increasing social progress and creating conditions for increasing the quality of life.

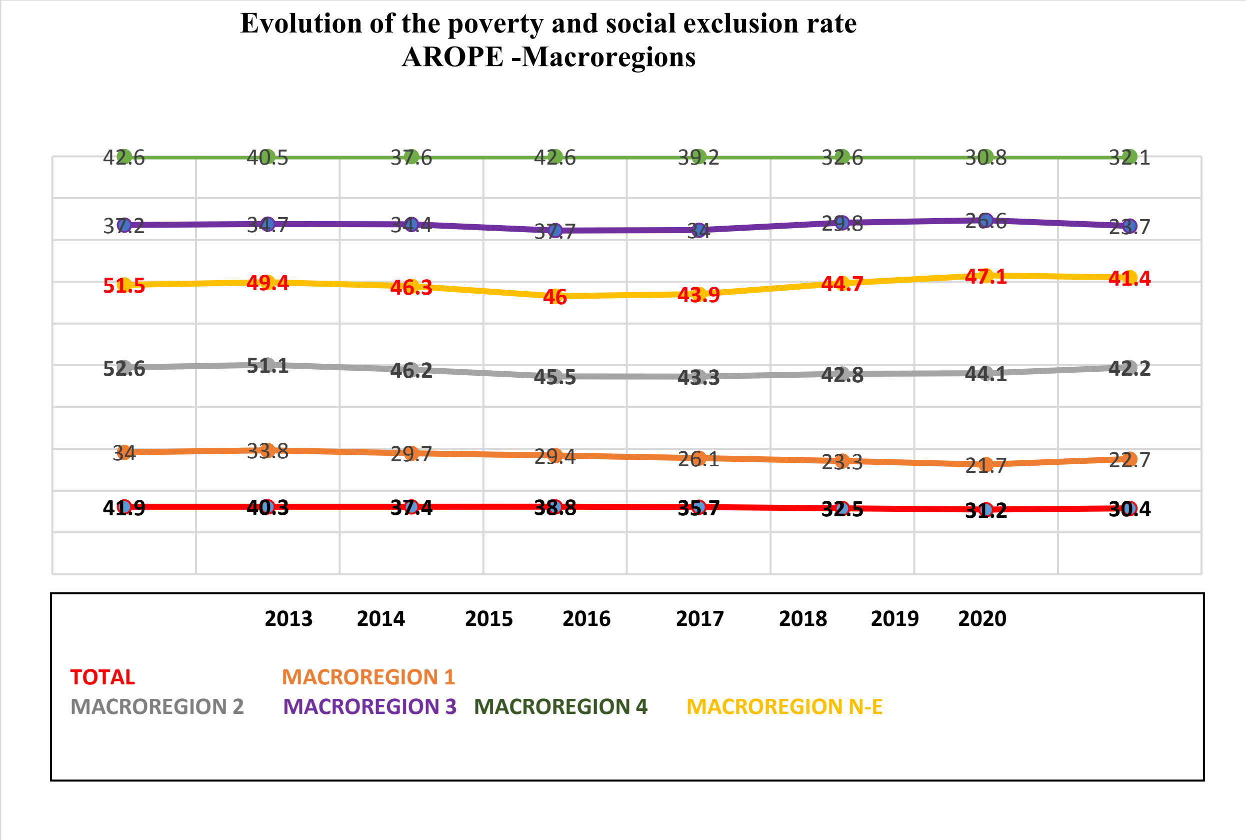

Fig. 2. Evolution of the poverty and social exclusion rate AROPE –Macroregions
Source: Own processing based on the data from INSSE, Tempo Online [13].

Romania's progress in SDGs

In an article wrote in 2019, prior to pandemic crises, the economist Professor Jeffrey D. Sachs from Columbia University, New York, launched 6 elements to a Transformation SDGs Agenda, as follows:

„ (1) education, gender and inequality;
(2) health, well-being and demography;
(3) energy decarbonization and sustainable industry;
(4) sustainable food, land, water and oceans;
(5) sustainable cities and communities; and
(6) digital revolution for sustainable development.

Each Transformation identifies priority investments and regulatory challenges, calling for actions by well-defined parts of government working with business and civil society. Transformations may therefore be operationalized within the structures of government while respecting the strong interdependencies across the 17 SDGs" [12].

The National Strategy for Romania`s 2030 Sustainable Development, underlines that for achieving SDG 4 - Quality Education – is required that all students to gain the knowledge, the skills and the abilities necessary for a longlife learning and sustainable development. [18].

The department of sustainable development of the Romanian Government, released an report, an analyses on the progress made by Romania in achieving SDG 4. In comparison to EU 28, Romania show low percent on reading and also low percent of people choosing tertiary education. An element of plus is the higher percent on the segment of preschool population, which in medium and long term could have positive effect on the equal opportunities in education.

Table 2 shows the actual progress made by Romania to achieve the SDG 4 Quality Education.

Table 3. Analysis of Romania`s progress in SDG 4

Romania						EU-28			
Basic education	Unit of measure	Year	Percent	Year	Percent	Year	Percent	Year	Percent
Persons who left earlier the educational system	% of population age between 18-24 y.o	2013	17,3	2018	16,4	2013	11,9	2018	10,6
Preschool	% of population age between 4 - 7 y.o	2012	85,5	2017	89,6	2012	94,0	2017	95,4
Low level in reading	% of 15 y.o students	2015	38,7	2018	40,8	2015	19,7	2018	21,7
young people who are not professionally employed and do not follow any educational program	% of population age between 19 -25 y.o	2013	19,6	2018	17,0	2013	15,9	2018	12,9
Tertiary education	Unit of measure	Year	Percent	Year	Percent	Year	Percent	Year	Percent
Graduates of tertiary education	% of population age between 19-29 y.o	2013	22,9	2018	24,6	2013	37,1	2018	40,7
Employment rates of new graduates	% of population age at least 16 y.o	2013	67,2	2018	77,4	2013	75,4	2018	81,7
Adult Education	Unit of measure	Year	Percent	Year	Percent	Year	Percent	Year	Percent
Adult participation in learning process	% of population age between 25-64 yers old	2013	2,0	2018	0,9	2013	10,7	2018	11,1

Source: Own processing based on the data from [11].

CONCLUSIONS

In today`s Knowledge Society the need for collaboration between experts and specialists from all fields is increasingly felt for finding solutions to the problems concerning sustainable/durable development, the quality of life, education, to name a few. In the academic and political circles around the world there is a substantial concern regarding sustainable development, and how it can be applied with beneficial, visible solutions and effects in the society. The obvious purpose is creating sustainable societies, with a decent level of quality of life. A sustainable society must concretely ensure at least a decent level of quality of life for all. This can be achieved mainly through economic growth, quality education, a performing health system, accessible and open to all, job creation, etc. In a constantly changing world, the goals and targets of sustainable development involve integrating the life perspectives of the younger generation so that the sustainable development would take place as a whole, in the future. This implies respect for human rights and gender equality, respect for the multiculturalism and promotion of culture in attitude of non-discrimination, peace, non-violence, cultural appreciation of diverse cultural backgrounds, cultivation a proactive attitude toward working culture and a positive insertion on labour market [16].

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USING IMAGE PROCESSING TO EVALUATE THE QUALITY OF ORANGE FRUITS IN A NON-DESTRUCTIVE MANNER

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Abstract

The aim of this research is to develop an image processing system that relies on machine vision to evaluate the chemical and physical properties in a non-destructive, fast and effective way to evaluate the quality of the orange fruits. Chemical and physical features such as TSS, titrated acidity, pH, TSS/T.acidity, liquid percentage, chlorophyll a, chlorophyll b, total chlorophyll and carotenoids were estimated. The results of the study showed that there is a relationship between the chemical and physical properties and the ripening of fruits. Relationships between R/G ratio range, G/R ratio, R/(R+G+B) range, NDVI1 index, VARI index, and VARI1 with some properties such as acidity, liquid percentage, pH, (TSS), TSS/ T.Acidity, chlorophyll a, chlorophyll b as well as the concentration of carotenoids at different ripening days. Correlation coefficient and multiple regression analysis were obtained by testing the correlation between (TSS), acidity, TSS/T. acidity, chlorophyll a, chlorophyll b and carotenoids, and ratios R/G ratio, R/(R+G+B), NDVI index and VARI index and VARI1 for orange fruits. The results showed that the mean of the indices of VARI, VARI1, NDVI1, and the R/G range provided a better indicator of the concentrations (TSS), acidity, TSS/T. acidity, and chlorophyll a and b for orange fruits. R/(R + G + B) ratio gave the highest regression coefficient with carotenoids (R^2=95***). while NDVI1 index gave the highest regression coefficient with chlorophyll a and chlorophyll b (R^2=91***and R^2=92***), respectively.

Key words: *image processing, orange fruits quality, RGB Index, chemical composition*

INTRODUCTION

The citrus fruit industry in Egypt is among the fastest-growing agribusiness industries in the country. Also, Egypt is one of the largest exporters in the world of some products such as oranges. citrus fruits in Egypt produced about 4.25 million tons of cultivated areas and amounted to about 0.42 million feddans in 2019/2020 (ASB, 2020) [2]. The average production of oranges in 2018 was 10.41 tons/ feddan, and increased to 10.64 tons/ feddan in 2020 (FAO, 2021) [12]. In 2020, Egypt became the first exporter of oranges in the world. The production and export of oranges increased dramatically over the past three decades. Egypt's exports also amounted to nearly 2 million tons of citrus, worth 661 million dollars (El-Khalifa et al 2022) [9].
Ahmed et al. (2011) [4] showed Orange juice is a rich source of water-soluble vitamins, ascorbic acid, and antioxidants important for our health. Citrus fruits provide a large amount of vitamin C, potassium, pectin, and folic acid, and also contain a large group of plant-based antioxidants that protect human health. Extensive studies focusing on the edible part of citrus fruits have shown that their juices and extracts possess important antioxidants because they are an important source of phenolic compounds, especially phenolic acids, and flavanones (Ramful et al 2010) [22]. Apart from the importance of orange juice color in product quality, it is important to measure the transaction accurately as it has been demonstrated that color measurements can be used to rapidly estimate carotene content for quality control purposes using some techniques (Meléndez - Martínez et al 2010) [20]**.** Orange juice is a rich source of water-soluble vitamins, ascorbic acid, and antioxidants important for

our health (Ahmed et al 2011) [4].

Wanitchang et al. (2010) [25] stated that the common destructive method for measuring the ripening and growth of dragon fruit is to analyze the total acid, pH, and total soluble solids, as well as the percentage of total soluble solids and the total weight converted into a major component, which is used to determine the individual maturity index. (Fouda et al. 2013) [13] used the Envi program to analyze orange images to help get some color properties which, there are the relations between it (VARI, R/G ratio band, and average of RGB bands indices) with carotenoids and chlorophyll a&b. this study aimed at the effect of citrus area analysis in terms of skin color and size in the RGB color model related to the ripeness, sweetness of citrus fruits. The relationship between citrus weight, body area, and fruit color was analyzed, and sweetness was measured by a refractometer. So was the Selection of size based on the image analysis results, as it was found to be related to citrus weight (Ahmad et al 2010) [3]. The study demonstrated the application of image processing to characterize the taste of oranges. The features are RGB component, color component ratio R/G and R/B. The results show that image processing can be used to classify the taste of oranges (Adelkhani et al 2013) [1].

According to colour vision systems are more useful for colour inspection. Red, green, and blue (RGB) components of an image can be represented by decoding a colour camera output into three images. Intensity, saturation, and hue images can be created by recombining the three elements of a colour image in hardware or software, which may make further processing easier (Ismail and Razali 2012) [16]. the vegetation index was correlated with the difference The natural (red–blue)/(red + blue) chlorophyll b, TSS content, titrated acidity and carotenoids, with R^2 values of 0.57, 0.57, 0.59 and 0.53, respectively. Our data showed that the newly developed index (NDVI-VARI)/(NDVI-VARI) showed highly significant and close correlations with chlorophyll, chlorophyll a and chlorophyll t readings, where R^2 = 0.78, 0.71 and 0.71, respectively (Elsayed et al 2016) [11]. Fouda et al 2017 [14] showed that the ENVI software package was used to analyze orange fruit images. The results showed significant correlations with some chemical and color indicators. The results obtained in this study show that the R/G ratio indices contribute to the understanding of total soluble solids and anthocyanins. Kaur et al (2018) [17] proposed a system based on the use of image processing techniques to identify the different ripening stages of the plum cultivar. The results showed that the RGB indicators of the fruit images were related to the chemical properties. It showed a strong correlation between the average intensity of green color and fruit acidity (R^2 = 0.9966). Also, the large variance in TSS was explained by the variance in the R/G ratio (R^2 = 0.8464). showed the development of many vegetation indices. The NDVI index was found to be the most studied and commonly used. Other indicators have been developed that use RGB data such as the Visible Atmosphere Resistance Index (VARI) (Costa et al 2020) [8].

The aim of this research is to use an image processing method to estimate the characteristics of oranges in a non-destructive and easy way including TSS, ph, titrated acidity, ripeness index TSS/T, chlorophyll a and b, carotenoids and the liquid percentage. The research is to detect the quality of navel oranges at different stages of ripeness using image indicators (RGB).

MATERIALS AND METHODS

This research was conducted in the laboratory of the Faculty of Agriculture, Tanta University. Navel oranges were randomly selected at different growth stages. The experiment was conducted in 2021 to predict the quality of Navel orange fruits by estimating chemical properties using image processing during different growth stages (Photo 1).

A Navel orange sample was selected from a private farm in Gharbia Governorate at different growth stages. The fruits were picked by hand and at random. Fruit samples were numbered one by one.

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Computer vision system

The system consists of a photographic box with a black, non-reflective fabric attached to a 20-megapixel digital camera. The camera was installed at a height of 25 cm from the bottom of the shooting box. The position of the two light sources has been adjusted to provide uniform light intensity. The photos were taken to capture shadow-free fruit images. After the images were taken, they were stored on a personal computer for analysis. Capture Cards (WINFAST DV2000, 320H X 240V). A personal computer was used to analyze the images.

Image	Color
	Dark Green
	yellowish green
	Orange

Photo 1. Orange images at different maturity stages
Source: designed by authors.

ENVI program: ENVI (Environment for Visualization Image) is the ideal software for the visualization, analysis, and presentation of all types of digital images. There are many ENVI handlers available, covering almost all the functionality available in ENVI interactive programs. Each processing routine is an IDL procedure or function and is used like any other IDL routine. A full index of these functions and a full reference page for each function can be found in the ENVI Reference Guide (available from ENVI Help)**.**The image processing steps up to an average value with three different RGB bands and image indices are shown in Fig. 1.

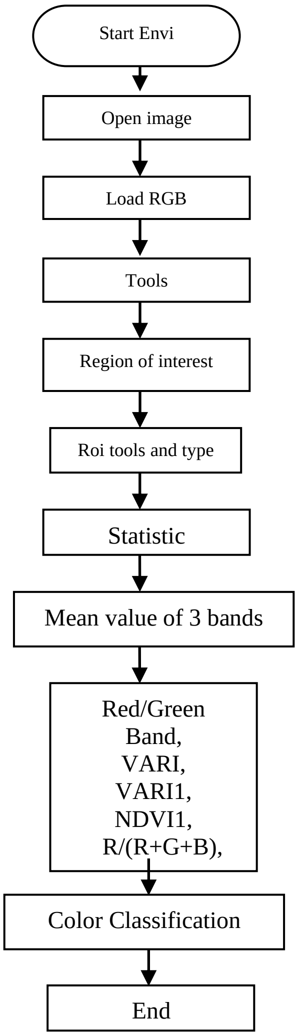

Fig. 1. Image processing steps until an average value with three different bands (RGB) and image indices.
Source: designed by authors.

Measurements

-The TSS: was estimated by reading a single digital refractometer taken from juice extracted from Orange fruits.

-Titrated acidity: The titrated acidity of Orange fruit juices was determined as a percentage of anhydrous citric acid by titrating a given volume of known juice with 0.1 N standard NaOH using 1% phenolphthalein as an indicator according to A.O.A.C. (1990) [5].

-Maturity index (TSS /TA): TSS/ TA ratio was calculated from the soluble solid content values divided by the total acids values.

- **The pH** value was measured by using a pH meter.

-spectrophotometer: it was used for measuring the absorption at wavelengths 480, 645, and 663 nm chlorophyll a (chl,a), chlorophyll b (chl,b), and carotenoids (car.) content of crude extracts in different plants were determined following the method of (Arnon, 1949) [6]**.**

$$\text{Chlorophyll a mg/g} = 12.7(A663) - 2.69(A645) \times \frac{V}{1{,}000 \times W}$$

$$\text{Chlorophyll b mg/g} = 22.9(A645) - 4.68(A663) \times \frac{V}{1{,}000 \times W}$$

$$\text{Chlorophyll t mg/g} = 20.2(A645) + 8.02 (A663) \times \frac{V}{1{,}000 \times W}$$

$$\text{Total carotenoids(mg/g)} = [\boldsymbol{A}_{480} + (0.114 \times \boldsymbol{A}663) - (0.638 - A645)] \times \frac{V}{1{,}000} \times W$$

where:
A = absorbance at specific wavelengths.
V = final volume of chlorophyll extract.
W = fresh weigh of tissue extracted.

Calculations of image indices

Table 1. Various image indices have been studied and compared in this work using equations

Index abbreviation	Formulae	References
VARI	(Green − Red)/(Green + Red − Blue)	Gitelson et al. (2003) [15]
VARI1	(Green−VARI)/(Green +VARI + Blue)	Elsayed et al. (2016) [11]
NDVI1	(Red − Blue)/(Red + Blue)	Kawashima and Nakatani (1998) [18]
RGRI	R/G	Elmetwalli and Salah (2015) [10]
Nomalized Red (Rn)	R/(R + G + B)	Kumaseh et al (2013) [19]
GRRI	G/R	Aynalem et al. (2006) [7]

Source: [7, 10, 11, 15, 18, 19].

RESULTS AND DISCUSSIONS

Relation between Total Soluble solids (TSS) and image indices

The Total soluble solids (TSS) content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the Total soluble solids content is low, and it increases with increase the maturity of the fruit (orange), therefore the Total soluble solids affected the image analysis collected from fruits. The correlation coefficient for the association between different band ratio indices and the measured (TSS) of Navel orange fruit is shown in Figure 2.

At various growth stages, most of the tested image analyses were remarkably significantly correlated with the measured (TSS). GRRI and Rn have the highest significant correlations for predicting the (TSS) concentration of Navel orange fruit. Overall various tested image indices, VARI, VARI1 and NDVI1 were also shown as the optimum indices for predicting (TSS) with a high determination coefficient of 0.90.

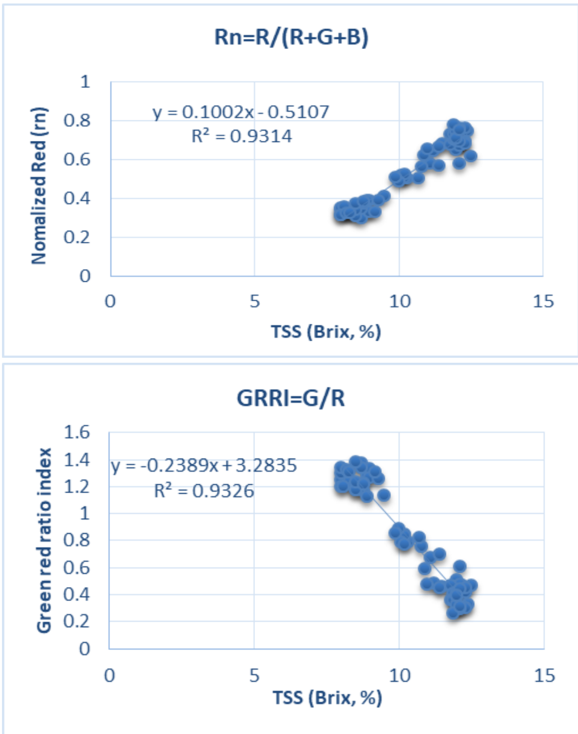

Fig. 2. Relation between Total Soluble solids (TSS) and image indices
Source: Own research results.

Figure 2 shows the relationship between GRRI and Rn and the (TSS) content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between both indices and the (TSS) content of orange fruits (R^2 = 0.93). Kaur et al (2018) [17] found that the

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large variance in TSS was explained by the variance in the R/G ratio (R^2 = 0.8464). Elsayed et al (2016) [11]found that the vegetation index was also correlated with the difference The natural (red–blue)/(red + blue) TSS content, R^2 values of 0.57.

Relation between Titrated acidity (T. acidity) and image indices

The Titrated acidity (T.acidity) content of Navel orange fruit is linked to the fruit growth stage.

At the first growth stage (green fruit), the Titrated acidity content is high, and it decreases with increase the maturity of the fruit (orange), therefore the Titrated acidity affected the image analysis collected from fruits.

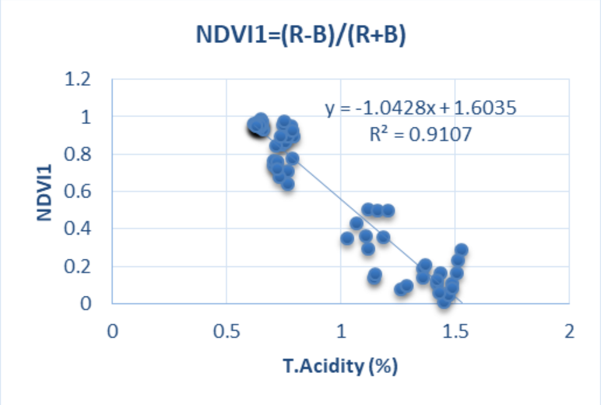
The correlation coefficient for the association between different band ratio indices and the measured (T.acidity) of Navel orange fruit is shown in Figure 3.

At different growth stages, most of the tested image analyses were remarkably significantly correlated with the measured (T.acidity). NDVI1and VARI1 have the highest significant correlations for predicting the (T.acidity) concentration of Navel orange fruit.

Overall various tested image indices, VARI, Rn and GRRI were also shown as the optimum indices for predicting (T.acidity) with a high determination coefficient of 0.80.

Figure 3 shows the relationship between GRRI and Rn and the (T.acidity) content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between NDVI1and VARI1 indices and the Titrated acidity (T.acidity) content of orange fruits (R^2 = 0.91), (R^2 =0.86), respectively.

Kaur et al (2018) [17] showed a strong correlation between the average intensity of green color and fruit acidity (R^2 = 0.9966). Elsayed et al (2016) [11] found that the vegetation index was also correlated with the difference The natural (red–blue)/(red + blue) titrated acidity, R^2 values of 0.59.



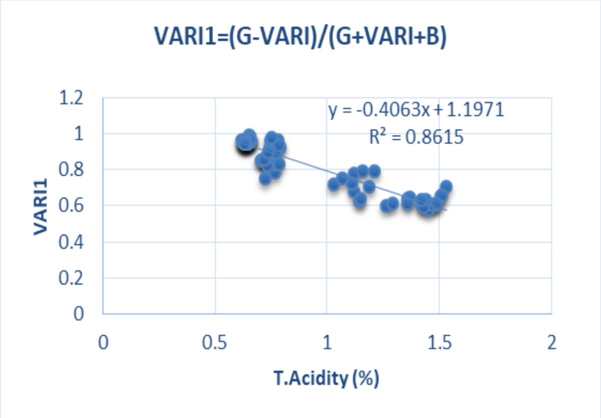


Fig. 3. Relation between Titrated acidity (T.acidity) and image indices
Source: Own research results.

Relation between Chlorophyll a (Chl, a) and image indices

The Chlorophyll a (Chl, a) content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the (Chl, a) content is high, and it decreases with increase the maturity of the fruit (orange), therefore the (Chl, a) affected the image analysis collected from fruits. The correlation coefficient for the association between different band ratio indices and the measured (Chl, a) of Navel orange fruit is shown in Figure 4.

At different growth stages, most of the tested image analyses were remarkably significantly correlated with the measured (Chl, a). NDVI1and GRRI have the highest significant correlations for predicting the (Chl, a) concentration of Navel orange fruit. Overall various tested image indices, VARI, Rn, RGRI and NDVI were also shown as the optimum indices for predicting (Chl, a) with a high determination coefficient of (R^2 =0.85). Figure 4 shows the relationship between GRRI and Rn and the (Chl, a) content of

Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between NDVI1and GRRI indices and the (Chl, a) content of orange fruits (R^2= 0.91), (R2=0.88), respectively. Rasool et al (2022) [23] found that the image index (VARI) and (GRVI) showed the highest coefficients of determination for the fruit chlorophyll a of (R^2=0.85 and R^2=0.86), respectively. Elsayed et al (2016) [11] Our data showed that the newly developed index (NDVI-VARI)/(NDVI-VARI) showed highly significant and close correlations with chlorophyll a, where (R^2= 0.71).

from fruits. The correlation coefficient for the association between different band ratio indices and the measured Chlorophyll b (Chl, b) of Navel orange fruit is shown in Figure 5. At different growth stages, most of the tested image analyses were remarkably significantly correlated with the measured Chlorophyll b (Chl, b). NDVI1and RGRI have the highest significant correlations for predicting the Chlorophyll b (Chl, b) concentration of Navel orange fruit. Overall various tested image indices, VARI, Rn, GRRI and NDVI were also shown as the optimum indices for predicting Chlorophyll b (Chl, b) with a high determination coefficient of (R^2=0.85).

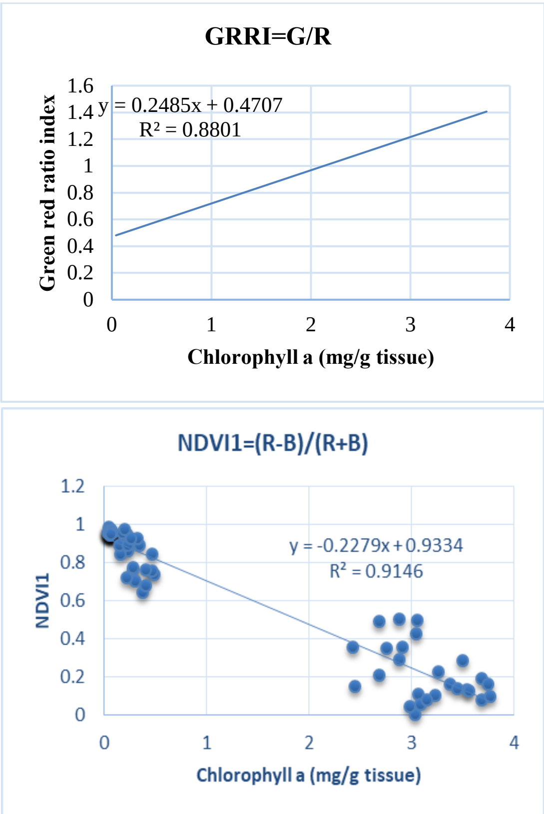


Fig. 4. Relation between Chlorophyll a (Chl, a) and image indices
Source: Own research results.

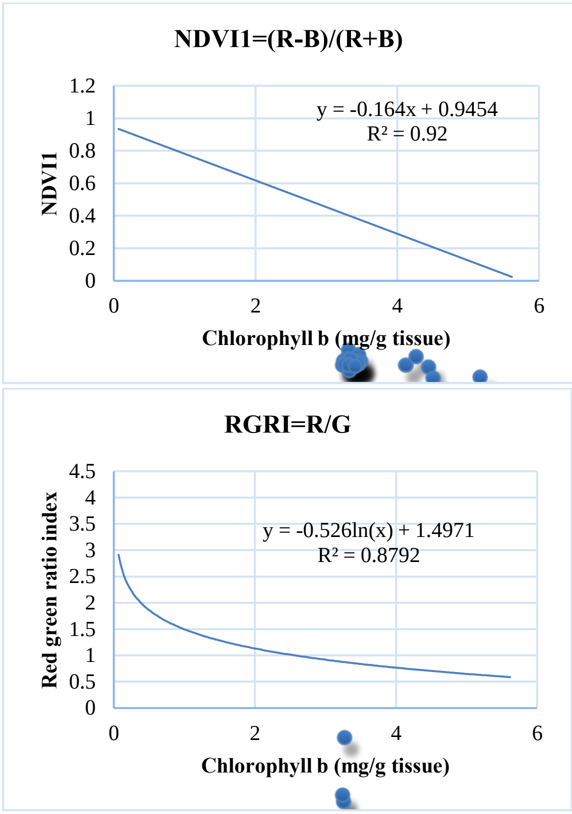


Fig. 5. Relation between Chlorophyll b (Chl, b) and image indices
Source: Own research results.

Relation between Chlorophyll b (Chl, b) and image indices

The Chlorophyll b (Chl, b) content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the Chlorophyll b (Chl, b) content is high, and it decreases with increase the maturity of the fruit (orange), therefore the Chlorophyll b (Chl, b) affected the image analysis collected

Figure 5 shows the relationship between GRRI and Rn and the Chlorophyll b (Chl, b) content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between NDVI1and RGRI indices and the Chlorophyll b (Chl, b) content of orange fruits (R^2= 0.92), (R^2=0.87), respectively. Rasool et al (2022) [23] found that the image index

(VARI) and (GRVI) showed the highest coefficients of determination for the fruit chlorophyll a of (R^2=0.85 and R^2=0.86), respectively. Elsayed et al (2016) [11] found that the vegetation index was also correlated with the difference The natural (red–blue)/(red + blue) chlorophyll b, R^2 values of 0.57.

Relation between Carotenoids (Car) and image indices

The Carotenoids (Car) content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the Carotenoids (Car) content is low, and it increases with increase the maturity of the fruit (orange), therefore the Carotenoids (Car) affected the image analysis collected from fruits.

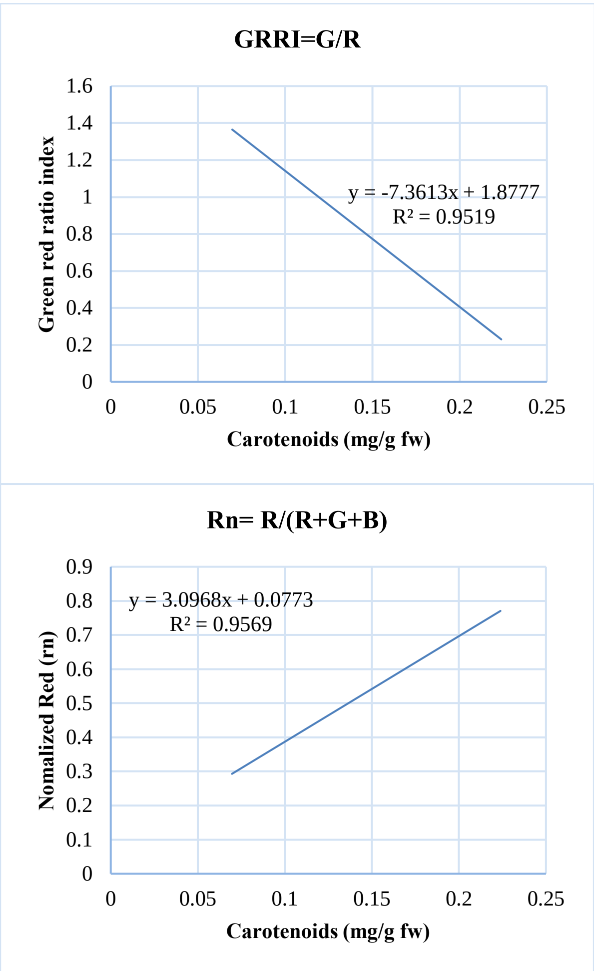


Fig. 6. Relation between Carotenoids (Car) and image indices
Source: Own research results.

The correlation coefficient for the association between different band ratio indices and the measured Carotenoids (Car) of Navel orange fruit is shown in Figure 6.

At various growth stages, most of the tested image analyses were remarkably significantly correlated with the measured Carotenoids (Car). GRRI and Rn have the highest significant correlations for predicting the Carotenoids (Car) concentration of Navel orange fruit. Overall various tested image indices, VARI, VARI1 and NDVI1 were also shown as the optimum indices for predicting Carotenoids (Car) with a high determination coefficient of (R^2= 0.90).

Figure 6 shows the relationship between GRRI and Rn and the Carotenoids (Car) content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between both indices and the Carotenoids (Car) content of orange fruits (R^2= 0.95). Elsayed et al (2016) [11] found that the vegetation index was also correlated with the difference The natural (red–blue)/(red + blue) carotenoids, R^2 values of 0.53.

Relation between liquid percentage and image indices

The liquid percentage content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the liquid percentage content is low, and it increases with increase the maturity of the fruit (orange), therefore the liquid percentage affected the image analysis collected from fruits. The correlation coefficient for the association between different band ratio indices and the measured liquid percentage of Navel orange fruit is shown in Figure 7.

At various growth stages, most of the tested image analyses were remarkably significantly correlated with the measured liquid percentage. GRRI and Rn have the highest significant correlations for predicting the liquid percentage concentration of Navel orange fruit. Overall various tested image indices, VARI, VARI1, RGRI and NDVI1 were also shown as the optimum indices for predicting liquid percentage with a high determination coefficient of (R^2=0.70).

Figure 7 shows the relationship between GRRI and Rn and the liquid percentage content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between GRRI and Rn indices and the liquid percentage content of orange fruits (R^2= 0.75), (R^2=0.77), respectively. Salah et al. (2022) [24] Juice content of orange fruit should depend on R672/R550 which produced the highest correlations (R^2 = 0.91).

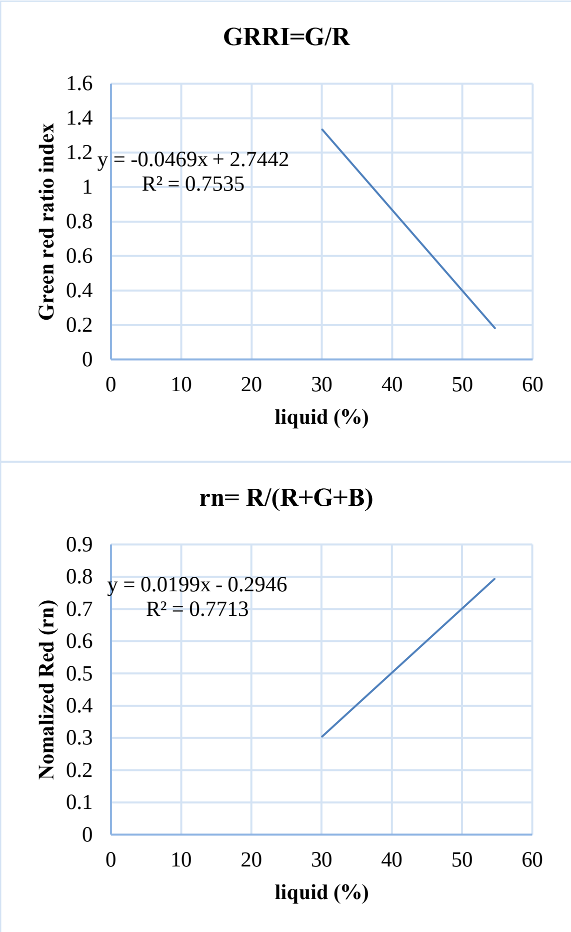


Fig. 7. Relation between liquid percentage and image indices
Source: Own research results.

Relation between Maturity index (TSS /TA) and image indices

The Maturity index (TSS /TA) content of Navel orange fruit is linked to the fruit growth stage. At the first growth stage (green fruit), the Maturity index (TSS /TA) content is low, and it increases with increase the maturity of the fruit (orange), therefore the Maturity index (TSS /TA) affected the image analysis collected from fruits. The correlation coefficient for the association between different band ratio indices and the measured Maturity index (TSS /TA) of Navel orange fruit is shown in Figure 8.

At various growth stages, most of the tested image analyses were remarkably significantly correlated with the measured Maturity index (TSS /TA). GRRI and Rn have the highest significant correlations for predicting the Maturity index (TSS /TA) concentration of Navel orange fruit. Overall various tested image indices, VARI, VARI1, RGRI and NDVI1 were also shown as the optimum indices for predicting Maturity index (TSS /TA) with a high determination coefficient of (R^2=0.90).

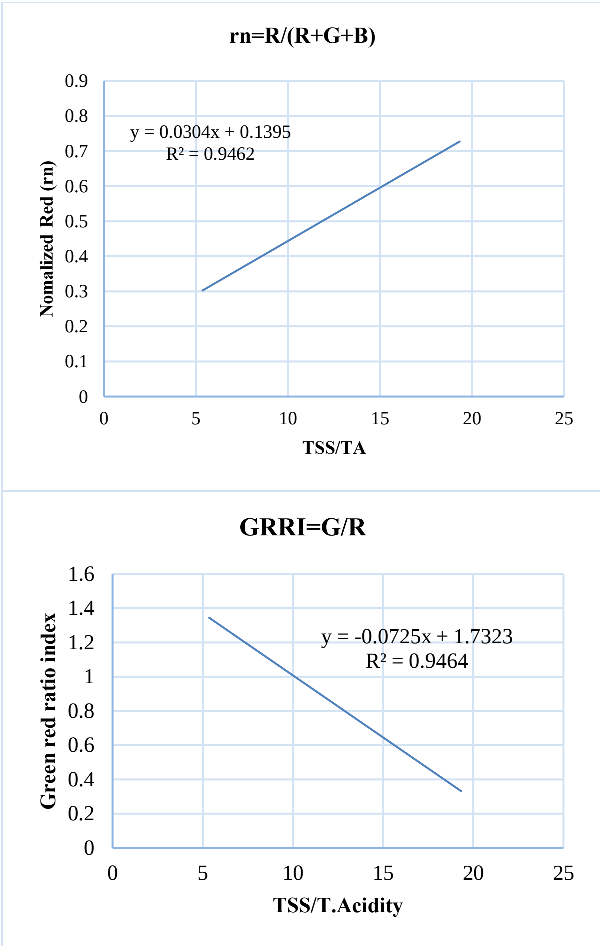


Fig. 8. Relation between Maturity index (TSS /TA) and image indices
Source: Own research results.

Figure 8 shows the relationship between GRRI and Rn and the Maturity index (TSS /TA) content of Navel orange fruit at various growth stages. It is obvious from the graphs that there are strong significant correlations between both indices and the Maturity index (TSS /TA) content of orange fruits (R^2 =

0.94). Pires et al. (2022) [21] found that the non-destructive assessment of the maturity of Citrus based on a prediction of internal quality characteristics (IQA). Which gave a good predictive performance for maturity index (MI) (R^2 = 0.80; RMSEP = 1.38; SDR = 2.2). Salah et al. (2022) [24] maturity index of orange fruit should depend on R672/R550 which produced the highest correlations (R^2 = 0.96).

CONCLUSIONS

An image processing technique was found to be an appropriate and accurate method for evaluating the quality of orange fruits. Relationships between the range of R/G ratio, G/R, Rn, VARI, VARI1, NDVI1 index with TSS, titrated acidity, chlorophyll a and b, carotenoids, liquid percentage, and maturity index (TSS/TA) were determined. Multiple regression analysis and correlation coefficient tested the association between TSS, titrated acidity, chlorophyll a and b, carotenoids, liquid percentage, Maturity index (TSS /TA) and various range ratios including G/R ratio and Rn to determine the optimal index sensitivity of fruit quality. The results showed that the range of R/G ratio, G/R, Rn, VARI, VARI1 and NDVI1 index provided a better index for the concentrations of TSS, titrated acidity, chlorophyll a and b, carotenoids, liquid percentage and Maturity index (TSS /TA).

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ECOTOURISM AND SUSTAINABLE RURAL DEVELOPMENT: THE CASE OF YOZGAT, TURKEY

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Abstract

This paper focuses on examining how ecotourism can help rural development. Eco-tourism is an important type of tourism that provides economic and social benefits to the local community by exhibiting rural life, culture, and nature in rural areas. The study was conducted in Yozgat province of Turkey using primary and secondary data. In this context, interviews were had with the authorities of the Culture and Tourism Provincial Directorate, Yozgat Culture, Tourism and Development Association, and local administrations, plus it was observed in the field. Published publications and scientific studies on the subject were also used as secondary sources. According to the research findings, ecotourism was considered an effective and important model for the sustainable development of local communities. In the study, the eco-tourism potential of the province, strengths (S), weaknesses (W), opportunities (O), and threats (T) were revealed by SWOT analysis. Opportunities and strengths were considered significant for sustainable ecotourism potential. Focusing on local tourism and rural development as a leverage point, this paper puts forward proposals on management strategies and offers a different viewpoint on the need for rural innovation.

Key words: *ecotourism, rural development, swot analysis, Turkey*

INTRODUCTION

Rural development studies are extremely important in achieving national development goals. It is important to activate local dynamics in rural development. In recent years, ecotourism places, one of the local dynamics, have been rapidly brought into tourism. Thus, it is contributed to rural development without the need for large investments. At this point, ecotourism is considered a type of tourism that is based on the sustainability of natural resources on earth, helps the economic development of the local community, and protects and observes their social and cultural integrity [26]. Ecotourism is unique tourism nature-based [17].

Depending on the changing living conditions, the tourism tendencies of individuals also change. Today, instead of traditional tourism understandings, visits to calmer, natural and original places are preferred. In other words, tourists have started to prefer natural and rural areas, in short, activities where they can be intertwined with nature instead of sea-sand-sun tourism [18]; [4]. Thus, social mobility has increased, local entrepreneurship has developed, and great cultural changes have occurred in rural areas. In this context, ecotourism provides an ideal platform for the conservation of nature and the development of rural communities [19]; [5]; [27].

Ecotourism has become a rapidly growing sector in the world tourism industry. It is seen as a potential solution for social, cultural and economic development, especially in developing countries [8]; [2]. For developing a sustainable management of ecotourism sites a public-private partnership is required [28]. For rural development and hence economic development targets, places suitable for ecotourism should be considered and brought into tourism. Thus, in this study also, the ecotourism potential in Yozgat, which has a high rural character, was investigated and its relationship with rural development was analyzed and commented on.

Yozgat province, which is one of the oldest settlements in Turkey has very suitable potential for ecotourism due to its large rural and natural fields, and rich forests. Although there have been some scientific studies on tourism in the province, no studies on ecotourism and rural development have been met. For this reason, this study has an original feature.

The study consists of four parts, including the introduction. General information about the subject is presented in the introduction part of the study. The material and method used in the study are explained in the second part of the study. In the third chapter, which has findings and discussions, ecotourism activities and their relationship with rural development are examined in depth in Yozgat province. In the fourth and last part of the study also, a series of measures and suggestions are listed on management policies for the progress of ecotourism in Yozgat province.

MATERIALS AND METHODS

In this study, both primary data and secondary data were used. In the study, first of all, a wide literature review was conducted on the determination of suitable places for ecotourism in Yozgat province. Along with the literature review, by making use of the opinions of the Culture and Tourism Provincial Directorate and the Yozgat Culture, Tourism and Development Association, places suitable for ecotourism were determined in Yozgat. Thus, Akdağmadeni, Aydıncık, Çayıralan, Çekerek, Kadışehri, Merkez, and Sarıkaya districts were chosen as the research area. In the research, the qualitative research method was applied. In this context, interviews were had with the authorities of the Culture and Tourism Provincial Directorate, Yozgat Culture, Tourism and Development Association, and local administrations. Information aimed at the interview was carried out in the form of taking notes. In order for supporting information and findings obtained from interviews, it was observed in the field. In the study, images of ecotourism activities were also used to document in terms of promotion. This information and findings obtained constituted the primary data of the study.

The interview method, which was used as the primary data collection means in the study, is a qualitative research method, the basis of which is based on verbal and visual communication, and is shaped by the answers of the viewed person within a conversation and dialogue [25]; [1]. The qualitative research method is considered a method in which qualitative data collection methods such as the interview, observation and focus group are used, and data are collected, analyzed, and interpreted according to the statements of individuals [3]; [22]. With this method, it became possible for creating a direct interview environment with target organizations. In interviews with target organizations, interviews were had on the issues of suitable places for ecotourism throughout the province, types of ecotourism, ecotourism investments, the importance of ecotourism and why it is needed, the contribution of ecotourism to rural development, ecotourism and environment interaction, biodiversity in ecotourism areas, future of ecotourism, policies proposed on the improvement of ecotourism, and opportunities, strengths, threats, and weaknesses, etc. aimed at ecotourism. The information obtained from the interview and observation was analyzed as content, and the ecotourism potential in the region, its relationship with rural development, andecotourism management strategies were considered separately.

In this study, in addition to primary data, secondary data were also used. Published books, journals, papers, and institutional reports on the subject formed the secondary data of the study. With the analysis of primary and secondary data, the goal of the paper was achieved.

RESULTS AND DISCUSSIONS

Ecotourism activities in Yozgat province

Yozgat province hosts all types of ecotourism with its wide natural and rural areas and perfect geography. Especially in recent years, due to the changes in people's tourism preferences, the low cost of ecotourism, and the efforts to promote ecotourism, it has been observed that there has been a distinct increase in the number of ecotourists visiting

Yozgat. In 2015, a total of 56,516 ecotourists, 423 of which were foreign and 56,093 of which were local, visited Yozgat. In 2018, 1,212 foreign and 182,558 local ecotourists visited Yozgat, and the total number of tourists visiting Yozgat was 183,770 [10].

In this study, places suitable for ecotourism in Yozgat province and ecotourism-based tourism activities were determined and presented below. In the study, ecotourism activities were also supported with visuals in that for promotion.

Canoeing/Rafting (Stream Tourism)

Rafting tourism is a type of tourism that gives ecotourists extraordinary excitement and experience. Rafting is a tourism and sporting activity with a definite starting and ending point, and which is usually performed by using a boat and shovel on the river surface. Features such as flow rate, route and rocky condition of the stream are important for rafting.

Canoeing tourism, on the other hand, is a type of tourism that requires a struggle with time on streams similarly to rafting, enables reaching the goal with paddles that can be used at both ends and is also made as an olympiad sport. Canoeing is an activity that requires a high level of experimentation with natural or artificial obstacles in high-flow streams for sports or entertainment purposes. Canoeing trails generally have lengths varying between 500-1,000 meters. Canoe/rafting ecotourism can easily accord with activities such as camp/caravan, trekking/hiking, and cycling [12].

In Photo 1, the Çekerek River Rafting Area, which is a suitable place for canoe/rafting tourism, was given. A suitable flow rate can be obtained with the water released from the Çekerek Dam for rafting/canoeing.

Thus, a rafting area was built in the Çekerek district. Rafting area is 850 meters long and 10 meters wide and has social opportunities such as a rafting racing circuit, bungalow houses, sports and fitness areas, camping areas, caravan park areas, children's playgrounds, an amphitheater, and a cafeteria. There is also a lavender garden of 5,000 square meters in the racing circuit area.

Photo 1. Rafting Area (Cekerek district)
Source: [12].

Trekking/Hiking (Nature Walk Tourism)

Trekking/hiking is a type of ecotourism based on a nature walk that is carried out in open areas and allows tourists to interact with the environment. Nature walks are a tourism activity that people usually engaged in alone or in groups in rural and natural areas. Nature walks are a type of activity most preferred by almost all age groups. In the study, the areas/places where trekking/hiking activities can be carried out in Yozgat were determined, and given in Table 1.

Table 1. Suitable areas for trekking / hiking in Yozgat province

Districts	Trekking/hiking areas
Akdağmadeni	Akdagmadeni Forests
Akdağmadeni	Yukariçulhali Village
Akdağmadeni	Asagiçulhali Village
Akdağmadeni	Bascatak Village
Akdağmadeni	Davulbaz Village
Akdağmadeni	Çerçialanı Village
Akdağmadeni	Veziralani Village
Akdağmadeni	Ortakoy Eğriağız Downland
Aydıncık	Aydıncık Forests
Aydıncık	Kazankaya Canyon
Aydıncık	Dereçiftlik Village
Aydıncık	Sebek Plateau
Aydıncık	Uzuncayir Downlands
Çayıralan	Çayıralan Forests
Çayıralan	Yahyasaray Dam and Village
Çayıralan	Sobeçimen Village
Çayıralan	Avşaralani Village
Çayıralan	Guzelyayla Village
Çekerek	Pulling Forests
Çekerek	Bazlambac Town
Çekerek	Pulling Dam
Center town	Yozgat Piny National Park and Fatih Nature Park

Source: Research results; [12].

In addition to being a nature-based activity, nature walks have many advantages such as gaining an adventure experience, allowing for cultural interaction of the local community with tourists, and educational.

In Photo 2a, trekking/hiking tourism was given in Yozgat Piny National Park.

Photo 2a. Trekking/Hiking Tourism (Yozgat Piny National Park-Center town)
Source: [20].

Kazankaya Canyon, which is one of the most beautiful places for trekking / hiking in Yozgat province, is situated 10 kilometers from the Aydıncık district. From the Aydıncık district to İncesu village of Çorum, Kazankaya Canyon has an area of 12 km. Kanyo's historical and natural beauties are tried to be kept alive without being destroyed. Thousands of tourists visit Kazankaya Canyon every year due to the fact that the region is brought into tourism. The joint efforts of Yozgat Governorship, Aydıncık Municipality, and Central Anatolian Development Agency have been effective in opening Kazankaya Canyon in tourism.

The Canyon, which has a rich content in terms of flora and fauna, has walking areas, a climbing racing circuit, an observation hill, watchtowers, and accommodation places.

The Canyon, which is also named a hidden paradise, has been the visiting point of many local and foreign tourists.

In the research, it was determined that Kazankaya Canyon provides opportunities for many ecotourism activities such as first of all camp/caravan and trekking/hiking, flora and fauna watching, and bird watching. The image of the Canyon was given in Photo 2b.

Photo 2b. Trekking/Hiking Area (Kazankaya Canyon-Aydincik district)
Source: [29].

Camping/Caravan Tourism

One of the ecotourism activities that have become popular in recent years is camping/caravan tourism. Camping/caravan tourism is also nature-based, and economic. It has been much more popular due to the changes in the holiday habits of tourists. Camping/caravan tourism is a tourism activity that ecotourists perform with caravans or tents in nature [20].

Areas where camping/caravan tourism can be conducted are; meadows and pastures, forests, heathland, sea or lake sides, and low noisy environments.

The forest areas, downlands, dams, ponds, streams, canyons, and valleys in the Center town, and Akdağmadeni, Çayıralan, Çekerek, and Aydıncık districts are quite suitable areas for camping/caravan tourism as determined in this research.

There are nearly 30 camping/caravan tourism centers throughout the province. In Photo 3, Davulbaztepe Nature Park Camping/Caravan Tourism Area was given.

Photo 3. Camp Tourism Area (Davulbaztepe Nature Park-Center town)
Source: [30].

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Flora versus Fauna Watching

Flora is a concept that contains the entire plant existence in a particular region ecologically. Fauna expresses all animal species in an ecologically limited region. When wildlife observation is related to plants, it is called flora observation, and when it is related to animals, it is called fauna observation. Flora and fauna observation is currently carried out as a tourism activity in the research area.

In order for a region to be suitable for flora observation, it has to get rich with respect to plant diversity and endemic plant species have to exist. At this juncture, the research region is rich in flora, and it hosts 1,526 plant species. 244 of them are endemic and 8 of them are in the local endemic group. As for the fauna observation in the research area, it was determined that large forest areas, especially in the northern and eastern regions of the province, constitute the habitat of many wildlife species. There are 50 species of mammals in the provincial fauna. In Photo 4a and 4b, images of flora and fauna were given.

Photo 4a. Flora Whatching (Cehirlik Tulipa-Center town)
Source: Research archive.

Photo 4b. Fauna Watching (Center town).
Source: [20].

Bird Watching

Bird observation is the activity of observing the natural habitat environments of birds. Bird watching is a tourism activity that is generally preferred by ecotourists with high education and income. Bird observation is the activity of observing the natural habitat environments of birds. Bird watching is a tourism activity that is generally preferred by ecotourists with high education and income. For this reason, bird observation is important in terms of contributing to the regional economy. The fact that bird watching has a very low effect on environmental destruction shows that it is protectionism tourism. It is considered the most significant tourism based on nature.

Suitable areas for bird watching are generally watery areas, steppe lands, and open areas. Clear and flat places in forested areas are also suitable for bird observation.

Since Yozgat province is located within the Kızılırmak and Yeşilırmak basins, there are many watery areas. In the northern and eastern parts of it, the richness of forest and vegetation, and the presence of many dams and ponds have created a suitable ambiance for bird watching (Photo 5).

Photo 5. Bird Watching Center town)
Source: Research archive.

Farm Tourism

The concept of farm tourism has emerged as a consequence of the formation of the desire to walk away from urban life and stressful environments and the longing for natural life in people. The main purpose of ecotourists performing farm tourism is to walk away from urban life city life for a while, see the farm life, and rest. As farm tourism can consist of areas assigned only for farm tourism, it can be in the form that individuals open to farm tourism the areas where they live in villages or farms.

In this context, suitable areas for farm tourism in the research region are; Kabalı Integrated Orchard of Kadışehri and Lavender Island of Çekerek. Agricultural products such as dwarf apple, cherry, peach-nectarine, quince, strawberry, goose, sheep, and beekeeping are cultivated in Kabalı Integrated Orchard, which is one of the largest orchards in Turkey. The cherry garden in the Integrated Orchard is the third largest in Europe. In Photo 6, the image of Kabalı Integrated Orchard was given.

Photo 6. Farm Tourism (Kabalı Integrated Orchard-Kadışehri district)
Source: [31].

Downland Tourism

Downland tourism is a type of tourism that is among the transhumance culture and traditions of Anatolia and that gives people longing for natural life the chance to league together with nature and experience different cultural experiences. Downland tourism presents people both with fun, rest, and relief opportunities in a natural environment, and high-quality landscapes.

In the study, downlands in Yozgat province were determined and given in Table 2.

Table 2. Downland tourism in Yozgat province

Districts	Downlands
Aydıncık	Şebek Downland
Aydıncık	Uzunçayır Downland
Akdağmadeni	Şirin Downland
Akdağmadeni	Nalbant Downland
Akdağmadeni	Eğriağız Downland
Çayıralan	Sırıklı Downland
Çayıralan	Tahtalı Downland
Çayıralan	Konuklar Downland
Çekerek	Özükavak Downland
Çekerek	Çayırözü Downland
Sarıkaya	Hisarbey Downland

Source: Research results; [12].

Photo 7 shows Hisarbey Downland in the Sarıkaya district.

Photo 7. Downland Tourism (Hisarbey Downland-Sarıkaya district)
Source: Research archive.

Forest Therapy Tourism

Forest therapy tourism expresses to capitalize on forest resources to improve health and soul.

It is a tourism activity that ecotourists consider alternatively to be able to reduce the negative effects of a stressful life.

Forested areas are in Akdağmadeni, Aydıncık, Çayıralan, Çekerek, and Kadışehri districts. It was determined that forested areas in Akdağmadeni and Çayıralan districts are the most suitable places for forest therapy tourism (Photo 8a and 8b).

Photo 8a. Forest Therapy Tourism Area (Akdağmadeni Forests-Akdağmadeni district)
Source: [32].

Photo 8b. Forest Therapy Tourism Area (Çayıralan Forests-Çayıralan district)
Source: Research archive.

Bicycling Tourism

The bicycle, which was used for transportation purposes before, started to be used as a fun, sports, and cultural activity together with the development of tourism culture. In this context, the bicycle, which is considered a combination of nature, culture, sports, and travel, has recently come into prominence in ecotourism. It is a new type of tourism [21].

Bicycling tourism has a process that can vary from daily trips to long-term holidays. Factors affecting the selection of route place for bicycling tourism are; bicycle tour route, bicycle facilities, bike lane condition, road slope, scenery, route safety, scenery diversity, ride length, and route diversity.

In the study, it was determined that Akdağmadeni, Çayıralan, Çekerek, and Aydıncık districts and Yozgat Piny National Park are quite suitable areas for bicycling tourism.

In Photo 9, bicycling tourism was given in Yozgat Piny National Park.

Photo 9. Bicycling Tourism (Yozgat Piny National Park-Central district)
Source: [20].

Hunting Tourism

Hunting tourism is one of the nature-based tourism activities. Both foreign and domestic ecotourists participate in hunting tourism. Ecotourists participating in hunting tourism are in good condition in terms of income and are considered tourist groups that spend in the region they go to. For this reason, hunting tourism contributes to the regional economy in terms of income and employment.

In this study, it was determined that Yozgat province has a rich potential in terms of hunting grounds and there are 33 hunting grounds throughout the province.

Evaluation of ecotourism with SWOT analysis

In the study, in light of information and findings obtained from interviews and the researcher's observations, the ecotourism potential of the research region was evaluated by SWOT analysis, and presented below.

Strengths:

- Existence of clean air, water and soil, and intact nature in Yozgat province.
- That Yozgat Piny National Park, which is Turkey's first National Park, is located in the city center.
- The fact that it is rich in fauna and flora.
- Favourableness of soil and climate structure for all kinds of fauna and flora.
- Presence of a large natural area in Yozgat.
- Hospitableness of Yozgat humans.
- Height of the number of the young labor force.
- Yozgat's being at close range to metropolitans such as Ankara, Kayseri, Sivas, and Samsun.
- Adequateness of the infrastructure of natural gas and electric energy in the province.
- Its having a strong railway, high-speed train, and road highway connecting the east and west of Turkey.
- The fact that Hattusha, the capital of the Hittites, who founded the first empire in Anatolia, is at close range to Yozgat.
- The fact that Sarikaya Roman Bath is the only bath belonging to the Roman Empire whose originality has not been destroyed.
- Presence of a lot of natural, historical, and archaeological protected areas,
- The fact that there are more historical and archaeological protected areas than 400 registered in the region.
- Existence of large forested areas, promenades, and downlands.
- Being protected naturalness in ecotourism areas.
- The fact that Yozgat is also suitable for winter, culture, faith, cave, sports, gastronomy, and health tourism together with ecotourism.
- Presence of luxury hotels and rest areas in Sorgun, Sarıkaya, Saraykent, and Yerköy districts.

- The fact that there are many dams (Süreyyabey, Musabeyli, Gelingüllü, Uzunlu, İnandık, and Yahyasaray dams) and ponds in the area.

Weaknesses:

- Population migration from Yozgat to other regions. Since population migration is effective in weakening social mobility, it is thought that it will negatively affect the improvement of ecotourism.
- Lack of awareness about ecotourism in the local community.
- Inadequateness of the relationship and communication between Yozgat Bozok University and the Yozgat community.
- Lack of rural industry.
- Weak integration between organizations related to tourism.
- Insufficient promotional efforts aimed at ecotourism.
- Insufficient attempts about marketing local products and crafts.
- Inadequateness of facilities regarding ecotourism.
- Qualified personnel shortage.
- Lack of knowledge on financing for ecotourism investments.
- Lack of travel companies throughout the province.

Opportunities:

- The richness of historical and touristic values in the region.
- Presence of high-speed train stations in ecotourism centers.
- Closeness of ecotourism areas to the town center.
- Suitability of transportation and traffic infrastructure for ecotourism.
- Suitability of the region for all nature tourism.
- Yozgat to be included the primary region for development in terms of public aid.
- The topographic and its climatic structure to be suitable for summer and winter tourism.
- Due to low population density, natural areas to remain without being destroyed.
- Its to be rich in terms of local crafts.
- Being on a good wicket of food culture.
- The height of agriculture and animal breeding potential.
- Presence of Central Anatolian Development and Agricultural Development Support Institution to encourage tourism investments.
- Yozgat Bozok University Faculty of Communication and Culture and Tourism Provincial Directorate to be able to play a part in the promotion of ecotourism.

Threats:

- Destruction risk in historical and natural areas due to the possibility of pollution and neglect.
- Insufficiency in cooperation and communication between authorized institutions and the local community on ecotourism.
- Lack of qualified and experienced personnel for this cooperation.
- Deterioration and destruction risk in ecotourism areas due to global warming, climate change, and natural disasters.
- Low income per capita in the region.
- Insufficiency of shares the province receives from public investments.
- Reduction in the young population due to population migration.
- Sufficiently undeveloped ecotourism perception in the region.
- Weakening and deterioration risk in traditional and local cultures.

The role of ecotourism in sustainable rural development

Rural development is a process in which rural efforts are activated together with the public sector, and contributed to national development in order to be able to improve the economic, social, and cultural conditions of rural communities [24]. Sustainable rural development is a total of activities, depending on the sustainable natural resource use in rural areas on the one hand, aiming to reduce development differences by increasing the income level and quality of life of the rural community, and on the other hand, considering the conservation and development of environmental, and taking into account by cultural values, social, cultural and economic needs, potentials and dynamics [11]; [5].

Sustainable rural development depends on the sustainable use of local resources in terms of ecological, economic, and sociocultural aspects [9]. In this context, mobilizing local resources and their sustainability will be the right approach for sustainable development. With sustainable tourism also, it is understood that the current requirements of tourists and visited places are met with future opportunities. This approach is related to economic, social, and cultural needs and the continuity of ecological processes and biodiversity.

As for rural sustainability, it means that local communities stay in their traditional environments through sustainable employment and revenue growth. In order to be able to manage rural development effectively, first of all, it is necessary to define the main threats aimed at sustainable development well and to evaluate agricultural, economic, and social indicators in rural areas well [7]. Although special importance has been placed on sustainable rural development in recent years, it is still insufficient studies carried out on this subject are sufficient.

In this study, in light of the primary data, it occurred that ecotourism is an effective tool in sustainable rural development. According to the research findings, ecotourists, throughout sightseeing, not only have been going for an outing to the touristic areas but also making expenses for food, meals, cleaning, hunting, shelter, etc. Thanks to ecotourism, local community have been earning additional income by selling local food products and handicrafts on the roadside. Local food products sold in ecotourism areas have been; consisting of finger buns, fenugreek, roasted wheat, noodles, buffalo butter, churned yogurt, and butter, homemade tomato paste, local roast, grape molasses, molasses sausage, village phyllo, and dried vegetables. Local carpets and rugs, pinked hoops, hand embroidery, silver embroidery, shawl, lace, embroidered towels, and local socks are some of the local crafts. Facilities and infrastructure investments for tourism purposes in ecotourism areas have been forming elements of rural development.

In the interviews with the target organizations, it was also stated that ecotourism has been an effective tool in protecting local cultures and cultural enrichment, and that ecotourism strengthens traditional culture, hospitality, and traditions and is effective in reducing social conflicts. In observation in the field also, it was understood that local cultures have been introduced to ecotourists, and local community have been also benefiting from ecotourists' cultures. Ergo, ecotourism has been contributing to the rural development of the region culturally.

According to information obtained from the interviews, it was determined that population migration from the region to other cities has decreased thanks to ecotourism. The researcher's observations have also been confirming this. The human mobility in the region, plant production pattern, and vitality in nature have been showing that the local community has still lived in rural areas. On considering labor, employment, and expenditure contributions of the population to the economy, it can be stated that ecotourism has contributed through expenditure and employment to development. Also in the literature studies on this subject, the relationship between ecotourism and rural development was clearly stated. Some of these studies were:

[14] stated that ecotourism turned into a strategy for creating sustainable livelihoods and played an important part in the management of local communities. Ecotourism seems an ideal means to improve socioeconomic development. Also in the study performed by [13], it was stated that when the definitions of ecotourism are examined generally, the condition of gaining benefit/welfare to the local community is in the foreground. If the local community in ecotourism regions cannot revenue any direct or indirect generation from ecotourism activities or does not provide any benefit to themselves, this type of tourism cannot be qualified as ecotourism. If rural community develops in all respects in ecotourism regions, this is expressed as sustainable rural development. In real terms, ecotourism should hold the welfare and development of the local community at its core. In the study conducted by [15], ecotourism was stated as a small-scale tourism type that aims to protect the ecological balances and to turn the interactions between nature-human-

environment and tourism activities into an advantage, meanwhile, that also supports local entrepreneurs and economic development. In the study, it was explained that ecotourists contribute to the economic welfare of the local community by creating employment and financial instruments, and they raise awareness for the protection of ecotourism areas. Ecotourism as specified is an effective process in decreasing migration from rural to urban areas and keeping local culture, arts, and crafts alive. According to [16], ecotourism is a sub-component of sustainable tourism. In the study, it was expressed that ecotourism is perceived as an effective tool for sustainable development and that developing countries now include it in their economic development strategies. As alternative tourism, ecotourism is a nature experience-based tourism that ensures the economic and social development of local communities. [23], in their study, emphasized that ecotourism-based tourism activities should be developed in ensuring the rural development of forest villages located in the Yıldız Mountains. In the study, it was stated that the economic situation of the people living in the region has been not at a sufficient level, and they need to benefit from the ecotourism potential sufficiently for their income level to able to increase. In the region, household effects and knickknackery, and local products to be produced from forest products can create added value to rural development significantly. These products with high added value can be marketed to tourists through the sales stands to be set up on the roadside by Agricultural Development Cooperatives. In addition to these, the governorship, provincial and district municipalities, Culture and Tourism Provincial Directorate, and non-governmental organizations should also place importance on the promotion of ecotourism places in the region. In the event that these proposals can be realized at a certain level, it is thought that there will be no significant obstacle to the rural development of the region.

CONCLUSIONS

Changes in people's tourism preferences have increased the demand for ecotourism in recent years. With Increasing hobby gardening and intense interest in rural areas, ecotourism turned into an important tourism type. In this respect, Yozgat province offers a good ecotourism opportunity change with its excellent geography, biodiversity, and forest existence. Here, in this study, it was also determined that Yozgat province has a good ecotourism potential.

In the study, the ecotourism potential of Yozgat province was evaluated with a SWOT analysis. In evaluations, it was seen that SWOT analysis could be used as a useful means of tourism research. It is thought that this study can help local government managers and other organizations interested in tourism on sustainability.

Based on the information and findings obtained from the research, management strategies determined related to ecotourism were presented below:

1) Developing efforts aimed at understanding nature and socio-cultural values, and increasing the tendency to turn them into contributions.

2) Developing tendencies to minimize the negative effects of socio-cultural activities on nature and the environment.

3) Constructing physical facilities in accordance with the natural environment in ecotourism areas.

4) Attaching special importance to education and information studies on the promotion of ecotourism activities.

5) Being put emphasis on the quality of ecotourism, and having an impeccable natural environment.

6) Activating inactive ecotourism places.

7) Conservation of endemic plants, biological diversity, and wildlife, and integration of all these with the natural environment.

8) Protection of cultural heritage, keeping the traditions and customs of the local community alive.

9) İmproving interaction between ecotourists and rural communities.

10) Carrying out activities in charge of both ecotourists and the local community in order

to minimize the negative nature and socio-cultural effects.

11) At the same time, implementation of long-term control programs.

12) Developing new policies and doing plans related to ecotourism.

13) Paying special attention to marketing and promotion.

14) From the local community, bringing up publicists interacting with nature and rural life, highly educated about the environment, having environmental experience, relating nature, and knowing a foreign language.

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CONSEQUENCES OF LAND DEGRADATION ON LIVELIHOOD AND FOOD SECURITY OF RURAL FARMERS IN SOUTH-EAST, NIGERIA: A COMPARATIVE ANALYSIS

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Abstract

This study analyzed the consequences of land degradation on livelihood and food security of rural farmers in South-East, Nigeria. The study adopted purposive and stratified sampling techniques in the selection of locations and 900 respondents (450 farmers farming on water degraded farm lands and 450 farmers farming on non-degraded water erosion farm lands). The data collected were analyzed using mean, frequencies, percentages mean score and z-test. The result showed that the mean annual food expenditure of the rural farmers in degraded and non-degraded farm lands were ₦273264.22 and ₦290,592.67 respectively with mean annual farm incomes of ₦122,024.55 and ₦172,737.72 respectively. The perceived socio-economic consequences of water erosion degradation on farm lands were: decreased farm income ($\bar{X}$= 4.70), destruction of crops ($\bar{X}$ = 4.62), reduction in soil nutrient/organic matter ($\bar{X}$ = 4.59), increase in cost of production due to additional money spent in controlling/maintain degraded farm lands ($\bar{X}$ = 4.42), threat to food security ($\bar{X}$ = 4.47), decrease in farm land available for cultivation ($\bar{X}$ = 4.34), reduction in farm yields (output) ($\bar{X}$ = 4.44), laborious agricultural activities ($\bar{X}$ = 3.96) and destroyed properties and infrastructure ($\bar{X}$ = 3.87). The result showed that 56.67% and 60.44% of rural farmers on water degraded and non-water degraded farm lands respectively were food secured. The z-test showed significant differences in incomes and food security status of the two groups of farmers at varying alpha levels. The study recommended that government should ensure that farmers have access to affordable credit and land to increase their ability and flexibility to change production strategies in response to environmental degradation.

Key words**:** *land degradation, food security, rural farmers, South - East Nigeria*

INTRODUCTION

Land degradation refers to a temporary or permanent decline in the productive capacity of the land or its potential for environmental management [2]. [12] also submitted that land degradation is a reduction in the productivity of land resulting from soil loss (water erosion), breakdown in soil structure, water logging, nutrient loss, and pollution from toxic substances. It can be viewed as any act on land that changes it from its natural ecological state and makes it unfit for effective use.

Soil quality has a deep impact on productivity and it could be also influenced by agronomic land-use practices [9, 33].

Water erosion is the primary cause of land degradation in South-eastern part of Nigeria. The South-eastern states are water erosion menace prone because they are on moderate to very gentle dipping, poorly consolidated sandstones usually associated with local or regional highland [8]. Water erosion is a terminal and cancerous ecological disease that destroys within days and weeks land formed with natural nutrients over hundreds, thousands and millions of years ago. [6] noted the disastrous physical and socio-economic effects of water erosion in South-Eastern Nigeria to include among others: loss of lives and livelihoods, destruction of roads, farmlands and homes. Excessive water erosion causes both on-site and off-site problems. On-site impacts include decrease in agricultural productivity and natural landscapes, because of the loss of nutrient rich upper soil layers. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment related damage to roads and houses [17].

Land sites degraded by water erosion are now common land features of Agulu, Nanka, Ekwulobia, Nnobi, Nnewi, Oraukwu and Alor (Anambra State); Item, Ohafia, Arochukwu, Isuikwuato and Isuochi (Abia State); Arondizuogu, Amucha, Ideato and Okigwe (Imo State); and parts of Ebonyi State [36]. This has led to acute depletion of land- which threatens existence of many communities in terms of having stable lands for farming, building of residential houses, civic centres, roads, schools and cottage industries. These problems threaten the food security and livelihood of people residing in the affected communities.

Food security and insecurity are terms used to describe whether or not households have access to sufficient quality and quantity of food. The terms emerged following the 1974 world food conference and shift in food policy debate from food supply to food demand and the emergence of new emphasis on food entitlement, sustainability, vulnerability, risk and access [19]. Food security as defined by [16] is a situation when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life. According to [13], food security is widely seen as access by all people at all times to enough food for an active life, while food insecurity is the inability of a household or individuals to meet the required consumption levels in the face of fluctuating production, price and income. Food security has been identified as having food availability, food accessibility, utilization and stability of food access as its elements [18].

Water erosion is presently the major ecological problem in south-eastern Nigeria in the sense that compared to other land degradation agents like poor sanitation, excessive use of inorganic fertilizer, poor investment in land and pollution its effects are more serious [1]. In many African countries including Nigeria, food security at both national and household level is dismal. At the national level, per-capita growth of production of major food items in Nigeria has not been sufficient to satisfy the demand of an increasing population. Food demand in Nigeria has generally grown faster than food production and supply. [4] reported that the rate of increase in food production of 2.5 percent per annum does not keep pace with the annual population growth rate of 2.8 percent per annum. The result is a gap between national food supply and food demand [3]; a situation which increases food import bill and threatens national food security. The problem becomes more worrisome considering the fact that the bulk of Nigeria's agricultural production is controlled by small holder, resource poor farmers who live in rural areas and depend on the exploitation of lands that are highly vulnerable to degradation [30, 32].

Erosion has resulted in the separation of adjacent villages and towns as it may involve the collapse of bridges linking them together. This has had negative impacts on such areas since some facilities such as schools, hospitals and water supplies shared by the affected neighboring communities may become inaccessible. Transportation of farm produce has also been affected and this also often leads to loss of agricultural products especially the perishable ones. Traders who also go to these areas for their trade are also cut off from their normal day-to-day business [5].

However, the socio-economic implications of land degradation are particularly severe in Sub-Saharan Africa including Nigeria because 65.0% of the population is rural and the main livelihood of about 90.0% of the population is agriculture. Every year, the country is losing billions of birr in the form of soil, nutrient, water and agro biodiversity losses [34]. As a result, poverty and food insecurity are concentrated in rural areas [20].

An examination of the spread and socio-economic consequences of active land degradation (water erosion) on livelihood and food security of farm households would proffer insights into new ways of reducing hunger and food insecurity among farming households in Nigeria. This study is also significant because it will examine how the rural farmers can benefit by taking advantage of strategies for water erosion mitigation or prevention so as to improve agricultural production and livelihood. It will contribute to the debate on land degradation and water erosion especially as it affects livelihood and alleviate level of food insecurity. It will as well provide first- hand information on water erosion issues in South East, Nigeria. It is hoped that the findings of this study if implemented would help in fulfilling some of the aspirations of the Nation's National Economic Empowerment Development Strategy (NEEDS) and the United Nations Millennium Development Goals, and serve as a base for further research on similar issues.

The specific objectives of the study were to:

(i)describe the socio-economic characteristics of rural farmers in water degraded and non-water degraded farm lands in South East, Nigeria;

(ii)analyze farmers' perceived socio-economic consequences of degraded erosive farm sites;

(iii)profile food security status of the farm households on degraded and non-degraded farm lands;

(iv)compare livelihood (income) and food security status of farm households on degraded and non-degraded lands in South East, Nigeria.

Hypothesis of the Study

HO_1: The recommended intervention measures to farm land degradation have no effect on livelihood and food security of farmers on degraded farm lands in South East, Nigeria.

MATERIALS AND METHODS

The study area

The study was carried out in the South-Eastern states, (Abia, Anambra, Ebonyi, Enugu and Imo states) of Nigeria where a greater portion of the farmland management abuse take place [22]. South-east Nigeria is located between Latitudes $5^0 06'$N and $6^0 34'$N of the Equator and Longitudes $6^0 38'$E and $8^0 08'$E of the Greenwich Meridian. South-East geo-political zone shares boundaries with Kogi and Benue states to the north, Edo state to the north-west, Cross River state to the east, Akwa-Ibom and Rivers States to the south, Bayelsa state and Delta state to the south-west and west respectively. According to [24], the population of Southeast zone of Nigeria was 16,381,729 persons, disaggregated into 8, 306, 306 males and 8,075,423 females. Southeast Nigeria experiences two distinct seasons, namely: rainy and dry seasons. The inhabitants of this zone are predominantly farmers cultivating food crops such as cassava, yam, cocoyam, maize and rice, and cash crops such as oil palm, cocoa and cashew [25].

Sampling technique

Purposive and stratified sampling techniques were used to select sampling locations and the respondents for the study. In the first stage, three of the five states in South-East Nigeria, were selected purposively. The selected states were Abia, Anambra and Enugu States. The locations selected for the study were those areas intensely affected by water erosion in the South East. A visit was made to Erosion Control Department in each of the selected states. Nigeria Erosion and Watershed Management Project (New Map) and Ministries of Environment and agriculture in the three selected states were specifically visited to obtain a list of active water erosion sites in the States. Using the list, one agricultural zone with the highest water erosion incidence was also purposively selected from each of the selected three states of South East to give a total of three zones. The zone selected were Ohafia Agricultural zone (Abia state), Nsukka Agricultural zone (Enugu state) and Aguata Agricultural zone (Anambra state). Three blocks were selected randomly from each zone to give a total of 9 blocks. The selected blocks for Ohafia Agricultural zone (Bende, Isuikwuato and Uzuakoli), Nsukka Agricultural zone (Isi-uzo, Uzo-Uwani and Igbo-Eze North) and Aguata Agricultural zone (Aguata, Orumba North and Orumba South). The fourth stage involved selection of 5 circles from each of the selected blocks to give a total of 45 circles. Lists of farmers in the selected circles were obtained from the Zonal Agricultural Development project office, and the farmers were stratified into two groups with the assistance of the extension agents living in those selected circles. Group one consisted of farmers operating on water degraded farm lands and group two consisted of farmers operating on non-degraded farm lands. From the stratified list, twenty (20) farmers were randomly selected (10 farmers farming on water degraded lands and 10 farmers farming on non-degraded lands) from each of the selected circles. This gave 900 respondents for the study (450 farmers farming on water degraded lands and 450 farmers farming on non-degraded lands).

Method of data Collection

The study made use of both primary and secondary data. Primary data were collected from the selected sample following a field survey conducted with a pre-tested and validated semi-structured questionnaire. Data collected from farmers were on their socio-economic variables such as, household size, farming experience, membership of farmers associations, access to credit and annual farm income. In addition, data on rural farmers' household food expenditure, food security status, land degradation adaptation and mitigation measures were collected.

Secondary data were also used for the study. Secondary data were collected from textbooks, newsletters from Newmap, ministry of environment, articles and journals from agriculture and related institutions

Method of data analysis

Objective (i), was analyzed using descriptive statistics of mean, frequencies and percentages. Objective (ii) was achieved with mean score. Objective (iii) was achieved with food security index. Paired z-test was used to realize objective (iv).

Model specification

Mean score

Mean score was obtained through a five point Likert scale. The scale graded are thus: very high = 5; high = 4; moderate = 3; low = 2 and very low = 1). The Likert scaling is a method of ascribing quantitative values to qualitative perception to make it amenable to statistical analysis. The values of the responses were added and further divided by 5 to obtain a mean score of 3.0, which was regarded as threshold mean level. Rural farmers with mean score of 3.0 and above perceived the socio-economic consequences, while those with score of less than 3.0 did not perceive the socio-economic consequences.

Thus mean threshold score = $\bar{X}$

$\bar{X} = \sum fx/N$, (the mean score).

Mean ($\bar{X}$) of each item was computed by multiplying the frequency of positive response to each question with its appropriate Likert nominal value and the sum was divided by the sum of the number of the respondents to the items. This is summarized with the equation below:

$$\bar{X} = \sum fn/N. \quad (1)$$

where:

$\bar{X}$ = mean score;

$\sum$ = summation sign;

F = frequency or number of respondents who responded positively;

n = Likert nominal value;

N = Number of respondents.

Food security index

The farm households were classified into food secure, food insecure and extremely food insecure using food security index, which was used to establish the food security status of various households [26, 28]. It is given by:

Fi = per capita food expenditure for the i^{th} household/ 2/3 mean per capita food expenditure of all households…. (2)

where:

Fi = food security index, which could be interpreted as follows:

when Fi $\geq$ 1 = food secure i^{th} household;

Fi $\leq$ 2/3 = food insure i^{th} household;

Fi < 1/3 = extremely food insecure household.

A food secure farmer was therefore that whose per capita monthly food expenditure fall above or is equal to two-third of the mean per capita food expenditure. On the other hand, a food insure farmers is that whose per capita food expenditure falls below two-third of the mean monthly per capita food expenditure and extreme food insecure are those whose monthly per capita food expenditure fall below one third [28].

Z-test

Z-test analysis used to compare the food security status of rural farmers in water degraded and non-degraded farm lands is explicitly stated as used by [29].

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad \ldots\ldots\ldots\ldots(3)$$

where:
Z = Z statistic;
$\bar{X}_1$= Mean annual farm incomes/annual food expenditure of farm households on degraded farm lands;
$\bar{X}_2$= Mean annual farm incomes/annual food expenditure of farm households on non-degraded farm lands;
S_1^2 = Variance of Mean farm annual incomes/annual food expenditure of farm households on degraded farm lands;
S_2^2 = variance of Mean farm annual incomes/annual food expenditure of farm households on non-degraded farm lands;
n_1 = Sample size farm households on degraded farm lands;
n_2 = Sample size farm households on non-degraded farm lands.

RESULTS AND DISCUSSIONS

Socio-economic characteristics of rural farmers

The distribution of the rural farmers in water degraded and non-water degraded farm lands in South-East, Nigeria according to socio-economic characteristics is presented in Table 1.

With respect to household size, the table shows that mean household sizes of the rural farmers in water degraded and non-degraded farm lands of South East, Nigeria were 6.34 persons and 6.39 persons respectively. Following [35] classification of farmers by household size (< 5 persons = small; 5 – 8 persons = moderate; > 8 persons = large), the mean household size of the farm households indicate that they had moderate household size.

This means that in the absence of well-functioning labour markets, household members are used as cheap source of farm labour [30].

This is expected to influence agricultural production, livelihood, food security and use of farm land management technologies positively.

Table 1 also shows that 46.67% and 46.22% of the rural farmers in water degraded and non-water degraded farm lands were members of cooperatives.

Farmers involved in cooperatives share knowledge and innovation ideas, discuss problems and challenges with others, and engage in collaborative decision-making [21].

Furthermore, Table 1 shows that 50.89% and 50.22% of the rural farmers in water degraded and non-water degraded farm lands had access to credit.

This implies that farmers in water degraded farm lands had more access to credit than farmers in non-water degraded farm lands. Farmers would be more financially stable and can afford to use land degradation adaptation and mitigation practices when their investment funds increase as a result of access to credit.

Therefore the probability of the farmers' to use adaptation and mitigation measures to reduce advancement of water induced farm land degradation, improve food security and livelihood generally will likely increase with increase in credit access.

Availability of access to credit could enable farmers to purchase farm inputs and solve financial constraints associated with use of land management practices [14].

In addition, Table 1 shows that 48.44% and 51.11% of the rural farmers households in water degraded and non-water degraded farm lands in South East, Nigeria had annual food expenditure of between ₦370,000.00 and ₦519,999.00 respectively.

The mean annual food expenditure of the rural farmers in degraded and non-degraded farm lands in South-East were ₦273,264.22 and ₦290,592.67 respectively.

This translates to ₦748.67 and ₦796.14 per day. This implies that both farmers in water degraded and non-water degraded farm lands are below the estimated base of FAO of 2.16 United State Dollar ($) /day/adult equivalent

[10]. A similar result was obtained by [38]. Table 1 also shows that the mean annual farm incomes of the rural farmers in water degraded farm lands and non-water degraded farm lands were N122,024.55 and ₦172,737.72 respectively. This mean annual farm incomes translate to 10,168.71Naira and 14,394.81 Naira per month which is less than the government approved minimum wage of 30,000 Naira monthly. In the face of the current economic crunch and inflation in South-East Nigeria, this income level may not be adequate to meet production and investment requirements of the rural farmers, hence the income farm households earn from farming have implications on the number of improved technologies and amount of food they can be able to access. The higher the annual farm incomes, the more likely farm households can save and invest in improved technologies for increased farm output and adapt to erosion mitigation and control strategies [31].

Table1. Socio-economic characteristics of rural farmers in South–East Nigeria

	Water degraded farm lands		Non-water degraded farm lands	
Socio-economic characteristics	**Frequency**	**percentage**	**Frequency**	**percentage**
Household Size				
1-4	129	28.67	129	28.67
5-8	218	48.44	212	47.11
9-12	103	22.89	109	24.22
Mean	6.34		6.39	
Membership of cooperatives				
Yes	210	46.67	208	46.22
No	240	53.33	242	53.78
Access to credit				
Yes	229	50.89	226	50.22
No	221	49.11	244	49.78
Annual food expenditure				
70,000.00-219,999.00	169	37.56	145	32.22
220,000.00-336,999.00	63	14.00	72	16.00
370,000.00-519,999.00	218	48.44	230	51.11
520,000.00 and above	0	0	3	0.67
Mean	273,264.22		290,592.67	
Annual farm income				
Below 100,000	253	56.22	136	30.22
100,000-199,999	125	27.78	142	31.56
200,000-299,999	39	8.67	98	21.78
300,000 and above	33	7.33	74	16.44
Mean	122,024.55		172,737.72	
Total	450	100.00	450	100.00

Source: Field survey, 2022.
$ 1 is equivalent to ₦710

Perceived socio-economic consequences of degraded water erosion sites in South-East, Nigeria

The distribution of rural farmers according to perception on the socio-economic consequences of degraded erosion sites is presented in Table 2.

The table shows that the perceived socio-economic consequences of degraded erosion site were decreased farm income ($\bar{X}$ = 4.70), destruction of crops ($\bar{X}$ = 4.62), reduction in soil nutrient/organic matter content ($\bar{X}$ = 4.59), increase in cost of production due to additional money spent in controlling/maintain degraded land ($\bar{X}$ = 4.42), threat to food security ($\bar{X}$ = 4.47) and decrease in farm land available for cultivation ($\bar{X}$ = 4.34).

This implies that land degradation as a result of water erosion can cause yield reductions, reduction in agriculture productivity, high cost of production, loss of cultivable lands, food insecurity and reduction in soil fertility. In some region of the world, problems of insufficient land for cultivation arise due to the soil degradation that cause long term effects to agricultural production [11].

[23] observed that in case of high rated soil erosion events, the removed nutrients (nitrogen phosphorus, potassium, calcium, to mention but a few) are three times more than nutrient particles remaining in the soil.

The table also showed that reduction in farm yields (output) ($\bar{X}$ = 4.44) was perceived as consequences of degraded erosion sites by rural farmers in South-East, Nigeria.

Crops suffer yields loss due to the degradation of physical and chemical composition of the soil. Degraded farm lands not only produce less, but they demand more resources to manage. The poor rural farmers are vulnerable because they farm marginal areas, rely more on the intrinsic quality of their soils and landscape, have fewer capital assets to improve their farm land or invest in conservation technologies, denying their land the necessary labor to manage the resources in a sustainable way and have less resources to be resilient in the face of major problems such as drought, floods and diseases.

Those impacts occur cumulatively and long-term due to successive soil erosion. Soil erosion affect crop yield and loss of arable land areas due to earth fall from landslides and channels formation within the arable areas [17]. Table 2 further showed that farm land degradation made agricultural activities more laborious ($\bar{X}$ = 3.96) and destroyed properties and infrastructure ($\bar{X}$ = 3.87) as were perceived by rural farmers as consequences of degraded erosion sites in South-East, Nigeria.

Table 2. Perception of rural farmers on socio-economic consequences of water degraded farm lands in south East, Nigeria

Socio-Economic Consequences	Very High (5)	High (5)	Moderate (3)	Low (2)	Very low (1)	Total	Mean Adoption Score
Decrease in farm land available for cultivation	208(1,040)	204(816)	23(69)	15(30)	0	1,955	4.34
Reduction in soil nutrient/organic matter	268(1,340)	182(728)	0	0	0	2,068	4.59
Destruction of properties and infrastructure	192(960)	106(424)	68(204)	70(140)	14(14)	1,742	3.87
Displacement of people and loss of lives	28(140)	48(192)	78(234)	113(226)	183(183)	975	2.17
Decreased farm income	317(1,585)	133(532)	0	0	0	2,117	4.70
Threaten food security	310 (1,550)	41(164)	99(297)	0	0	2,011	4.47
Make agricultural activities more laborious	117(585)	106(530)	213(639)	14(28)	0	1,782	3.96
Reduction in farm yield (output)	228(1,140)	192(768)	30(90)	0		1,998	4.44
Increase in cost of production due to additional money spent in controlling degraded land	221(1,105)	197(788)	32(96)	0	0	1,989	4.42
Destruction of cropped land	312(1,560)	103(412)	35(105)	0	0	2,077	4.62
Grand Mean							

Source: Field survey, 2022.
Decision Rule 3.0 and above = perceived; < 3.0 = Not perceived
*multiple responses recorded
Figures in parenthesis = likert norminal values

Food security index of the farm households in water degraded and non-degraded lands in South-East, Nigeria

Food security status of the rural farm households on water degraded and non-water degraded farm lands in South East Nigeria is presented in Table 3.

Table 3 shows that 70.22% of rural farm households on water degraded farm lands were food secured while 21.33% of them were food insecure.

On the other hand Table 3 shows that 74.22% of rural farm households on non-water degraded farm lands were food secured while 23.11% of them were food insecure.

This result is not a surprise since land degradation do not only deteriorate the ecosystem services but also hinders regional sustainable agricultural development.

Table 3. Food security status of rural farmers in water degraded and Non-water degraded farm lands in South-East Nigeria

Food Security Indices	Farmers in water degraded lands	Farmers in non-water degraded land
Mean Annual household food expenditure (₦)	273,264.22	290,592.67
Food security line (2/3 of pooled mean household food expenditure) (₦)	182,176.15	193,728.45
Extreme food insecurity line (1/3 of the pooled mean household food expenditure) (₦)	91,088.07	96,864.22
Food secure	316(70.22)	334(74.22)
Food insecure	96(21.33)	104(23.11)
Extreme food insecure	38(8.44)	12(2.67)

Source: Field Survey, 2022
Figures in parenthesis = %
$ 1 is equivalent to ₦710

This means that more farmers in water degraded lands were food insecure than in non-water degraded farm lands. This is because of reduction of the productive capacity of land in water degraded farm lands [7].

Comparism of Food Security Status and Livelihood (Income) of Rural Farmers on Water Degraded and Non-Degraded Farm Lands in South-East, Nigeria

Table 4 shows the estimates and comparism of mean annual farm income and mean monthly per capita food expenditure of farm households on water degraded and non-degraded farm lands in South-East, Nigeria. Specifically, Table 4 shows that the mean annual farm income of the farmers on water degraded farm lands was ₦122,024.55, while the mean annual farm income of the farmers that are not on water degraded land was ₦172,737.72. The mean difference between the two groups of farmers was ₦50,713.17. The paired t-test result showed a statistical difference between the two groups of farmers and significant at 1.0% alpha level (t-value = 7.768).

This implies that the farmers on water degraded farm lands had significantly lower annual farm incomes compared to the farmers on non-water degraded farm lands.

This result compares favourably with the findings of [27] that farmers on degraded farm lands generate less farm income in relation to farmers on non-degraded lands.

The result further lends credence to [15] assertion that decreased productivity of farm lands attributed to land degradation, contributes directly to reduced livelihoods among the rural and agricultural population of Africa.

Table 4 also shows that the mean annual household food expenditures of the farmers on water degraded farm lands was ₦273,264.22, while the mean annual household food expenditure of the farmers that are not on water degraded farm lands was ₦290,592.67.

The result of the paired t-test (1.983) for mean difference revealed significant difference at 5.0% alpha level, thus lending credence to [37] assertion that land degradation result to changes in levels of production, income as well as household food security and all these affect the socio-economic status of farmers. Land degradation has adverse effect on productive capacity of land, and thus, on food security of the farm households [7].

Table 4. Test of Difference in livelihood (Income) and Food Security Status of Farmers in water degraded farm lands and non- Water Degraded Farm Lands (n = 900)

Variables	Individual mean	Mean difference	Std.dev.	t-value	Sig. (2-tailed)
Mean annual farm income of farmers in water degraded lands (₦)	122,024.55	50,713.17	6,528.86	7.765	0.000
Mean annual farm income of farmers in non-water degraded lands (₦)	172,737.72				
Mean annual food expenditure of farmers in water degraded farm lands (₦)	273,264.22	17,328.44	185,351.97	1.983	0.027
Mean annual food expenditure of farmers in non-water degraded farm lands (₦)	290,592.67				

Source: Field survey, 2022
,* = Significant at 5.0% and 1.0% alpha levels
$ 1 is equivalent to ₦710

CONCLUSIONS

The study had shown evidence that rural farmers perception of the socio-economic consequences of water erosion degraded farm lands to include decreased farm income ($\bar{X}$ = 4.70), destruction of crops ($\bar{X}$ = 4.62), reduction in soil nutrient/organic matter ($\bar{X}$ = 4.59), increase in cost of production due to additional money spent in controlling/maintain degraded land ($\bar{X}$ = 4.42), threat to food security ($\bar{X}$ = 4.47), decrease in farm land available for cultivation ($\bar{X}$ = 4.34), reduction in farm yields (output) ($\bar{X}$ = 4.44), laborious agricultural activities ($\bar{X}$ = 3.96), destroys properties and infrastructure ($\bar{X}$ = 3.87). The study showed that, livelihood (income) and food security of farmers in non-water degraded were significantly higher compared to the farmers in water erosion degraded farm lands

Therefore, the study recommends that farmers should take advantage of cooperative membership and collaborate with relevant agencies and scientists such as extension personnel, soil scientists, ministry of environment and other relevant stakeholders for trainings and workshops on modern methods, combined with local knowledge to prevent and/or combat land degradation problems.

There is need for governments (federal, state and local government) and non-governmental organization to extend emergency food and sustainable income to boost the livelihood of these farmers (water erosion degraded farms) as a deliberate policy to save these farmers from impending famine and hunger.

There has to be a deliberate policy by the governments (federal, state and local) to create a special insurance and emergency fund for farmers facing this awkward natural emergency. This fund will assist the farmers to cushion the debilitating effect of these disasters when they occur. This fund should be separate and different from the agricultural insurance policy. The poor resource farmers may not be capable of contributing to the monthly payment which may bear them from benefiting in case of disaster occurrence. This is a fund to be specially set aside to met the ecological challenges of the farmers in these well established and known areas after due investigation.

To restore, sustain and enhance the productive and protective functions of the land in the areas, farmers should intensify, the use of organic manure due to its regenerative powers on land, the use of alley cropping system to effectively make use of the advantage of trees in the cropping system.

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WHEAT QUALITY INDICES IN RELATION TO NITROGEN FERTILIZATION

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Abstract

The study analyzed the variation of quality indices of wheat grains in relation to nitrogen fertilization. The experiment was carried out at the University of Life Sciences "King Mihai I" from Timisoara, Didactic and Experimental Resort (DER), in the 2021-2022 agricultural years. The wheat 'Venezio' cultivar was cultivated in a non-irrigated system. Fertilization was done with ammonium nitrate in eight doses: 0, 40, 80, 120, 160, 200, 240 and 280 kg ha^{-1} N a.s. (a.s. – active substance). The studied quality indices showed variable values, between 13.8-16.4±0.30% in the case of the protein content (Pro), 27-34±0.83% in the case of the gluten content (Glt), 57-73±1.91% in the case of the Zeleny Index (Zel Ind), 74.6-76.5±0.20 kg hl^{-1} in the case of hectolitre weight (HW), respectively 11.5-11.8±0.04% in the case of moisture (Mstr). The variation of the quality indices values in relation to N was described by polynomial equations of the 2nd degree, under variable conditions of statistical safety ($p<0.001$ in the case of Pro, Glt, Zel Ind; $p=0.0428$ in the case of HW; $p=0.0729$ in the case of Mstr). The variation of Zel Ind in relation to other quality indices (Pro and Glt) was quantified by quadratic regression analysis ($R^2=0.996$, $p<0.001$). According to PCA, a distribution and association of the variants was obtained in relation to the level of the evaluated quality indices: variants T1 and T2 were placed independently, variants T3 and T8 were associated with humidity (Mstr); variants T4 and T7 were associated with Pro, Glt and Zel Ind indices, and variants T5 and T6 were associated with HW. PC1 explained 87.168% of variance and PC2 explained 8.0113% of variance.

Key words: *models, nitrogen fertilizer, PCA, quality indices, wheat*

INTRODUCTION

The quality indices of wheat grains are important in relation to the production destination, such as for bakery, fodder wheat, or other uses [7, 15, 33].
The quality indices depend primarily on the biological material and have been studied in relation to different cultivated wheat genotypes [1, 25].
Environmental factors (temperature and precipitation, including water and thermal stress conditions), also showe d influence on quality indices, quantified in different studies [8, 21, 31].
The quality indices of wheat production were analyzed in relation to farming system [25], agricultural practices [3, 6, 9] and key parameters [20].
As an expression of the interaction [genotype × environment × crop technology] quality indices of grain production in wheat have been increasingly studied from this perspective, as they reflect more realistically the final result of a wheat crop, regarding the quality of grain production [10, 22, 25, 34].
Within the crop technologies, fertilization occupies an important place, and nitrogen is a nutrient element with a major role in the quantitative formation, in particular, but also the quality of wheat production [4, 19, 28].
Wheat genotypes respond differently to fertilization (e.g. nitrogen fertilization), both in terms of the level of quantitative production and in terms of qualitative indices [5, 27, 30].
Knowing the (production potential) response capacity of a wheat genotype in relation to fertilization is important in order to optimize inputs, agricultural technologies and management at the farm level [12, 14, 16, 23].
The present research evaluated the main quality indices in wheat production in relation to nitrogen fertilization, and described through mathematical models the variation of the

values of the quality indices considered in relation to nitrogen doses.

MATERIALS AND METHODS

The experimental study was organized within the University of Life Sciences "King Mihai I" from Timisoara, Didactic and Experimental Resort (DER), Photo 1. The wheat crop was established on a chernozem type soil, in a non-irrigated crop system, agricultural year 2021 - 2022; the climatic conditions are presented in Figure 1 [24]. The biological material was represented by the 'Venezio' wheat cultivar. Fertilization was done with granular ammonium nitrate, in doses that ensured eight levels of nitrogen (0, 40, 80, 120, 160, 200, 240 and 280 kg ha^{-1} a.s.; a.s. – active substance).

To evaluate the quality of wheat production, the following indices were considered: protein content (Pro, %), gluten content (Glt, %), Zeleny Index (Zel Ind, %), hectolitre weight (HW, kg hl^{-1}), moisture (Mstr, %). The determination of the considered indices was done by non-destructive methods (NIR), with the AGRI CHECK and PFEUFFER GRANOMAT devices.

Photo 1. Aspect from the experimental field, agricultural year 2021 - 2022
Source: Original photo of the field (made by authors).

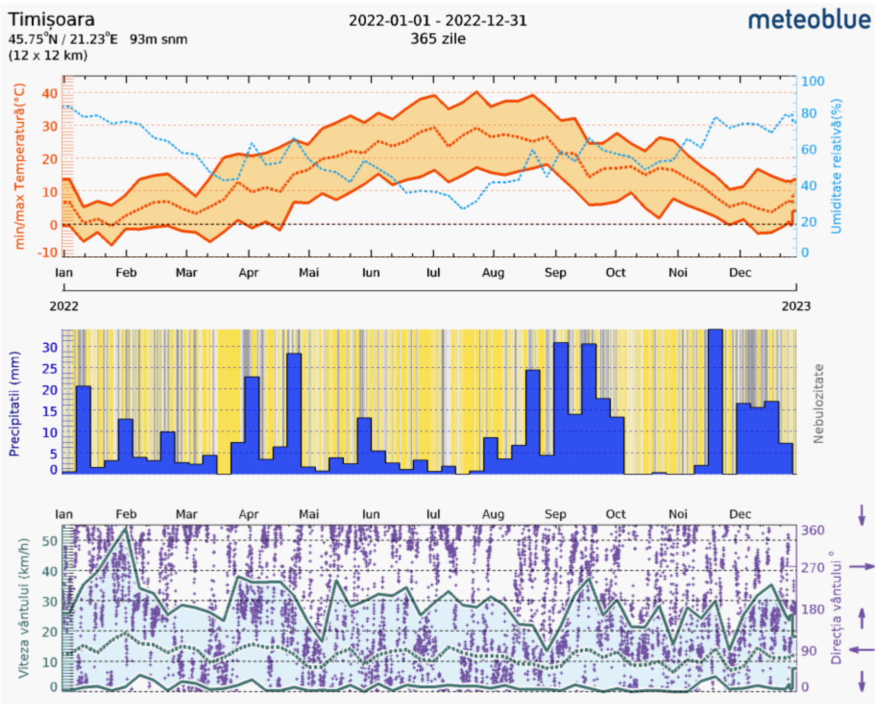

Fig. 1. Climatic conditions for the area of the experimental field during the study period [24]
Source: Original figure.

The experimental data resulting from the analyzes were evaluated by appropriate mathematical and statistical methods, for the evaluation of the variance, the statistical certainty, the level of correlations and interdependencies between the analyzed indices and the doses of N, as well as between certain quality indices [11, 13, 32].

RESULTS AND DISCUSSIONS

The quality of wheat production, the 'Venezio' cultivar was analyzed in relation to nitrogen doses in terms of quality indices, respectively protein content (Pro, %), gluten content (Glt, %), Zeleny Index (Ind Zel, %), hectolitre weight (HW, kg hl^{-1}), and grain moisture (Mstr, %). The studied quality indices showed variable values, between 13.8-16.4±0.30% in the case of the protein content, 27-34±0.83% in the case of the gluten content, 57-73±1.91% in the case of the Zeleny Index, 74.6-76.5±0.20 kg hl^{-1} in the case of hectolitre weight, respectively 11.5-11.8±0.04% in the case of moisture, table 1. The Anova single factor test confirmed the presence of variance in the experimental data set, and the safety of the data (F>Fcrit, p<0.001, Alpha=0.001).

Table 1. Values of quality indices for wheat, 'Venezio' cultivar

Trial	**Nitrogen doses**	**Quality indices**				
		Pro	Glt	Zel Ind	HW	Mstr
	(kg ha^{-1} a.s.)	(%)			(kg hl^{-1})	(%)
T1	0	13.8	27	57	74.6	11.8
T2	40	15.2	31	65	74.9	11.6
T3	80	15.7	32	69	75.3	11.7
T4	120	16.1	33	71	75.4	11.6
T5	160	16.1	34	72	75.8	11.4
T6	200	16.2	34	73	76.5	11.5
T7	240	16.4	34	73	75.5	11.6
T8	280	15.5	32	68	75.2	11.7
SE		±0.30	±0.83	±1.91	±0.20	±0.04

Sources: Original data from the experiment.

Table 2. Correlation table (Kendall's Tau B)

Variable		N	Pro	Glt	Zel Ind	HW	Mstr
N	Kendall's Tau B	—					
	p-value	—					
Pro	Kendall's Tau B	0.618*	—				
	p-value	0.034	—				
Glt	Kendall's Tau B	0.617*	0.904**	—			
	p-value	0.040	0.003	—			
Zel Ind	Kendall's Tau B	0.618*	0.963**	0.943**	—		
	p-value	0.034	0.001	0.002	—		
HW	Kendall's Tau B	0.500	0.837**	0.926**	0.909**	—	
	p-value	0.109	0.004	0.002	0.002	—	
Mstr	Kendall's Tau B	-0.231	-0.511	-0.708*	-0.589	-0.694*	—
	p-value	0.441	0.093	0.024	0.052	0.021	—
* p < .05, ** p < .01, *** p < .001							

Source: Original data.

The correlation analysis led to the values in Table 2. In relation to the doses of N, there were positive correlations (* p<0.05) in the case of the protein content (r=0.618), for the gluten content (r=0.617) and the Zeleny index (r=0.618). Very strong correlations were recorded between protein and gluten (r=0.904), between protein and the Zeleny Index (r=0.963), between gluten and the Zeleny Index (r=0.943), between gluten and hectolitre weight (r=0.926) and between Zeleny index and hectolitre weight (r=0.909), under conditions of p<0.01 (**p). Moderate correlation was recorded between Glt and Mstr (r=-0.708), and weak correlation was recorded between Zel Ind and Mstr (r=-0.694).

The variation of the values of the studied quality indices was analyzed in relation to the nitrogen doses. Thus, the variation of protein content (Pro) in relation to N was described by equation (1), under conditions of R^2= 0.940, p<0.001, F=39.3213, RMSE=0.1916. The variation of gluten content (GLT) in relation to N was described by equation (2), under conditions of R^2=0.961, p<0.001, F=61.03113, RMSEP= 0.4373. The variation of the Zeleny Index (Zel Ind) in relation to N was described by equation (3), under conditions of R^2=0.971, p<0.001, F=84.2206, RMSE=0.8574. The variation of hectolitre weight (HW, kg hl^{-1}) in relation to N was described by equation (4) under conditions of R^2=0.716, p=0.0428, F=6.3133, RMSE= 0.2868. The variation of humidity (Mstr, %) in relation to N doses was described by equation (5), under conditions of R^2=0.649, p=0.0729, F=4.6255, RMSE=0.0691.

$$\mathrm{Pro} = -7.4\mathrm{E}-05x^2 + 0.026607x + 13.9833 \quad (1)$$

$$\mathrm{Glt} = 0.000205x^2 + 0.07256x + 27.45833 \quad (2)$$

$$\mathrm{Zel\,Ind} = -0.000476x^2 + 0.17202x + 57.75 \quad (3)$$

$$\mathrm{HW} = -46\mathrm{E}-05x^2 + 0.01625x + 74.4166 \quad (4)$$

$$\mathrm{Mstr} = 1.15\mathrm{E}-05x^2 - 0.00368x + 11.8042 \quad (5)$$

The variation of the Zeleny Index (Zel Ind) in relation to protein and gluten (as a direct and interaction effect) in wheat grains, 'Venezio' cultivar was described by equation (6), under conditions of R^2=0.996, p<0.001, F=119,899, with graphic representation in figures 3 and 4.

$$\mathrm{Ind\,Zel} = \mathrm{a}\,x^2 + \mathrm{b}\,y^2 + \mathrm{c}\,x + \mathrm{d}\,y + \mathrm{ex}\,y + \mathrm{f} \quad (6)$$

where: Ind Zel – Zeleny Indices (%);
x – Pro – protein content (%);
y – Glu – Gluten content (%);
a, b, c, d, e, f – coefficients of the equation (6);

a= -19.18893355;
b= -1.33510877;
c= 264.05119413;
d= -81.18275597;
e= 10.67439110;
f= -744.66604398

Based on the PCA, the diagram in Figure 4 was generated, in which the experimental variants (T1 and T9) were distributed in relation to the association with the quality indices considered in the study (as biplot in the PCA diagram).

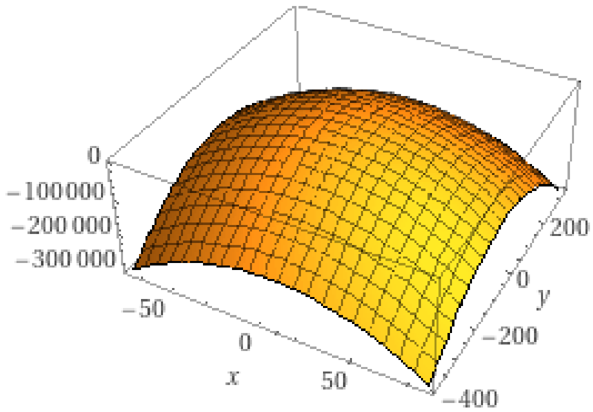

Fig. 2. 3D model of variation of Zel Ind in relation to Pro (x-axis) and Glt (y-axis), 'Venezio' wheat cultivar
Source: Original figure.

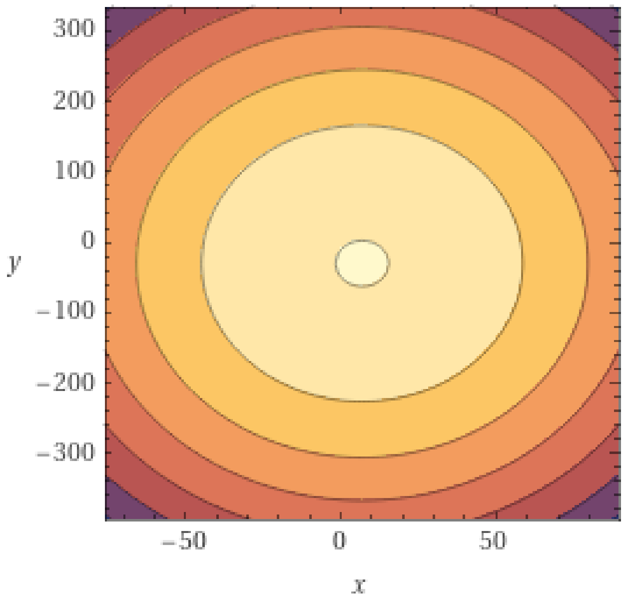

Fig. 3. Model in isoquants format of variation of Zel Ind in relation to Pro (x-axis) and Glt (y-axis), 'Venezio' wheat cultivar
Source: Original figure.

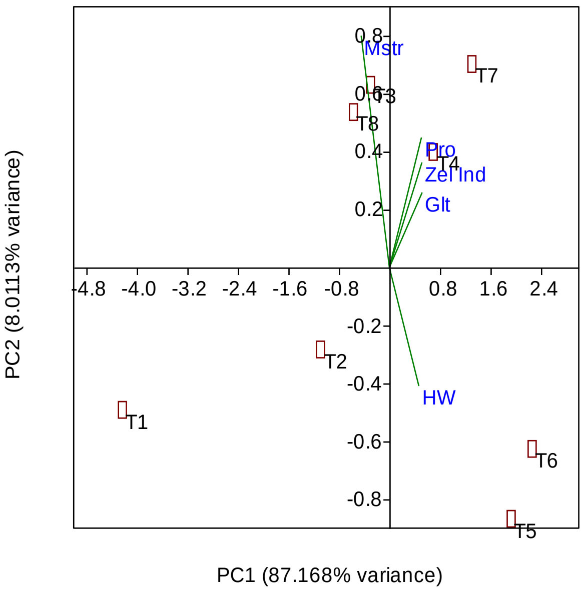

Fig. 4. PCA diagram in the study variants, 'Venezio' wheat cultivar, in relation to quality indices
Source: Original figure

The T1 and T2 variants were placed independently. The variants T3 and T8 were associated with grains moisture (Mstr). The T4 and T7 variants were associated with Zel Ind, Pro and Glt indices, and the T5 and T6 variants were associated with HW. PC1 explained 87.168% of variance, and PC2 explained 8.0113% of variance.
The Cluster Analysis led to the dendrogram in figure 6, in which the variants were associated based on similarity in relation to the values of the considered quality indices (Coph.corr. =0.925).

The T1 variant was placed in an independent position, with the lowest values of the considered quality indices.
The other variants were grouped into two sub-clusters, based on similarity. Based on the calculated SDI values, a high level of similarity was recorded between variants T3 and T8, and between variants T6 and T7, respectively (SDI=1.0247), Table 3.

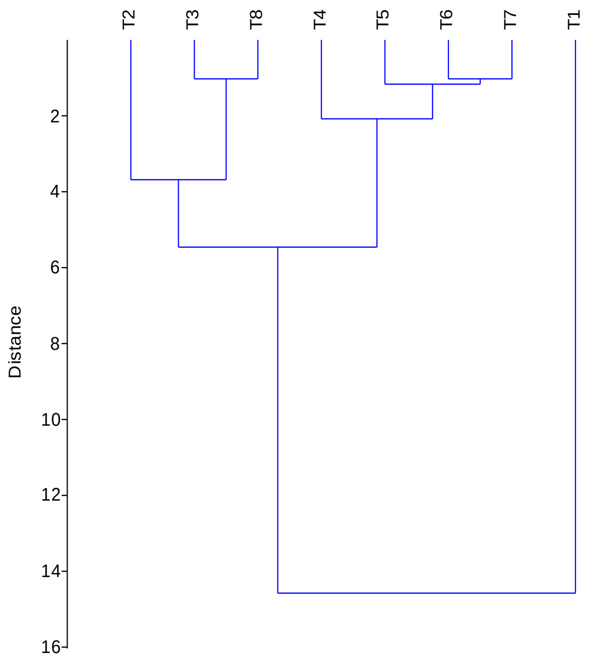

Fig. 5. Dendrogram of wheat variants grouping based on Euclidean distances, in relation to quality indices
Source: Original figure.

Table 3. SDI values for fertilization variants in wheat, 'Venezio' cultivar, in relation to the considered quality indices

	T1	T2	T3	T4	T5	T6	T7	T8
T1		9.0604	13.1570	15.4260	16.7600	17.7330	17.6810	12.2170
T2	9.0604		4.1737	6.4078	7.7240	8.7504	8.6487	3.1922
T3	13.1570	4.1737		2.2760	3.6742	4.6615	4.5321	1.0247
T4	15.4260	6.4078	2.2760		1.4832	2.4960	2.2583	3.2265
T5	16.7600	7.7240	3.6742	1.4832		1.2288	1.1045	4.5618
T6	17.7330	8.7504	4.6615	2.4960	1.2288		1.0247	5.5875
T7	17.6810	8.6487	4.5321	2.2583	1.1045	1.0247		5.4690
T8	12.2170	3.1922	1.0247	3.2265	4.5618	5.5875	5.4690	

Source: Original data.

Fertilization with N generated a different variation in the values of the studied quality indices, equations (1) – (5) and a variable growth rate (Δ) for quality index creation, Table 4.

Fertilizers contribute variably to achieving quality indices in wheat grains. The variation of quality indices was analyzed in relation to different types, doses and application conditions of fertilizers [3, 14, 25].

Table 4. Growth rate values (Δ) in relation to N dose in wheat, 'Venezio' cultivar

Trial	N	Δ-Pro	Δ-Glt	Δ-Zel Ind	Δ-HW
T1	0	-	-	-	-
T2	40	1.4	4	8	0.3
T3	80	1.9	5	12	0.7
T4	120	2.3	6	14	0.8
T5	160	2.3	7	15	1.2
T6	200	2.4	7	16	1.9
T7	240	2.6	7	16	0.9
T8	280	1.7	5	11	0.6

Source: Original data

Different models of variation in wheat production and quality indices, resulting from regression analysis, were communicated in relation to the fertilization applied to the wheat crop, or within the interaction [genotype × environment × technology] [2, 18, 20, 23, 34]. Response models of wheat production and protein content in relation to the optimization of nitrogen fertilization in climatic conditions specific to the Mediterranean basin were communicated by Ortuzar-Iragorri et al. (2010) [26]. The authors communicated quadratic models to describe the variation of production and protein content based on 13 experiments, under statistical safety conditions.

Zhu et al. (2012) [35] communicated models of variation in production and some wheat quality indices, obtained through regression analysis, in relation to applied fertilization, under statistical safety conditions (e.g. R^2>0.900, p<0.001). Lamlon et al. (2023) [17] communicated the variation of production, some productivity and quality indices in wheat in relation to organic substance and biofertilizers ($p \leq 0.005$).

Sala and Herbei (2023) [29] communicated models of variation and estimation of wheat production (Alex cultivar) in relation to 11 fertilization options, and the model based on applied fertilizers (F model) facilitated the estimation of production in conditions of statistical safety (R^2=0.763 based on applied fertilization; R^2=0.717 when checking the model based on production and fertilization communicated by other studies).

The present study described, with statistical certainty, the variation of the quality indices considered in the wheat analysis, the 'Venezio' cultivar, through models obtained through quadratic regression analysis, as well as through 3D models and in the form of isoquants, and the multicriteria analysis (PCA, CA) facilitated the classification of fertilization variants in relation to the considered quality indices.

CONCLUSIONS

Differentiated fertilization with nitrogen, 8 variants, range 0 - 280 kg ha^{-1} (variation rate of 40 kg ha^{-1}) led to specific values of the quality indices for the 'Venezio' wheat cultivar.

High amplitude of variation was recorded at the Zeleny index, $CV_{Zel\ Ind}$=7.8808, followed by gluten content CV_{Glt}=7.3357, protein content CV_{Pro}=5.3628 and hectolitre weight CV_{HW}=0.76352. In the case of humidity, the value of the coefficient of variation was CV_{Mstr}=1.0733.

The variation of the values of the quality indices in relation to nitrogen was described by polynomial equations of the 2nd degree, under conditions of statistical safety.

According to PCA, T4 and T7 variants were associated with Pro, Glt and Zel Ind indices, T5 and T6 variants were associated with HW, T3 and T8 variants were associated with moisture (Mstr), while variants T1 and T2 were placed independently, with the lowest values for the analyzed quality indices.

On the basis of the CA, the dendrogram of cluster grouping of the variants on the basis of similarity was obtained in relation to the values of the evaluated quality indices. The dendrogram has practical applicability to select fertilization options that lead to similar results in relation to quality indices, but in different fertilization conditions, a useful fact for optimizing fertilizer inputs and agricultural technologies.

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PRELIMINARY RESULTS OF INTEGRATED FERTILIZATION WITH GREEN MANURE AND MINERAL FERTILIZERS ON MAIZE YIELD

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Abstract

Maize (Zea mays L.) is an essential crop worldwide, and the application of fertilizers is a vital management strategy that significantly enhances its yield. The objective of this investigation was to assess the impact of green manure and mineral fertilization on the yield of maize. The experiments were conducted in an experimental field at Agricultural Research and Development Station Braila during the first decade of September 2021 to the second decade of October 2022. A bifactorial experiment was carried out based on the formula A × B, where A represents the green manure crops (a1– control – without green manure crop; a2- winter pea (Pisum sativum L. var. arvense); a3- white mustard (Sinapis alba L.); a4- winter rye (Secale cereale L.); a5- white mustard (Sinapis alba L) + rapeseed (Brassica napus L.); a6- rapeseed (Brassica napus L.) and B represents the mineral fertilization (b1– N0 unfertilized; b2- N60 (60 kg/ ha of N); b3- N90 (90 kg/ ha of N); b4- N120 (120 kg/ ha of N)). The results of this study show the benefits of integrated fertilization with green manure and mineral fertilizer. Maize grain yield was found to be enhanced by using green manure crops.

Key words: *maize, green manure crops, mineral fertilization*

INTRODUCTION

With the increasing trend of global climate change, particularly as a result of drought stress, the growth, and yield of maize decrease dramatically around the world, particularly in arid and semi-arid regions. Organic and inorganic fertilizers can modify plants' morphological, physiological, and biochemical processes for improved adaptation to harsh environments [7].
Current methods for global food security mislead farmers into using the maximum amount of inputs (chemicals) for crop productivity. Green manure has evolved as a cost-effective alternative to artificially created chemical fertilizers for farmers fields. From germination to harvesting, green manure can fulfill of the physical, chemical, biological, and pathological needs of plants [1].
Green manuring is the process of incorporating or plowing green plants into the soil, whether they were grown in the field or elsewhere and were in the vegetative or flowering stages. Green manures are leguminous crops or forages that are grown to conserve soil by incorporating their leafy materials. Green manure crops are characterized by their short duration, rapid growth, and high production of organic matter, and as a result, they release nitrogen, phosphorus, potassium, and other plant nutrients. Through nodule formation in their roots, leguminous green manure plants are able to fix atmospheric nitrogen [11].
The decomposition of green manure crops releases nutrients and recycles nitrogen, phosphorus, and potassium in an integrated plant nutrition system [13].
Including green manure crops throughout the year in the crop rotation is a benefit where animal manures are limited. In addition to improving soil fertility, a green manure crop can reduce weed problems in annual staple crops following green manure crop periods [12].
Green manure crops offer a variety of benefits that can be broadly categorized as increased

soil fertility. Green manures enrich the soil with organic matter and recycle nutrients. They prevent soil nutrients from being washed away. The green manure absorbs the nutrients and stores them within the plant. Legumes and other nitrogen-fixing plants are advantageous as they facilitate the transfer of nitrogen from the atmosphere to the soil. The principal advantage of utilizing green manure is its ability to serve as a source of nitrogen in instead of fertilizers. Green manures, particularly legumes, contain relatively more nitrogen, have a low carbon-nitrogen ratio, and behave almost identically to chemical nitrogen fertilizers [8].

The FAO states that permanent soil cover is a characteristic of conservation farming. Cover crops are useful for protecting the soil by providing an additional source of organic matter, recycling nutrients such as P_2O_5 and K_2O and mobilizing them in the soil profile, and utilizing nutrients that are easily leached, particularly N [3].

In a modern agricultural system, green manuring can be one of the best methods for sustaining soil health and crop yield [11].

In a long-term maize and sunflower cropping system, continuous use of nitrogenous fertilizers alone and an unfertilized control significantly decreased crop yields and soil fertility. Integrating the application of inorganic and organic fertilizers is critical for ensuring adequate nutrient delivery and sustaining crop productivity cropping method [10].

A wide variety of plant species have the potential to serve as green manures. Green manuring crops can be plant of grain legume

The most common cover crops in temperate regions of Europe are winter cover crops [6, 5, 4].

Green manuring crops can be plant in this region are legumes such as field pea or winter pea (*Pisum sativum* L. ssp. sativum var. arvense) [2]; cereals such as barley (Hordeum vulgare L.), triticale (*Triticosecale* Wittm.) and rye (*Secale cereale* L.) [2]; and brassicas such as white mustard (*Sinapis alba* L) and rapeseed (*Brassica napus* L.) [9].

The experiment was conducted to study the effect of green manuring in combination with nitrogen fertilizer on the yield of maize.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research and Development Station (ARDS) Braila-Chiscani Experimental Center during the period from September 2021 to October 2022. Soil was a vermic chernozem with a medium humus content 2.4 - 3.1% in the upper horizons and only 1.6% in the transition horizon, 0.14-0.25 % total nitrogen content.

The experimental design employed was a fully randomized block design with four replications. The primary determinant of the plot was the green manure species, while the secondary factors were the mineral fertilization treatments carried out in the subplot. Each test plot had a surface area of 42 m^2, while the overall surface area of the research plot was 4,032 m^2 .

The experimental factors are as follows:

Factor A- Green manure crops

a_1– control – without green mure crop

a_2 - winter pea (*Pisum sativum* L. var. arvense.)

a_3- white mustard (*Sinapis alba* L.)

a_4- winter rye (*Secale cereale* L.)

a_5 - white mustard (*Sinapis alba* L.) + rapeseed (*Brassica napus* L.)

a_6- rapeseed (*Brassica napus* L.)

Factor B – Mineral fertilization

b_1– N_0 unfertilized

b_2- N_{60} (60 kg/ ha of N)

b_3- N_{90} (90 kg/ ha of N)

b_4- N_{120} (120 kg/ ha of N)

Green manure pure crops were sown after winter wheat according to the following norms: winter pea 180 kg/ha, white mustard 10 kg/ha, winter rye 170 kg/ha, white mustard 6 kg/ha + rapeseed 4 kg/ha, rapeseed 8 kg/ha. These were seeded in the first decade of September 2021. The chopping and incorporation of the green manure into the soil were carried out in the third decade of April 2022 using the rotary harrow at a depth of 10-15 cm. Mineral fertilization was achieved by administering a complex NPK 15:15:15

fertilizer at the same time as seedbed preparation, and fractional dosages of urea were applied during the V5 and V8 maize growth stages. This yielded a basic fertilization of 40 kg/ha P and 40 kg/ha K for all experimental variants. Overall levels of N applied by fertilization were 60 kg/ha for N60, 90 kg/ha for N90, and 120 kg/ha for N120.

Maize was sown in 04.05.2022 with F423 hibrid at a density of 65,000 plants ha and harvesting was performed in the second decade of October.

After the maize were harvested, samples were taken to measure the moisture in the lab using a hygrometer (Granomat Pfeuffer). Standardizing the moisture content of maize to 14%, which is the national standard for moisture content, production was computed (STAS).

The effect of green manure and N rate treatments on maize production was determined by measuring maize grain yield.

The study utilized Analysis of Variance (ANOVA) to evaluate variations in treatment outcomes. Additionally, a Fisher's protected Least Significant Difference (LSD) test was employed to ascertain the statistical significance of differences between the experimental factors and control, with p-values of 0.05, 0.01, and 0.001.

RESULTS AND DISCUSSIONS

On the whole, the agricultural year 2021–2022 was a deficit year in precipitation; the deficit recorded was 156 mm, and the thermal deviation was positive (+1.6 °C).

The year 2022 was characterized as an unfavorable year for maize crop with severe drought stress in May, June and July. For the growing period of maize the rainfall was significant less than multiannual average value, deficit reaching -112 mm.

The largest positive deviations of the average monthly temperatures as compared to the multiannual average are registered in the months: June (+ 1.8°C), July (+1.9°C) and August (+2.9°C). Under these conditions, it was necessary to apply a reduced irrigation water norm.

Table 1. Monthly and growing season temperature and precipitation at ARDS Braila 2021-2022

Months	Temperature (°C)		Precipitation (mm)	
	2021-2022	Multiannual average	2021-2022	Multiannual average
October	10.2	11.5	33.1	30
November	8.1	5.6	27.1	33
December	2.5	0.6	43.8	36
January	1.3	-2.1	6.5	28
February	4.1	-0.2	11.1	27
March	3.8	4.7	13.8	26
April	11.9	11.2	25.1	35
May	18	16.7	24.3	48
June	22.7	20.9	33.3	62
July	24.8	22.9	8.9	46
August	24.9	22	26.9	39
September	17.9	17.3	31.8	32
Average/ Total	**12.5**	**10.9**	**286**	**442**

Source: Meteorological Stations Braila.

Table 2. Influence of green manure on maize yield, 2022

Green manure crop	Yield		Differences		Significance
	kg/ha	%	±kg/ha	%	
a1- control	5,805	100	Mt		
a2- winter pea	6,929	119.4	1124	19.4	***
a3- white mustard	6,699	115.4	894	15.4	***
a4- winter rye	6,530	112.5	725	12.5	***
a5 white mustard + rapeseed	6,195	106.7	390	6.7	*
a6- rapeseed	6,588	113.5	784	13.5	***
LSD (5%)= 321.04 kg/ha; LSD (1%)=512.97 kg/ha; LSD (0.1%)=709 kg/ha					

Source: Own results.

Table 3. Influence of mineral fertilization on maize yield, 2022

Mineral fertilization	Yield		Differences		Significance
	kg/ha	%	±kg/ha	%	
b1-N0	6,458	100	Mt		
b2-N60	7,463	115.6	1,005	15.6	***
b3-N90	7,892	122.2	1,435	22.2	***
b3-N120	9,082	140.6	2,625	40.6	***
LSD (5%)= 198.65 kg/ha; LSD (1%)=264.6 kg/ha; LSD (0.1%)=344.41 kg/ha					

Source: Own results.

The influence of green manures on maize production is shown in Table 2. From the analysis of the presented data, the following results were obtained: Maize yield is influenced by green manure fertilization, so it increases from 5,805 kg/ha for the variant without green manure to 6,195 kg/ha for the variant with mustard and rapeseed, 6,530 kg/ha for the variant with rye, 6,588 kg/ha for the variant with rapeseed, and 6,699 kg/ha for the variant with mustard. The highest yield was achieved for the variant with peas, at 6,929 kg/ha.

Compared to the non-fertilized green manure control, all variants result in increased yield. Differences from the control are very significant for four of the variants, the highest yield increase was obtained in the pea variant with a yield increase of 1,124 kg/ha and a 19.4% yield increase. The variant with mustard and rapeseed recorded a significant difference, but the yield increase was smaller, only 6.7%. Upon examination of the yield outcomes resulting from the application of mineral fertilization (as presented in Table 3) in the absence of green manure fertilization, it appears that maize yields increased proportionally to the amount of mineral nitrogen applied, as follows: unfertilized 6,458 kg/ha, N60- 7,463 kg/ha, N90- 7,892 kg/ha, and N120- 9,082 kg/ha.

Table 4. Effect of integrated nutrient management on productivity of maize

Factor b- mineral fertilization	Factor a – green manure								
	a1- control			a2- winter pea			a3- white mustard		
	Yield (kg/ha)	Dif. (kg/ha)	Sign.	Yield (kg/ha)	Dif. (kg/ha)	Sign.	Yield (kg/ha)	Dif. (kg/ha)	Sign.
b1-N0	5,805	0		6,929	0		6,699	0	
b2-N60	6,297	492	*	7,883	954	***	7,907	1,208	***
b3-N90	6,710	906	***	8,359	1,430	***	8,416	1,717	***
b4-N120	7,284	1,479	***	9,491	2,562	***	10,292	3,593	***
Factor b- mineral fertilization	Factor a – green manure								
	a4- winter rye			a5- white mustard + rapeseed			a6- rapeseed		
	Yield (kg/ha)	Dif. (kg/ha)	Sign.	Yield (kg/ha)	Dif. (kg/ha)	Sign.	Yield (kg/ha)	Dif. (kg/ha)	Sign.
b1-N0	6,530	0		6,195	0		6,588	0	
b2-N60	8,009	1,479	***	7,664	1469	***	7,016	429	-
b3-N90	8,112	1,582	***	7,947	1752	***	7,809	1221	***
b4-N120	9,112	2,882	***	9,248	3053	***	8,767	2180	***
LSD (5%)= 486.58 kg/ha; LSD (1%)=648.13 kg/ha; LSD (0.1%)=843.64 kg/ha									

Source: Own results.

The analysis of the data presented in Table 4 shows that fertilization with mineral nitrogen on an unfertilized green manure background has less influence, with yield increases compared to the N0 variation ranging from 492 kg/ha to 1,479 kg/ha. The application of mineral nitrogen doses on a green manure with a mustard background resulted in a progressive increase in the yield obtained, the increases being the highest compared to the other variants, with the yield increases compared to the N0 variant ranging from 1,208 kg/ha to 3,593 kg/ha. From the analysis of the data in Table 4, it can be seen that the influence of nitrogen fertilization is very significant for all variants. Only the N60 variant on an unfertilized background showed a significant difference, and the N60 variant on a green manure background showed an insignificant difference.

CONCLUSIONS

The results of this study show the benefits of integrated fertilization with green manure and mineral fertilizer. Maize grain yield was found to be enhanced by using green manure crops.

The year 2022 was characterized as an unfavorable year for maize crop with severe drought stress in May, June and July.

Based on the analysis of production data when mineral fertilizer was used without green manure fertilization, it appears that maize yields increased proportionally to the amount of mineral nitrogen applied, as follows: unfertilized 6,458 kg/ha, N60 7,463 kg/ha, N90- 7,892 kg/ha, and N120- 9,082 kg/ha.

Compared with the no green manure crops treatment, the variant with white mustard and N120 obtained a high yield per hectare, respectively 10,292 kg/ha, which preceded the variant with winter pea and N120 with a production of 9,491 kg/ha.

Given an optimal growing environment for green manure, incorporation of the generated biomass will increase maize yield.

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TRENDS ON THE TOMATO MARKET IN ROMANIA IN THE PERIOD 2010-2021

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Abstract

The study presents the main trends in the Romanian tomato market in the last decade. In order to identify trends in the tomato market, national and regional studies were carried out and a number of indicators were analyzed, including cultivated area, tomato production, average yield per hectare, base price, tomato consumption, but also the foreign trade of tomatoes (export and import). The processing methods included: descriptive statistics regarding mean, standard deviation, coefficient of variation and annual growth rate. Although the area cultivated with tomatoes decreased by approximately 30%, the average production per hectare reached 21,681 kg/ha in 2021, an increase of 40%. However, Romania's tomato market currently has a significant deficit in the trade balance (approximately 112,694 thousand euros in 2021). For this reason, it is necessary to stimulate productivity growth and increase efficiency along the chain of agri-food products by investing in modern agricultural exploitation.

Key words**:** *marketing, agriculture, tomatoes, trade, Romania*

INTRODUCTION

An important characteristic of tomatoes is related to the fact that they can be consumed in a variety of forms, both fresh and processed into various products such as juices, sauces, ketchup, paste chicken, and in dry form, which makes them the second most important vegetable product in the world [8].
In 2019, the world tomato production was approx. 197 million tons, of which 75% was destined for the fresh market and 25% for processing [3].
The tomato processing industry is one of the most important sectors of the agro-food industry. Annually, over 40 million tons of tomatoes are processed globally [2].
Considered sometimes a "vegetable", sometimes a "fruit", tomatoes appeal not only for their red or yellow color, but also for their different sizes and shapes, but above all for their sweet taste and juicy content. In terms of chemical composition, tomatoes contain 80% water, 2% protein, 3% sugar, minerals, vitamins, citric, malic, and pectic acids, oxalates [7, 14, 19].
It is scientifically proven that 100 g of tomato provides 33% of an adult's vitamin C requirement, 8% of vitamin B1, 5% of folic acid, 13% of vitamin A and 16-20 calories, although their nutritional value varies depending on the technology used, climatic factors and storage conditions. Eating tomatoes also strengthens the body's defenses against infections, regulates digestive function, regulates the cardiovascular system, and revitalizes the skin and eyesight [11,12,13].
Tomatoes originate from Central America. They began to be cultivated in Europe starting from the 16th century, and in Romania, tomatoes were cultivated from the 19th century in small areas, and with the demographic growth, the areas cultivated with tomatoes also increased. These are one of the most representative vegetable species cultivated in Romania [16, 18].
Tomatoes are of particular importance for the food industry, as an intensification of the factors of land use and labor resources, fodder, export, and last but not least as a source of profit. Understanding the functioning mechanism of the market, namely the relationship between the demand and supply of a product, we can say that the relationship between the buying and selling

market is an essential and specific element [9]. It must be remembered that with tomatoes there is a need to increase the strengthens the body's defences against infections, regulates digestive function, regulates the cardiovascular system, and revitalizes the product's perishable natureransit speed (in the market), due to the perishable nature of the product. In the long term, tomato breeding programs have focused on crop yield, shape, and shelf life. However, over the past 30 years, tomato producers have pursued the development of superior-quality tomatoes to meet consumer demands for fresh vegetables with a pleasing visual appearance, and higher organoleptic and nutritional characteristics [1, 3, 6].

According to the Fideicomisos Instituidos en Relación con la Agricultura report, "the volume of world tomato exports has grown at an average annual rate of 5.19% since 2007. In 2016, tomatoes were the most traded vegetable worldwide, accounting for 20.86% of the total export volume of fresh vegetables according to United Nations data".

According to FAOSTAT estimates, "tomatoes are also the most cultivated vegetable in the world, with a historical peak reached in 2016 (177.04 thousand tons) in a total harvested area of 4.78 thousand ha and with a yield of 37.02 t/Ha. More than half of the world's tomato production (56.71%) is concentrated in four countries. China is the world's largest producer of tomatoes (31.81%), with almost a third of world production, followed by India (10.39%), USA (7.36%) and Turkey (7.12%)".

"Regional trade agreements (NAFTA and EU28), where tomatoes are currently traded on a large scale, remain unstable between member states, generating an uncertain trade situation on both sides of the Atlantic; Brexit will result in the loss of the UK's free trade status with other EU states and tariffs will increase the cost of exports and also the cost of imports by a third. Import prices will also rise in the UK, where more than a third of imports come from the EU and the UK is the EU's the third largest tomato market. The threat of the US withdrawing from NAFTA and declaring trade war against China and the EU28 have increased uncertainty in international trade" [4].

In Romania, the tomato market, like the agricultural market as a whole, is in a difficult situation, the foreign trade in tomatoes is characterized by a significant deficit in the trade balance, which requires a series of government measures to reduce this deficit [5].

To increase productivity and economic efficiency in the production chain, it is necessary to expand the cultivation of tomatoes in protected spaces, like greenhouses, which can be achieved by investing in modern farms with new cultivation technologies. Tomato producers should combine their capital and efforts in the form of cooperatives, such as agricultural cooperatives, to obtain cheaper agricultural inputs, apply modern technologies, and have a greater openness to the market [15].

The financial resources required for the application of the de minimis aid scheme amount to 187,500 thousand lei (the equivalent of 39,477 thousand EUR) and are provided from the 2020 budget. The value of the de minimis aid is a maximum of 3,000 EUR/beneficiary/year. The system is addressed to agricultural producers who are natural persons with producer certificates, authorized natural persons established pursuant to GEO no. 44/2008, individual businesses, family businesses, and legal entities.

Research on *Solanum lycopersicum* L. shows that tomatoes are perishable products and therefore prices fluctuate according to supply and demand. It is necessary to forecast tomato prices during the harvest season so that producers can make informed production decisions [17].

In this context, the purpose of the paper was o analyze the main trends in the Romanian tomato market in the last decade, in terms of cultivated area, average yield, basic price, consumption, but also foreign trade (export and import) using the available statistical data for the period 2010-2021.

MATERIALS AND METHODS

This research is based on statistical data provided by the National Institute of Statistics (INS), as well as the data series provided by the International Trade Center (INTRACEN) regarding tomato trade (trade balance) in the period 2010-2021.

The research methods applied in developing the research were systematic and creative analysis as well as the complex approach to the theme regarding the "tomato trade" by researching the studies carried out by different researchers in the agricultural field.

Statistical indicators such as:

Arithmetic means, calculated as the ratio between the sum of the values of the data series and the number of years considered.

$$m= \frac{x_1+x_2+\cdots+x_n}{n} \qquad \text{.............................(1)}$$

The standard deviation indicates how much the values are dispersed from the mean.

$$\partial = \sqrt{\frac{\sum(xi-\bar{x})^2}{n-1}} \text{............................(2)}$$

where:
∂ = standard deviation;
xi = values of the data series over a number of years;
n = number of years considered.

Coefficient of variation:

$$C = \frac{\partial}{\bar{X}} * 100 \text{.......................................(3)}$$

It can take values between 0 and 100%. Between 0-10% attests to a greater degree of homogeneity of the series, between 10-20% - medium variation; over 20% - high variation.

Annual growth rate, this shows the annual growth of the analyzed phenomenon:

$$r = \sqrt[n-1]{\prod\left(\frac{p\,n}{p\,n-1}\right)} - 1 \text{.............................(4)}$$

where:
r= average annual growth rate,
∏pn/pn-1 = indicators of chain growth.

RESULTS AND DISCUSSIONS

Cultivated area with tomatoes

The areas cultivated with tomatoes at the level of development regions in the period 2010-2021 showed a downward trend in Romania, as can be seen in Table 1.

The areas cultivated with tomatoes registered limits between 34.12 thousand ha in 2020 and 51.75 thousand ha in 2011. In 2021, 34.75 thousand ha were recorded, decreasing with about 43% compared to the area registered in 2010, respectively 49.77 thousand ha.

Analyzing the area cultivated with tomatoes at the level of development regions, the South-Muntenia Region (7.49 thousand ha in 2021) and the North-East Region (6.06 thousand ha in 2021) and the South-East Region (5.80 thousand ha in 2021) are the regions that stood out for large cultivated areas.

At the opposite pole, was the Bucharest-Ilfov Region, with only 1.29 thousand tons in 2021.

In the same year, the distribution of the cultivated area with tomatoes in the territory reflects that tomatoes are mainly cultivated in North East of the country (6.06 thousand ha), South Muntenia (5.80 thousand ha) and in South West Oltenia (5.21 thousand ha).

The smallest surface is cropped in Bucharest Ilfov region of development and accounted for 1.29 thousand ha.

In the analyzed interval, the highest declined was achieved in South -East region from 9.23 to 5.80 thousand ha (- 3.43 thousand ha, -37.2 %) and in South -West Oltenia from 10.33 to 5.21 thousand ha (-5.12 ha, - 49.6%).

As we may notice from the figures, the decrease of the cultivated area with tomatoes was carried out in all the micro regions of development (Table 1).

Following the analysis of the statistical indicators for the area cultivated with tomatoes in the period 2010-2021, the following results were obtained:

-The standard deviation recorded limits between 0.20 thousand ha in the Bucharest-Ilfov Region and 1.96 in the South-West-Oltenia Region, in total the standard deviation recorded 5.77 thousand ha.

-The coefficient of variation on the surface with tomatoes varied between 7.53% in the

North-West Region and 26.71% in the South-West-Oltenia Region.
-The annual growth rate showed negative values for all development regions of the country, between -0.69% in the Bucharest-Ilfov Region and -6.04 in the South-West-Oltenia Region (Table 2).

Table 1. The area cultivated with tomatoes by development regions in the period 2010-2021 (thousands of hectares)

Development regions	Years											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	UM: thousands of hectares											
North-West	4.15	3.30	3.43	3.83	3.66	3.60	3.69	3.58	3.62	3.50	3.15	3.26
Center	2.60	2.58	2.58	3.33	2.84	3.32	3.01	2.89	3.00	3.04	2.20	2.10
North-East	7.52	8.04	7.74	7.74	6.98	6.96	6.57	6.46	6.82	6.64	4.70	6.06
South-East	9.23	9.91	8.72	8.57	7.27	7.27	7.23	6.87	6.91	6.77	6.95	5.80
South Muntenia	9.65	10.98	10.41	9.96	9.44	9.47	8.26	8.13	8.21	8.98	7.17	7.49
Bucharest Ilfov	1.39	1.85	1.72	1.78	1.57	1.57	1.45	1.41	1.43	1.41	1.22	1.29
South-West Oltenia	10.33	10.01	10.20	8.18	7.42	7.40	6.14	6.12	6.16	5.98	4.80	5.21
West	4.92	5.08	4.87	4.99	4.68	4.66	4.65	4.58	4.60	4.53	3.93	3.53
TOTAL	**49.77**	**51.75**	**49.66**	**48.37**	**43.86**	**44.26**	**41.00**	**40.04**	**40.74**	**40.85**	**34.12**	**34.75**

Source: INS data processing - TEMPO Online - AGR108A - The area cultivated with the main crops, by ownership forms, macro-regions, development regions, and counties, for the main food and beverage products, Accessed on 15.02.2023 [10].

Table 2. Statistical indicators calculated for the area cultivated with tomatoes in the period 2010-2021

Development regions	2021/2010	2021/2020	MIN.	MAX.	AVERAGE	STANDARD DEVIATION	*COEFFICIENT OF VARIATION (%)	ANNUAL GROWTH RATE (%)
North-West	-21.25%	3.49%	3.15	4.15	3.56	0.27	7.53	-2.15
Center	-19.06%	-4.54%	2.10	3.33	2.79	0.39	14.04	-1.90
North-East	-19.34%	29.10%	4.70	8.04	6.85	0.90	13.20	-1.93
South-East	-37.14%	-16.47%	5.80	9.91	7.62	1.20	15.76	-4.13
South Muntenia	-22.33%	4.55%	7.17	10.98	9.01	1.18	13.05	-2.27
Bucharest Ilfov	-7.29%	5.67%	1.22	1.85	1.51	0.20	13.00	-0.69
South-West Oltenia	-49.58%	8.46%	4.80	10.33	7.33	1.96	26.71	-6.04
West	-28.18%	-10.22%	3.53	5.08	4.59	0.44	9.66	-2.96
TOTAL	**-30.18%**	**1.85%**	**34.12**	**51.75**	**43.26**	**5.77**	**13.34**	**-3.21**

Source: INS data processing - TEMPO Online - AGR108A - The area cultivated with the main crops, by ownership forms, macro-regions, development regions, and counties, for the main food and beverage products, Accessed on 15.02.2023 [10].

Tomato production

Regarding the total tomato production, the analysis of Table 3 shows that from 2010 to 2021, Romania's tomato production is on a downward trend, registering values between 627 thousand tons in 2016 and 911 thousand tons in 2011, with an average of 730 thousand tons (Table 3).

At the level of the development regions, the highest total production was recorded in the South-Muntenia Region (158 thousand tons in 2021) and the South-East Region (144 thousand tons in 2021). At the opposite pole, the Bucharest-Ilfov Region ranks, with 28 thousand tons in 2021 (Table 3).

Table 3. Total tomato production by development regions in the period 2010-2021 (thousand tons)

Development regions	Years											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	UM: thousands of tons											
North-West	63	64	49	56	55	52	55	60	59	54	62	56
Center	35	43	35	45	44	47	43	44	48	42	45	40
North-East	105	124	98	111	106	104	88	94	101	94	86	118
South-East	175	210	133	155	150	147	160	147	158	147	176	144
South Muntenia	142	173	134	149	139	141	117	132	155	156	158	158
Bucharest Ilfov	37	55	32	35	29	29	22	21	24	21	24	28
South-West Oltenia	145	166	144	128	121	119	84	101	112	104	108	133
West	67	76	59	70	63	63	59	81	86	71	86	76
TOTAL	**769**	**911**	**683**	**749**	**706**	**702**	**627**	**680**	**743**	**689**	**746**	**753**

Source: INS data processing - TEMPO Online - AGR109A - Vegetable agricultural production for the main crops, by forms of ownership, macro-regions, development regions and counties, for the main food and beverage products, Accessed on 15.02.2023 [10].

Table 4. Statistical indicators calculated for total tomato production in the period 2010-2021

Development regions	2021/2010	2021/2020	MIN.	MAX.	AVERAGE	STANDARD DEVIATION	*COEFFICIENT OF VARIATION (%)	ANNUAL GROWTH RATE (%)
North-West	-12.07%	-10.13%	49	64	57	4.55	7.96	-1.16
Center	15.04%	-12.69%	35	48	42	4.22	9.93	1.28
North-East	13.10%	37.55%	86	124	102	11.56	11.30	1.13
South-East	-17.72%	-17.98%	133	210	159	20.40	12.86	-1.76
South Muntenia	11.76%	0.04%	117	173	146	15.01	10.27	1.02
Bucharest Ilfov	-23.82%	16.41%	21	55	30	9.52	32.02	-2.44
South-West Oltenia	-8.77%	22.58%	84	166	122	22.51	18.43	-0.83
West	14.29%	-10.93%	59	86	71	9.85	13.81	1.22
TOTAL	-1.97%	1.03%	627	911	730	69.96	9.59	-0.18

Source: INS data processing - TEMPO Online - AGR109A - Vegetable agricultural production for the main crops, by forms of ownership, macro-regions, development regions and counties, for t,he main food and beverage products, Accessed on 15.02.2023 [10].

From the analysis of the statistical indicators calculated for the total production of tomatoes, in the analyzed period the following results were obtained: the standard deviation registered limits between 4.22 thousand tons in the Central Region and 22.51 thousand tons in the South-West Oltenia Region, and at the country level, the standard deviation was 69.96 thousand tons.

The coefficient of variation of total tomato production varied between 7.96% in the North-West Region and 32.02% in the Bucharest-Ilfov Region. The annual rate of growth recorded negative values for 4 of the analyzed regions, respectively North-West (-1.16%), South-East (-1.76%), Bucharest-Ilfov (-2.44%), and South-West Oltenia (-0.83%) (Table 4).

Tomato yield

Regarding the average production per hectare, an increasing trend was highlighted, with values between 13,761 kg/ha in 2012 and 21,876 kg/ha in 2020, with an average of the period equal to 17,098 kg/ha (Table 5).

Table 5. Average tomato production per hectare by development region in the period 2010-2021 (kg/ha)

Development regions	Ani											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	UM: Kg/ ha											
NORTH-WEST	15,276	19,377	14,406	14,684	15,055	14,455	14,935	16,861	16,304	15,380	19,639	17,059
CENTER	13,294	16,693	13,465	13,545	15,349	14,070	14,192	15,131	15,884	13,977	20,655	18,897
NORTH-EAST	13,914	15,416	12,617	14,284	15,240	14,924	13,326	14,552	14,788	14,089	18,311	19,510
SOUTH-EAST	19,004	21,177	15,251	18,143	20,628	20,193	22,168	21,340	22,924	21,752	25,331	24,872
SOUTH--MUNTENIA	14,669	15,772	12,875	14,990	14,679	14,927	14,201	16,227	18,852	17,370	22,058	21,105
BUCHAREST - ILFOV	26,521	29,739	18,797	19,465	18,240	18,501	15,097	15,121	16,672	15,167	19,789	21,790
SOUTH-WEST OLTENIA	14,090	16,546	14,098	15,629	16,362	16,094	13,655	16,547	18,198	17,452	22,560	25,497
WEST	13,608	15,007	12,022	14,055	13,386	13,465	12,582	17,593	18,780	15,592	21,829	21,657
TOTAL	**15,443**	**17,602**	**13,761**	**15,488**	**16,102**	**15,857**	**15,297**	**16,978**	**18,235**	**16,879**	**21,858**	**21,681**

Source: INS data processing - TEMPO Online - AGR110A - Average production per hectare, for the main crops, by forms of ownership, macro-regions, development regions and counties, for the main food and beverage products, Accessed on 15.02.2023 [10].

Table 6. Statistical indicators calculated for the average production per hectare obtained for tomatoes in the period 2010-2021

Development regions	2021/2010	2021/2020	MIN.	MAX.	AVERAGE	STANDARD DEVIATION	*COEFFICIENT OF VARIATION (%)	ANNUAL GROWTH RATE (%)
NORTH-WEST	11.67%	-13.14%	14,406	19,639	16,119	1,810	11.23	1.01
CENTER	42.15%	-8.51%	13,294	20,655	15,429	2,310	14.97	3.25
NORTH-EAST	40.22%	6.55%	12,617	19,510	15,081	1,970	13.07	3.12
SOUTH-EAST	30.88%	-1.81%	15,251	25,331	21,065	2,787	13.23	2.48
SOUTH--MUNTENIA	43.87%	-4.32%	12,875	22,058	16,477	2,842	17.25	3.36
BUCHAREST - ILFOV	-17.84%	10.11%	15,097	29,739	19,575	4,551	23.25	-1.77
SOUTH-WEST OLTENIA	80.96%	13.02%	13,655	25,497	17,227	3,513	20.39	5.54
WEST	59.15%	-0.79%	12,022	21,829	15,798	3,400	21.52	4.31
TOTAL	40.39%	-0.81%	13,761	21,858	17,098	2,477	14.49	3.13

Source: INS data processing - TEMPO Online - AGR110A - Average production per hectare, for the main crops, by forms of ownership, macro-regions, development regions and counties, for the main food and beverage products, Accessed on 15.02.2023 [10].

The analysis of the statistical indicators calculated for the average production per hectare obtained for tomatoes gave the following results for the analyzed period. The standard deviation showed limits between 1,810 kg/ha in the North-West Region and 4,551 kg/ha in the Bucharest-Ilfov Region, and for the whole country, the standard deviation was 2,477 kg/ha. The coefficient of variation of the average tomato production per hectare oscillated between 11.23% in the North-West Region and 23.25% in the Bucharest-Ilfov Region. Regarding the annual growth rate, it recorded negative values only in the Bucharest-Ilfov Region (-1.77%), for the other development regions it recorded positive values (Table 6).

Average annual tomato consumption per dweller

In Romania, the average annual consumption per dweller increased by about 5.25% in the period 2010-2020, from 40 kg per inhabitant to 42.1 kg per inhabitant. From the calculation of linear type regression, an increase in average tomato consumption with 0.3182 kg/inhabitant per year has been observed.

The increase in the standard of living of Romanians is reflected in the evolution of the annual consumption of tomatoes per capita. This is highly influenced by the volatility of the price of valorization in tomatoes (Figure 1).

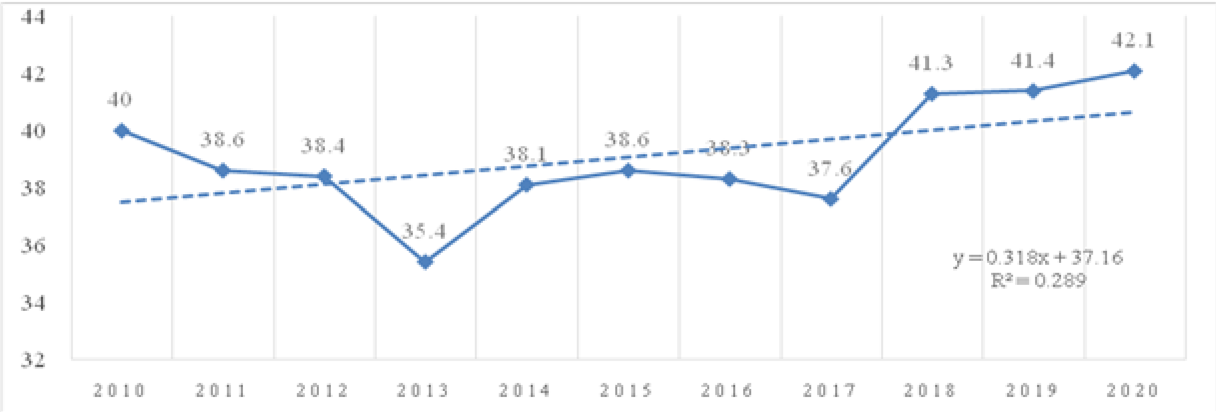

Fig. 1. Evolution of the annual tomato consumption per inhabitant in the period 2010-2020 (kg/inhabitant)
Source: INS data processing - TEMPO Online - CLV104A - Annual average consumption per inhabitant, of the main food and beverage products, Accessed on 15.02.2023 [10].

Tomatoes basic price

Regarding the basic price of tomatoes, it was increased by about 37% during the analyzed period. Calculating the linear type regression, it was observed that the basic price of tomatoes has increased by approx. 149 lei/ton per year (Figure 2).

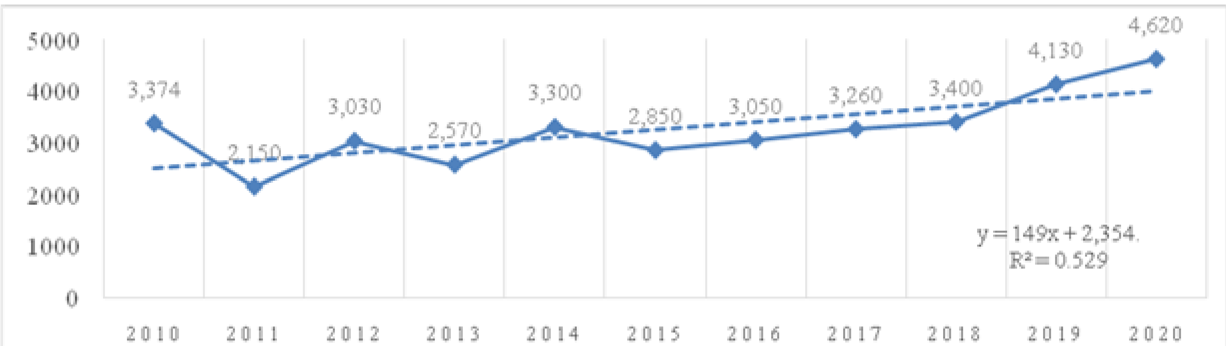

Fig. 2. Evolution of the average basic price of tomatoes in the period 2010-2020 (lei/ton)
Source: Data processing Ins - Tempo online - AGR209a - Statistics of unitary values, basic prices, Accessed on 18.10.2022 [10].

Tomato export

The analysis of the tomato export showed a descending tendency at the level of the period 2010-2021. From a value point of view, the export varied between 250 and 2,251 thousand euros, and in terms of its quantity, the variation between 348 and 2,990 tonnes was noted (Figure 3).

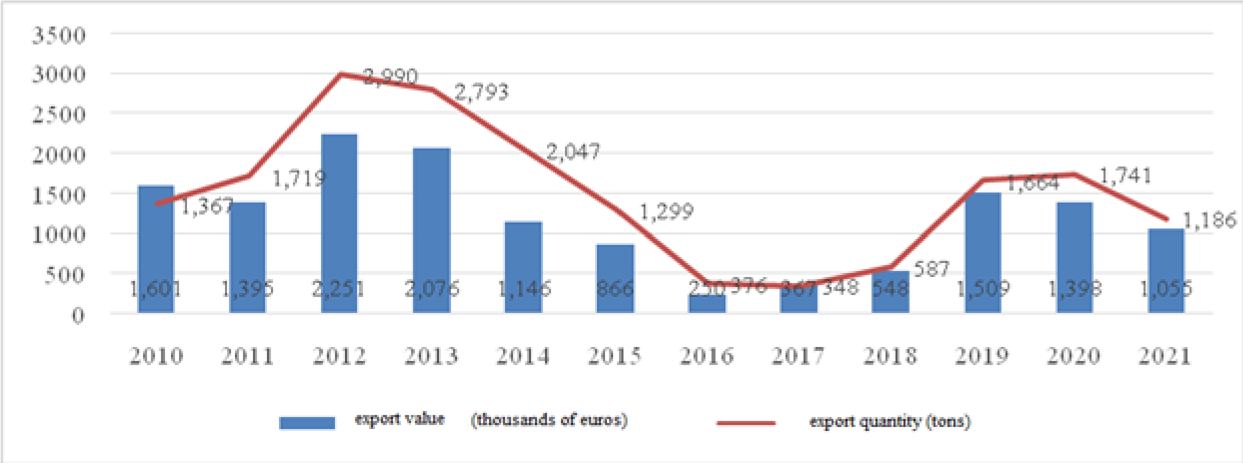

Fig. 3. Evolution of tomato export during 2010-2021
Source: Data processing Intracen.org - Trade Map - Product: 0702 Tomatoes, Fresh or Chilled, Accessed on 15.02.2023 [20].

The top of the first six countries that imported tomatoes from Romania consists of the following countries: Poland (476 thousand euros and 555 tonnes), Republic of Moldova (222 thousand euros and 256 tonnes), Spain (68 thousand euros and 80 tons), Belgium (63 thousands and 56 tons), the United Kingdom (39 thousand euros and 38 tons) and Greece (36 thousand euros and 42 tons) (Table 7).

Table 7. List of the main 6 countries that imported tomatoes from Romania in 2021

Importing countries	Exported value (Thousand Euro)	Exported quantity (Tons)
Poland	476	555
Moldova, Republic of	222	256
Spain	68	80
Belgium	63	56
United Kingdom	39	38
Greece	36	42

Source: Data processing Intracen.org - Trade Map - Product: 0702 Tomatoes, Fresh or Chilled, Accessed on 15.02.2023 [20].

Tomato import

Regarding, the import of tomatoes, the analysis highlighted an upward trend at the level of the period 2010-2021. From a value point of view, the import oscillated between 28,858 thousand Euros and 92,561 thousand euros and quantitatively ranged between 41,395 tons and 92,561 tons (Figure 4).

Although the production of tomatoes grown in protected areas has increased, national production cannot cover the consumption needs of the population even in off-season periods and it is necessary to resort to imports from countries such as Turkey. (53,223 thousand euros and 58,464 tonnes), Germany (18,644 thousand euros and 11,293 tons), the Netherlands (15,697 thousand euros and 5,495 tons), Spain (12,770 thousand euros and 7,075 tons) or Italy (4,768 thousand euros and 3,402 tons) (Table 8).

Table 8. List of the main 6 countries that exported tomatoes to Romania in 2021

Exporting countries	Import value (Thousand Euro)	Imported quantity (Tons)
Türkiye	53,223	58,464
Germany	18,644	11,293
Netherlands	15,697	5,495
Spain	12,770	7,075
Italy	4,768	3,402

Source: Data processing Intracen.org - Trade Map - Product: 0702 Tomatoes, Fresh or Chilled, Accessed on 15.02.2023 [20].

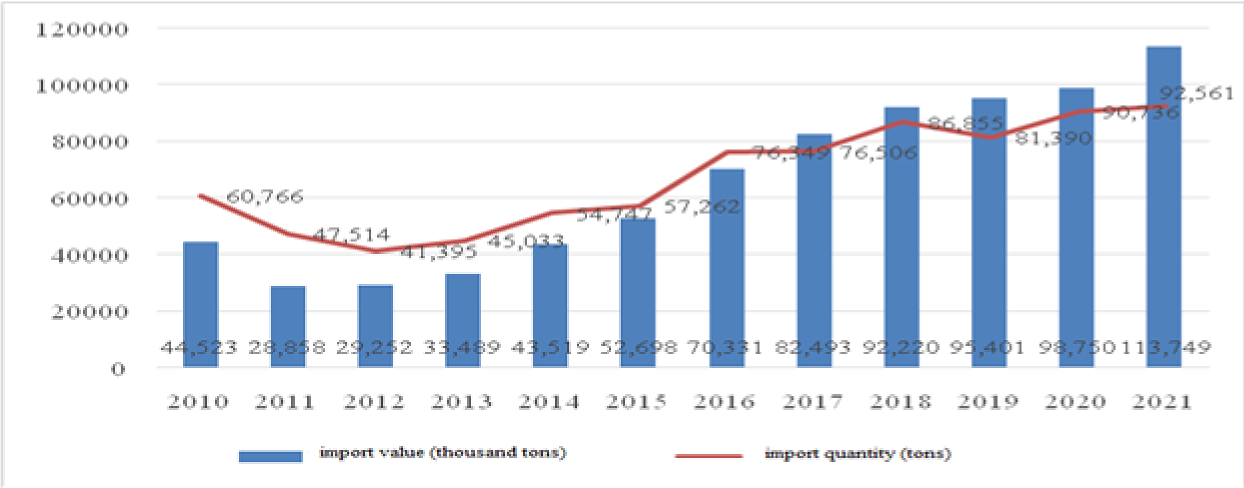

Fig. 4. Evolution of import of tomatoes in the period 2010-2021
Source: Data processing Intracen.org - Trade Map - Product: 0702 Tomatoes, Fresh or Chilled, Accessed on 15.02.2023 [20].

The trade balance of tomatoes

The commercial balance of a country reflects the imports and exports of goods and services, over time, representing the net difference between the value of exported and imported goods and services. The balance is favorable if imports are smaller than exports, otherwise, the commercial balance is deficient.

An analysis of statistical data (Figure 5), reveals that in Romania, imports exceed tomato exports, resulting in a commercial deficit of -27,001 thousand Euros in 2012 until -97,352 thousand Euros in 2021.

According to the tendency line y = -8,054.3x - 11,882, the commercial balance decreased on average by approx. 8054 thousand euros per year (Figure 5).

Fig. 5. The evolution of the commercial balance of tomatoes in the period 2010-2021(thousand euros)
Source: Data processing Intracen.org - Trade Map - Product: 0702 Tomatoes, Fresh or Chilled, accessed on 15.02.2023

CONCLUSIONS

Romania has the potential to become a country with performance in the horticultural field, especially for tomatoes, especially organic ones. Family farms specialized in vegetables are a tradition in our country, which is why our country currently holds a large part of vegetable holdings in the European Union. However, many of them have a very small dimension, for which they are not competitive, but contribute to the vitality of the Romanian village, and to maintaining the traditions and culture in the rural area.

Before 2000, the greenhouse area had thousands of hectares, and now it is approx. 300 hectares. Currently, this greenhouse area is too small to ensure the vegetables we need during the cold season. In this sense, it is necessary to implement special programs for the cultivation of vegetables in protected areas and to supply consumer products in winter.

According to statistics, almost two-thirds (65.1 %) of the population of Romania does not consume fruits and vegetables daily. In view of this situation, it is necessary to develop a special program the for daily consumption of vegetables and fruits. European funds and common agricultural policy are important tools for supporting the horticultural sector in Romania.

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STUDY ON THE ROLE OF FACTORING IN BUSINESS FINANCING

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Abstract

The financial challenges of the last two years generated by the pandemic, military conflicts, etc. have determined Romanian companies to evaluate their businesses and choose the best sources in order to continue their economic activity. The companies' short- and medium-term objectives were shaped according to the new economic and social conditions. Access to financing is a key element for development, to build new jobs, to remain competitive. Consequently, the need for short-term financing increased and was honored by accessing factoring products by companies. Through the conducted study, it was highlighted that for small and medium-sized companies, factoring products are of interest and are very useful. The evolution of the products granted by Romanian financial institutions are in correlation with the international market, but the proportions are different. Developed countries promote financing through factoring, the proof is the volumes reported by factoring companies. At the same time, financial institutions maintain their prudential criteria in conditions where the economy is influenced by social and political factors, some unpredictable and with a high degree of risk

Key words**:** *factoring, financing, business, services*

INTRODUCTION

Factoring represents a combination of financial services that include covering the risk of non-payment, amicable collection, financing, debt management. After the 2008 crisis, many small companies had difficulties in obtaining traditional bank loans [3].

The seller assigns the receivables to a factoring company or banks and immediately receives cash.

Within a factoring contract, the contractual parties are specifically named:

- The adherent is the company that assigns the receivables issued in favor of a trader (debtor)
- The factor is the financial institution that becomes the transferee. The Adherent transfers the receivables of the Factor before they reach maturity.
- The accepted debtor is the commercial partner of the adherent with whom he concludes commercial contracts.

The object of the factoring contract is the totality of the present and future claims that an adherent holds in favour of a debtor, as well as their accessories arising from all commercial contracts, invoices, orders and any other commercial documents.

The receivables are transferred by assignment to the Factor who becomes the creditor of the accepted Debtor. For the services offered, the factor charges *commissions* that must be specified in the factoring contract:

- the factoring commission calculated flat at the nominal value of the invoices assigned by the Factor to the Adherent plus a fixed amount for each assigned invoice. It is charged at the time of assignment of invoices.

By paying this commission, the Adherent accesses the amicable collection services, invoice management and/or covering the risk of non-payment or insolvency of the debtor.

- the debtor analysis commission charged by the bank at the time of concluding the factoring contract
- the financing commission. It represents the price that the member pays if he wants to obtain the financing of certain, liquid, payable debts. The subscriber can request financing at the time of transfer or after this moment, but not later than the due date of the invoices. It is charged throughout the financing period.

The size of commission and size the amount that will be paid immediately to clients depends on the receivables, its quality, business reputation of the debtor etc. [22].

- the commission for granting/ extending/ increasing the financing ceiling and the ceiling for covering the risk of non-payment. It is charged as a percentage of the value of the ceiling approved at the time of the event.

All commissions within the factoring contract are subject to VAT.

The *financing documents* presented by the Adherent in the factoring contract:

- Notification Letter of the accepted debtor issued according to the Factor's instructions
- Commercial contracts concluded with debtors
- The List of the assigned invoices

Guarantees requested by the Factor:

- mortgage on all accounts opened with the factor
- money order ticket in white, signed

Legal aspects of the factoring contract:

According to the study carried out by the EBRD in 2018, which includes 24 countries, in Romania, the definition of the factoring contract is not specifically mentioned [6].

The Accounting Regulation implementing the relevant European directives, dated 17 July 2015, applicable from 1 January 2016 defines factoring, as a contract concluded between the client named Adherent and a financial institution [4]. The object of the transaction is effected by the transfer the property of its commercial receivables (invoices) to the Factor. During the validity of the agreement, Factor has to ensure the collection of the adherent's receivables. The institution, based on the received documentation, pays the nominal value of the receivables, less agio, either immediately or at their due date or at the contractually due date established with the adherent. A similar definition is provided by the Accounting Regulation according to financial reporting international standards, applicable to credit institutions, dated 16.12.2010 [8].

Debt assignment is regulated by the Civil Code, it does not specifically refer to factoring (with or without recourse).

Based on the Civil Code future receivables can be assigned, provided that the assignment document includes elements that permit the determination of the assigned receivable.

The “true sale” concept is not defined under Romanian law. In practice, from a legal perspective, achieving true sale is often translated into Romanian law concepts as achieving the transfer of the ownership right over the receivables from the patrimony of the assignor to the patrimony of the assignee.

The factoring contract is:

- it is a synalagmatic contract, it generates rights and obligations for the adherent and factor,
- it is a contract with onerous title - the Adherent pays a price to the factor for the services offered
- it is a commutative contract - the extent of the obligations is established from the beginning
- it is a consensual contract - it is concluded with the agreement of the parties
- it is an adhesion contract - the Factor establishes the contractual clauses for the most part, and the Adherent accepts them under the conditions formulated by the financial institution
- it is a commercial contract - the parties are legal entities, merchants, and the effects of the contract are generated by commercial acts concluded by the member with his debtors

Legal aspects regarding international transactions are also generated by the law applicable to contracts. The non-existence of national regulations regarding factoring, the lack of knowledge of the legislation of the debtor's country by the seller, the internal legislative specificities regarding the assignment of debt, the prohibition of assignment, the transfer of ownership led to the idea of standardizing the law of international contracts.

There are two international instruments indented to promote the movement of goods and services across national borders by facilitating increased access to a lower cost credit. The first instrument of unification is the UNIDROIT (International Institute for the Unification of Private Law) Convention on International Factoring (Ottawa, 1988) which is entered into force in 1995 with the ratification of six countries (France, Hungary, Italy, Lithuania and Nigeria) and became through that ratification a part of the national legislation of those countries. Under auspices of UNCITRAL (UN Commission for International Trade Law) another instrument of unification has been created in the field of receivables financing. It is the United Nations Convention on the Assignment of Receivables in International Trade which is issued in 2001 [31].

The following receivables cannot be the subject of the factoring contract, according to the United Nations Convention on the Assignment of Receivables in International Trade:

(a) Transactions on a regulated exchange;

(b) Financial contracts governed by netting agreements, except a receivable owed on the termination of all outstanding transactions;

(c) Foreign exchange transactions;

(d) Inter-bank payment systems, inter-bank payment agreements or clearance and settlement systems relating to securities or other financial assets or instruments;

(e) The transfer of security rights in, sale, loan or holding of or agreement to repurchase securities or other financial assets or instruments held with an intermediary;

(f) Bank deposits;

(g) A letter of credit or independent guarantee

From the specialized literature and banking practice, the receivables that the Adherent can assign to obtain non-payment risk coverage services and financing services must also meet the following conditions:

- To represent firm obligations resulting from commercial facts (sales of goods, provision of services)
- Not to represent sales on consignment, or deposit, in the barter system, or, in general, any sale under a suspensive or resolutory condition;
- Not to represent advance payments, cash-on-delivery deliveries, pay-as-you-go deliveries, sales or services to companies under special administration, in reorganization, in the bankruptcy or preventive composition procedure.
- Their deadline should not be exceeded.
- That they have not already been assigned or encumbered in any way in favor of a third party and that they are freely assignable, without any restrictions;

The debtor's notification regarding the conclusion of the factoring contract and the assignment of receivables was made in writing. Through this document, the accepted debtor is notified of the existence of the factoring contract, receives instructions regarding the account in which he will pay the invoices (in the account indicated by the Factor).

Registration (with the Electronic Registry of Movable Property Collateral- AEGRM) is necessary for making the transfer effective against third parties and for establishing the priority ranking between creditors. The registration of security interests in AEGRM is mandatory for certain types of transactions, such as financial leasing, factoring, and commercial loans secured by movable assets.

The electronic registration of movable property collateral in AEGRM provides a more streamlined and secure process for both creditors and debtors.

The notification of the debtor is not required for validity purposes, but rather for making the assignment effective against the debtor.

The assignment does not exonerate the assignor from liability against the debtor as a result of breaching the contractual prohibition.

VAT issues - Under the Romanian VAT law, transactions with receivables are VAT exempt, without deduction right, except for the receivables' recovery/factoring operations which qualify as taxable transactions, subject to VAT. Nevertheless, if the aim of the transaction does not consist in receivables' recovery but in a granting of a credit, the transaction would be VAT exempt, not qualifying for the above mentioned exception.

Another important legal aspect refers to commercial disputes or disputes that may arise between the member and the debtor during the period of the factoring contract. They are events that lead, until the solution to the suspension of financing, to cover the risk of non-payment for future debts. The adherent remains obliged to continue transferring the Factor's claims. The dispute can be considered any event that leads to the refusal to pay the debts by the debtor, or by any other party in connection with the assigned debt. If the disputes are not resolved, the Factor can withdraw from the client the claims that are the subject of the dispute, requesting the recovery of the financing.

The services included in the factoring contract:

- Financing invoices following the assignment of receivables. The customer receives advance payment on the basis of assigned invoices.
- The financing percentage is usually between 70%-90% of the value of the invoices approved for financing. It is determined by the factor after the analysis of the commercial history between the contractual partners. Elements such as the existence of discounts, scraps, returns, compensations, actual payment terms, commercial disputes are taken into account

The financing commission has as its component the EURIBOR/LIBOR/ROBOR interest rate chosen according to the currency of the factoring contract and the Factor's margin.

- Invoice management - through the transfer of receivables, the Factor manages the receivables in the portfolio, the client receives reports on the portfolio of assigned invoices
- Covering the risk of non-payment or insolvency of the debtor. The factor obligates himself if the debtor does not pay the invoices when due or if the debtor declares insolvency to pay the counterparty the value of the invoices.
- Friendly collection. The factor performs collection services with the debtor for the entire period of validity of the factoring contract for invoices that have not been collected.

Checks with the debtor before the receivables are due, late payment signals can be considered measures to reduce the risk of non-recovery of the receivables and increase the quality of their portfolio.

Romania has transposed the EU Late Payments Directive, which applies to commercial transactions between companies ("undertakings"), as well as between companies and the public sector [25]. In addition to the default interest, the EU Late Payments Directive provides for fines in case of late payments.

From the Factor's point of view, the moment of closing a transaction is when the sums are collected from the debtor and all the commissions and charges generated by the factoring operation are recovered.

In case of the occurrence of undesirable events of late payment, commercial disputes, insolvency of the debtor, financial difficulties of the Adherent, effective amicable or legal collection actions are required (direct communication with the debtor and the adherent, establishment of a mutually agreed plan with the contracting parties in order to the recovery of receivables and the continuation of the factoring contract).

In specialized literature, several types of factoring are known, the classification criteria being defined below:

Depending on the requested services:

- Factoring without recourse (includes all four financing services, invoice management, amicable collection, non-payment risk coverage). The risk analysis is carried out per debtor. The factor assumes the coverage of the risk of non-payment in case of late payment or insolvency of the debtor.
- Recourse factoring includes three of the four services, namely financing, invoice management, friendly collection. The risk analysis is analysed on Adherent. The Factor is directed at the adherent in the event of a non-payment event on the part of the debtor [23].

"Reverse" factoring, a variation of non-recourse factoring, is useful in case of the financial situations of the Adherent are not the most favourable for obtaining financing, in the conditions in which the risk and creditworthiness of the debtor are analysed. Factoring allows the transfer of credit risk from the member to the debtor when his creditworthiness is high. In reverse factoring (also called "approved payables finance"), the buyer approves the invoice for payment, and finance is raised separately against the accounts payable by the supplier from a bank or other finance provider, who relies on the creditworthiness of the buyer without recourse to the supplier [5].

The benefits and opportunity of choosing factoring with recourse or without recourse are highlighted by Kouvelis and Xu, 2021 in the form of a study of the characteristics of each type of product [24]. The conclusion shown is in the form of the determining parameters: the credit rate of the member and the risk of liquidity, the credit rate of the debtor, the payment capacity of the debtor.

Depending on the country of the parties:

- International factoring - if the Adherent and the Debtor are from different countries
- Domestic factoring - if the parties are in the same country
- Depending on the number of Factors involved:
- Factoring in the two-factor system or indirect factoring. In the transaction, there are the Factor of the Adherent and the Factor of the debtor's country. It is used in the case of non-recourse international factoring. In the international factoring business there are four participants: the client-assignor (the Adherent), the Factor, the International Buyer-debtor and Correspondent Factors [22]
- Direct factoring in which only the financial institution of the Adherent is involved.
- Depending on the publication of the debt assignment and the client informing the debtor about the conclusion of a factoring contract:
- Factoring with disclosure
- Undisclosure factoring

The difference between the traditional short-term credit lines in view of the conditions, procedures and related contracts is as follows:

- Short-term credit is based on the client's financial analysis. The guarantees requested by financial institutions can be real estate, collateral deposits, personal guarantees.
- Banks can request audited financial statements, which leads to additional costs;
- Sustainability and financial analysis of the client's entire business are very important in the case of credit.
- by loan it is very important that the size of asset is bigger than a amount of credit—what can at small and medium companies create a barrier due relatively high level of risk, because of lack of liquidation

Firms extend trade credit for many reasons, Mian and Smith (1992) identified three main incentives: cost advantage, market power, and taxes [28]. Emery (1984) and other argues that trade credits are extended to avoid financial intermediary “rent” by directly conducting business outside the financial market [7, 27]. Consequently, in general for the firm to adopt the policy of “buy now and pay latter”, credit extension becomes a source of survival and growth [29].

Soufani (2001) recognized that the use of the financing option such as factoring becomes an important decision to increase the firms liquidity by providing the accounts receivable as the collateral to acquire finance [29].

Ivanovic et al [22] highlights the theoretical advantages of accessing factoring products both from the perspective of obtaining funds and from the financial perspective:

- application process and fund insurance through factoring is much more faster, than a short-term bank credit lines. In this case it takes time to establish it;
- risks are reduced, as debtors with increased financial risk are eliminated from the portfolio, in the case of non-recourse factoring
- factoring is not considered a credit product, it is not registered in the company's accounting, it is highlighted in the balance sheet. Factoring is kept off-balance sheet and may not be disclosed to potential credit institutions
- The exchange rate risks are reduced because the funds are obtained quickly.
- No real estate or personal guarantees are required.
- Reducing costs by the fact that invoice management is carried out by the Factor.
- For companies that need to improve their cashflow in the short term, to sustain their production cycles for periods between 30-180 days, until they collect their receivables, factoring is a product to be taken into consideration.

Factoring is regulated at national level, the National Bank of Romania governs the activities of financial institutions that can grant factoring products to legal entities.

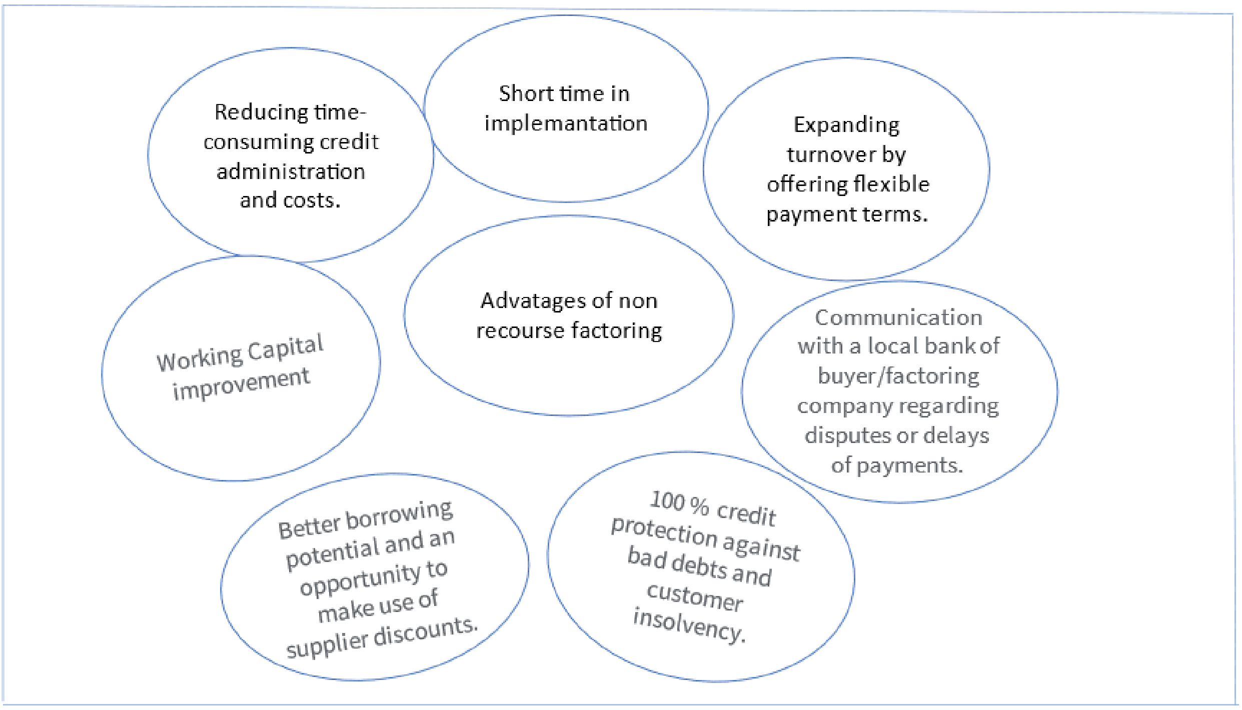

Fig. 1. The advantages of factoring
Source: Own processing.

In Romania, the Romanian Factoring Association (RFA) is the structure that was established in 2011, with the aim of protecting and representing the general interest of the factoring sector and the people involved. The members of the association are financial institutions, most of them being banks (Access Financial Services IFN SA, Banca Comercială Română S.A., BRD – Groupe Societe Generale S.A., Banca Transilvania S.A., EximBank, IFN Next Capital Finance S.A., ING Bank Romania S.A., Intesa Sanpaolo Bank, Patria Bank, Raiffeisen Bank S.A., Unicredit Bank S.A.).

Worldwide, factoring companies and banking institutions that have factoring products in their portfolio are represented by international bodies:

- Factor Chain International (FCI) is the association that governs the activities of factoring companies and the financing of domestic and international commercial receivables in an open account. FCI was founded in 1968 as a global non-profit association, currently headquartered in Amsterdam. With nearly 400 member companies in over 90 countries, FCI offers a unique cross-border factoring cooperation network. Members' transactions account for almost 60% of the world's international correspondent factoring volume [21].
- The International Factoring Association (IFA) is another international body that unites factoring companies from 12 countries.
- A number of factors can influence the volume of products granted at the level of financial institutions: Credit rate; High transaction costs; Lack of liquidity of financial institutions; Capital constraints; Financial performance of debtors; Country risk rate; BASEL requirements; AML/ KYC requirements.

From the analysis carried out by the EBRD in the 37 countries, it can be seen that the uniformity of the application of the international rules governing factoring and debt assignment is important.

In 70% of the responding countries there are rules to regulate factoring operations (that is, in 26 of the 37 countries), there are capital limits for carrying out financial activities, there is a national body that supervises factoring operations. In 22 of the 37 countries (60%) of factoring companies need an operating license (Table 1).

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Table 1. Regulation on factoring operations

Country	Regulated factoring industry	License needed to operate	No capital adequacy requirements	Factoring companies are supervised
Albania	Yes	Yes	Yes	Yes
Armenia	Yes	Yes	No	Yes
Azerbaijan	Yes	Yes	Yes	Yes
Belarus	Yes	Yes	Yes	Yes
Bosnia and Herzegovina	Yes	Yes	Yes	Yes
Bulgaria	Yes	No	Yes	Yes
Croatia	Yes	Yes	Yes	Yes
Cyprus	No	No	Yes	No
Egypt	Yes	Yes	No	Yes
Estonia	Yes	No	Yes	Yes
Macedonia	Yes	Yes	Yes	Yes
Georgia	No	No	Yes	No
Greece	Yes	Yes	Yes	Yes
Hungary	Yes	Yes	No	Yes
Jordan	No	No	Yes	No
Kazakhstan	Yes	Yes	Yes	Yes
Kosovo	Yes	Yes	Yes	Yes
Kyrgyzstan	Yes	Yes	No	Yes
Latvia	No	No	Yes	No
Lebanon	No	No	Yes	No
Lithuania	Yes	No	Yes	Yes
Moldova	No	No	Yes	No
Mongolia	Yes	Yes	No	Yes
Montenegro	No	No	Yes	No
Morocco	Yes	Yes	No	Yes
Poland	No	Yes	Yes	No
Romania	Yes	Yes	No	Yes
Russia	Yes	Yes	No	Yes
Serbia	Yes	Yes	Yes	Yes
Slovakia	No	No	Yes	No
Slovenia	No	No	Yes	No
Tajikistan	Yes	Yes	Yes	Yes
Tunisia	Yes	Yes	No	Yes
Turkey	Yes	Yes	Yes	Yes
Turkmenistan	No	No	No	No
Ukraine	Yes	No	Yes	Yes
Uzbekistan	Yes	Yes	Yes	Yes

Source: [2].

MATERIALS AND METHODS

The research methodology assumed the use of time series analysis indicators, both absolute indicators and relative indicators. Starting from the level indicators that show the value of the characteristic at a certain moment in time (y_i), and which are results from the primary statistical data, all the other analysis indicators of the time series were then calculated, analysed and interpreted: absolute change with fixed base, the absolute change with a chain base. For the chronological (time) series indicators, data statistics obtained after processing can be absolute, relative and average data which, together, they allow the statistical characterization of the development of phenomena studied by interpreting the objective trend of their development in any given stage [1].

Absolute indicators:

Y_i - the absolute levels of the terms of the series

$\Delta i/0$ absolute change (absolute increase or decrease) calculated with a fixed base

$\Delta_{i/i-1}$ - absolute change (absolute increase or decrease) calculated with base in chain.

The methodology for calculating the indicators used to characterize a series it is elaborated on the example of the series of time intervals, which

ensure continuity time variation and can be interpreted as an analytical function of time.

$y_i = f(t_i)$

y_i - the values of the studied variable

t_i = the numerical values of the time variable.

The absolute indicators are expressed in the concrete units in which they it also measures the phenomenon under investigation.

The absolute change with a fixed base allowed us, starting from the same comparison base, to determine the evolution of the phenomenon between different moments of time, according to the following relationship:

$$\Delta i = yi - y1 \quad (1)$$

where:

yi – level index

y1 – the value of the characteristic y at a moment in time.

The absolute change with the base in the chain allowed us to compare each phenomenon in relation to the previous year, using the following formula:

$$\Delta i/i\text{-}1 = yi - yi\text{-}1 \quad (2)$$

where:

yi – level index

yi-1 – the value of the characteristic y at a moment in time.

The dynamics index with a fixed basis was used in the case of the terms of the time series compared with a single basis, being calculated as follows:

$$\Delta_{i/1} = y_i/y_1 \quad (3)\ [1]$$

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Fixed base growth rate x is a ratio of fixed base growth x of each period and year level chosen as a base. It is denoted by $R_{i/0}$ and is de the rule expressed as percentages.

The pace of the dynamics allowed us to quantify the change relative to the value we used as the basis for comparisons, being calculated as follows:

$$R_{y/0} = \frac{yi - y0}{y0} \quad (4)\,[1]$$

RESULTS AND DISCUSSIONS

The analyzed period included the time period 2009-2021.

The data provided by FCI and the Romanian Factoring Association show that factoring products are increasingly being accessed by companies. The volume of receivables assigned to factoring companies, banks or financial institutions, globally and nationally is increasing [9-20].

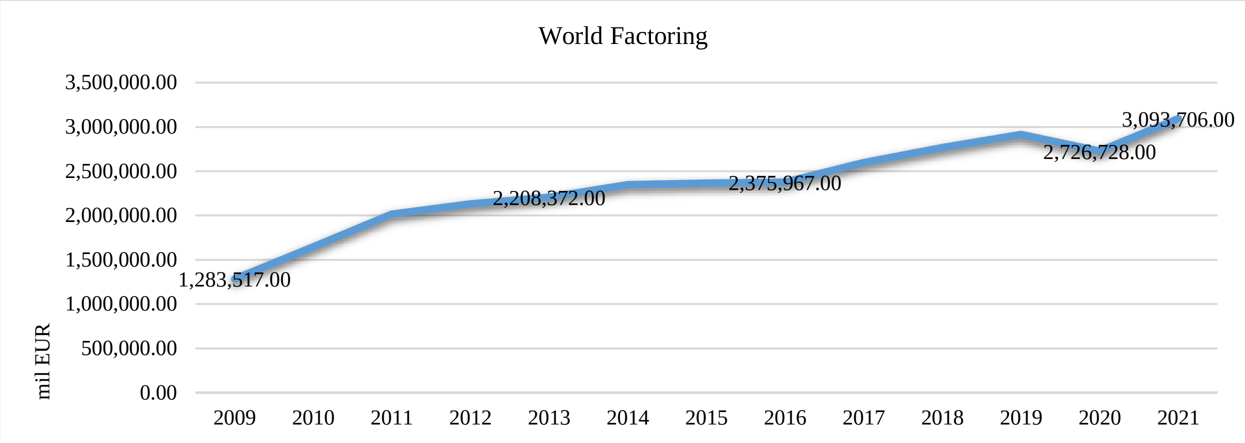

Fig. 2. The evolution of factoring
Source: Own processing, FCI [9-20].

The data (Figure 2 and Figure 4) show that international factoring volumes steadily increased between 2009 and 2019 with the important growth in 2010 and 2011. In 2020 the world factoring business was slowly decreased, due to pandemic's influence on the global economic environment. In 2021, the volume of financing through factoring increases again. The volume of the "Top Ten" FCI Members' Total Factoring volume by Country/Territory accounts for 88% of the total, China leading the way with 26%, followed by Spain (14%), Italy (13%), France (9%), United Kingdom (7%), Japan, USA, Germany, and Taiwan with 4% each and Poland (3%) [8-19].

In 2021, at the level of FCI members, the main clients using factoring are represented by SMEs (44%). Small companies represent 26%, and corporations 30% [8-19].

The industries that access factoring remain the traditional ones, even if technology and digitization are becoming more and more present (Figure 3).

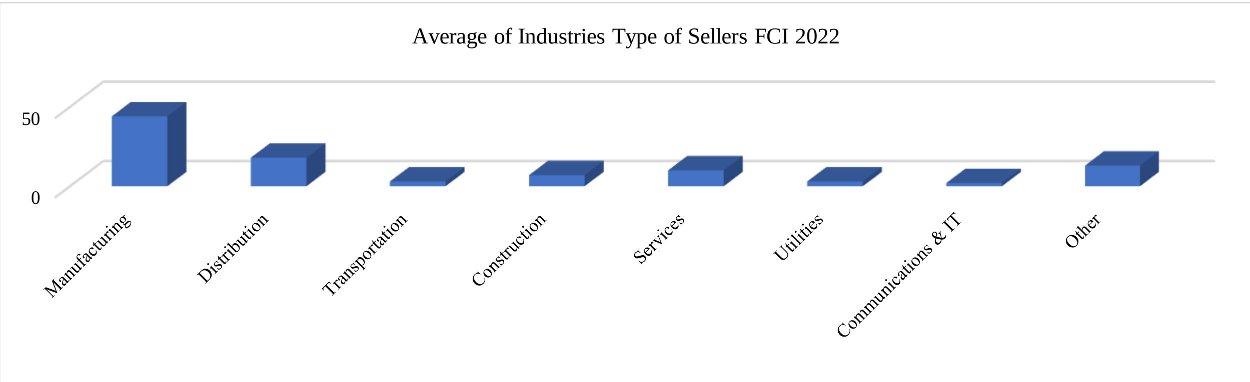

Fig. 3. Average of Industries Type of Sellers FCI 2022
Source: FCI [9-20].

Thus, it can be seen that Manufacturing, Distribution, Other categories of activities and Services are on the first places, otherwise respecting the same structure of businesses registered at the global level.

Table 2. Evolution of World Factoring

Evolution of World Factoring Products (mil EUR)	2015	2016	2017	2018	2019	2020	2021
Invoice Discounting	310,313.00	333,544.00	333,544.00	266,606.00	263,236.00	189,095.00	192,244.00
Recourse Factoring	301,948.00	236,61.,00	231,270.00	245,583.00	191,167.00	143,882.00	138,914.00
Non-Recourse Factoring	434,456.00	481,172.00	478,640.00	482,885.00	474,564.00	494,366.00	554,512.00
Reverse			50.01	89,482.00	139,358.00	76,305.00	151,344.00
Total Domestic Factoring FCI	1,104,441.00	1,098,800.00	1,104,058.00	1,141,741.00	1,122,019.00	953,682.00	1,107,887.00
Export Factoring	261,21.,00	256,551.00	292,408.00	211,195.00	216,721.00	15,899.00	139,332.00
Import Factoring	66,612.00	63,44.,00	55.46	31.72	28.46	18,095.00	21,753.00
Total International Factoring FCI	424,697.00	428,035.00	458,469.00	310.12	298,727.00	217,249.00	216,84.,00
Grand Total FCI	1,529,138.00	1,526,836.00	1,562,527.00	1,451,861.00	1,420,746.00	1,170,93.,00	1,324,731.00
World Domestic Factoring	1,838,366.00	1,868,855.00	2,078,758.00	2,244,214.00	2,375,406.00	2,206,000.00	2,496,438.00
World International Factoring	529,37.,00	507,112.00	519.54	522,852.00	541,699.00	520,728.00	597,268.00
World Total	2,367,745.00	2,375,967.00	2,598,298.00	2,767,067.00	2,917,105.00	2,726,728.00	3,093,706.00

Source FCI [9-20]

The evolution of factoring products in Romania (Figure 4) is in the same ascending manner as the international one. The volumes declared by Romanian Association of Factoring (RAF) demonstrate this evolution.

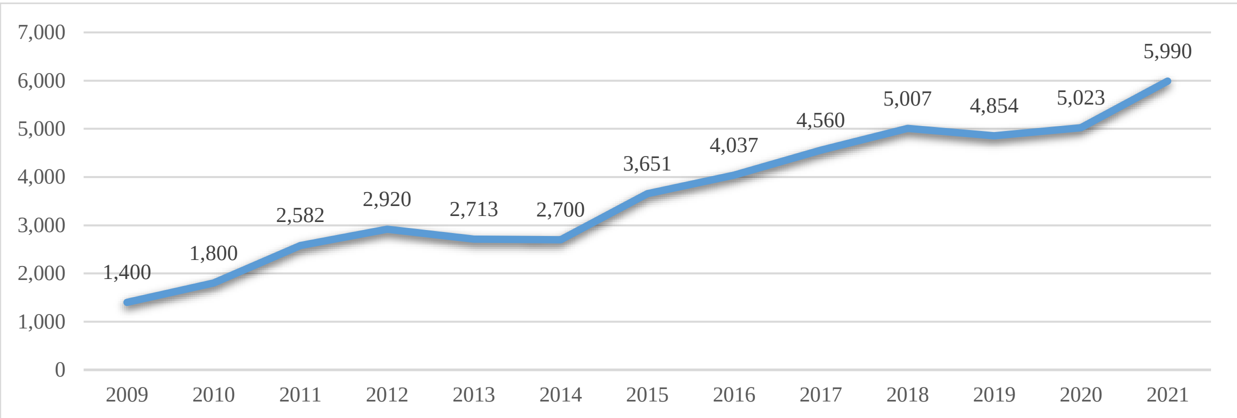

Fig. 4. The evolution of factoring in Romania
Source: Own processing, FCI [9-20].

Compared to 2009, the value of factoring products increased in 2021 by 4.27 times. However, the highest growth rates from one year to another were recorded in 2010 and 2011, which were 29% and 42%, respectively. The next rate of growth was recorded in 2021 when compared to 2020 the increase was 19%. It is also noted that there have been periods of decline in the rate of use of factoring (in 2013, the decrease compared to the previous year was 7% or in 2019 when the decrease compared to 2018 was 3%) (Figure 5).

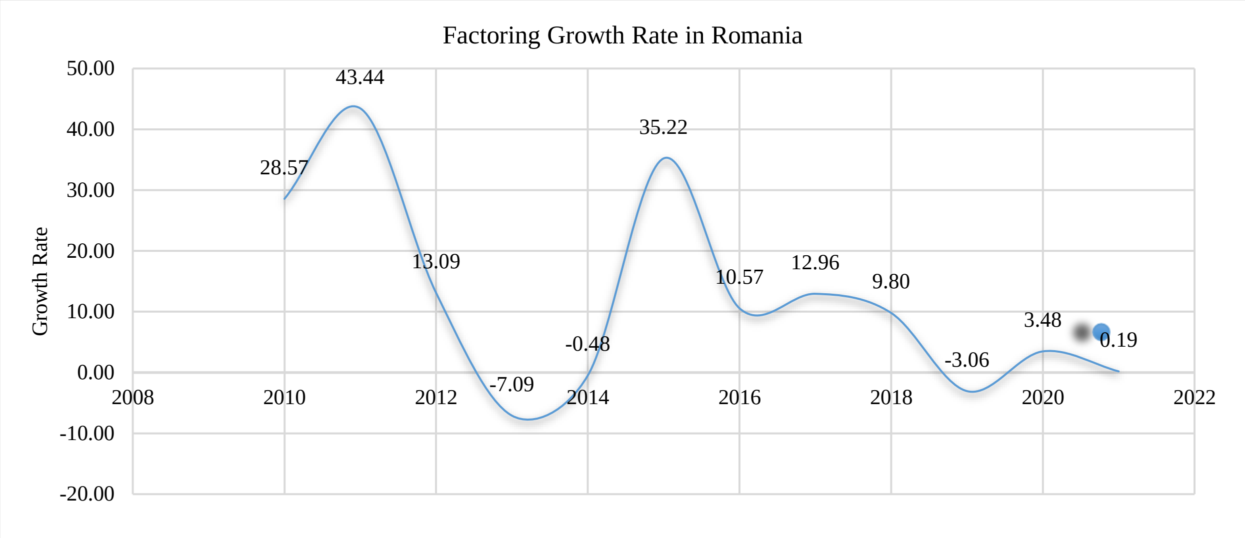

Fig. 5. Factoring Growth Rate in Romania
Source: Own processing: FCI [9-20].

The factoring market in Romania experienced steady growth during the period under consideration (Figure 5), with factoring volumes increasing every year except for 2013 and 2019. The highest growth rates were recorded between 2010 and 2012, and in 2015 and 2016, indicating an increasing demand for factoring services during these periods.

In 2021, the best represented sector of activity is represented by FMCG, with a weight of 19.5% and a total volume of 592.5 million euros, followed by the field generically titled "metals, chemicals, water, recycling", with a total value of receivables 527 million euros and a share of 17% in the total market, followed by the "vehicles, machines, equipment" sector, with a share of 14%, the Electronics, IT&C sector with a volume of 392 million euros, the share being 13% [30].

The companies in their turn became more responsible, they started to think much better about their investment strategy or making investments [23].

CONCLUSIONS

Internationally, there is a growing interest in factoring products. Small and medium-sized companies can access short-term financing much more easily by assigning or transferring certain liquid and payable receivables to factoring companies (banking or non-banking financial institutions).

As regards the Factor, the one who takes the risk of non-payment, there is an increase in prudence in assessing the creditworthiness of debtors in unstable economic conditions determined by the pandemic and political factors [26]. In the 2020-2021 period from the point of view of risk, the factoring companies have adopted management measures for the existing portfolio, the appetite for new business being less than in previous years.

The factoring market in Romania is also maturing, which could lead to further growth in the coming years as businesses become more aware of factoring services and Factors become more willing to provide such services in the country.

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INVESTIGATION OF THE COST AND PROFITABILITY OF APRICOT PRODUCTION IN ISPARTA

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Abstract

The aim of this study was to examine the cost and profitability of apricot farms in Isparta province. The main material of the research; The data obtained from 138 apricot farms in the villages where apricot cultivation is intense in Yalvaç and Senirkent districts of Isparta province, which has a planting area of 91% and a production share of 87%, were obtained by the survey method. Neyman Method was used in the determination of the sample volume. As a result of the calculations, the sample volume was determined as 138 enterprises. The data obtained from the enterprises belonged to the production season of 2021. Apricot production costs per decare were calculated as 6 013.62 TRY, gross production value was 25090.66 TRY, gross profit was to be 21933.14 TRY, absolute profit was 19077.04 TRY and relative profit was calculated as 4.17 on average of farms. Production cost of 1 kg of apricot was determined as 1.84 TRY. Since the profitability of apricot production is high as of the year examined, it can be stated that the producers will continue to produce in the coming years.

Key words*: *apricot, production cost, profit, Isparta

INTRODUCTION

Apricot is produced in 78 countries worldwide. In terms of apricot exports and production, Türkiye plays a significant role. In terms of production and export, it comes in first place worldwide [3][14].

Apricot is produced in 78 countries around the world. While the world apricot production amount was 2.78 million tonnes in 2004, it increased by 29% in 2021 to 3.58 million tonnes. In this period, the highest increase in production (about 10 times) was in Armenia. It was followed by Azerbaijan, which increased its production 4.3 times, Afghanistan, which increased 3.1 times, and Uzbekistan, which increased 2.5 times. The most important apricot producing countries are Türkiye, Uzbekistan, Iran, Algeria, Italy, Pakistan, Spain, Afghanistan and Japan. Türkiye ranks first with 800 thousand tonnes of apricot production. Uzbekistan ranked second with 425 thousand tonnes, Iran ranked third with 323 thousand tonnes and Algeria ranked fourth with 190 thousand tonnes of apricot production on FAOSTAT data [9]. Türkiye, which is the leader in apricot planting area and production, remains below the world average in terms of yield. Türkiye, which is also the leader in dried apricot exports, has gained momentum in fresh apricot exports in recent years. Especially after 2011, it exceeded 50 thousand tonnes.

Horticultural crops have played a significantly vital part in supplementing the diet of people with their unique flavor and diverse biochemical with high antioxidant effect [6] [19].

In Isparta province, which was selected as the research region, the apricot planted area, which was 9,870 decares (1 decare equal 0.1 hectare) in 2004, increased 2.2 times in 2022 and reached 26,227 decares. The production amount was 12.3 thousand tonnes in 2004. In 2022, apricot production in Isparta province increased 2.4 times compared to 2004 and reached 29.1 thousand tonnes depend on TURKSTAT data [24]. This increase is mostly due to the expansion in apricot planted areas.

The reasons for the selection of apricot product and Isparta province as the subject of the study were: (i) Türkiye's apricot production ranks important in the world, (ii) the significant development in Isparta province as an alternative to apple and cherry in recent years, (iii) the insufficiency of researches on economic evaluation in the province on the subject.

In Isparta province, which was selected as the research region, apricot production is intensive in Yalvaç and Senirkent districts. Based on 2004, there was an expansion of 4.34 times in the apricot planted area in Senirkent district in 2022. Yalvaç district experienced an increase of 2.82 times. In this period, the change in the amount of production was 2.36 times increase in Isparta province, 5.2 times increase in Senirkent district and 2.1 times increase in Yalvaç district. Changes in yield are especially affected by spring frosts.

In this study, apricot production costs and profitability in Isparta province were analysed and the problems of producers were examined.

MATERIALS AND METHODS

The main material of the research was the primary data obtained by the face-to-face survey method of the apricot producer from farms in the Senirkent and Yalvaç districts of Isparta. In order to determine apricot orchard establishment costs, data were collected from five sample farms in Senirkent and Yalvaç districts of Isparta province. The data obtained from apricot farms belonged to the production period of 2021. The number of farmers to be interviewed was calculated as 138 farmers with a margin of error of 5% and 99% confidence interval by using the Neyman Method, one of the stratified sampling methods.

The farms were divided into three strata according to apricot planted area. Farms with apricot planting area of 7.50 decares or less (21 farms) were defined as group I, farms between 7.51-20.00 decares (55 farms) were defined as group II, farms with apricot planting area of 20.01 and more decares (62 farms) were defined as group III.

The farms interviewed in the research region were active in other production branches besides apricot cultivation. For this reason, single product budget analysis method was used in the calculation of farm costs. Apricot production costs of apricot farms were calculated under two headings: variable costs and fixed costs.

In the calculation of the family labour wage equivalent, the prevailing wages of female and male foreign labour in the region were taken into account. Revolving fund interest was calculated by taking half (9%) of the loan interest rate (18%) applied by the Turkish Ziraat Bank for crop production. General administrative expenses were calculated by taking 3% of the total variable costs incurred in apricot production.

In the economic evaluation of apricot farms, gross production value, gross profit, absolute (net) profit and relative profit were calculated.

In the Neyman method, the arithmetic mean applied in the calculations does not reflect the average of the research area, since more samples are taken from the stratum with high variance. For this reason, the coefficient calculation was made for each stratum by proportioning the number of frequencies per farm stratum to the total number of frequencies. The data obtained for each stratum were multiplied by the calculated coefficients and calculated as the general farm average value and regional average [12][13].

In fruit growing, there are facility period and production period. Facility costs refer to the sum of the expenses spent for the works carried out until the perennial plants begin to yield. Not all facility costs are incurred in the first year. Some of them are incurred in the first year, some for a few years and some every year until the yield is obtained. By dividing the sum of facility costs by the economic life of the garden, the depreciation share of facility costs was found. By adding this value to the costs incurred during the production period, the general sum of the production period costs is obtained. Normal interest of 7%, 3% administrative expenses and 5% bare land value were added to the total of the costs incurred during the establishment period each year. The establishment period was taken as 5 years [1][7]. According to the depreciation rates of 2021, the useful economic life of the apricot tree was reported as 25 years by the Turkish Revenue Administration [11]. Considering this economic life, depreciation for the plant period was calculated.

RESULTS AND DISCUSSIONS

Value of production in farms

The gross production values were calculated by multiplying the amount of plant and animal production produced in the 138 farms interviewed by the prices of these products and adding the increase in productive fixed assets to the value obtained by multiplying the prices of these products. According to the farm average, the total production value (GPV) was calculated at 842,459.59 TRY. 85.27% of the total gross production value was obtained from apricot production, 7.62% from animal products and 7.11% from other plant products. Total gross production value was determined at 101,783.16 TRY in the first layer, 364,993.79 TRY on the second layer and 1,516,892.22 TRY for the third layer. According to the business groups, the share in the total gross production value of apricot was 79.17% in the first layer, 71.62% in the second layer and 88.32% in the third layer. The highest gross production value was detected in farms in the third layer (Table 1). The factors that influence this are the transitory varieties of the apricot sold and, in general, the availability to the foreign market through export.

Demirtaş [7] determined the value of gross production of enterprises producing apricot in the districts of Insel or Mut and Gülnar at prices of 3,003.98 TRY in 2021. Fidan [10] calculated the gross production value of enterprises producing apricot in the Iğdır or Central district and Tuzluca districts at an average of 2,904.67 TRY at 2021 prices. Sarıbaş [21] calculated the production value of enterprises producing apricots in Malatya or Akçadağ, Battalgazi, Darende, Hekimhan and Central districts as an average of 3,758.74 TRY at 2021 prices. In the study carried out in the province of Malatya in 2019, the average gross production values of enterprises producing organic apricot found 157,960.5 TRY [4].

The gross production value in the research area was found to be comparatively higher than that in other studies. This is due to the high prices of apricots in the last two years. The fact that late spring frosts are not too much has influenced the yield in a positive direction. Manufacturers sold 1 kg of apricot in the price range of 6-15 TRY, depending on the case of sale to the domestic and foreign market. Late varieties have influenced the higher formation of the price in a positive direction.

Table 1. Value of production in farms

Production Branches	Farming groups			FA	RA
	I	II	III		
	Quantity (TRY)				
Apricot's GPV	80,581.78	261,399.61	1,339,742.08	718,356.56	321,395.11
Other plant's GPV	13,182.33	56,388.00	78,915.47	59,934.26	43,553.85
Animal's GPV	8,019.05	47,206.18	98,234.68	64,168.77	39,101.08
Total's GPV	101,783.16	364,993.79	1,516,892.2	842,459.59	404,050.04
	Ratio (%)				
Apricot's GPV	79.17	71.62	88.32	85.27	79.54
Other plant's GPV	12.95	15.45	5.20	7.11	10.78
Animal's GPV	7.88	12.93	6.48	7.62	9.68
Total's GPV	100.00	100.00	100.00	100.00	100.00

FA: Farm average; RA: region average
1 TRY = 8.89 ABD$ (2021 average)
Source: Own calculation.

Farmers' Costs of Apricot Production

Cost calculations of farms engaged in agricultural production are very important. In the agricultural production process, the monetary value of the goods and services that need to be consumed in order to produce a product is referred to as cost. In general, the comparison of the gross production value obtained in a production period with the costs reveals whether the activity is economic or not. In general, the costs incurred in production in the short term are classified as variable and fixed costs. Fixed costs are costs that do not depend on the level of production and are incurred whether production is carried out or not. Depreciation, interest, land rent, building repair and maintenance costs, tax and insurance fees, permanent labour wages are included in the fixed costs.

Variable costs are characterized as costs that increase or decrease depending on the level of production. Examples of variable costs are chemical fertilizer, water fee, feed, temporary worker wages, pesticide, spraying fee, oil-repair and maintenance costs, fuel oil, tool and machine rent, marketing costs, revolving fund costs [2] [16] [17].

The most common expenses incurred for apricot production are spraying, irrigation, harvesting and pruning. While early variety apricot cultivation positively affects the income of the producer, the low yield due to adverse weather conditions leads the producers to reduce the cost elements to be incurred for the next production year [8].

The variable cost elements of apricot farms are fertilizer, medicine, temporary labour, water cost, machine rent, marketing and revolving capital interest. According to this, the average variable costs of apricot farms totalled 90,401.36 TRY. According to the regional average, the total of variable costs was determined as 48,493.50 TRY. According to the planted area width, the total variable costs of the farms in the first stratum were 15,679.51 TRY, 47,697.09 TRY in the second stratum and 153,593.20 TRY in the third stratum (Table 2).

The share of variable costs in total production costs was identified at 52.51%. The share of variable costs in the region average was 51.00%. The share of the variable costs of the farms in total costs according to the width of the plant area was determined as 46.14% in the first layer, 50.65% in the second layer and 53.30% on the third layer. When the average values of proportionally variable costs were analyzed, the highest share belonged to marketing with 11.40%. The marketing item is followed by machine rent with 9.60%, fertilizer with 8.60%, temporary labour with 6.80%, pesticide with 5.89% and water fee with 5.87% (Table 2).

The fixed cost items of the farms examined were general administrative expenses, land rent, permanent family labour force, facility depreciation and facility period interest. The average value of the fixed costs incurred by the farms for apricot production was 81,771.31 TRY. The average value of the region was found as 46,591.93 TRY. The fixed costs of the enterprises were calculated as 18,306.43 TRY in the first stratum, 46,477.75 TRY in the second stratum and 134,576.28 TRY in the third stratum (Table 2).

The share of fixed costs in total production costs was 47.49% while the regional average was 49.00%. The ratio of fixed costs was found to be 53.8 % in the first layer, 49.35% in the second layer and 46.70% in the third layer. In proportional terms, the most important expense item in fixed costs was found to be land rent with 17.93%. Land rent was followed by plant depreciation with 10.84%, plant period interest with 10.52%, permanent family labour with 6.63% and general administrative expenses with 1.58% (Table 2). Demirtaş and Gül [8] determined that apricot farms' fixed cost share was 39.70% and their variable cost share was 60.30% in the Mersin province. Uçar and Engindeniz [26] found that the share of apricot variable costs in total costs was 63.52% in their study in Malatya province.

On average, the surveyed farms calculated that the cost of apricot production was 172,172.67 TRY, while on the regional average it was 95,085.43 TRY.

Table 2. Costs of apricot production

Cost elements	Farming groups			FA	RA
	I	II	III		
	Production costs (TRY per farms)				
Fertiliser	1 972.14	7 044.00	26 055.00	14 813.37	7 428.54
Agrochemical	2 311.19	5 905.45	16 563.23	10 146.78	5 852.73
Temporary workforce	2 695.79	5 911.05	19 898.95	11 706.19	6 378.53
Water cost	2 328.90	5 733.09	16 611.61	10 102.51	5 773.79
Machine rental	3 362.86	10 376.82	26 461.29	16 535.83	9 729.30
Marketing	1 713.99	8 788.39	35 321.11	19 632.35	9 326.56
Revolving fund interest	1 294.64	3 938.29	12 682.01	7 464.33	4 004.05
Variable costs	***15 679.51***	***47 697.09***	***153 593.20***	***90 401.36***	***48 493.50***
General administrative expenses	470.39	1 430.91	4 607.80	2 712.04	1 454.80
Land rent	6 117.86	17 105.91	51 450.40	30 863.95	17 148.39
Permanent/family workforce	3 435.31	7 463.95	17 641.05	11 423.22	7 200.49
Facility depreciation	4 324.14	10 449.97	30 798.39	18 659.82	10 612.47
Facility term interest	3 958.74	10 027.01	30 078.64	18 112.28	10 175.78
Fixed costs	***18 306.43***	***46 477.75***	***134 576.28***	***81 771.31***	***46 591.93***
Production costs	***33 985.94***	***94 174.84***	***288 169.48***	***172 172.67***	***95 085.43***
	Ratio (%)				
Fertiliser	5.80	7.48	9.04	8.60	7.81
Agrochemical	6.80	6.27	5.75	5.89	6.16
Temporary workforce	7.93	6.28	6.91	6.80	6.71
Water cost	6.85	6.09	5.76	5.87	6.07
Machine rental	9.89	11.02	9.18	9.60	10.23
Marketing	5.04	9.33	12.26	11.40	9.81
Revolving fund interest	3.81	4.18	4.40	4.34	4.21
Variable costs	***46.14***	***50.65***	***53.30***	***52.51***	***51.00***
General administrative expenses	1.38	1.52	1.60	1.58	1.53
Land rent	18.00	18.16	17.85	17.93	18.03
Permanent family workforce	10.11	7.93	6.12	6.63	7.57
Facility depreciation	12.72	11.10	10.69	10.84	11.16
Facility term interest	11.65	10.65	10.44	10.52	10.70
Fixed costs	***53.86***	***49.35***	***46.70***	***47.49***	***49.00***
Production costs	***100.00***	***100.00***	***100.00***	***100.00***	***100.00***

Source: Own calculation.

The total production costs in the apricot production activity were found to be

33,985.94 TRY in the first layer, 94,174.84 TRY in the second layer and 288,169.48 TRY in the third layer (Table 2).

The total variable costs of the surveyed apricot farms were found to be 3,157.53 TRY per decares. According to the regional average, the total variable costs were found at 3,054.77 TRY per decares. The variable costs of the farms in the first layer were calculated at 2,676.99 TRY, 3,046.85 TRY in the second layer and 3,209.56 TRY for the third layer per decares (Table 3).

The fixed cost of farms was 2,856.10 TRY per decares. The fixed cost value in the regional average was 2,934.98 TRY per decares. The fixed cost value for the first layer was determined at 3,125.49 TRY, 2 968.96 TRY for the second layer and 2 812.18 TRY in the third layer per decares (Table 3).

The total average production costs of the farms surveyed were estimated at 6,013.62 TRY, while the regional average was 5,989.76 TRY per decares. The total production costs for the first layer were 5,802.48 TRY, 6,015.81 TRY for the second layer and 6,021.74 TRY per decares in the third layer (Table 3).

Demirtaş [7] calculated the total average variable cost of apricot farms in Mersin province to 34,147,985 TRY. The proportional distribution of the elements of the cost was also calculated in the form of temporary labour at 49.79%, fertiliser at 13.05%, tool-machine at 8.19%, agrochemical at 8.10%, marketing at 7.05%, water fee at 6.58%, capital interest at 6.49%, and revenue at 0.75%. Fidan [10] calculated the total variable cost of farms producing apricot in Iğdır province at 391.03 TRY. He found that labour costs accounted for 43.78% of the variable cost, while fertiliser cost was 20.33%, turnover capital rate was 8.25%, agrochemical was 11.93%, harvest and marketing was 6.95%, tool-machine was 4.41%, and water fee was 4.35%. The average fixed cost of was found at 175.38 TRY. Sarıbaş [21] found the variable cost of farms producing apricots in Malatya province to be 665.88 TRY. Uçar [25], calculated the average cost of apricot production for farms producing apricots in the province of Malatya as 975.29 TRY, labour costs 312.84 TRY and material costs 364.22 TRY. In the study carried out in the province of Malatya, Çatı [4] calculated the production costs per decares of farms producing organic apricots as 1 279.4 TRY per average land asset and 1 780.8 TRY per average apricot area, when all farms were taken into account.

Table 3. The cost of production of apricot on the unit area

Cost elements	Farming groups			FA	RA
	I	II	III		
	Production costs (TRY per farms)				
Fertiliser	336.71	449.97	544.46	517.40	467.95
Agrochemical	394.59	377.24	346.11	354.41	368.68
Temporary workforce	460.26	377.59	415.82	408.87	401.81
Water cost	397.62	366.23	347.13	352.86	363.71
Machine rental	574.15	662.86	552.95	577.56	612.88
Marketing	292.63	561.40	738.09	685.72	587.51
Revolving fund interest	221.04	251.57	265.01	260.71	252.23
Variable costs	***2,676.99***	***3,046.85***	***3,209.56***	***3,157.53***	***3,054.77***
General administrative expenses	80.31	91.41	96.29	94.73	91.64
Land rent	1,044.51	1,092.71	1,075.13	1,078.01	1,080.24
Permanent/family workforce	586.52	476.79	368.64	398.99	453.58
Facility depreciation	738.27	667.54	643.58	651.75	668.52
Facility term interest	675.88	640.52	628.54	632.62	641.01
Fixed costs	***3,125.49***	***2,968.96***	***2,812.18***	***2,856.10***	***2,934.98***
Production costs	***5,802.48***	***6,015.81***	***6,021.74***	***6,013.62***	***5,989.76***

Source: Own calculation.

Profitability indicators of farms

Gross production value refers to the value increase resulting from the crop and animal production obtained as a result of a farm's agricultural production activity for one year. Gross production value can be calculated separately for different production branches in the farm or for the whole farm.

The gross value production value obtained from apricot production per decare of the farms examined was calculated as 25,090.66 TRY. The gross production value per decare in the average of the region was found to be 20,245.77 TRY. Gross production value per decare was determined as 13,757.86 TRY in the first layer, 16,698.00 TRY in the second layer and 27,995.96 TRY in the third layer (Table 4).

Gross profit was calculated by subtracting the changing costs from the gross production value of apricot production of the enterprises. Accordingly, the gross profit per decare of the farms analysed was calculated as 21,933.14 TRY and the gross profit per decare in the average of the region was calculated as 17,191.00 TRY. Gross profit per decare was calculated as 11,080.87 TRY in the first stratum, 13,651.15 TRY in the second stratum and 24,786.39 TRY in the third stratum (Table 4).

Absolute (net) profit was calculated by subtracting the production costs per decare from the gross production value per decare. The absolute profit per decare of the enterprises was determined as 19,077.04 TRY. According to the regional average, absolute profit per decare was calculated as 14,256.02 TRY. Absolute profit per decare was calculated as 7,955.39 TRY in the first stratum, 10,682.19 TRY in the second stratum and 21,974.22 TRY in the third stratum (Table 4).

Relative profit was calculated by dividing gross production value by production costs. The relative profit per decare of the farms was found to be 4.17. According to the average of the region, the relative profit was calculated as 3.38 (Table 4).

The relative profit was calculated as 2.37 in the first stratum, 2.78 in the second stratum and 4.65 in the third stratum. The production value obtained for apricot production in return for one unit of cost is expressed by the relative profit value. According to this, it was determined that for every 1 TRY cost incurred in apricot production activity, a production value of 4.17 TRY was obtained, thus 3.17 TRY profit was obtained for every 1 TRY in the average of the farms interviewed. It was determined that 1.37 TRY profit was obtained for every 1 TRY in the farms in the first stratum, 1.78 TRY profit was obtained for every 1 TRY in the farms in the second stratum and 3.65 TRY profit was obtained for every 1 TRY in the farms in the third stratum. The highest profit was found in the third stratum. It was calculated that the profit rate increased with the width of the planted area (Table 4).

Demirtaş [7] calculated the gross production value per decare in apricot production of farms in Mersin province as 3,003.98 TRY, gross profit as 1,607.94 TRY, absolute profit as 840.36 TRY and relative profit as 139% in 2021 prices. Fidan [10] calculated the gross production value of the farms in Igdir province as 2,904.67 TRY, gross profit as 1,474.46 TRY, absolute profit as 833.05 TRY, and relative profit as 1.40% in 2021 prices. Sarıbaş [21] calculated the gross production value of apricot farms in Malatya province as 3,758.74 TRY, absolute profit as 570.81 TRY, and relative profit as 117.91% in 2021 prices. Uçar [25] determined the gross production value per decare of apricot farms in Malatya province as 1,607.43 TRY and the relative profit as 164.82%. Çatı [4], in his study conducted in Malatya province, calculated the gross production value of organic apricot farms as 157,960.5 TRY, their absolute profit per decare as 1,448.6 TRY according to average land assets and 2,016.2 TRY according to average apricot areas.

Demirtaş [7] determined the relative profit in the Mersin to be 1.39. Moreover, Gül and Özen [15] computed the relative profit as 1.40 for farmers in the Mersin who used loans and 1.41 for those who did not.

Obtained results are broadly consistent with earlier researches. Although the differences are thought to be mainly caused by the variation of the investigated genotypes, differences in cultivars, ecological characteristics, altitude, maturity stage, harvest time and type, process, storage etc. cause serious variations on crop quality [5][18]thus effect the last economic gain of crops or products.

Table 4. Profitability indicators in apricot production

Indicators	Farming groups			FA	RA
	I	II	III		
	Quantity (TRY per decares)				
GPV	13,757.86	16,698.00	27,995.96	25,090.66	20,245.77
Gross profit	11,080.87	13,651.15	24,786.39	21,933.14	17,191.00
Absolute profit	7,955.39	10,682.19	21,974.22	19,077.04	14,256.02
Relative profit	2.37	2.78	4.65	4.17	3.38

Source: Own calculation.

Apricot price per unit, production cost and profit margin of the investigated farms were calculated with the following formulae.

1 kg apricot production cost = Total apricot production costs/Amount of apricot produced (kg)

1 kg apricot price = Total gross production value of apricot / Amount of apricot produced (kg)

1 kg apricot profit margin = 1 kg apricot price - 1 kg apricot cost

By dividing the gross production value by the total apricot production amount, the average sales price of one kg apricot of the farms was found as 7.68 TRY. According to the average of the region, apricot sales price per kg was calculated as 6.93 TRY, while the sales price per kg of the farms according to the planted area width was 5.87 TRY in the first stratum, 6.19 TRY in the second stratum and 8.07 TRY in the third stratum. Apricot prices increased due to the increase in the width of the planted area. At this point, economies of scale and the fact that large farms include more new and late apricot varieties helped them to achieve this high price advantage.

According to the data of the Turkish Statistical Institute in 2021, the average selling price of one kg of apricot in Türkiye was 6.66 TRY. In Isparta province, which covers the research region, 5.8 TRY was reported [24]. The sales price determined in the research region was found to be high according to TURKSTAT data. This situation can be attributed to the cultivars grown (early, late) and enterprise facilities.

One kg apricot production cost was calculated by dividing the total apricot production costs of 138 apricot farms by the amount of apricot produced. Accordingly, the average cost of one kg of apricot was found to be 1.84 TRY. According to the regional average, one kg apricot cost was calculated as 2.05 TRY. In the enterprise groups, one kg apricot cost was found as 2.48 TRY in the first layer, 2.23 TRY in the second layer and 1.74 TRY in the third layer.

The average profit margin of the farms was determined as 5.84 TRY by subtracting the kilogram cost from the kilogram sales price of apricot. According to the regional average, this ratio was determined as 4.88 TRY. In the farms in the first stratum, 3.40 TRY, in the second stratum 3.96 TRY and in the third stratum 6.33 TRY were calculated. The highest profit margin was realized in the farms in the third stratum. The reason for this may be that the new varieties of apricots produced are more in this group and higher yields are obtained and sold at higher prices than other apricot varieties through exports.

Impact of agricultural support on profitability indicators

The average gross production value of the farms in the research region was calculated as 25,133.34 TRY per decare with the effect of agricultural subsidies received from the public. In the average of the region, the gross production value per decare was 20,285.96 TRY. According to the planted area width, the gross production value was calculated as 13,780.05 TRY in the first stratum, 16,740.47 TRY in the second stratum and 28,039.55 TRY in the third stratum. The average gross profit of the farms was 21,975.81 TRY per decare, net profit was 19,119.72 TRY and relative profit was 4.18 (Table 5).

The agricultural subsidies received by the farms in the research region increased the gross production value by 0.17%, gross profit by 0.19%, net profit by 0.22% and relative profit by 0.17%.

Şirikçi and Gül [23] found that agricultural subsidies utilized by farmers positively changed the profitability indicators in quince production activity. They found that the support received by farmers increased their relative profitability by 0.04.

Table 5. Profitability indicators with the impact of agricultural support

Indicators	Farming groups			FA	RA
	I	II	III		
	Quantity (TRY per decares)				
GPV	13,780.05	16,740.47	28,039.55	25,133.34	20,285.96
Gross profit	11,103.06	13,693.62	24,829.98	21,975.81	17,231.19
Absolute profit	7,977.57	10,724.66	22,017.80	19,119.72	14,296.20
Relative profit	2.37	2.78	4.66	4.18	3.39

Source: Own calculation.

Problems in Cultivation

The biggest problems of the examined farms related to apricot production, facility and cultivation were high input prices 28.99%, diseases and pests 22.46%, frost damages 10.14%, fragmentation of lands 9.42%, irrigation shortage 7.97%, high water fee 6.52%, high certified sapling prices 5.07%, electricity supply 4.35%, labour supply difficulty 3.62%, and lack of facilities 1.45% (Table 6).

The operators stated that they could not fertilize and spray at the desired level in apricot production due to the high prices of production inputs. Since the tree cannot get the necessary nutrients from the soil, there may be a decrease in product yield and quality. One of the most important problems of the producers in the studied region is diseases and pests. Cultural and chemical control is carried out for diseases and pests. The presence of pigs in the region also causes economic damage to apricot trees and fruits. As in all regions where apricot production takes place, frost damage is another important problem. Frost events can affect the producers partially or completely negatively. Due to late spring frosts, some years the producers get very low yields and some years they do not get any yields. While frost damage is experienced in some of the apricot gardens in the same region, it is not experienced in some gardens. The reason for this is the location of the land where the garden is established. In other words, it is the wrong installation. Therefore, the location of the garden should be determined consciously before the garden is established. Another problem is the fragmentation of the land structure, which restricts the agricultural mechanization activities of the producers and causes loss of time.

Producers in the region irrigate their apricot orchards with water from Lake Eğirdir, the fourth largest lake in Türkiye. Drinking water of Isparta province and irrigation water used in agricultural production activities in the region are supplied from Lake Eğirdir. Due to global warming, unconscious water use and other factors, the water of Lake Eğirdir is shrinking. This situation has further increased the level of sensitivity of the people of the region and in line with all these reasons, farms have started to use drip irrigation system long ago (for about 13 years).

Table 6. Problems encountered in apricot cultivation

Problems	Farming groups			FA
	I	II	III	
	Ratio (%)			
High input prices	28.57	32.73	25.81	28.99
Diseases and pests	28.57	23.64	19.35	22.46
Frost damage	9.52	12.73	8.06	10.14
The fragmentation of the land	4.76	3.64	16.13	9.42
Irrigation shortage	4.76	7.27	9.68	7.97
High cost of water	4.76	10.91	3.23	6.52
High prices of certified saplings	4.76	1.82	8.06	5.07
Electricity supply	4.76	1.82	6.45	4.35
Difficulty in labour supply	9.52	3.64	1.61	3.62
Lack of facilities	0.00	1.82	1.61	1.45
Total	100.00	100.00	100.00	100.00

Source: Own calculation.

High water fees, lack of electricity in some lands where apricot orchards are located, difficulties in obtaining labour and the lack of facilities where apricot can be processed are other important cultivation problems stated by the producers.

Problems faced in marketing

When the problems encountered by the farms in the marketing process were analyzed, the most important marketing problem was found to be the lack of an official market with a rate of 29.71%. Price determination by brokers was mentioned by 21.01% of the farms, lack of supervision in marketing by 18.84%, storage problem by 8.70%, buyer's fraud by 7.25%, lack of a co-operative by 5.80%, broker's not making payment properly by 4.35%, lack of a processing industry by 2.17% and packaging problem by 1.45%. Due to the lack of a market in the region, producers stated that they had to sell their products to traders and brokers. The fact that the brokers are late or do not receive the return of the product, the problems experienced in the supply of crates, the lack of a storage system, and the marketing mechanism being far from a certain control negatively affect the producers (Table 7).

Özen and Gül [20], in their study conducted in Mersin province, identified inadequate apricot fruit set, lack of marketing opportunities and fluctuations in apricot prices as the main problems.

Şirikçi and Gül [22] found a positive relationship between relative profitability and marketing structure variable in quince farming.

Table 7. Problems in the apricot marketing process

Problems	Farming groups			FA
	I	II	III	
	Ratio (%)			
Lack of fresh fruit and vegetable market	28.57	21.82	37.10	29.71
Brokers' pricing	19.05	29.09	14.52	21.01
Marketing unsupervised	14.29	20.00	19.35	18.84
Storage shortage	4.76	9.09	9.68	8.70
Buyer's fraud	9.52	5.45	6.45	7.25
Lack of cooperative	9.52	5.45	4.84	5.80
Broker not paying properly	4.76	5.45	3.23	4.35
Lack of processing industry	4.76	1.82	1.61	2.17
Packaging problem	4.76	1.82	1.61	1.45
No marketing issues	0.00	0.00	1.61	0.72
Total	100.00	100.00	100.00	100.00

Source: Own calculation.

At this point, improvements in the marketing structure factor will positively affect the relative profitability in quince cultivation. It can be stated that the same situation is valid for apricot production.

Problems faced in finance

To the question asked to determine whether the enterprises had problems with loan collateral, 97.83% said no and 2.17% said yes. Some of the enterprises stated that they could not use loans due to high loan interest rates.

CONCLUSIONS

Small-scale farms predominate in the region. The main source of income in the interviewed farms was the income from apricot production. The average production cost per decare in apricot production of the farms was 6,013.62 TRY.

Gross production value per decare in apricot production was 25,090.66 TRY; gross profits were calculated as 21,933.14 TRY, net profits as 19,077.04 TRY, and relative profits as 4.17. In the 2021 production season considered, apricot farms in the region made high profits from apricot production.

Based on the findings of this study, (i) farmers should be encouraged to benefit from economies of scale, (ii) the Government should provide necessary technological improvements to farmers regarding irrigation and provide more training opportunities to farmers regarding input use.

As a result, especially the good price realization in 2020-2021 increased the profitability of apricot farms.

This factor is also decisive and important for the sustainability of apricot production in the region.

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THE CURRENT SITUATION OF AGRICULTURAL INNOVATION-DERIVED INVESTMENTS AND ACCESS TO FUNDING IN AZERBAIJAN

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Abstract

Agricultural producers' financial resources should be available to undertake agricultural innovation-derived investments. Although Azerbaijan is now undergoing a lot of reforms in this area, the situation is still far from satisfactory. The article emphasizes the importance of state support in particular for ensuring the sustainability of the activities of agricultural producers. Nowadays, more than 90 percent of agricultural products are owned by private owners, family-peasant farms and households. Nonetheless, those economic subjects' access to financial sources is not at a satisfactory level. The article also discussed the effect of subsidies in agricultural producers' revenue and established the unique weight of subsidies in income for a number of major goods. The state's policies in this direction in Azerbaijan, as well as its positive outcomes, were also highlighted. The data collected by the systematic approach were analyzed utilizing horizontal, vertical, and trend analysis methods from financial analysis techniques. To ensure the data's legibility, comparison charts have been created. Based on the economic growth in this industry during the previous two years, it was determined that the manufacturing of crops is a priority.

Key words: *food security, innovation-derived investment, agricultural producers, agricultural cooperatives, farmers, subsidies*

INTRODUCTION

Having access to financial resources is one of the most significant factors for agriculture's long-term development. Farmers who wish to expand their farmland and/or grow higher value-added products are unable to access funding, limiting their ability to boost their earnings. As a result, that farmer is unable to contribute to the growth of Azerbaijan's gross domestic product. On the other side, the main obstacle for food security is low agricultural production, which is exacerbated by farmers' lack of access to financial resources. Adequate agricultural finance is one of the methods of strengthening that has the potential to boost productivity, assure food security, increase farmers' export potential, and raise the rural population's standard of life in the long run [5]. Access to financial resources also increases farmers' investment capacity in terms of acquiring and using current technology for growing abundant and high-quality crops. It demonstrates the importance of finance in this industry, both in terms of productivity and the quality standards necessary in global markets for export-oriented agricultural products.

Agricultural financing is typically used in two distinct ways: 1) as working capital to cover current production expenses, and 2) as investment capital to acquire new equipment and technology. Farmers' investment and production decisions appear to be impacted by simple access to financial instruments and fair interest rates [12].

The purpose of this research is to investigate the current state of innovation-derived investments in the agricultural field, to identify opportunities for access to financial sources and the problems that may arise in this regard, and to study the role of financial institutions in the application of innovative investment in Azerbaijan by examining global

experience. To explore the aforesaid, the following tasks have been assigned:
- to investigate the current state of agricultural innovation-derived investment funding in the Republic of Azerbaijan;
- to explore advanced world experience of interactions with financial sources in agricultural innovation-derived investment;
- to determine the role of financial institutions in funding agricultural innovation-derived investment;
- to study the possibilities of access to financial sources in funding agricultural innovation-derived investments of farm producers.

MATERIALS AND METHODS

If there is no systematic approach to the study of the complex economic life of society, then we will collect contradictory facts and events. It is vital to employ scientific approaches to collect systematic data and identify the internal regularities of the economy. Understanding the essence of economic phenomena is only achievable via the use of the research system. The study of the economy as an economic system implies the presence of a specific technology, which is the consistency of this research.

As the facts characterizing a certain economic phenomenon were collected in the first stage of the research, we also collected the necessary information and facts by examining the theoretical issues, advantages, and existing problems in the direction of access to financial sources in innovation-derived investments in agriculture. Collected facts were analyzed and summarized and a general analysis of those data was conducted. One of the stages of the research methodology is the examination of the global experience in the direction of the application of innovation-derived investment. In this regard, the experience of the United States, European countries and Turkey has been carefully considered, as well as the prospective application of the method utilized in these countries in the Republic of Azerbaijan has been explored. In the next stage, the impact of innovation-derived investments in agriculture across the country on productivity in Azerbaijan was investigated.

Analysis of the data obtained as a result of the research is based on horizontal, vertical, and trend analysis methods. The horizontal analysis method reflects the percentage increase or decrease of two or more indicators, this method allows us to find out how the state support affected agriculture in the last 5 years. The vertical analysis method reflects the percentage ratio of relevant indicators within their groups (when calculating, the amount is multiplied by 100 and divided by the total amount of the group) in order to make the research work comparable, the trend analysis method reflects an increase or decrease of indicators covering a period of more than 4 or 5 years compared to the first year. MAX EXCEL program was used to minimize deviations in calculations [10]. To ensure the readability of the data and the efficiency of the analysis methods in the paper, many graphs were created in computer programs.

During the research, the materials of the State Statistics Committee of the Republic of Azerbaijan, as well as the data obtained from surveys conducted with farmers and agricultural cooperatives in Ganja-Dashkasan and Mil-Mugan economic regions of the republic were broadly used.

RESULTS AND DISCUSSIONS

Azerbaijan has recently taken significant progress in the innovation of economic processes. Innovative approaches predominate in the Strategic Roadmap of the National Economy and the Main Sectors of the Economy adopted by the Decree of the President of the Republic of Azerbaijan dated December 6, 2016 [8]. Azerbaijan is already taking practical steps to establish a management framework for innovative processes. The Decree of the President of the Republic of Azerbaijan dated November 6, 2018 on the formation of the Innovation Agency under the Ministry of Transport, Communications, and High Technologies of the Republic of Azerbaijan comes into force and is now being implemented. Furthermore, starting from 2012, the process of organizing the Hi-Tech Park in Pirallahi is underway, and enterprises are being formed here [1]. Thus, in the near future, Azerbaijan will need to considerably strengthen strategic approaches to the formulation of innovation policy and innovation processes, and we believe it is crucial to concentrate on a number of issues:

- Azerbaijan's innovative growth potential should be thoroughly studied and appraised;
- the processes of creating the national innovation system should be completed and the justified strategic directions of innovative development should be defined;
- the structure of the management system of innovation processes and the application processes of flexible management mechanisms should be assured;
- in accordance with Azerbaijan's strategic goals for economic growth, goals for the national economy's immediate and long-term innovation should be developed, creative development plans and big innovation-investment projects should be created and implemented, and so on.

Also, innovation is curicial for every nation including Azerbaijan where countries have equal access to cutting edge technologies and infrastructures. Each country’s strategic goals are founded on a cohesive vision that is commonly accepted. According to the European Union’s Sustainable Development Goals, innovation in all countries’ technological value chains must be built on the utilization of ICT recources, and innovative approaches must be applied in all processes [9]. To accomplish the intended goals, the sources of funding for innovative agricultural investment must first be identified. In reality, each approved creative development plan is largely achieved through investments. Considering that agriculture is a high-risk sector across the world that is continually in need of government assistance, the precise identification and investigation of investment sources is the basis of innovative development. As a result, analyzing the funding sources of agricultural innovation-derived investments might help to solve the problem. The primary issue in this process is determining the ratio of the specific weight of the types of agricultural funding sources.

Real life has shown that a one-sided approach to the source of agricultural investments has failed. This approach overlooked the core aspects of agriculture. This fundamental feature is that agricultural producers' low level of income limited their utilization of the market type. The low level of income is explained by the high risk in this area. The market approach of investment financing is distinguished by the fact that it directs investments solely to high-profit regions. As a result, beginning in the early 2000s, the government began to play a prominent role in agricultural funding. Agriculture is a multifunctional area, hence state funding is required.

Its relevance is not limited to the country's food security, it also plays a vital part in the country's social and cultural development, the construction of other areas of the economy (light industry), and providing the fundamental necessities of the population. In addition to the broad features of agriculture given above, it is critical to evaluate its current position while analyzing the sources of innovation-derived investments in this industry. This includes the country's geographical climatic conditions, farm size, and production weight, the strategic importance of the area, level of self-sufficiency with foodstuffs, agricultural product import and export ratio, the modern state of the material and technological basis, and so on [4].

As a result, one of the primary factors determining the success of agricultural modernization strategy is the cardinal (fundamental) solution to the problems of funding innovation-derived investments in the field by the government. Due to the features of agriculture outlined above, it is difficult to create and update its contemporary infrastructure without active governmental engagement in the investment process in this field.

At the moment, global experience in the field of financing investment projects suggests that the loan portion of new projects typically ranges between 20 and 30%, with the remaining 70-80% covered by other sources. As an example of the establishment of such sources, we may consider the emission of securities. The primary role of financial markets is to transform saved money into an investment. In this context, financial markets may be a major source of agricultural investment. According to 2022 statistics, the world's leading stock markets include 43 significant corporations that manufacture agricultural products and provide services in this industry. The share prices of these firms range from $0.33 to $3675.16. Dividends paid per share range from 0 to 18.9 dollars. The market valuation of the corporations ranges from 3 billion dollars to 126.5 billion dollars [11]. The data we are referring to are from the world's leading agricultural production and service companies. Furthermore, the engagement of large farmers in financial markets grows each year. One of the key paths of diversification of agricultural firms' foreign investment sources is active engagement in financial markets. Unfortunately, Azerbaijan's financial markets are largely underdeveloped and serve as a limited source of investment. However, the expansion of this market can ensure the expansion of agricultural investment sources. Given that Azerbaijan's significant agricultural firms are now formed on the basis of agro parks, the participation of such companies in financial markets with their securities can be ensured in the future. As a result, we believe that as Azerbaijan's financial markets grow, the issuance of agricultural enterprise securities as the primary source of funding may become the primary choice in the future.

Table 1. Dynamics of fixed capital investment, million manats

	2016	2017	2018	2019	2020	2021	2021/2016 %
Investment directed to fixed capital by sectors of the economy, total	16,772.8	17,430.3	17,244.9	18,539.5	17,226.1	16,815.5	0.3
including: agriculture, forestry and fishing	325.1	617.8	764.4	769.5	520.6	341.9	5.2
The share of investment directed to agriculture, %	2.1	3.5	4.4	4.2	3.0	2.0	-4.7

Source: Own calculations based on the data from The State Statistical Committee of the Republic of Azerbaijan, Statistical indicators of Azerbaijan 2022. p. 506 [7].

According to the data of the State Statistics Committee, as can be seen from the dynamics of the investment directed to the fixed capital, the rise of agricultural investments by 2020 is visible in absolute numbers. In 2019, fixed capital investment in the relevant area increased more than twice as much as it did in 2016 [7]. This upward tendency was mirrored in the particular weight of total investments. However, after 2020, there has been a reduction. This is because to the COVID-19 pandemic, which is hitting Azerbaijan as well as the rest of the world. To begin with, COVID-19 caused an economic supply problem and had a negative influence on investment volume. However, in 2021, the beneficial effect of prior years' increasing agricultural investment was reflected in a rise in overall agricultural production.

As can be seen from Figure 1, in 2021, despite the complications caused by the COVID-19 pandemic, an increase of 3.4 percent was observed in the production of overall agricultural products compared to 2020. It should also be noted that this growth occurred at the expense of agricultural products. Compared to 2020, the increase in the relevant area was 3.2 percent. In animal husbandry, it decreased by 0.3 percent. Achieving such productivity in the field of horticulture can be explained primarily by innovation-derived investments in this field [7].

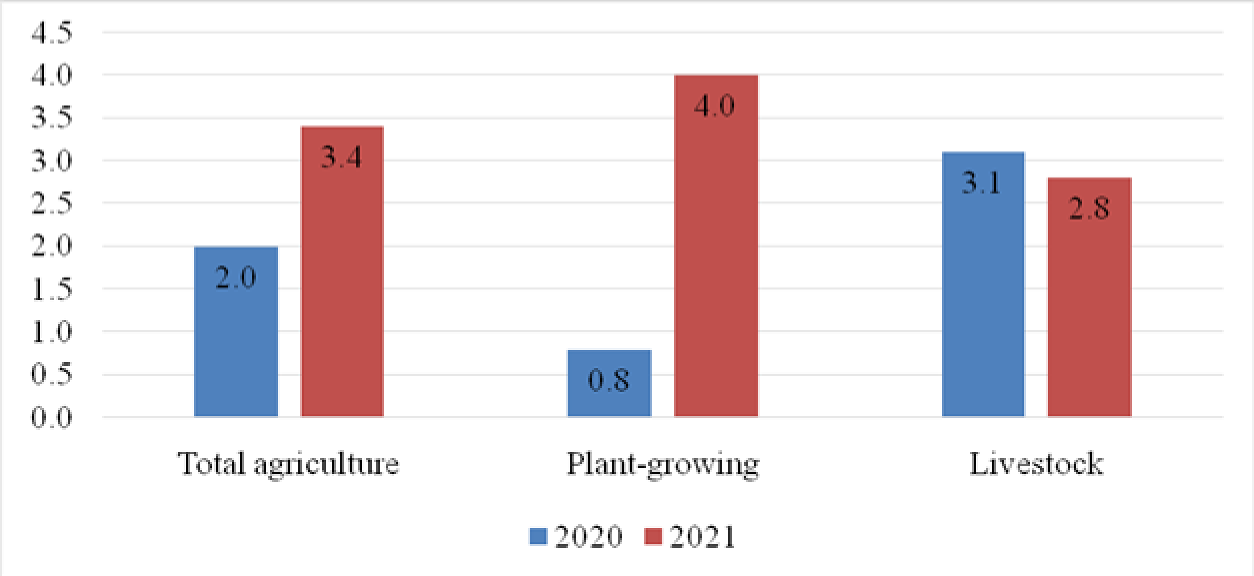

Fig. 1. Agriculture physical volume index (with comparable pricing compared to the previous year, (%)
Own calculations based on the data from The State Statistical Committee of the Republic of Azerbaijan, The Agriculture of Azerbaijan 2022. p. 506 [7].

As can be seen from Table 2, the number of tractors and their aggregates has increased over the previous six years. The number of tractors in 2021 has more than doubled compared to 2016 and reached 36,808 units. The similar upward tendency may be seen in the number of aggregates. For example, the number of plows increased about 5.6 times, cultivators increased nearly 20 times, grain-seed sowers increased approximately 13 times, mowers increased approximately 13.3 times, and threshers increased approximately 2.5 times [7].

Table 2. Park of the main types of agricultural machinery, by the end of the year, number

Years	Tractors	Plows	Cultivators	Grain and seeds sower	Mowers	Threshers
2016	17,043	1,002	79	294	128	683
2017	21,787	1,624	192	603	440	824
2018	34,829	4,350	589	1,697	660	1,656
2019	34,936	4,413	1,094	1,797	755	1,580
2020	34,954	4,519	1,277	3,233	1,312	1,512
2021	36,808	5,602	1,618	3,819	1,703	1,697
2021/2016 %	116	559	2,048	1,299	1,330	248

Source: Own calculations based on the data from The State Statistical Committee of the Republic of Azerbaijan, Statistical indicators of Azerbaijan 2022. p. 70 [7].

This tendency may also be seen in the increase in the use of other farm machinery (Table 3).
Statistical analyses demonstrate that the number of agricultural machinery has increased during the previous six years.
Thus, in comparison to 2016, the number of potato harvesters climbed 12 times, sugar beet harvesters increased 142 times, solid mineral fertilizers disintegrators increased 10 times, and sprinklers and pollinators increased 13 times [7].
Without the state's support in the relevant sector, recording the aforementioned rapid growth indicators would be impossible.
Thus, agricultural machinery leasing is governed by Cabinet of Ministers of the Republic of Azerbaijan Decision No. 58 of March 31, 2005, "Rules for leasing agricultural machinery and technological equipment belonging to Agroleasing Open Joint-Stock Company to legal and natural persons," and is carried out in accordance with the approved Rules.

Table 3. A park of the main type of agricultural machinery, by the end of year, unit

Years	Machineries			
	Potato harvester	Sugar beat harvester	Solid mineral fertilizers disintegrators	Sprayers and pollinators
2016	5	1	54	130
2017	12	8	82	194
2018	39	31	211	849
2019	43	35	281	961
2020	49	34	335	1,299
2021	59	142	518	1,665
2021/2016%	1,180	14,200	959	1,280

Source: Own calculations based on the data from The State Statistical Committee of the Republic of Azerbaijan, Statistical indicators of Azerbaijan 2022. p. 70 [7].

Legal and natural persons who seek to purchase agricultural machinery through leasing must pay at least 10% of the total cost of the machinery in advance, and the remaining part no later than 10 years, by applying to "Agroleasing" OJSC by electronic application or directly, including the insurance charge. At the same time, keep in mind that the lease procedure has been made as simple as possible. The following are the simplified rules:

1. An entrepreneur can buy agricultural machinery through leasing by providing an ID card and the requisite payment.
2. When 20 percent of the initial cost of agricultural machinery is paid, a 40 percent incentive is applied at the expense of the state budget [6].

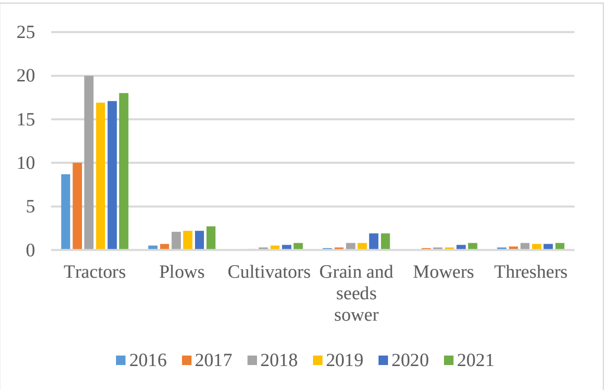

Fig. 2. The main indicators reflecting the machinery per 1,000 ha arable land, 2016-2021 (number/1,000 ha)
Source: Own calculations based on the data from The State Statistical Committee of the Republic of Azerbaijan, Statistical indicators of Azerbaijan 2022. p. 52, 70 [7].

Despite a recent growth in the quantity of agricultural machines, the existing machinery is still insufficient for agricultural development. As can be seen from the figures, the number of machines per hectare of arable land is not even 0.1 units. As a result, Azerbaijan's agriculture productivity is quite poor by global standards.

According to this viewpoint, increasing the amount of machinery will create circumstances for increased production, and as a result, agricultural product producers' earnings will rise.

In comparison, Azerbaijan's cereal yield in 2021 was 32.8 centners, whereas Germany's yield reached 70 centners (2.1 times more) [3].

In developed countries like Germany, innovative technologies make it possible to make concrete proposals to promote economic, social and environmental sustainability. This necessitates the upgrading of agri-food systems [2].

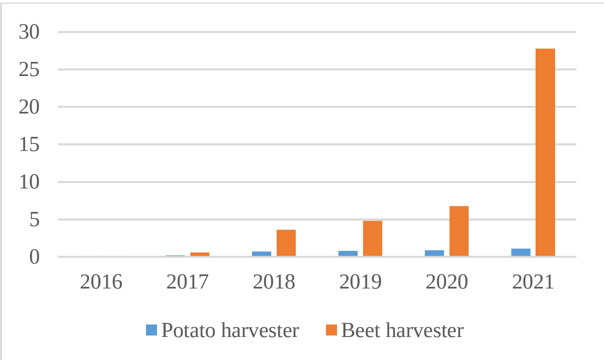

Fig. 3. The main indicators reflecting the number of harvesters per ha of potato and sugar beet cultivated area 2016-2021 (Number/1,000 ha)
Source: State Statistical Committee of the Republic of Azerbaijan, Statistical indicators of Azerbaijan 2022. p. 52,70,71 [7].

This circumstance is likewise comparable to potato and beet harvesters. Potatoes grown in Azerbaijan, particularly in remote areas, are harvested only mechanically. This eventually leads to low productivity and increased imports to fulfill domestic demand for those products. The number of beet pickers has recently increased in comparison to potato pickers. However, this figure is also not at a satisfactory level. As can be observed, the lack of machinery, in general, has a significant impact on crop cultivation productivity in Azerbaijan's agriculture. We consider that there is an essential need in our country to study overseas experience in this area and apply that knowledge to local settings.

It was vital to emphasize the importance of subsidies in funding sources for farmers to focus on innovative agricultural initiatives. As a result, our research indicates that the special weight of the subsidy on income is significant. Cotton plant subsidies range from 21 to 24 percent, grain crops from 6 to 9 percent, seedlings from 7 to 10 percent, cabbage crops from 12 to 19 percent, and onions from 5 to 18 percent. These figures highlight the unique role of government assistance in agricultural financing. Because credit and insurance institutions' involvement in the agricultural sector in Azerbaijan is now unsatisfactory.

It should also be noted that regional state structures and private institutions should cooperate more closely, natural and economic resources in the region should be productively involved in the financial circulation of the economy, the creation of reliable and sustainable sources of taxation, ensuring the honesty and transparency of financial reports, protecting the principles of business and healthy competition in the business environment will all be significant.

CONCLUSIONS

In recent years, monies devoted to machinery and equipment used in horticulture have expanded several times in Azerbaijan as part of fixed capital investments. Despite the negative impacts of the pandemic, this has resulted in a rise in production in the relevant sector. Investors will invest more in locations where financial and investment activity is high, firms are not operating at a loss, business entities are developing, and the payback potential of the resultant investments is formed. In addition, the formation and development of relevant institutions and structures that have the authority to implement the functions of formation, concentration, and distribution of regional financial and credit resources at the local level should be ensured. Evaluation of various segments of financial markets at the regional level, provision of access to financial and credit resources are characterized as very important issues. In addition, the funding sources of Azerbaijan's innovation-derived agricultural investment should be properly identified and analyzed. Access to financial resources for agricultural innovation-derived investments is essentially determined by the direction of these investments. As a result, such directions should be researched and their priority status established. Internal and external funding are the two primary means of financing innovative agricultural investments. Based on our research, we came to the conclusion that the absolute dominance of small producers in Azerbaijan's agriculture significantly limits domestic resources. For this reason, external sources play the main role in accelerating investment. Public-private partnership plays an important role in the wide spread and development of innovation-oriented investments. First of all, this partnership should be considered as a strategic tool that will ensure the competitiveness and sustainable development of local producers in both domestic and foreign markets. At the same time, along with the creation of this partnership, it is proposed to create an appropriate infrastructure system for access to the sources of innovative investment.

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USE OF AGRICULTURAL POTENTIAL FOR ECONOMIC RECOVERY/GROWTH

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Abstract

In the current context, after a pandemic that has left traces in all socio-economic fields and during major geo-political problems, Basic research is needed in order to identify directions for rapid and sustainable socio-economic recovery. The agricultural sector has played a particularly important role in speeding economic growth and development in less developed countries. As a result, we may argue that the agriculture sector has aided these countries' integration into global trade. The proposed paper aims to identify the degree of dependence of the Moldovan economy on agriculture and how this dependence can be transformed into a challenge that will help the country's economy. Also, the paper aims to identify the link between agricultural production and gross domestic product at the level of the Moldovan economy, as well as the need to create a stability in the labour market in agriculture. The above mentioned will be achieved in the conditions in which there is already a decrease in the labour force, a decrease due to medical, geo-political and migration factors. To develop a sustainable economy, sustainable agricultural public policies must be enacted, resulting in the attraction of personnel from metropolitan regions (where unemployment is higher) to rural areas.

Key words*: *agricultural, Lewis's theory, human development, labour, employees, investments

INTRODUCTION

The current economic context can be an opportunity for developing countries to find effective ways of recovering the agricultural sector.
The surplus theory, based on Arthur Lewis' 1954 work, is a viable growth model. In the Lewis model, economic growth is closely linked to the cheap labour market attracted to the industrial sector, which leads to increased value added and thus increased investment volume. Thus, Arthur Lewis introduced the dual sectoral model, or the Lewis model. This model combined an analysis of the historical experience of developed countries with the central ideas of classical economists. This integrated approach led to the production of a broad picture of the development process [8], [7], [2], [15].
If we report to of the subsistence economy, there is an “unlimited” labour market, which means that the capitalist sector can expand without the need to raise wages. This leads to higher profits that are then reinvested in the accumulation of capital. Increasing employment, according to the analysed model, can be a modern approach from an economic point of view, as the process becomes self-sustained.
Obviously, with the increase of the productivity of labour in agriculture, the socio-economic life of the human resources involved in this activity will be improved. This improvement in quality of life will be achieved by increasing wages according to conventional growth models [1], [16].
If one avoids the limitations of Lewis’ approach and reflects on the variations in his models, one can develop a pragmatic approach aimed at accumulation and trade as historical and contemporary issues and at the fundamental role that agriculture plays in development.

It can therefore be said that the limits of the use of the Arthur Lewis model today are given by the fact that one cannot speak of an increase in population, but by a reduction in it and the present economic and political actions. This limit, however, can be exceeded because there is still a substantial amount of idle labour in rural areas.

Looking at the importance of agriculture in the GDP of several industrialized countries, there is a downward tendency. Agriculture is also more developed in impoverished and developing countries than in developed countries.

The EU-27 Economic Accounts for Agriculture have fluctuated over the past four years (according to Eurostat): from EUR 418,873.74 million in 2019, we have in 2020 the value of EUR 415,220.66 million, in EUR 2021 449,937.73 million to have EUR 536,648.83 million in 2022. Thus, there may be visible growth in 2022, indicating that U27 has taken economic measures to support this branch of industry [5], [4], [3].

The agricultural sector is critical to the economy of the least developed and developing countries, accounting for a considerable portion of GDP (about two-thirds). At a time when agricultural income makes for a significant share of GDP, it goes without saying that agricultural enterprises are among the top jobs. These companies employ a significant proportion of the workforce that exceeds 50% in most cases. The agricultural sector is also the sole source of livelihood and income for more than half the population of developing countries. The close upstream and downstream links that exist in the rural sector as well as with other sectors of the economy also have a stimulating effect on growth and revenue generation. It is clear that poor countries cannot make progress in economic development, poverty reduction and greater food security without adequate human resources and adequate productive capacities. In light of the foregoing, we can conclude that agriculture should be a top priority for governments in developing countries. All agriculture (including agricultural output and the food sector) must be prioritized in the implementation of all countries' economic recovery and growth programs. This need has been all the more visible in recent years when the world has undergone major changes and it has been observed that food safety is an essential element in global geo-political stability.

In this context, the purpose of this paper is to analyze in what measure the Moldovan economy depends on agriculture and how this dependence to be transformed into a chance for sustaining the country's economy. The connection between agricultural production and gross domestic product was analyzed in order to find solutions for a stable labour market in agriculture.

MATERIALS AND METHODS

The proposed methodology analyses the degree of dependence of the main economic field that influences the income of a less developed country. This level of reliance cannot be assessed without considering the influence of the level of employment in the industry in issue. The proposed analysis begins with a look at the relationship between GDP and agriculture. The next step is the analysis of the impact of human resources on agriculture. The regression method is generalized by the theory of the "general linear model", in which several dependent variables are allowed simultaneously and also factorial variables that are not linear independent. Econometric analysis of the model involves identifying regression that includes both dependent and independent variable. For the analysis carried out in this paper, the dependence variable is GDP and the independent variable is agricultural production. The correlation matrix will also be run to confirm the relationship between variables.

The problem of estimating prediction errors will be dealt with the presentation of the general model that involves defining the equation related to the linear model. By applying the method of the smallest squares, the coefficients a and b. The estimated value, however, is an average. Accuracy depends on how well the regression right fits with the

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actual data. This match is evaluated using the standard estimate error.

Regression analysis helps to understand whether the two variables identified are associated and their degree of association. The correlation coefficient is denoted by "r" and has values from "-1" to "+1". A null value indicates no association. If the correlation coefficient has a value of "+1" it indicates a perfect positive association. If the correlation coefficient has the value "-1" it indicates a perfect negative association.

The correlation coefficient is defined by:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{(\sum(x_i - \bar{x})^2)(\sum y_i - \bar{y})^2)}} \qquad (1)$$

Because R tends to exaggerate the link between x and y, R2 is the square of the multiple correlation coefficient.

The link of GDP to agricultural revenue in the Republic of Moldova for the period 2015-2020 will be examined using this methodology. The information was acquired from the Republic of Moldova's National Statistical Office.

RESULTS AND DISCUSSIONS

Moldova's economy has an unstable structure that does not indicate proper conditions for development. Geo-political conditions have often led to the impossibility of developing a policy that could lead the country in a more favourable direction.

Agriculture continues to be an important sector, although the share of this sector in economic revenues has declined over the past decade. It is characterized by small, family farms, and their competitiveness is low regarding productivity, product quality and low value added with an important influence of agriculture contribution to export and GDP [11, 12, 13].

However, even under these conditions, Moldova is among countries where the agricultural sector accounts for the highest proportion of GDP.

Agriculture has the potential to preserve its current value position because the country has products that can compete in any overseas market. The sole requirement is that there is availability to explore this route.

From the point of view of economic performance, Moldova is among the countries with the lowest economic performance if we compare to the average of European countries. This fact is visible tests when we analyse the revenues collected at the state budget.

For this analysis, the information from the period 2015-2020 was collected. The information is obtained from the Statistical Yearbook of the Republic of Moldova and from the databases of the National Statistical Office of the Republic of Moldova.

According to the provisions of the National Statistics Department (NDS) "Moldova 2020", human capital is one of the few resources that can offer the Republic of Moldova a competitive advantage [9], [6]. If we look at the last few years, we can see that the employment rate in agriculture is decreasing, even if the percentage is still important. This can be a negative element for the economy because it will lead to a need for human resources. In a context where all European countries are facing this problem, clear human resource policies are needed to reduce labour migration in particular. Looking at the statistical data, we can see that agricultural labour productivity has increased in the studied country.

Table 1. The evolution of GDP and income from agricultural production in the Republic of Moldova in 2014-2020 (thousands lei)

Years	GDP	Income from agriculture, forestry and fishing
2014	133,481,634	18,568,633.83
2015	145,753,642	18,813,937.43
2016	160,814,564	19,844,093.46
2017	178,880,890	21,472,170.48
2018	192,508,553	19,183,954.81
2019	210,351,082	20,957,310.30
2020	199,733,684	18,708,438.60

Source: [10].

However, this increase remains low if compared to other countries in the region. In the context of the above: Gross domestic product and income from agricultural production, forestry and fishing can be seen from the perspective of their evolution.

Income from agriculture has a significant impact on the economy. This will open up the prospect of enhancing agricultural labor productivity. Using the presented model, we may reach the levers for agricultural development and, indirectly, income growth in a country.

The evolution of the analysed indicators is presented in Table 1.

The evolution of the analyzed indicators: GDP and income from agriculture, can be seen in Figures 1 and 2.

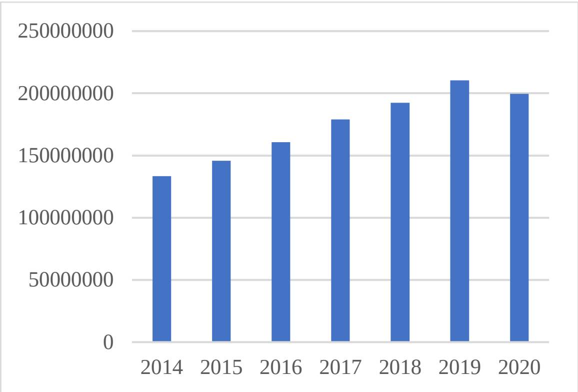

Fig. 1. GDP growth in the period 2014-2020 (Thousand lei)
Source: Own contribution made after the data from [10].

Figure 1 shows the clear picture of the evolution of gross domestic product in the period 2014-2020. Thus, 2019 recorded the highest growth, followed by a decrease in 2020. This decrease may be normal in the economic context specific to 2020.

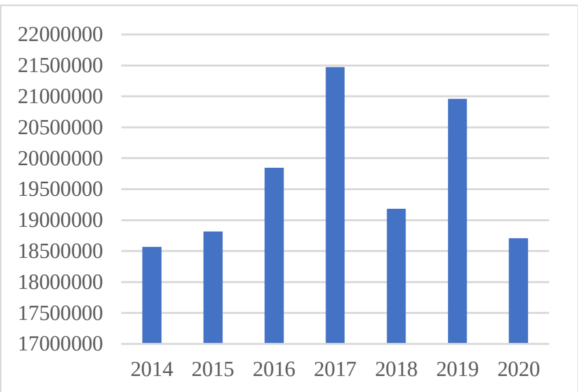

Fig. 2. The evolution of agricultural production revenues in 2014-2020 (Thousand lei)
Source: Own contribution made after the data from [10].

From the point of view of the evolution of incomes from agriculture it can be seen that in 2017 was the peak of the increase in incomes from agriculture, after which there was a decrease that in 2019 there was again an increase followed by a significant decrease in 2020.

Thus, taking into account the information presented in the table above, it is found that the indicators subjected to the analysis varied in the same sense, which is why we can say that between them there is a relationship of dependence. The analysed period 2014-2020 shows a quite important variation in the share of agricultural production in the country's GDP. Thus, in 2014 the share was 13.9%, in 2015 the share was 12.9%, in 2016 the share was 12.3%, in 2017 the share was 12%, in 2018 the share was 10%, in 2019 the share was 10% and in the last analysed year, 2020, the share was 9.4%.

From the data presented above it can be seen that after 3 consecutive years of growth, agricultural production and, respectively, the gross added value generated by this sector decreased (-2%) compared to the previous year due to adverse climatic consequences. The year 2020 had its peculiarities, besides the climate problems were also the problems caused by the COVID pandemic. The decline in agricultural production, which remains one of the main branches of the national economy, usually negatively influences other types of activities. In 2019, according to preliminary calculations of the National Bureau of Statistics (NBS), the gross domestic product amounted to 210 billion lei, with an increase, in real terms, of 3.6% compared to the previous year. In 2020, revenues from agriculture, forestry and fishing contributed 9.4%. In terms of GDP formation.

From the perspective of the impact of agricultural income on gross domestic product, we need to analyze the employment rate of the agricultural workforce. Created on the Lewis model of economic recovery, a system of development is developed that includes important social reforms. Table 2 shows a study of agricultural employment during the last six years.

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Table 2. The progression of the number of agricultural workers in Moldova between 2015 and 2020. (thousands of persons)

Years	Number of employees
2015	36,760
2016	36,726
2017	37,603
2018	37,685
2019	36,439
2020	34,214

Source: [10].

In order to identify the typology of the regression function, the graphic representation of the pairs of points that include the values of the Gross domestic product and those of the incomes from agriculture was made. The statistical calculation was done in Excel.
From the point of view of the estimated regression values these are shown in Figure 3 where the right regression is specified and the value of the coefficient of determination R^2.

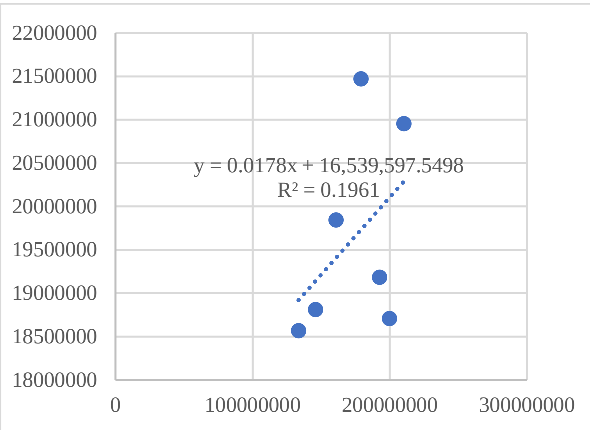

Fig. 3. Revenue from agriculture, forestry, and fishing from 2015-2020
Source: Own contribution using data from Table 1.

The coefficient of determination has been shown to have an exact value equivalent to the square of the multiple correlation coefficient. The purpose of this article is to calculate the degree of dependence between the two variables analysed.
As shown in Table 3, the coefficient of determination is 0.1961. Thus, the value of this indicator shows the degree of dependence of the domestic product but on the income from agriculture.
If there is a direct link between the variables, then the value that is created can be seen if it is produced directly from the variables. Therefore, it is possible to state that there is a connection, albeit a weak one, between the two variables that were analyzed. This conclusion can be reached despite the fact that the correlation is tenuous.
In this example, the value of multiple R indicates the multiple correlation coefficient (R) of the simple correlation that occurs between x and y. The simple correlation is represented by the value of single R. A conclusion drawn from the value of multiple R's suggests that between 2015 and 2020, the value of GDP in the Republic of Moldova is influenced by the income from agriculture. This positive correlation was obtained based on the value of R.

Table 3. Regression Statistics

Regression Statistics	
Multiple R	0.4428
R Square	0.1961
Adjusted R Square	0,0353
Standard Error	28,245,013.01

Source: Own contribution based on the information in Table 1.

Adjusted R Square is a corrected coefficient of determination with degrees of freedom having the same meaning as R^2. Standard Error is the standard error that shows how far the observed values yi deviate on average from the theoretical values on the right of regression, $\hat{y}_i$ (in this case ±28,245,013.01).
As observed from statistical data, agriculture has an important share in the formation of gross domestic product.
We used regression to examine the sort of relationship between GDP and agricultural revenue. The association fence between the examined indicators is determined by the correlation coefficient value (0.4428). Because the relationship between the two indicators studied is positive, it demonstrates that the gross domestic product is dependent on agricultural income. The correlation coefficient can indicate the direction of analysis in order to optimize the income obtained from agriculture. The dependence of the GDP of the Republic of Moldova on the primary sector of the economy is obvious.

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In the context of the above, the country under consideration must strengthen its competitive advantage from the point of view of agriculture. Thus, an integrated approach to agricultural reforms is needed, with a focus on investment and research. This approach will lead to an increase in labour productivity and, implicitly, to an increase in agricultural income.

To achieve significant and sustainable levels of growth, governments must strive to increase agricultural productivity while stimulating capital accumulation in all other sectors of the economy.

In light of the foregoing, one can observe the evolution of agricultural employment. As a result, Figure 4 depicts this evolution from 2015 to 2020.

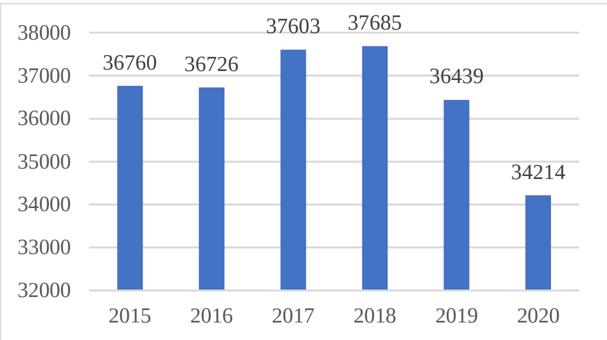

Fig. 4. Evolution of employees number in the field of agriculture
Source: Own contribution using information in Table 2.

The decrease in the number of employees in agriculture can be due both to socio-political causes and the fact that the country's industry has started to develop and the vast majority of available employees have migrated to higher-paid industrial branches. Also, the demographic decline can be a factor that influences economic indicators not only in Moldova and throughout Europe.

National Bureau of Statistics (NBS) projections for the Republic of Moldova predict an almost 49.9% increase in agricultural production worldwide across families of all income levels in 2021 compared to 2020. The worldwide expansion in agricultural output is largely due to a 75.5% increase in plant output. Preliminary projections from the NBS also place agricultural production in all types of households around the world at 70.2% in 2022. The fall in agricultural output was driven by a 36.8% drop in plant production and a 2.6% drop in animal production over the world. Applying the model described above, it is noted that the economy of the Republic of Moldova is influenced to a large extent by agriculture. However, the major problem of agriculture is the lack of qualified human resources. In this regard, especially in the current economic, political context, where migration is a rather important issue, the capacity to integrate more people into the labour market in agriculture must be stimulated. This can only be achieved by achieving sustainable labour market policies.

The need for coherent and applicable policies is all the more important as unemployment in the first and second quarters of 2020 is much higher in urban areas than in rural areas, which can be a resource for agriculture.

The risks associated with the COVID-pandemic period, The post-COVID period can turn into opportunities in the situation where there will be clear public policy in the agricultural field and the population that is in the urban area and who no longer has a job to be oriented toward the jobs that will be created in the rural area. The limits of using Arthur Lewis' model are given by the fact that one cannot talk about population growth, but only population reduction due to the COVID pandemic, migration, and the political situation in the area, but this limit can be exceeded because population growth is not possible at the rural level. There is still a substantial amount of unemployed labour, and rising global unemployment as a result of the closure of many industrial or service units provides a steady source of labour.

CONCLUSIONS

The analysis carried out can lead to other models and studies that can create a development infrastructure for the agricultural field. All proposed ideas can be integrated into a common platform leading to the increase of the country's agricultural capacity. This is all the more important as the country currently has a direct dependence relationship between GDP growth and agricultural income. This means that for every unit increase in agricultural production in the country analysed, GDP increases by 0.91 or a value close to one unit. According to the statement, there is a consistent relationship of dependence. This fact makes us say that agriculture is the driving force of the country's development at the moment, and that public policies in the agricultural field can make a difference, leading the country to economic prosperity.

A development strategy for Moldova 2030 must be established and developed to integrate the 2030 Agenda and, in particular, those sustainable development goals that will be considered priorities and have an accelerated development effect, with a view to increasing the contribution of agriculture to GDP, based on the direct correlation between these two analysed indicators. Even though 2020 is one where incomes could be noticed, there are at this moment the premises for the country to be an important pole in terms of agricultural production.

Moreover, the development of the new national development strategy based on the 2030 Agenda will implicitly involve the integration of the Association Agenda, given that most of the sustainable development objectives are found in the Association Agreement Moldova-EU [8], [14], [17].

The methodology achieved can be improved by adding variables that can influence agricultural production. However, we must bear in mind that agriculture can also extend to the food industry and incomes can increase. This research can take into account the innovative factor in agriculture, as innovation leads to increased labour productivity, which means an increase in agricultural production A relocation of the human factor between the industrial sectors of a country is a solution to meet human resource requirements. It is also of interest to analyse the share of innovation in agriculture, the costs with this process and the subsequent revenues. The Republic of Moldova has potential for economic growth. It also has products already established in foreign markets. In this regard, the only possibility for agricultural development is to engage in research and development and to establish clear priorities in this area. You will also attract human capital and implicitly boost productivity by doing so.

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DIGITALIZATION AND AGRICULTURE - IMPACT ON HUMAN RESOURCES IN THE EUROPEAN UNION AND ROMANIA

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Abstract

The paper aims to identify the main aspects of digitalization in the EU and Romania at present, in general, and emphasizing on agriculture, because in this sector has a deep impact on infrastructure and work resources. The EU average for DESI index quantifying digital economy performance was compared with the index in the member states to show the differences in the performance of the digital economy. The aspects related to the impact of digitalization in agriculture from many points of view, but mainly on human resources have also been highlighted. Index scores differ from one country to another and reflect the performance result of the efforts that each member state has made to implement digital economy. The higher the index value, the higher the digital economy performance in that country. During the period 2017-2022, Finland, Denmark, the Netherlands and Sweden have maintained their top position in the EU, while Romania and Bulgaria are situated on the last places. Romania should be focused on the improvement of digital infrastructure, promotion of digital competences, innovation and entrepreneurship in order to increase its performance in digital economy. Major efforts should be done to improve connectivity, educational programmes in digital competences and to develop a favourable business environment for contributing to its digital transformation and integration into the EU digital unique market.

Key words: *digitalization, agriculture, human resource management, economy, European Union, Romania*

INTRODUCTION

The era of IR 4.0 digital transformation and of 4.0 industries, IoT and Artificial Intelligence/Machine Learning has a deep impact on decision making and personnel competences. The exponential growth of the information volume has led to changes in systems complexity, which have become automated and are called to offer predictions based on models, algorithms and structured data in a short period of time [22]. Business Intelligence has become a tool more and more used for making right decisions in order to attain the proposed objectives.

Artificial intelligence can have implications in business and digital economy and brings its contribution to the economic growth [4].

Other authors affirm that AI technologies will have also a deep impact on jobs which will become more automated, but the effect on employment is not obvious because it will depend on the nature of demand [3] and that automatization may affect the job market and the employees' adaptability to run new tasks [2], while [18] considers that digitalization could lead to jobs redistribution, the need for new competences and jobs.

The EU pays a special attention to digitalization in all the fields of activity, agriculture and rural development being included.

The twin digital economy and green deal will accelerate the pace to change all the aspects of our lives and will have a deep impact on the future of work, job types, structure, labour market, personnel recruitment, productivity and income level [5].

The EU aims at digital economy to become a tool of "solidarity, prosperity and sustainability for empowering work force and businesses, ensuring the security and resilience of its digital ecosystems and supply chains" [11].

The NextGenerationEU (NGEU) is destined to offer "financial support for public and private investment to drive “a sustainable and resilient recovery”, “repair the immediate damage caused by the COVID-19 pandemic” and “support the EU’s green and digital priorities” [28].

The NGEU emphasizes the need of digitalization in order to ensure the sustainable economic development, job creation by means of research, innovation and development.

Digitalization can be a helpful tool to develop smart technologies, able to monitor resources, energy consumption, reduce waste, capture carbon, diminish greenhouse gas, reducing the impact of climate change, promoting sustainable development, good business models and practices, solutions to reduce poverty and eliminate social exclusion, improve medical system and health [12].

Intelligent agriculture is required to produce more and of higher quality food ensuring food security and safety [9, 10].

Mobile technologies, remote sensing services, robotized systems for assisting crop and animal growing, intelligent water delivery, chemicals control in smart agriculture, work platforms will increase production and efficiency across the product chain and will reduce the operational expenses.

However, agriculture, like many other economic fields, is facing challenges and difficulties in the implementation of the digitalization, regarding the work force recruitment, professional reconversion, data protection and cyber-security [17].

The key of success will depend on the implementation of the IoT infrastructure in agriculture in order to use Big data systems which can provide viable solutions for a sustainable agriculture [21].

In Romania, the National Programme for Recovery and Resilience aims to combine the objectives of the Green Deal with Digitalization, a sustainable economic development, social and territorial cohesion, health and institutional resilience, education and competences [29].

The quantification of digital economy performance in the EU is made by means of a composite index named DESI - Digital Economy and Society Index, which allows the comparison between the member states across five dimensions: Connectivity, Human capital use, Use of Internet, Integration of Digital technologies and Digital public services [8].

Index score as a whole and by each of its dimensions differs from a country to another and reflect the performance result of the efforts that each member state has made to implement digital economy. The higher the index value, the higher the digital economy performance is in that country.

In this context, the purpose of the paper is to identify the main aspects of digitalization in the EU and Romania at present, in general, and especially in agriculture, where the implementation of digital economy is a more complex process with a deep impact on human resources.

MATERIALS AND METHODS

This study is based on various information sources, documents from the European Union, data from Statista and National Institute of Statistics, and results mentioned in various published articles on the topic.

To characterize the performance of digital economy in the EU member states, the following specific indicator was used: Digital Economy and Society Index (DESI), with its five dimensions: (1) connectivity, (2) human capital, (3) use of Internet services, (4) integration of digital technology, (5) digital public services, which have been analysed separately, pointing out the highest and the lowest scores among the EU member states.

(1) *connectivity* refers to: broad band coverage, the high scores reflecting opportunities for using digital skills, Internet services, digital technology and access to digital public services.

(2) *human capital score* indicates the Internet user skills and employment of the ICT specialists.

(3) *use of Internet services* refers to: the frequency of accessing the Internet for online activities and transactions.

(4) *integration of digital technology* refers to the impact of digital technology on business environment.

(5) *digital public services* characterize the efforts made by the Government to improve the communication with the public via online tools.

The EU average DESI score was used as a reference term for making comparisons with the scores obtained by the EU member states, pointing out the countries with the highest and lowest performance in digital economy.

The structured ideas and logical presentation belong to the authors' decision.

First, it was presented in brief a statistical situation at the EU level and then in different member states, and also separately in Romania.

The role of the digitalization was approached in general and also in particular, in agriculture. A special attention was given to challenges and thresholds facing digitalization in agriculture, opportunities for digitalization in agriculture and other fields, impact of digitalization on human resource management.

RESULTS AND DISCUSSIONS

Brief statistical view on digitalization in the EU and Romania's economy and society

DESI - the aggregate digital economy and society index score

In 2022, the EU average DESI - the aggregate digital economy and society index score was 11.4 for Human capital, 15 for Connectivity, 9 for Integration of digital technology and 16.8 for Digital public services.

For this index, in the period 2017-2022, Finland, Denmark, the Netherlands and Sweden have maintained their top positions.

Romania registered 7.73 for Human capital, 13.8 for Connectivity, 3.8 for Integration of digital technology and 5.3 for Digital public services, all these results being far away from the EU average [44].

Taking into account "Human capital", the EU average score of 11.4 was exceeded by the following countries, in descending order: Finland 17.8, the Netherlands 15.8, Ireland 15.7, Sweden 15.5, Denmark 14.8, Luxemburg 14.4, Malta 14.1, Estonia 13.5, Austria 12.7, France 12.5, Belgium 12.2 and Portugal 11.5.

The last positions were occupied by Bulgaria with 8.8 and Romania with 7.73 [52].

For "Connectivity", the EU average of 15 was surpassed, in the descending order, by: Denmark 19.3, the Netherlands 17.5, Spain 17.4, France 16, Ireland 15.4, Sweden 15.1.

On the last positions came Belgium with 10 and Poland with 11.6, while Romania and Bulgaria scored 13.8 and, respectively 12.7.

For "Integration of digital technologies", the EU average index score was 9 in 2022. A higher index score was achieved by: Finland 14.8, Denmark 14.5, Sweden 14.1, the Netherlands 13, Malta 12, Belgium 12, Ireland 10.8, Italy 10.2, Austria 10, Spain 9.6, Portugal 9.6, Lithuania 9.3, Croatia 9.2, Estonia 9.1.

At the opposite pole, there were Bulgaria and Romania with the lowest index: 3.9, and, respectively 3.8.

For "Digital public services", the EU average score was 16.8, this value being higher in case of: Estonia 22.8, Finland 21.8, Malta 21.5, the Netherlands 21, Ireland 20.9, Denmark 20.8, Luxembourg 20.8, Sweden 20.5, Lithuania 20.4, Latvia 19.2, Austria 18, Slovenia 17.4, Portugal 17.

The lowest values were scored by Romania 5.3 and Greece 9.8. Bulgaria and Slovakia had 13 each [44].

Access to Internet

In January 2023, the number of the world Internet users reached 5.9 billion, being by 8% higher than in 2022 and representing 64.4% of the globe population. Also, the number of social media users accounted for 4.88 billion [45].

In the EU, the share of households with Internet access increased from 64.15% in 2009 to 92.44% in 2022. The access to Internet differs from a country to another.

The highest level belongs to the Netherlands 98.2%, Luxemburg 97.6%, Finland 97.5%, Spain 96%, Denmark 95.1%, Sweden 94.35, Belgium 94%.

Romania has 89.42% coming on the 6th position from the end of the list [47].

Digital skills of Internet users index score

This indicator is also different, the users being divided into two categories: above basic digital skills and at least basic digital skills.

Table 1. Digital skills of the Internet users in the EU by skill level in 2022

Country	Above basic digital skills	At least basic digital skills
EU-Average	10	27
Finland	18.2	39.6
Netherlands	19.6	39.5
Ireland	15	35.2
Denmark	14.2	34.3
Sweden	13.5	33.3
Spain	14.4	32.1
Luxemburg	12	31.9
Austria	12.7	31.7
Croatia	11.8	31.7
France	11.8	31.0
Malta	13.4	30.6
Czechia	9.1	29.8
Estonia	10.5	28.2
Portugal	10.8	27.7
Slovakia	7.9	27.6
Belgium	10	27.1
Greece	8.2	26.2
Latvia	9	25.4
Cyprus	7.9	25.1
Slovenia	7.5	24.8
Hungary	8.2	24.5
Germany	7.1	24.5
Lithuania	8.7	24.4
Italy	8.5	22.8
Poland	7.8	21.5
Bulgaria	3.0	15.6
Romania	3.3	13.9

Source: [48].

By member state, the situation of digital skills score in the EU in the year 2022 is shown in Table 1.

The data shows that the top position is occupied by Finland with 39.6 score and Romania is situated on the last position for 13.9.

Access to Internet in the urban and rural areas

The access to Internet as well as the digital skills are completely different in the rural area versus urban area.

In the cities, there is a higher percentage of households connected to the Internet and more population has digital skills, compared to the people living the communes and villages.

At the EU level, the average percentage of households having Internet at home increased from 2007 to 2022 as follows: in the cities, from 57.07% to 94.08%; in towns and suburbs from 56.5% to 92.9%; in the rural areas from 42.7% to 90.03% [49].

The share of daily Internet users

Also, the share of daily Internet users increased in the EU from 59.5% in 2013 to 84% in 2022 [50].

The share of ICT professionals in the EU total workforce

Concerning this indicator, the average in the EU is very small, just 4.55. But, a higher percentage of professionals is present in the following member states: Sweden, Finland, Luxemburg, Netherlands, Ireland, Estonia, Denmark, Belgium, Malta, Germany, Slovenia, Portugal, Czechia, France and Austria.

Below the EU average, there are: Romania with 2.6% on the penultimate position and Greece with 2.4% on the last place [51].

Comparative analysis between Romania and other EU Countries concerning the assessment of digital economy

Table 2 offers a comparative analysis of the EU member states regarding the performance of digital economy (DESI) 2022, whose level is given by Connectivity, Human capital, Integration of digital technologies and Digital public services.

The global competitiveness index 4.0 2019 measures the country competitiveness defined as the set of institutions, policies and factors which determine the productivity level based on innovation, technological development and business complexity.

According to DESI 2022 Report, Romania obtained a score of 30.58, reflecting the lowest level of the digital economy performance versus the other EU states [46]. Romania has still big problems regarding the DESI dimensions.

Table 2. Comparisons between the values of three index among the EU countries for the evaluation of the performance of the digital economy

EU member states	Digital Economy and Society Index (DESI) in 2022	Global competitiveness Index 4.0 in 2019	Easiness to make business in 2020
Austria	54.68	76.6	78.7
Belgium	50.31	76.4	75.0
Bulgaria	37.68	64.9	72.0
Croatia	47.55	61.9	73.6
Cyprus	48.35	66.4	73.4
Czechia	49.14	70.9	76.3
Denmark	69.33	81.2	85.3
Estonia	56.51	70.9	80.6
Finland	69.6	80.2	80.2
France	53.33	78.8	76.8
Germany	52.88	81.8	79.7
Greece	38.93	62.6	68.4
Hungary	43.76	65.1	73.4
Ireland	62.74	75.1	79.6
Italy	49.25	71.5	72.9
Latvia	49.71	67.0	80.3
Lithuania	52.71	68.4	81.6
Luxemburg	58.85	77.0	69.6
Malta	60.88	68.5	66.1
Netherlands	67.37	82.4	76.1
Poland	40.55	68.9	76.4
Portugal	50.76	70.4	76.5
Romania	**30.58**	**64.4**	**73.3**
Slovakia	43.45	66.8	75.6
Slovenia	53.37	70.2	76.5
Spain	60.77	75.3	77.9
Sweden	65.22	81.2	82.0

Source: [7, 46].

Regarding the Global Competitiveness Index 4.0 2019, Romania came on the 51st position of a number of 141 countries. On the top position was Singapore with 84.8 score and on the last position was Ciad, with 35.1 on a scale from 0 to 100.

Romania's position in this hierarchy suggests that it needs improvements in innovation and technological training at the national level.

From this Table, it is observed that Finland, Denmark, Netherlands, and Sweden have the best results in digital economy, DESI index having the highest levels and the global competitiveness index as well for these countries.

They developed a advanced digital infrastructure, high digital competences and favourable business environment.

As a member of the EU, Romania plays a significant role in the digital economy and has succeeded in achieving important progress in the last years.

Romania made significant investment in large-band infrastructure, which allowed a large-scale access of high-speed Internet. According to the data from National Institute of Statistics, starting from the year 2022, 82.1% of the households in Romania have access to Internet. In addition, Romania is among the top countries regarding the 4G cover and Internet speed, factors which contributed to the extent of the digital services, electronic commerce and digital innovation (Table 3).

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Table 3. Internet penetration rate in Romania (%)

Year	%
2016	65.0
2017	68.6
2018	72.4
2019	75.7
2020	78.2
2021	80.8
2022	82.1
Difference 2022-2016	+17.1

Source: Own calculation based on the data from [31].

Electronic commerce market has considerably increased from Euro 2.8 Billion sales in 2017 to Euro 6.3 Billion in 2022 [20, 35].

Romania improved its innovation eco-system for enhancing the digital transformation and entrepreneurship. Numerous technological parks, innovation centers and startup accelerators were established to support innovative business (Techcelerator, Innovation Labs and Impact Hub Bucharest).

Also, important efforts were made for IT education, digital literacy, professional development as more and more citizens to get digital competences (Digital Education Strategy, Digital Skills and Job Coalition and Code Week). However, there are still discrepancies regarding the digital abilities in the urban and rural areas in Romania and between Romania and other member states.

Digital economy includes a large range of activities: e-commerce, digital services, software development, information and communication technologies which have a direct and indirect contribution to GDP, whose level in 2022 was 6% [20].

Role of digitalization in agriculture

Digitalization is a path and a tool to technologies and management change in agriculture, rural communities and people and by innovation it is called to strengthen and sustain this sector of activity in order to increase productivity, product quality, agricultural households profitability and economic efficiency [33].

Agriculture needs a smarter digital approach and also a green dimension to boost local production, to shorter food chain from farmers to consumers, to strengthen fair collaboration along the value chain and ensure food security and safety [23].

Digitalization is expected to change farmers' age structure, increasing the share of young farmers who will have not only high technological and economical knowledge and skills, but also digital skills called to enable them to apply a modern and efficient farm management based on a digital decision making process [24].

Prediction and production forecasts could be easier set up by means of modern IT, high precision and artificial intelligence tools, thus reducing the business risks. Automatized and computerized technologies are called to monitor crops along all the stages of production, transport, storage, processing, delivery, helping the farmers to perform the planned parameters regarding yield, production, product quality and economic efficiency per surface unit [26].

Digitalization will also bring a surplus of value and precision in land monitoring, planning the territory, registration of the cadastral data [40].

The negative impact of climate change on agriculture could be diminished by using drones and satellite information, whose images could be processed by computers and software, offering to farm managers precious data to improve technologies and increase production, and reduce material and financial losses caused by extreme weather phenomena, such as strong storms, huge rainfalls, long and severe droughts, heat waves, floods etc. [19, 34].

To achieve this goal, digitalization should have a deep impact in the field of education, where a new type of educational strategy and system, programmes and curricula have been established to help young people: scholars, students, graduates, and future professionals in a word to become more employable in the workforce market, where digital knowledge and skills are more and more required [24, 25].

Digitalisation will create new jobs in agriculture and rural areas, will change the life of the rural population and could be a source generating income and a better living standard [27].

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Challenges and thresholds facing digitalization in agriculture

As many researchers affirmed, the EU agriculture is dominated by small family farms, mainly of subsistence and semi-subsistence farms, with a small average size of 17.4 ha, the smallest one being in Romania, 4.2 ha [36].

Most of farmers are old and many of them have no digital knowledge and skills [41,42,43].

Most of the farms have not a modern technical endowment and no financial resources for investments [37, 39].

However, the EU provides funding at present to strengthen the activity and efficiency of the family farms.

More than this, only the large agricultural households have financial resources from which a part to be invested in innovative tools. They are endowed with computers, software, drones and other tools of high precision.

But, in Romania, large agricultural holdings represent 1% of the total number of farms, but they work about 52% of arable land.

Most of the farms lack of modern endowment with a deep impact on productivity [38].

Therefore, digitalization is needed to modernize the farms helping them to monitor crops, animals, agricultural processes, and business transactions.

In agriculture and in the rural areas, it is a lack of IT professionals, because they are employed immediately in the cities where the request of highly qualifies specialists in IT is very high. Even the demand of IT professionals in the city is not yet covered by the offer [32].

The educational programmes and curricula do not provide enough knowledge in IT and they should be replaced by new programmes sustained by a teaching staff with high competence, computer rooms and other digital tools to improve the technical endowment in schools, vocational and high schools.

More than this, taking into consideration the fast development of the new digital technologies, continuous education is needed to update digital knowledge and skills.

Opportunities for digitalization in agriculture and other fields

The legal framework

First of all, the EU has created the legal framework which favours the expansion of digitalization in the rural areas and farms.

In this respect we could mention: Digital Strategy 2020-2025, Digital Services Act Package (15 Dec.2020), and Digital Markets Act (DMA), 2030 Digital Compass, the European way for digital decade [53, 13, 16].

Digital economy operates in a complex framework of regulations and policies, both at the global level and in the EU and in each country.

Governments, international bodies and regional bodies like EU and Europe Council have implemented measures for approaching the challenges and opportunities of the digital economy.

These regulations regard: data protection and confidentiality, digital market, cyber-security, digital infrastructure.

Recover and resilience strategy

After the Covid-19 pandemic, the EU has established a recover and resilience strategy according to which "the EU’s long-term EU budget, also known as the multiannual financial framework, will boost digital technologies and aid in recovery from the pandemic".

Budget for digitalization and other destinations

The EU budget of the new MFF accounts for €1.21 trillion. Also, a new recovery instrument called Next Generation EU which worth €810.57 billion will run from 2021-2024 (Table 4).

This budget will finance 7 programmes as presented in Table 4.

In addition, ICT investments for over €20 billion will be destined for digital cohesion across the EU, the funds coming from European Regional Development Fund (ERDF) [14].

Table 4. The EU Digitalization programmes " Next Generation EU" for 2021-2024

Programme	Destination	*Budget (Euro Billion)*	*%*
Total funding	Next Generation EU	*810.57*	*100.0*
Digital Europe Programme	supercomputing, core artificial intelligence, cyber-security, digital skills, business digitalization	7.6	*0.9*
Connecting Europe Facility-Digital	trans-European networks and transportation infrastructure, telecommunication and energy	2.07	*0.3*
Horizon Europe for Digital, Industry, and Space	artificial intelligence, next generation Internet, high performance computing, big data, key digital technology, 6G	95.5	*11.8*
Invest EU	investments in public and private sectors	26.2	*3.2*
Creative Europe MEDIA	Film and other media	1.4	*0.2*
EU4Health	Hospitals endowment and digitalization	5.3	*0.6*
Recovery and Resilience Facility	investments and reforms to sustain the green and digital transition and the resilience of the national economies	672.5	*83.0*

Source: Own calculations based on the data from [14].

In the EU agriculture, digitalization will help the stakeholders to benefit of a more streamlined value chain, with closer collaboration and improved communication between producers, processors, distributors, and retailers.

Also, new ideas and fresh perspectives will help the innovative SMEs to emerge and thrive, bolstering the industry.

Horizon 2020 programme provided more than €200 million for Research and Innovation (R&I) in digital technologies for the agricultural sector for smart farming systems, precision agriculture, integrated digital technologies into entire agricultural value chain. All these objectives aim to increase productivity and competitiveness in agriculture, and to diminish the environmental impact.

Important results have been already obtained in the development of one Robotics Digital Innovation Hub (DIH), also in IoT and digital platforms and additional R&I projects [15].

In Romania, "the Strategy regarding education digitalization in Romania" - Smart-education aims to ensure the access to a modern and accessible schooling system, based on digital resources and technologies [30].

This strategy provides the development of digital knowledge and skills for scholars and students, for emergent professions, initial and continue digital education for teaching staff, a high performance digital environment in education (infrastructure and digital technological resources, connectivity, open educational resources, cyber-security, data protection, online security and IT ethics).

Impact of digitalization on human resource management

Human resource is the key capital of a company and which contributes to its business success and attainment of the proposed objectives.

Digitalization will change the department structure within a company, favouring the sectors where digitized operations bring the highest efficiency.

Automatization of the activities will lead to a reduction of personnel with a positive effect to lower expenses with wages and contributions to the state budget.

But, on the other hand, automatization of the activities that employees have to fulfil will eliminate the manual tasks, will reduce the time for carrying out those activities, stimulating the focus on complex problems and a more efficient use of the working time.

In a digitalized company, new key performance indicators (KPIs) will be introduced regarding the training level, competences, abilities, skills, communication skills, collaborative attitudes, good work relationships among the employees and among the leaders and the subordinates.

Stability, cohesion, and efficiency in a company depends on the reliability and communication speed, and digitalization will increase communication efficiency in decision making by fast transmission of decisions to subordinates and by rapid collection of the information from the departments to leaders.

Digitalization is a solution for developing more efficient working teams [6].

Personnel recruitment will be improved and adapted to the requirements of the company regarding competences, abilities, skills emphasizing on digital skills, professional knowledge and work experience, fast and logical manner of thinking, abilities to run the competition for a vacancy using the pilot platform or to behaviour during an interview. All the received data will be stored, structured an objectively analyzed in order to select the best candidate who suits to the company's requirements.

The salary levels will be negotiated according to the tasks that need to be fulfilled in accordance with the digital job requirements.

After employment, the new employees will be periodically evaluated based on their achievements, will be encouraged and supported to improve their performance, to be motivated, and to develop their careers [1].

Digitalization will change the future potential employees in agriculture as well. They will have a new profile, new competences and will be for sure more employable.

The human resource management will be changed starting with the recruitment process, which will be based on solid knowledge and skills, not only in the field of technologies and economy, but also in digital competences [54].

This will change the personnel structure by work sectors, and also will change the promotion criteria, salary levels, labour productivity and work quality, management KPIs, involvement in the company life, attachment and fidelity.

More than this, the fast changes in the field of digital technologies will require a periodical training of the employees for updating their knowledge and skills for sustaining the productivity and competitiveness of the agricultural holding the business environment.

The use of artificial intelligence and high precision tools in agriculture will impose new competences to handle the new equipments and appliances, will create a more pleasant work environment, will reduce the working time and physical effort, will ensure comfort, develop a new way of approaching problem solving and way of thinking and acting. The employees will become more conscious of their role in the success of the company.

The media tools will facilitate a better and more effective communication between employees and between the company managers and subordinates.

The fast implementation of digitalization in a company depends not only on the financial resources allotted for innovation and digitalization, but also on managers' desire to implement it quickly and efficiently to sustain the company competitiveness in the business environment.

Therefore, the labour market requirements concerning the potential candidates for job vacancies will be more and more oriented to the ones who have strong digital skills, high training level, professionalism, competences and work experience.

Besides these requirements, the new employees will have to be flexible persons, easy adaptable to high time pressure work to sustain the competitiveness and economic and financial stability of the agricultural company.

All these aspects reflect the need for employers to look for new methods in human resource management and implement the most effective ones.

Therefore, digitalization will contribute to the development of a new "digital culture" without which none could be employed in the future in any field of activity, agriculture being included.

CONCLUSIONS

The comparison between Romania and the EU average and also versus other member states for various indicators reflecting the performance in digital economy allowed to observe the huge discrepancies which exist at present and shows what Romania has to do to diminish these gaps.

By analysing the results in digital education, e-commerce, digital innovation, digital competences and Government initiatives, it is easy to have an idea on Romania's position in the digital landscape.

Romania is facing major challenges regarding digital transformation and competitiveness.

Romania should be focused on the improvement of digital infrastructure, promotion of digital competences, innovation and entrepreneurship in order to improve its performance in digital economy. It must make efforts in the field of connectivity, educational programmes in digital competences and to develop a favourable business environment for contributing to its digital transformation and integration into the EU digital unique market.

Digital infrastructure and human resource management for having high professional and digital skilled employees are very important for a successful future, in all the fields of activity.

Digitalization in agriculture has to take into consideration its specificity regarding farm size, producers age, education level, financial resources, the importance of communication between farmers and their customers, to strengthen the food value chain, the need to develop a modern ICT infrastructure, to enable the employees to get digital skills, to improve the actual strategy to become more effective and develop services and digital applications according to the legislation in force in the EU.

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MODELS FOR AGRICULTURAL PRODUCTION OPTIMIZATION

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Abstract

The paper aims to present models of agricultural production optimization as tools for managers to increase yield, crop structure, crop rotation, increased efficiency and profitability. The two optimization models are: Case 1: Optimization of yield depending on wheat price and subsidy for increasing net return and profitability in wheat culture; Case 2: Optimal model for optimizing crop rotation in cereal culture with maximum income, having two solutions: (a) Basic optimal primal solution and (b) Basic optimal dual solution. The methodology included the calculations regarding the specific indicators reflecting the economic efficiency in wheat cropping for Case 1 and determination of the optimal primal and dual solutions assisted by SOLVER application from MS Excel for Case 2. The two examples come from vegetal farming but, other models of optimization could be developed in animal production for improving livestock structure by species and category and also in animal feeding setting up optimized feed ratios to sustain production.

Key words*: *optimization models, agriculture production, management

INTRODUCTION

Agriculture is a complex field of activity where farmers are focused every year on what kind of crops to cultivate on their land and what surface to allot to each plant. The decisions are always linked to economic efficiency of each cultivate hectare, more exactly on net returns level.

To make the best decision, farmers set up various alternatives taking into consideration soil type, climate conditions, crop type and its varieties, seed quality, crop rotation, fertilization, plant protection, and other factors, and all these factors quantified in costs have to be covered by the estimated delivery price at the harvest moment [40].

But price is uncertain, because it depends on market factors and offer/demand ratio, which is influenced in its turn by climate variation during the crop development with a deep impact on harvest level [36].

Therefore, the combination of crops should provide the maximum net return per surface unit, but this means to keep under control income variability which has to be minimized. From this point of view, farmers have to decide to cultivate the crops with higher expected net return in terms of risk and probability of achieving the highest level of net return.

During the last decades, climate change raised huge problems to farmers, and almost all the crops could be considered high risk crops which require that farmers to make calculations of the total expenses, total revenue and return over total expenses [40].

For modeling the farms, Hazell and Norton (1986) sustained that there are various techniques among which the most important ones are "choice of production methods, factor substitution, input/output response relations, quality differences in resources, production seasonality, buying and selling alternatives, crop rotation, joint products and intercropping, intermediate products, investment in farm activity, linear programming methods". But, in farm modeling it is compulsory to take into consideration risk factors, otherwise the farm planning decisions could be wrong, affecting the profitability and investment capacity of the farm in the long term.

Quantitative methods assisted by computing and modeling the data play a crucial role in agricultural economics. They are important tools for farmers and managers of agricultural holdings and also for policy makers and analysts in order to offer the best solutions for the large variety of problems that agriculture has [6, 12].

For predicting wheat growth and development, crop models are important tools belonging to intelligent agricultural production.

Designing a crop model is difficult task as it involves to set up equations and parameters, which require to establish the model structure and then to optimize the parameters according to the local conditions in term of climate, soil and management measures so that the simulated yield to be close to the actual local yield and the applicability of the model to be the best.

Besides maize and rice, wheat is one of the three major crops cultivated in the world. Wheat production accounted for over 781 million metric tons in 2022/2023, which is by 31.92% higher than in the year 1990-1991. The largest producers are China, the EU, India and Russia [41].

Various researchers were and are focused in wheat production optimization in order to produce more and of higher quality seeds with lower costs and high economic efficiency.

Wheat productivity is influenced by soil type and its fertility, climate conditions, seed quality, amount and type of fertilizers applied, applied agricultural system, crop maintaining from sowing to harvesting etc., aspects which have been studied by many researchers.

The importance of wheat for meeting the growth of the world population's demand, yield should be enhanced under the condition of assuring resource use efficiency by optimizing water and Nitrogen management which could contribute to a sustainable and regenerative farming as shown in China by Li et al (2022) [21].

To plan crop management in wheat farming under the climate change is a critical issue, which could affect food security. For avoiding this situation, the contribution of climate change and crop management have to be assessed and corresponding technological measures have to be taken to reach the expected wheat yield. This was proved by Liu et al. in China in 2020, who quantified the contribution of climate change and crop management on wheat yield between 1981 and 2018, using first-difference multivariate regression model [22].

In the areas where wheat is mainly cultivated, it is wise as farmers to avoid monoculture which could affect the future crops which will be cultivated in the next years and also it is compulsory to take into account climate change as mentioned by Burt and Johnson (1967) [5].

In order to avoid the negative effect of climate change, Belaqziz et al. (2021), optimized the sowing date to improve water management and wheat yield in a large irrigation scheme in the semi-arid region of Haouz (Morocco), through a Remote Sensing and an Evolution Strategy-Based Approach [1].

For the analysis and simulation of agricultural production plans, as well as for the study of impacts of the various policies in agriculture, in Greece, Manos ET AL, 2013, set up a mathematical programming model which maximized gross margin and minimized fertilizers and water used, under a set of constraints for land, labour, available capital, common agricultural policy in Thessaly region [26].

In Brazil, Osaki and Batalha (2014) established a model, based on operation research, for production planning in multiproduct farms under risk conditions in order to understand the different productive resource allocations in farms engaged in grain production. The adopted production system in Sorriso region helped the farmers to obtain good financial returns with lower risks [28].

These models usually combine the production of different products with different soil management and agricultural practices, efficiently allocating resources and minimizing costs.

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In Egypt, Kheir et al. (2018) used AQUACROP and APSIM-Wheat models in North Nile Delta where succeeded to optimize wheat yield, total biomass and water productivity under irrigated conditions [19].

Also, in Egypt, a multi-model analysis was applied by Kheir et al. (2022) in order to minimize trade-offs wheat yield and resource-use efficiency in the Nile Delta [20].

Wheat is largely cultivated in Romania, a country which has good soil and climate conditions for this crop in different regions, but especially in the South, South East, South West Oltenia and West parts. Romania is among the top producing, exporting and importing countries for wheat in the EU [32, 33, 34].

Many researchers have contributed to solve problems in wheat farming to increase yield, seed quality and economic efficiency.

Varieties are of high importance in assuring wheat yield potential [27].

Monoculture is not recommended because it leads to a low yield performance and affects soil fertility and the production of the future crops. In combination with a 4 year crop rotation, monoculture could be practiced maximum 2-3 years [3, 4].

Nitrogen fertilizer is beneficial for increasing wheat yield [39].

Climate change has had a negative impact on agriculture performance and deeply affected maize, wheat, sunflower and other crops during the last decade in Romania [35, 37, 38].

Farmers have been obliged to adapt the applied technologies to diminish the impact of climate change and reach the desired yields [2, 17, 18, 24, 25].

Other researchers were focused on the effect of conservation agriculture versus conventional system, fertilization level and plant protection measures on wheat yield [9, 10, 11].

Macra and Sala (2021) studied the variation of some wheat quality indices in order to optimize the mineral fertilization with nitrogen and with the Super Fifty foliar biostimulator [23].

Economic efficiency in agricultural production in terms of gross margin was approached per ha and per animal by [30, 31].

Optimization of crop structure has been done using linear simulation model for maximizing income [13].

Farmers training level is very important for having the corresponding managerial knowledge and skills to make use of modern tools provided by artificial intelligence for developing a sustainable agriculture [14, 15, 16].

In this context, the paper aimed to sustain agricultural production by developing an optimization model in vegetal farming regarding the farmer's decision for selecting the best alternative to: (a) cultivate wheat depending of its production potential, costs, income and net return, price and subsidy; (b) to optimize crop rotation with maximum income in cereals production, with (a) Basic optimal primal solution and (b) Basic optimal dual solution, whose determination was assisted by SOLVER application from MS Excel.

MATERIALS AND METHODS

The paper is based on two case studies regarding optimization of agricultural production in different alternatives.

Case study 1, Optimization of wheat yield for increasing profitability per surface unit and per product unit, in the agricultural year 2022/2023, in a farm situated in the plain region of South Oltenia, Romania. The soil is of high quality chernozem, the agricultural system is a conventional one, with non-irrigated land. The cultivated area with wheat is 50 ha, and the variety used by the farmer is Glosa, well known for high productive potential and resistance to high temperatures and drought.

The economic indicators calculated in this case study have been:

Production value, PV, which was determined by multiplying the physical yield, Q, by the average market price at delivery, p, as follows:

PV = Q x p...(1)

Gross product, GP, is the sum between yield value, PV and subsidy per ha (S), as shown in the formula:

GP = PV + S..(2)

Production costs, PC, which were calculated by summing the variable costs, VC, (seeds, fertilizers, herbicide) and fixed costs, FC, according to the formula:

PC = VC + FC...(3)

Profit, P, per surface unit which is the difference between PV and PC, according to the formula:

P_S = PV - PC ....(4)

Profit per 1 kg wheat seeds is determined by dividing profit P by wheat yield, Q, according to the formula:

$P_p = P_s / Q$..(5)

Profit rate, P_r is the percentage value resulting from dividing net profit, Pn, by Gross product, GP, as shown below:

P_r = Pn / GP x 100..................................(6)

Profit rate with subsidies, P_{rs} is the percentage value resulting from dividing net profit, Pn plus subsidies, S, by production costs, PC, as shown below:

P_{rs} = (Pn + S)/ PC x 100 ....(7).

Case study 2, Linear model for the optimization of crop rotation in cereals production characterized by:
- The unknown x_i are the surfaces which are going to be cultivated after predecessor plants;
- The restrictions regard: bilateral restrictions for successor plants; the cultivation of the whole surface with successor crops; surfaces with predecessor crops occupied by them.
-The economic functions are: Income, Expenses, Profit, Profit rate, Marginal profit rate.

The problem data and analysis is made according to the methodology established by Ene (2011) [7] and Ene and Ionitescu (2006) [8].
Based on the primary data of the problem in cereals culture, it set up the model of cereals rotation with limited expenses and maximum income for wheat, maize and soybean as predecessors and as successors: maize and sugar beet after Wheat, wheat and sugar beet after Maize and wheat, maize and sugar beet after Soybean.
Then, there are determined the optimal solutions with maxim income for cereals: (a) Basic optimal primal solution an (b) Basic optimal dual solution.
The model was solved using **SOLVER** application from **MS Excel** as described in the paper.

RESULTS AND DISCUSSIONS

CASE STUDY 1

Economic Model for assessing crop profitability for Winter wheat, Glosa variety

the farm is situates in a plain area, in South Oltenia, Dabuleni Locality, Dolj County, Romania.
The soil type of the farm is chernozem, and the applied agricultural system is a conventional one, with non irrigated land, the data regard the agricultural year 2022/2023.
The calculations are made for 1 ha and also for the whole cultivated surface with wheat, accounting for 50 ha.

Gross Product

The farmer prefers to cultivate Glosa variety which is a winter cultivar, resistant to drought, being recommended to be used in the South Romania, where it could successfully replace Dropia and Fundulea 4 and other varieties both under an irrigated or non - irrigated land.
In the agricultural year 2022/2023, wheat yield accounted for 6,500 kg/ha, which is considered a satisfactory production by the farmer, because in the South Oltenia the weather was not favourable for agriculture, due to the lack of precipitations, high temperatures and drought. In the fall 2022, it was noticed a lack of water and the sowing

was enough difficult. Winter was a real mild season, on January 1st, 2023 the temperature reaching 20^0C, and in the first part of March decreased to 5-7^0C and then it raised to 15-17^0C. Weak rainfalls were noticed at the end of March, and then a total lack of precipitations till harvesting.

Taking into account that the farmer will get Lei 1,100 subsidy per ha and the estimated average market price at harvest is Lei 1.1/kg, the value of wheat yield is Lei 7,150/ha. Therefore, gross product accounts for Lei 8,250, subsidy being included.

Production cost

Variable costs

(a)Material costs

The most important category of costs is represented by variable costs, which include: the expenses for materials, fertilizers, pesticides and others.

Seed cost was reasonable because the farmer does not practice to buy seed from suppliers, but to retain seed from his own production for the next agricultural year. For this purpose, the farmer cultivate 4-5 ha especially for that. The amount of seed used for sowing is 250 kg per ha, and the internal cost of production is Lei 7.5 per kg seeds. Therefore, making the calculations, it resulted Lei 1,875 per ha costs with the seeds used for sowing.

Fertilization consists of the complex fertilizer (NPK) whose acquisition price in the fall 2022 was Lei 2,300 per ton. The farmer applied 300 kg complex fertilizer per ha, meaning expenses of Lei 690.

Also, the farmer bought Nitrogen (ammonium nitrate) at the market price of Lei 1,900/ton and applied a dose of 500 kg/ha, meaning expenses of Lei 960/ha.

Summing these costs, it results Lei 1,640 per ha for soil fertilization.

Plant protection required just a herbicide whose cost per ha accounted for Lei 270.

(b)Expenses with own mechanized works

The agricultural works which need the use of agricultural machinery are: plowing, disking, sowing, and also harvesting. The related costs were Lei 2,450 per ha for plowing, disking, sowing, and, respectively Lei 500/ha for harvesting. Summing the figures, it results Lei 2.950 per ha expenses with mechanical works.

(c)Irrigations are missing in the South Oltenia, because the water supply channels from the Danube river to the farms are not restored and do not work. The farmer is interested in using irrigations but as long as it is no access to water, it is not possible to sustain production level in this way.

(d)Supply expenses. The farmer has no supply expenses because the suppliers bring the ordered products directly at the farm gate.

(e)Insurance costs are zero, because the farmer decided not to conclude any contract with any insurance company, as the reimbursement system is very complicated as it happened in the previous years. For example, in case of hailestones, the insurance company send its inspectors in the field to evaluate the damaged surface and the money were given late and not enough, and only for the difference from the whole cultivated surface.

Therefore, summing the variable costs, more exactly: materials Lei 3,785 per ha and own mechanized works Lei 2,950, it results Lei 6,735 per ha.

Fixed costs are not considered in the example, because the farmer has no employees, only from time to time he used seasonal workforce for seed bagging and storing. Also, he has no general and management costs, no credits from the banks, and no depreciation costs.

In a word, there are only variable costs which have to be taken into account and considered equal to total production costs, accounting for Lei 6,735 per ha cultivated with wheat.

Gross income, in fact gross margin, results from the difference between production value plus subsidy minus total production costs, leading to Lei 1,515 per ha.

The farmer is exempted from tax payment on income according to the legislation in force.

Net income is equal to Gross income and it accounts for Lei 1,515 per ha, if the subsidy is included, and for Lei 415 per ha, if the subsidy is excluded. This shows how important is the role of subsidy of Lei 1,100 per ha to sustain positive financial results in agricultural holdings.

It worth to mention that the farmer has built a warehouse for storing the wheat seeds for a couple of months when the market price is not favourable (only Lei 0.75- 0.8 per kg), and to sell the seeds in the next spring when the price is Lei 1.1 per kg.

If the farmer will sell his production at the end of the harvest and will have no subsidy, in this case he could register a loss of Lei -1,535 per ha. If he will receive the subsidy, the loss will be smaller, accounting for only Lei -435.

Only selling at a higher price than Lei 1, wheat cropping could be profitable (Table 1).

However, this farmer has run a good business in the agricultural year 2022/2023, compared to other farmers in Romania who registered Lei 6,500 per ha cultivated with wheat.

The presented variant in Table 1 is the optimized solution chosen by the farmer taking into consideration the technological factors and also the influence of price and subsidy on the profitability of wheat crop.

Table 1. Economic efficiency in winter wheat crop, in the plain area, South Oltenia, Dolj county, Romania, Soil type chernozem, non-irrigated surface, Glosa variety, 2022/2023

		Calculation per 1 ha		Calculation for 50 ha cultivated with wheat	
		MU	Value	MU	Value
1.	**GROSS PRODUCT**				
2	Wheat yield	Kg /ha	6,500	Kg	325,000
3	Average wheat price	Lei/kg	1.1	-	-
4	Value of wheat yield , 4= 2 x 3	Lei/ha	7,150	Lei	357,500
5	Subsidy	Lei/ha	1,100	Lei	55,000
6	GROSS PRODUCT, 6 = 4 +5	Lei/ha	8,250	Lei	412, 500
7	**PRODUCTION COSTS**				
8	**Variable costs**				
9	***Materials costs***				
10	Seed cost	Lei/ha	1,875	Lei	93,750
11	Fertilization	Lei/ha	1,640	Lei	92,000
12	Plant protection	Lei/ha	270	Lei	13,500
13	Total material costs 13 = 10+11+12	Lei/ha	3,785	Lei	189,250
14	***Own Mechanized works***				
15	Plowing, disking, sowing	Lei/ha	2,450	Lei	122,500
16	Harvesting	Lei/ha	500	Lei	25,000
17	Total mechanized works	Lei/ha	2,950	Lei	147,500
18	Total variable costs 18= 13+ 17	Lei/ha	6,735	Lei	336,750
19	**Fixed costs**	-	-	-	-
20	**Total production costs 20 = 18**	Lei/ha	6,735	Lei	336,750
21	**Gross Margin** 21= 6 - 18				
22	-With subsidy	Lei/ha	1,515	Lei	75,750
23	-Without subsidy	Lei/ha	415	Lei	20,750
24	Gross Income 24 = 21				
25	Taxes	-	-	-	-
26	**Net income= Net profit**				
27	-With subsidy	Lei/ha	1,515	Lei	75,750
28	-Without subsidy	Lei/ha	415	Lei	20,750
29	**Net profit rate per ha 29= 26/20 x100**				
30	-With subsidy	%	22.49	%	22.49
31	-Without subsidy	%	5.8	%	5.8
32	**Net profit rate per kg of wheat seeds 32= 26/ 2**				
33	-With subsidy	%	23.30	%	23.30
34	-Without subsidy	%	6.38	%	6.38

Source: Own calculations based on the data provided by the farmer [29].

Below are comparatively shown the losses estimated from the wheat price volatility at harvesting and 10 months later in spring season next year.

Table 2. Losses estimated from the wheat price volatility at harvesting and 10 months later in spring season next year

	Variant 1 Average price in a favourable market Lei 1.1 / kg wheat seeds	Variant 2 Average price in at harvesting Lei 0.8 /kg wheat seeds	Estimated losses resulting from Variant 2 Lei/ha
Marketed production 6,500 kg - 250 kg retained seeds for net sowing= 6,250 kg	6,250 kg x Lei 1.1/kg = Lei 6,875/ha	6,250 kg x Lei 0.80/kg = Lei 5,000 /ha	Lei -1,875/ha

Source: Own calculations based on the data provided by the farmer [29].

CASE STUDY 2 Linear model for crop rotation in cereal production

Crop rotation is needed because monoculture could favour weeding, the appearance of diseases and pests in vegetal production.

Therefore, between the predecessor crop and the successor plant it is a direct link which differs from a crop to another according to favourability.

Table 3. Problem data for crop rotation optimization in cereals culture

Predecessor crop→ **Succesor crope ↓**	**WHEAT**	**MAIZE**	**SOTBEAN**	**Threshold MIN (ha)**	
WHEAT		1,200 800	1,300 700	30 ha	
MAIZE	Income 1,500 lei Expenses 1,000 lei		1,600 900	40 ha	
SUGAR BEET	1,800 1,200	1,900 1,100	2,000 1,000	4 ha	
Areas with predecessor crops	45 ha	50 ha	5 ha	Total costs(lei) ≤ 100,000	Total income (lei) ≥ 140,000

Note: The coloured cell means the fact that after a predecessor crop it is not allowed to cultivate the respective successor crop.
Source: [7, 8].

Table 4. Model of cereals rotation with limited expenses and maximum income

Predecessors→	Wheat		MAIZE		SOYBEAN				
Succesors →	Maize	Sugar beet	Wheat	Sugar beet	Wheat	Maize	Sugar beet	**Sign**	Thresholds
Restrictions ↓	X_1(ha)	X_2(ha)	X_3(ha)	X_4(ha)	X_5(ha)	X_6(ha)	X_7(ha)		
1.Costs (C)	1,000	1,200	800	1,100	700	900	1,000	≤	100,000 lei
2.Surface	1	1	1	1	1	1	1	=	100 ha
3.Plot with predecessor wheat	1	1	0	0	0	0	0	=	45 ha
4. Plot with maize predecessor	0	0	1	1	0	0	0	=	50 ha
5. Plot with soybean predecessor	0	0	0	0	1	1	1	=	5 ha
6.Wheat MIN	0	0	1	0	1	0	0	≥	30 ha
7.Maize MIN	1	0	0	0	0	1	0	≥	40 ha
8.Sugar beet MIN	0	1	0	1	0	0	1	≥	4 ha
Incomes (V)	1,500	1,800	1,200	1,900	1,300	1,600	2,000	**MAX**	

Source: [7, 8].

Table 5. Optimal solutions with maxim income for cereals cereals

Basic optimal primal solution	Basic optimal dual solution
1)VPP(Cultivated areas with successors after perdecessors x_1=32.5 ha maize after wheat →x_2=12.5 ha sugar beet after wheat --- x_3=25 ha wheat after maize x_4=25 ha sugar beet after maize -- x_5=0 ha wheat after soybean x_6=0 ha Maize after Soybean x_7=5 ha Sugar beet after Soybean	3)VDE(Surplus of income Lei Mil. /ha crop) ye_1=0 lei surplus of income/ha Maize after Wheat →ye_2=-166.67lei surplus of income/ha Sugar beet after wheat --- ye_3=0 lei surplus of income/ha Wheat after Maize ye_4=0 lei surplus of income /ha Sugar beet after Maize --- ye_5=0 lei surplus of income/ha Wheat after Soybean ye_6=-166.67 lei surplus of income/ha Maize after Soybean ye_7=0 lei surplus of income/ha Sugar beet after Soybean
2)VPE(Differences between the consummed Resources and their limits) **→xe_1=0 lei unspent money** xe_2=0 ha uncultivated land →xe_3=0 ha wheat predecessor uncultivated →xe_4=0 ha maize predecessor uncultivated →Xe_5=0 ha soybean predecesor uncultivated xe_6=6.67 ha wheat surplus xe_7=5 ha maize surplus xe_8=14.33 ha sugar beer surplus	4)VDP(Marginal incomes) **→y_1= 1.5 lei income gain/one more Lei spent** y_2= 0 lei income growth/the 101st ha of land →y_3= 0 lei income growth /the 46th ha Wheat predecessor →y_4= 0 lei income growth/the 51st ha Maize predecessor →y_5= -333.33 lei income growth /the 6th ha Soybean predecessor y_6=250 lei income growth/ the 31st ha Wheat y_7=500 lei income growth /the 41st ha Maize y_8= -250 lei income growth /the 5th ha Sugar beet
$f_{maxim} = g_{minim}$ = 158,750 lei	

Source: [7, 8].

Income =158,750 lei=maxim; Expenses =100,000 lei; Profit = Income – Expenses =58,750 lei.

Economic indicators:

Profit average rate RMP =0.58 lei profit /1 lei spent

Marginal profit rate RDP = y_1 – 1 =1.5 lei profit increase / 1 lei spent

Elasticity of profit rate ERP = RDP / RMP = 2.58 % profit surpplus / 1 % costs surplus .

Model solving using **SOLVER** application from **MS Excel** as follows.

Table 6. Model description in the calculation sheet (data + calculation formulas)

	A	B	C	D	E	F	G	H	I	J	K	L
1	x1	x2	x3	x4	x5	x6	x7	FO				
2	0	0	0	0	0	0	0	0				
3	c1	c2	c3	c4	c5	c6	c7	MAX				
4	1500	1800	1200	1900	1300	1600	2000					
5	Restrictions											
6	1000	1200	800	1100	700	900	1000	<=	100000	0		
7	1	1	1	1	1	1	1	=	100	0		
8	1	1	0	0	0	0	0	=	45	0		
9	0	0	1	1	0	0	0	=	50	0		
10	0	0	0	0	1	1	1	=	5	0		
11	0	0	1	0	1	0	0	>=	25	0		
12	1	0	0	0	0	1	0	>=	30	0		
13	0	1	0	1	0	0	1	>=	4	0		
14	Calculation method:											
15	Step 1. Starting from the initial solution x1=x2=x3=x4=x5=x6=x7=0 written in the domain A2:G2											
16	Step 2. In the field A4:G4, write the FO coefficients (Objective Function) obiectiv)											
17	Step 3. In field A6:I13, write the model data											
18	Step 4. Calculation formulas:											
19	- for the objective function FO, write in cell H2 the formula =SUMPRODUCT(A2:G2,A4:G4)											
20	- for each restriction, in the field J6:J13, write the corresponding formula =SUMPRODUCT($A$2:$G$2,A6:G6)											
21	Step 5. Position the mouse cursor in cell H2 and call SOLVER from the DATA menu (See Ribbon)											
22	Step 6. The SOLVER option will display the Solver Parameters window (table 7) in which the required information will be filled.											

Source: Own determination.

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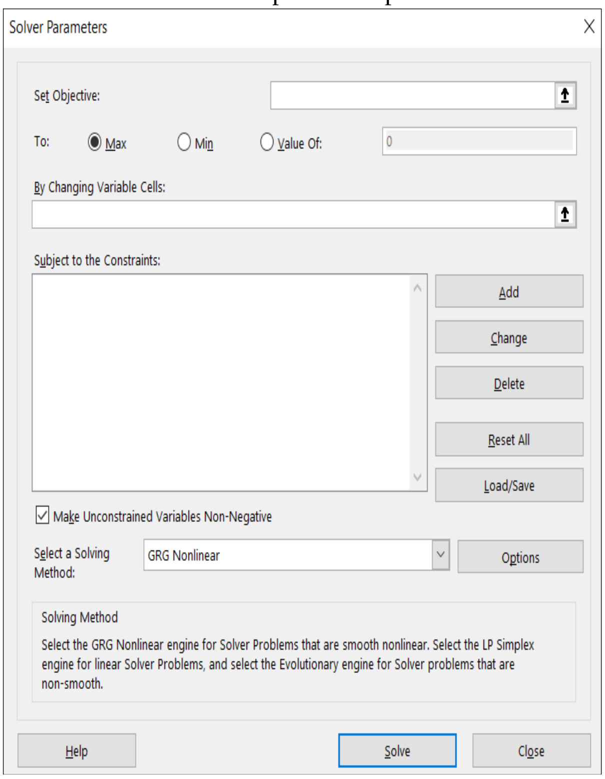
A good predecessor plant could assure for the successor crop higher yields, income and profit or with smaller expenses.
Beans, peas, soybean are good predecessor plants because they produce nitrogen which is left on the nods of the roots due to the bacteria fixing nitrogen.
Having in mind these aspects, this case study presents an optimal linear model for crop rotation characterized by:
- The unknown x_i are the surfaces which are going to be cultivated after predecessor plants;
- The restrictions regard: bilateral restrictions for successor plants; the cultivation of the whole surface with successor crops; surfaces with predecessor crops occupied by them.
-The economic functions are: Income, Expenses, Profit, Profit rate, Marginal profit rate.
The problem data and analysis is made according to the methodology established by [7, 8].

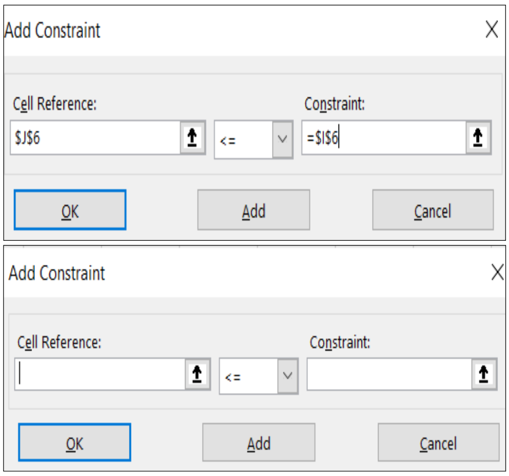
Table 7. It should be completeed as presented below



Source: Own determination

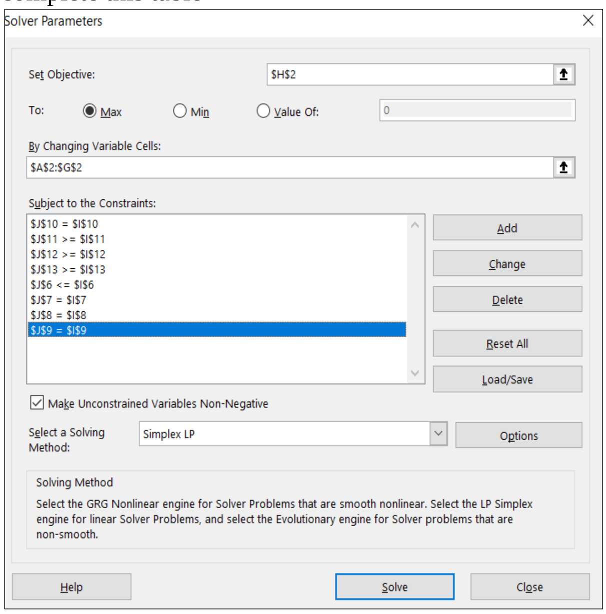
-in the zone Set objective, write the address of teh cell for FO calculus (here, it is H2)
-in the zone To, select MAX or MIN (cf. probl.)

-in the zone By Changing Variable Cells, write the field with the values of the variables (A2:G2)
-in the zone Subject to the Constraints, write each restriction, using Add (cell with the calculus formula, sign and limit).
For example:



-from the zone Select a Solving, select Simplex LP
- it is launched the option SOLVE
Table completed before to launch the option SOLVE is Table 8.

Table 8. Before launching the opition Solve, complete this table



Source: Own determination.

After launching the option Solve, it is obtained the next window where to tackle in case that the three types of reports: Answer, Sensitiviy and Limits will appear (Table 9).

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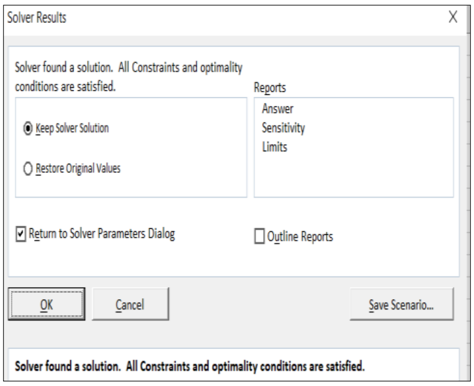
Modification or deletion of restrictions is done with the Change and Delete options, respectively.

The **Answer**, **Sensitivity** and **Limits** options will attach to the initial spreadsheet three other reports with results, namely: *the optimal primal and dual solutions, the optimal value and the intervals for the components that do not require reoptimization.*

Note: the values of the primary variables and the value of the objective function also appear in the initial spreadsheet.

Table 9. Answer, Sesitivity and Limits which offer informations on solutions



Source: Own determination.

Table 10. Results displayed on the main data sheet after the Solver launch

	A	B	C	D	E	F	G	H	I	J	K
1	x1	x2	x3	x4	x5	x6	x7	**FO**			
2	32.5	12.5	25	25	0	0	5	158750			
3	c1	c2	c3	c4	c5	c6	c7	MAX			
4	1500	1800	1200	1900	1300	1600	2000				
5	**Restrictions**										
6	1000	1200	800	1100	700	900	1000	<=	100000	100000	
7	1	1	1	1	1	1	1	=	100	100	
8	1	1	0	0	0	0	0	=	45	45	
9	0	0	1	1	0	0	0	=	50	50	
10	0	0	0	0	1	1	1	=	5	5	
11	0	0	1	0	1	0	0	>=	25	25	
12	1	0	0	0	0	1	0	>=	30	32.5	
13	0	1	0	1	0	0	1	>=	4	42.5	

Source: Own determination

Table 11. Answer Report worksheet

Microsoft Excel 16.0 Answer Report
Worksheet: [Book1]Sheet1
Report Created: 10/3/2023 3:09:37 PM
Result: Solver found a solution. All Constraints and optimality conditions are satisfied.
Solver Engine
Engine: Simplex LP
Solution Time: 0.031 Seconds.
Iterations: 8 Subproblems: 0
Solver Options
Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

Objective Cell (Max)

Cell	Name	riginal Valu	Final Value
$H$2	FO	0	158750

Variable Cells

Cell	Name	riginal Valu	Final Value	Integer
$A$2	x1	0	32.5	Contin
$B$2	x2	0	12.5	Contin
$C$2	x3	0	25	Contin
$D$2	x4	0	25	Contin
$E$2	x5	0	0	Contin
$F$2	x6	0	0	Contin
$G$2	x7	0	5	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$J$1(	=	5	$J$10=$I$10	Binding	0
$J$11	>=	25	$J$11>=$I$11	Binding	0
$J$1:	>=	32.5	$J$12>=$I$12	Not Binding	2.5
$J$1:	>=	42.5	$J$13>=$I$13	Not Binding	39
$J$6	<=	100000	$J$6<=$I$6	Binding	0
$J$7	=	100	$J$7=$I$7	Binding	0
$J$8	=	45	$J$8=$I$8	Binding	0
$J$9	=	50	$J$9=$I$9	Binding	0

Source: Own determination.

Table 12. Sensitivity Report worksheet

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [Book1]Sheet1
Report Created: 10/3/2023 3:09:37 PM

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$A$2	x1	32.5	0	1500	300	166.6666667
$B$2	x2	12.5	0	1800	166.6666667	300
$C$2	x3	25	0	1200	250	0
$D$2	x4	25	0	1900	0	250
$E$2	x5	0	0	1300	0	1E+30
$F$2	x6	0	-250	1600	250	1E+30
$G$2	x7	5	0	2000	1E+30	0

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$J$10	=	5	500	5	0	0.5
$J$11	>=	25	-250	25	1.666666667	8.333333333
$J$12	>=	32.5	0	30	2.5	1E+30
$J$13	>=	42.5	0	4	38.5	1E+30
$J$6	<=	100000	1.5	100000	500	2500
$J$7	=	100	0	100	0	1E+30
$J$8	=	45	0	45	0	0.416666667
$J$9	=	50	250	50	0	0.454545455

Source: Own determination.

Table 13. Limits Report worksheet

Microsoft Excel 16.0 Limits Report
Worksheet: [Book1]Sheet1
Report Created: 10/3/2023 3:09:37 PM

Objective		
Cell	Name	Value
$H$2	FO	158750

Variable			Lower	Objective	Upper	Objective
Cell	Name	Value	Limit	Result	Limit	Result
$A$2	x1	32.5	32.5	158750	32.5	158750
$B$2	x2	12.5	12.5	158750	12.5	158750
$C$2	x3	25	25	158750	25	158750
$D$2	x4	25	25	158750	25	158750
$E$2	x5	0	0	158750	0	158750
$F$2	x6	0	0	158750	0	158750
$G$2	x7	5	5	158750	5	158750

Source: Own determination.

A linear model can be reoptimized by changing the values of the coefficients. The most common changes are:
- modification of the coefficients of the objective function in which it is analyzed whether the existing primal optimal solution of the model remains the optimal one (so reoptimization is not necessary);
- modification of the limits of the restrictions, in which case it is analyzed if the existing dual optimal solution of the model remains the optimal one (therefore reoptimization is not necessary).

The answer to these questions is given by the Limits Report.

CONCLUSIONS

The paper has presented two case studies of optimization in agriculture in vegetal production, emphasizing on cereals cropping which is facing with big problems related to technological aspects and climate change impact on yield mainly to wheat and maize.
Two problems were approached:
(a)optimization of profitability in relation to wheat yield, subsidy per ha and delivery price. The calculations in the agricultural year 2022/2023 proved that without irrigation it could be obtained 6,500 kg wheat per ha in South Oltenia region, but to be a profitable culture, it needs that production costs to be compensated by income whose level depends on delivery price and subsidy per surface unit. Without subsidy and a higher price than Leu 1 per kg seeds at delivery, wheat could become a non profitable crop.
(b)optimization of crop rotation using a model with maximum income which had two solutions: Basic optimal primal solution and Basic optimal dual solution, whose calculation was assisted by **SOLVER** application from **MS Excel** as described in the paper.
The both examples reflect how important is optimization in agricultural production, and that the managers need to have not only good technological knowledge and skills but also IT skills and digital infrastructure to enable them to make the right decisions.

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EMPLOYEES PERCEPTION ON ORGANIZATIONAL COMMUNICATION – CASE STUDY

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Abstract

In the time of technology and globalization, effective organizational communication is critical for a company success. In a continuous changing world, companies must take a strategic and effective approach to communicate with the employees, customers and third-party stakeholders. The objective of this paper focuses on the study of organizational communication in an international company, one of the largest providers of communication services in Romania, with office in Bucharest. The purpose of this paper is to analyze and evaluate the way the company manages internal organizational communication and to identify ways in which it can be improved, with the ultimate goal to contribute to increase the company performance and competitiveness in the market. The case study carried out within the analyzed company had as objective the evaluation of organizational communication from the employee perspective, for which purpose, we elaborated and applied a questionnaire with 10 questions, on a sample of 100 people, in which we captured both their perception of the relevance, the frequency or transparency of information received from managers, as well as their opinion regarding the level of communication within the company, respectively, the employees involvement in the communication process and in the improvement of the organizational communication. The satisfaction regarding organizational communication was evaluated positively by a majority of respondents (64%). The quality of information received regarding projects and changes in the company was positively assessed by the majority of employees (66%). Communication between departments was generally considered positively (59%), and communication between management and employees was considered adequate by most respondents (69%). Regarding the employees involvement in the process of improving the organizational communication, the majority of respondents (67%) stated that they were not actively involved in this process. The results of the study also provided a perspective of how internal communication may affect the employee performance and satisfaction, as well as potential problems or constraints that could be resolved to improve the effectiveness of organizational communication within the company

Key words**:** *questionnaire, company, efficient communication, organizational communication, visión.*

INTRODUCTION

Organizational communication plays a crucial role in the functioning and success of an organization. It serves as a basis for building relationships, sharing information, making decisions and achieving common goals [14, 4]. An efficient communication can increase employee commitment, improve productivity and enhance collaboration between different teams and departments. It can also help create a positive organizational culture that fosters trust, transparency and open communication. [13]. Communication within an organization can take various forms, such as formal and informal communication, upward and downward communication, and internal and external communication. It is important to have clear and concise communication channels and methods that are appropriate for different purposes and contexts [3, 6].

In addition, efficient communication can help organizations adapt to change, whether it is due to technological advances, market changes, or other factors [11]. It can also help organizations navigate conflict and resolve issues, and provide a platform for employees to express their concerns and ideas [1, 7]. Generally, organizational communication plays a critical role in promoting the harmonious and efficient functioning of an organization and it is essential for creating a positive and productive work area [13, 18].

Organizational communication is closely related to an organization goals because it serves as a means of conveying, reinforcing, and aligning those goals within the organization [11].

By communicating the organization mission, vision and goals, employees can better understand how their individual roles contribute to the overall success of the organization. Efficient communication can also help ensure that everyone is on the same side and working toward common goals, which can improve the organization overall performance and competitiveness [7, 8].

In addition, efficient communication can help organizations track progress toward goals by providing regular updates, performance indicators, and feedback. This allows organizations to make adjustments as needed to stay on track and achieve their goals in a timely and efficient manner [5]. In general, efficient organizational communication is essential to the achievement of an organization goals because it serves as a means of aligning individual efforts to common goals, promoting a positive work area, and adapting to changing circumstances. Facilitating collaboration and understanding, among members is a key component of effective organizational communication. Organizations that prioritize collaboration and understanding tend to have higher employee engagement, increased productivity and better overall performance [10].

In order to facilitate collaboration and understanding, organizations can use a variety of communication strategies and methods [8, 9]. For example, they can create opportunities for employees to work together on projects and initiatives, provide training and development programs to help employees build relationships and develop cross-functional skills, and promote a culture of openness and transparency [16].

In addition, organizations can use technology to facilitate collaboration and understanding. For example, online collaboration tools and project management software can be used to promote teamwork and efficient communication among team members, regardless of their physical location or time zone. Moreover, creating a shared vision and understanding of the organization goals and objectives can help align individual efforts and promote a sense of unity and collaboration [2, 18]. The human dimension continues to remain the weakness of management practice. Whether times are good or bad, there is never a true understanding of the relationships between managers and employees and the interactions between employees and managers. When there are problems, everyone is aware that one of the causes could be a communication problem. [12].

Communication is one of the most important activities in an organization [14, 19]. Fundamentally, relationships develop through communication, and the functioning and survival of organizations is based on effective relationships between individuals and groups. Moreover, organizational capacities are adopted and developed through “intense communicational and social processes” [15]. Communication helps individuals and groups coordinate their activities to achieve goals and is vital in the processes of socialization, decision making, problem solving, and change management [2, 5].

MATERIALS AND METHODS

The purpose of this paper is to analyze and evaluate the way in which the company manages internal organizational communication and to identify the ways in which it can be improved, following the analysis of the employees perception on the aspects of organizational communication within the analyzed company. The objectives of the case study were the following: to identify the employees perception of the quality and relevance of the information received from the company management; evaluating the level of transparency in internal communication and how it influences employees perception; analysis of the degree of employees involvement and satisfaction on organizational communication and the evaluation of its impact on their performance within the company; identification of possible problems or dysfunctions in organizational communication; the analysis of significant differences in the perception of organizational communication according to the department or the hierarchical level of the employees.

By achieving these objectives, we aimed for a deeper understanding of how organizational communication affects the employees performance and satisfaction within the analyzed company, as well as the problems that need to be addressed and solved in order to improve the effectiveness of internal communication within the company.

In the case study, we started from the following assumptions:

*The organizational communication within the company is not perceived as transparent and efficient by employees;

*There are significant differences in the perception of organizational communication depending on the department or the hierarchical level of the employees;

*The degree of employees satisfaction and involvement on organizational communication can influence their performance and productivity;

*There is a need to improve organizational communication within the company to create a culture of transparency and effectiveness of internal communication.

By testing these hypotheses, we could identify existing problems or gaps in the company organizational communication and provided recommendations for its improvement in order to create an efficient and transparent communication culture.

As a working tool, we used a questionnaire consisting of 10 questions, applied to 100 respondents, from all departments of the company, with the aim of evaluating the employees perception of the company on the organizational communication within it.

The questionnaire was structured in such a way as to cover several aspects of organizational communication, such as the relevance and quality of information received, transparency of communication, employee involvement and satisfaction, the degree of collaboration between departments, feedback and the degree of involvement in the process of improving the organizational communication.

Each question had a set of predefined answer options to simplify the process of filling in and analyzing the results. The answer options were variable so that respondents could choose the one that best reflected their perception of the question. The results obtained after completing the questionnaire were analyzed and interpreted to identify problems and deficiencies in organizational communication within the company. By addressing the identified issues, it will be possible to improve the effectiveness and transparency of internal communication within the company.

RESULTS AND DISCUSSIONS

Organizational communication can contribute to motivate employees, strengthen trust, create a common identity or increase personal involvement; it offfers individuals a way to express their feelings, to share hopes and ambitions and to celebrate and remember achievements [12].

Communication is the way in which individuals and groups understand their organization, what it is and what it stands for.

The company in which the case study was carried out is an international telecommunication company, based in Bucharest, but with work points throughout the country, which was founded in 1994 and started to offer cable television services in Romania. It later expanded its range of services to include high-speed internet, fixed and mobile telephony, hosting and cloud services, as well as digital television services.

It is currently one of the largest telecommunications operators in Central and Eastern Europe, with operations in Romania, Hungary, the Czech Republic, Slovakia, Croatia and Italy. The company has over 10 million customers in all the countries in which it operates and approximately 11,000 employees.

The company has a team of qualified and dedicated professionals who work in a dynamic and innovative work area. In terms of the employee management, the company has an approach based on meritocracy and their professional development. The company invests significantly in the training and development of its employees, through

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training and mentoring programs. It also provides opportunities for career advancement and performance recognition so that its employees can develop to their full potential.

In terms of communication within the company, it emphasizes transparency and openness. The company has a well-defined internal communication policy that encourages the exchange of information between different departments and levels of the organization. It also has a number of internal communication channels, such as newsletters, online forums and periodic meetings, which facilitate communication between employees and management. Regarding the gender structure of the respondents, from the answers received from the 100 respondents, 40% of them are women, while 60% are men.

This gender distribution among employees can have significant implications for organizational communication. For example, there are significant gender differences in how they perceive transparency and involvement in the organizational communication process. It is important for the company to consider these differences and take steps to promote effective and inclusive communication among all employees, regardless of gender. It might also be useful to conduct further studies to investigate these differences more detail and to identify potential problems in organizational communication regarding gender diversity. Regarding the age structure of the respondents, the age distribution is relatively balanced: 25% of them are between 18 and 25 years old, 30% between 26 and 35 years old, 25% between 36 and 45 years old and 20% are 46 years old years or more.

It should be noted that younger respondents (between 18 and 35 years old) have a different perception of how information should be communicated within the organization compared to the older ones. In addition, it can be more difficult to communicate effectively with older people who are more conservative with digital technologies and communication channels. That is why it is important for the company management to consider the age differences of the employees in the process of organizational communication and adopt a flexible approach that takes into account the needs and preferences of all employees. It is also important to use a mix of communication channels to reach all employees, regardless of age. Further studies could investigate these differences in more detail and provide specific solutions to improve organizational communication across age groups. Looking at the place of residence, 70% of the respondents come from the urban area, while 30% come from the rural area. This distribution of the place of origin can have significant implications, because the employees who come from the urban environment have different expectations compared to those who come from from rural areas in terms of frequency and style of organizational communication. It is important to consider these differences and take steps to ensure effective and inclusive communication for all employees, regardless of their background.

To the question “How often do you receive information from the company management?”, from the answers received from the 100 respondents, 20% of them receive information from the company management daily, 35% weekly, 30% monthly, 10% rarely and 5% never, as shown in Figure 1.

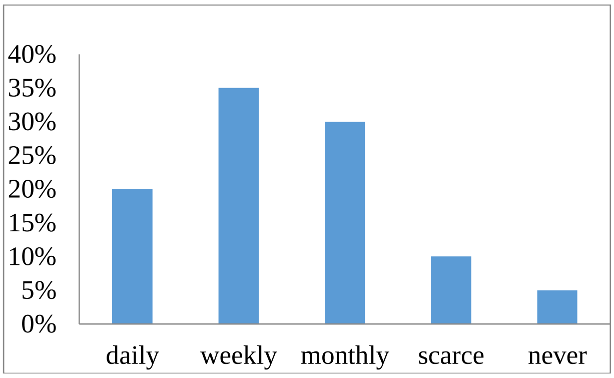

Fig. 1. Frequency of employees informing from the anagement
Source: Centralization of information obtained based on questionaire [17].

The obtained results mean that employees who receive information more frequently from management have a better perception of transparency and involvement in the organizational communication process. It is important to consider these differences and

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take steps to ensure efficient and inclusive communication for all employees. It is also important to use a mix of communication channels to reach all employees and adapt the frequency and style of communication according to their needs.
Further studies could investigate these differences in more detail and provide specific solutions to improve organizational communication and transparency in the decision-making process within the company.
To the question "How relevant do you consider the information received from the company management?", from the responses received, 45% of them consider the information received from the company management to be very relevant, 35% consider it relevant, 15% are neutral, and 5 % consider them irrelevant or very irrelevant, as shown in Figure 2.

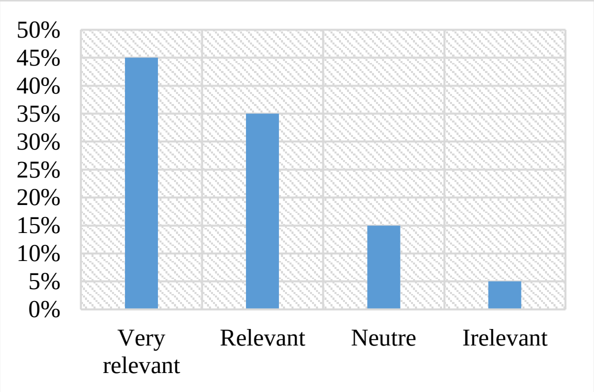

Fig. 2. Relevancy of informatio received from management
Source. Centralization of information obtained based on questionnaire [17].

It should be noted that employees who perceive the information received as relevant or very relevant are more involved in the communication process and are more likely to follow the directions set by management. At the same time, employees who perceive information as irrelevant or very irrelevant may not pay attention to it and may not be fully informed.
To the question „How transparent do you consider internal communication within the company?„ 30% consider internal communication within the company to be very transparent, 50% consider it transparent, 10% are neutral and 10% consider it opacity or very opacity, as it is shown in Figure 3.

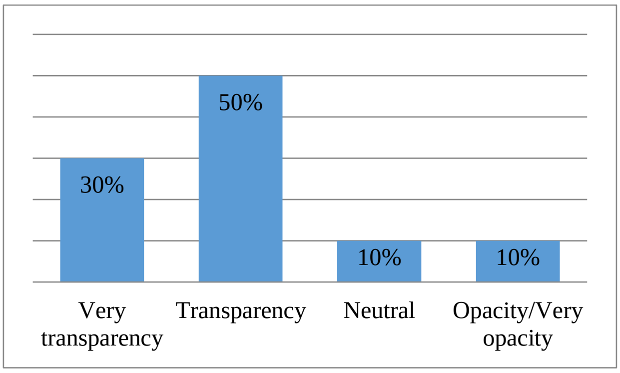

Fig. 3. Transparency of internal communicaton within the company
Source: Centralization of information obtained based on questionnaire [17].

This distribution of the perception of transparency in internal communication leads to the conclusion that employees who perceive internal communication as transparent or very transparent will be more likely to trust the company management and feel involved in the decision-making process. On the other hand, employees who perceive internal communication as opaque or very opaque may have a negative perception of the company and may be less involved in the decision-making process.
To the question "How involved do you feel regarding organizational communication within the company?", 40% feel very involved regarding organizational communication within the company, 35% feel involved, 15% are neutral, and 10 % feel little or very little involved, as shown in Figure 4.

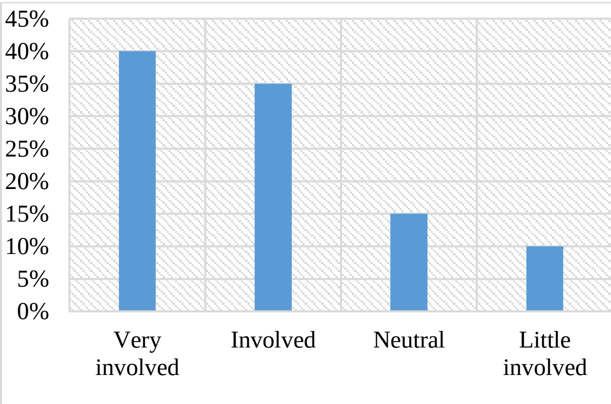

Fig. 4. Employees involvement in organizational communication of the company
Source: Centralizaion of inofmration obtained base don questionnaire [17].

This distribution can be an indicator of the level of employee involvement in communication and decision-making in the company. Employees who feel highly engaged or engaged are more likely to be involved and provide feedback in the communication and decision-making process, which can lead to more effective communication and higher employee satisfaction. On the other hand, employees who feel little or very little involved may be less involved in the communication and decision process and may be less satisfied with their work.

It is important for the company to take these perceptions into account and take steps to increase employee involvement in organizational communication and the decision-making process. The company can ensure that employees are involved in communication and decision-making through feedback sessions and regular meetings with managers, by creating transparent communication channels and involving them in the decision-making process. The level of involvement of employees in organizational communication can affect their satisfaction and involvement in the company. By increasing the involvement of employees in the communication and decision process, the company can improve the relationship with employees and achieve better results in terms of their involvement and performance.

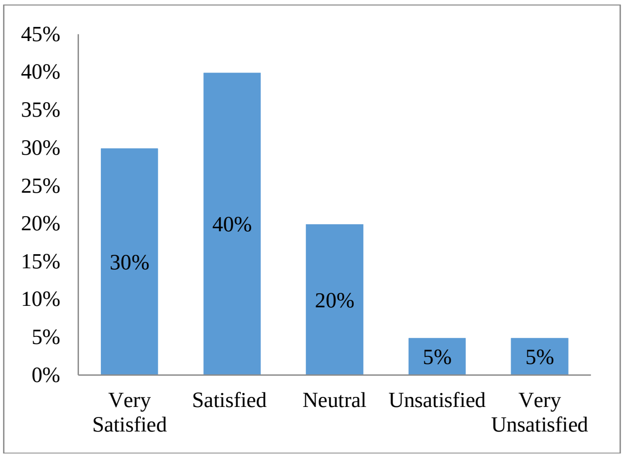

Fig. 5. Satisfaction towards the organizational communication within the company
Source: Centralization of information obtained based on questionnaire [17].

To the question "How satisfied are you with organizational communication within the company?", 30% declare themselves very satisfied with organizational communication within the company, 40% are satisfied, 20% are neutral, 5% are dissatisfied and 5% are very dissatisfied , as shown in Figure 5.

These results show that the majority of employees are satisfied with organizational communication within the company, and a significant number even declare themselves very satisfied. This can be an indicator that top management has good and transparent communication with its employees. However, there is also a significant percentage of employees who are dissatisfied or very dissatisfied with organizational communication within the company. It is important to consider these negative feedbacks and take steps to improve communication with these employees, by creating transparent and accessible communication channels and by encouraging feedback and employee participation in the communication and decision process .

To the question "How would you evaluate the quality of information received regarding projects or changes in the company?", 25% consider the quality of information received regarding projects or changes in the company to be very good, 40% consider it good, 20% are neutral, 10% consider it weak and 5% consider it very weak, as shown in Figure 6.

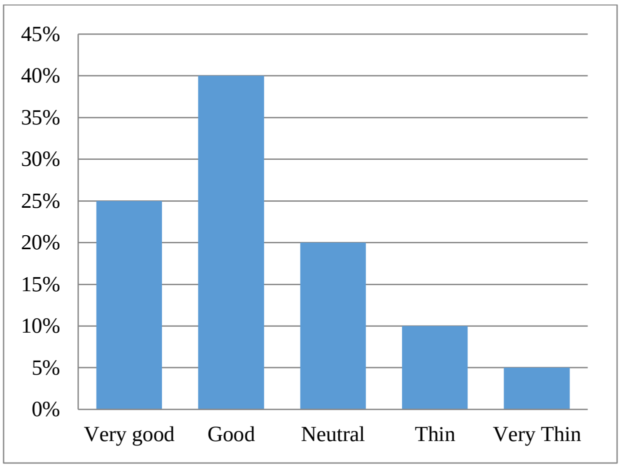

Fig. 6. Quality of information received regading the projects or chances in the company
Source: Centralization of information obtained based on questionnaire [17].

This suggests that most employees consider the information received about projects or changes in the company to be of good or very good quality. However, there is also a significant number of employees who believe that the information they receive is poor or very poor.

To the question "Do you feel that there is adequate communication between company departments?", 30% of them believe that there is always adequate communication between company departments, 50% said that there is adequate communication sometimes, 15% said that it rarely exists and 5% stated that there is no adequate communication between departments at all, as shown in Figure 7.

These percentages suggest that the majority of employees believe that there is adequate communication between departments in the company, but there is, however, a significant minority who believe that this is rare or non-existent.

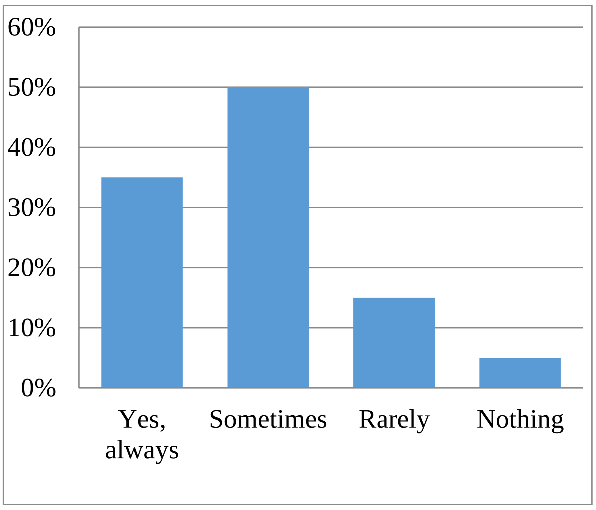

Fig. 7. Existence of an adequate communication between the company
Source: Centralization of information obtained based on questionnaire [17].

To the question "Do you feel that there is adequate communication between company management and employees?", 35% of them believe that there is always adequate communication between company management and employees, 50% stated that there is adequate communication sometimes, 10% said that it rarely exists and 5% stated that there is no adequate communication between management and employees at all, as shown in Figure 8.

It is found that the majority of employees believe that there is adequate communication between management and employees in the company, but there is, however, a significant minority who believe that this is rare or non-existent.

To the question „Have you been invited to express your opinion on important decisions made within the company?„ 20% of them stated that they are always invited to express their opinions on important decisions made within the company, 50% said that they are invited sometimes, 20% stated that they are rarely invited and 10% were never invited to express their opinions, as shown in Figure 9.

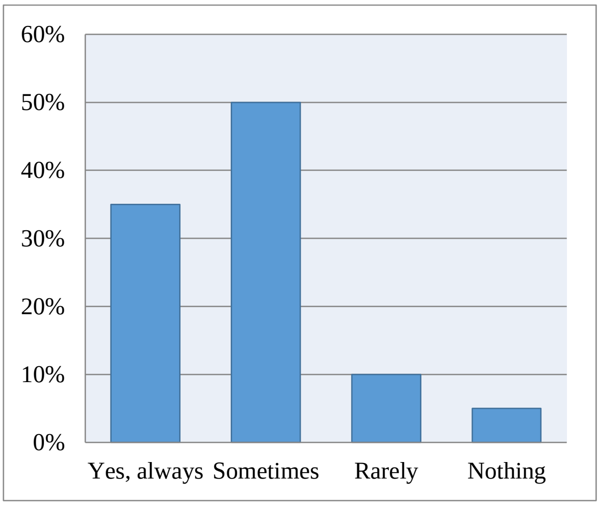

Fig. 8. Existence of an adequate communication between management and employees
Source: Centralization of information obtained based on questionnaire [17].

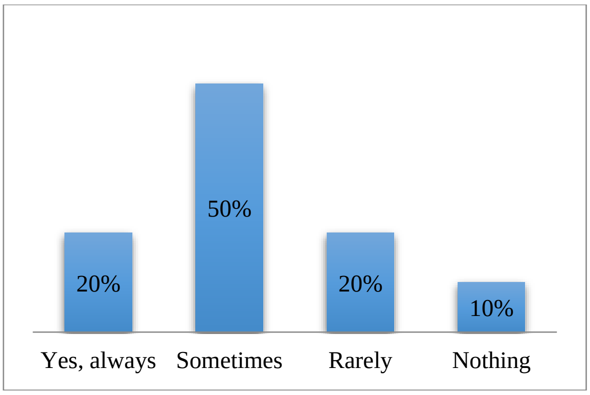

Fig. 9. Employees opinion on important decsions made in the company
Source: Centralization of information obtained based on questionnaire [17].

From Figure 9 it is easy to understand how important is that employees feel involved in the decision-making process, as this can increase their level of commitment and improve the performance of the company as a whole.

From the analysis of the answers received, 25% of the respondents stated that they were actively involved in the process of improving organizational communication within the company, while 40% indicated that they were involved to some extent. At the same time, 35% of the respondents stated that they were not involved in this process at all.

A significant number of respondents who indicated that they were not involved in the process of improving organizational communication indicates a low level of involvement and responsibility regarding the improvement of the communication process within the company. At the same time, the relatively high percentage of respondents who indicated that they were involved to some extent or actively indicates an increased desire to be involved in the process of improving organizational communication and to contribute to its improvement within the company When employees are informed and see the meaning of their work, they can understand their role in the bigger picture, working towards a common goal. With employees dispersed around the world, managers are no longer able to personally oversee or share the CEO plan with teams. When the workforce is spread across different locations, online and offline, there is a need for appropriate and adapted internal organizational communication processes.

CONCLUSIONS

Every internal communication plan should focus not only on providing information, but also on clarifying and explaining it so that it is easily understood by all. Selecting the appropriate methods of internal communication is essential to achieve this point. You must be able to connect with each employee. But all too often, a large number of employees can slip through the net; remote workers, those who are not up to date with technology. Without a regular flow of information and interaction, these workers can quickly become disengaged, increasing the employee turnover rate. Internal communication channels must build connections between management and employees, between departments and individuals. With widely dispersed human resources, as is the case of the company under review, barriers must be removed and the implementation of internal communication software should be considered to help management reach every employee. It will give everyone equal access to the same information. The goal of robust internal communications is not just to inform and connect employees. It will also inspire them. By building a culture of recognition and purpose, individuals go above and beyond to serve the higher purpose of their company vision. Knowing their contribution and working towards the same goal will also increase their overall health and well-being.

One of the common internal communication mistakes is failing to listen to what your employees have to say. Implement two-way channels and give employees a voice and a platform to use.

Organizational communication is an essential aspect of the efficient and effective functioning of any company. Following the analysis of the questionnaire, both strengths and weaknesses of organizational communication within the company were identified.

Like any study, this too has limitations and possible aspects that could be improved in further research. Here are some of them:
*Sample size: This study was conducted on a sample of 100 people from multiple departments and locations within the company. Although this number is sufficient to draw meaningful conclusions, a larger sample size could provide an even more detailed and accurate picture of organizational communication within the company.
*Questionnaire: Although the questionnaire tried to capture several aspects of internal organizational communication, it could be improved and adjusted to include additional and more specific questions that could provide

a more detailed picture of organizational communication within the company.

*Subjectivity: There is a possibility that the subjectivity and personal opinion of the respondents may have influenced their answers. In addition, it would be useful to add objective data, such as statistics on the number of internal communications and company events, to help evaluate organizational communication.

*Contextual aspects: This study was carried out in a certain period of time, and only in 3 counties where the company has work points, and such a study carried out in over 50% of the company's locations could influence the way employees perceive the organizational communication.

Following the case study carried out on organizational communication within the company, several further research directions can be suggested:

-Detailed analysis of internal communication channels used within the company and identification of the most effective communication channels for different categories of employees.

-Study of the experience of employees within the company regarding participation in the decision-making process and the possibility to express their opinions.

-Evaluating the impact of organizational culture on internal communication and identifying the factors that influence the effectiveness of organizational communication.

- Analysis of how the company adapts to new communication technologies and and their impact on organizational communication eficiency.

- Evaluating how the company approaches communication issues and conflict management within the organization.

These lines of research can contribute to the improvement of the organizational communication within the company and can be applied in a wide range of companies and organizations.

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DEVELOPMENT OF RURAL AREA BY NGOs PARTICIPATION. CASE STUDY CĂLĂRAȘI COUNTY, ROMANIA

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Abstract

In the era of globalization, the civil society was recognized as the "third" essential sector regarding its positive influence on the state, but also on the community it represents. The purpose of this study is to analyze and evaluate the way in which members of rural communities perceive the influence of existing NGOs in the commune, on its development. In this sense, we initiated an survey of opinion based on interviews, on a number of 379 respondents from four rural localities in Călărași county, located in different areas of the county and with a different number of NGOs established in the locality, both in number as well as in structure, and we considered the questions: Are there NGOs in the commune? and Do you think that the existence of NGOs can influence the development of your commune?, as edifying to capture the inhabitants' perception on the development of the rural area through the involvement of organized communities, respectively, of NGOs. It should be mentioned that, through this approach, we proposed that, in addition to gather information about the objective of the study, we would also inform the population about the role and importance of the activity carried out by these organizations, to promote the interests of the community they belong to. The research was based on the method of questionnaire survey and χ2 test. Analyzing the answers, it is found that the opinions are very different between the communes (significance threshold very significant), in the sense that those from Modelu and Grădiștea communes know about the existence of NGOs in the community, those from Dragalina commune know about this aspect in a percentage of approx. 50%, while those from Borcea commune do not know or do not know about the existence of these organizations. We find out that more than half of the respondents with higher education are aware of the existence of NGOs in the locality; those with secondary and high school education answered in percentage of 47.87% and those with primary education 30%. The existence of the community organized in the form of an NGO is evaluated differently, significantly, also by male respondents under 45.6% and female respondents in percentage of 56.4%. Through their participatory level, NGOs can support the development of human resources in the rural areas, through training and counseling actions to assist the unemployed workforce in order to reduce unemployment and exploit opportunities on the labor market.

Key words: *community, development, rural area, NGO, civil society*

INTRODUCTION

Community development is a long-term process, which normally requires both financial resources and sustainable local partnerships, in which civil society plays a fundamental role [21]. In most European countries, including Romania, civil society registered a notable evolution, through involvement in rural development, through participation in the elaboration of local strategies for a sustainable development [6, 7]. For the development of rural areas, it is necessary to mobilize the decision-making factors at the central, regional and national level, respectively, local authorities, civil society representatives, national profile organizations but also, implicitly, the formation of a viable partnership between these entities, with the aim of captures the main challenges at the local level, to identify development priorities and solutions, to design integrated measures and strategies [3,12]. These strategies must emphasize the links between the participating factors, with the aim of generating positive results on local, regional and national development [19, 13]. In this sense, it must aim at intensifying the strengths of the community, under all economic, social, environmental aspects and reducing vulnerabilities, weak points [7, 23, 26]. Since within the local communities we encounter significant differences regarding the experience of cooperation, conflict, institutional culture, it is very important that the existing local realities are taken into account within the partnership [28].

The concept of civil society emerged in the late 18th century, when philosophical and political theorists began to distinguish between the state and the rest of society as a result of the transition from the medieval to the modern era [10, 22]. Over time, this concept has taken on different forms. Civil society includes non-political associative forms that are not part of a fundamental institution of the state or the business sector [5, 3].

Thus, non-governmental organizations - NGOs (associations or foundations, trade unions, employers' unions) are civil society “actors” who intervene alongside the decision-makers and institutions of the rule of law, in the sense of defending the rights and interests of the groups of citizens they represent. It is therefore seen as an increasingly important agent for promoting good governance through transparency, effectiveness, openness, responsiveness and accountability [2, 15, 26].

Civil society can reach the stage of good governance through: policy analysis and *advocacy*; regulation and monitoring of state performance and by influencing the behavior of civil servants; developing social capital that enables citizens to identify and express values, beliefs, civic norms and democratic practices; mobilizing the vulnerable and marginalized sectors of the masses for their active participation in politics and public affairs; development activity aimed at the well-being of communities [1, 8, 21].

In our country, citizens' participation in the social-political life of the local community and as a whole is quite low. The main cause would be the concept according to which the state is obliged to do everything for [5, 9].

The concept of public-private partnership expresses, in general, a way of cooperation between public authorities and the private sector, non-governmental organizations or companies, with the aim of achieving projects aimed at local development from all points of view [8, 10].

The sustainable development of rural areas is one of the main objectives of the European Union. It is necessary to promote a general harmonious evolution, contributing to the reduction of disparities between the development levels of different regions [1, 22].

At the national level, the application of the Common Agricultural Policy is aimed at, which involves a set of measures planned and promoted by local and central public administration authorities, in partnership with various private or public “actors”. This policy aims to ensure a dynamic and sustainable economic growth, through the effective exploitation of agricultural potential, to improve living conditions and promote diversity and quality, respecting the variety of agricultural traditions of Europe and, implicitly, of Romania [2, 23, 28].

NGOs are privately established organizations from groups of people with common interests, who support and promote the interests of society and support the development of different communities [8, 10]. They are also considered main organizations or people's organizations, established to help others. These community organizations are typically formed by groups of individuals who have joined together to promote their interests, such as women's associations, youth clubs, cooperatives and farmers' associations [1, 15].

MATERIALS AND METHODS

The purpose of this study is to analyze and evaluate the way in which members of rural communities perceive the influence of NGOs existing in the commune on its development. Starting from the hypothesis that, through representatives of civil society, citizens can express their point of view and support for the local economic and social development strategy of the community in which they live, playing an active role in the creation of a democratic European model, we initiated a survey of opinion based on interviews in four rural localities in Călărași county, located in different areas of the county and with a different number of NGOs established in the locality, both regarding the number and structure, and we considered the questions: ***In the commune there are NGOs? and Do you think that the existence of NGOs can influence the development of your commune?,*** as edifying to capture the inhabitants' perception on the development of the rural area through the involvement of organized communities, respectively, of NGOs. It should be mentioned that, through this approach, we proposed that, in addition to gathering information related to the objective of the study, we would inform the population about the role and importance of the activity carried out by these organized structures, for the promotion of the interests of the community of which they are a part, being considered organizations of people, established to help others. The research was based on the method of questionnaire survey and χ2 test.

The questions were structured on 2 levels, respectively, 4 filter questions and 2 grid-type questions, with 3 or 4 predetermined answers, to simplify the process of completing and analyzing the answers but also so that the respondents could choose the one that reflects better their perception of that question.

A number of 379 people responded to the interview-questionnaire study and the answers were analyzed taking into account the following aspects: locality, age, education, gender and occupational profile. 379 people were surveyed, from 4 localities of Călăraşi county, respectively, Modelu, Grădiștea, Dragalina and Borcea. the sample was organized into 5 age groups: up to 30 years, 31-40 years, 41-50 years, 51-60 years, over 60 years.

Regarding the criterion regarding the level of studies, we structured as follows: primary school, secondary, high school and higher education; by gender: male and female; according to the occupational status, we structured the respondents into: farmer; employee; unemployed; without occupational status and pensioners.

In order to determine the cumulative distribution function, applied in this case to statistical distributions, through the χ2 ("hi-square") concordance test, which is applied to grouped data, also called frequency data, by associating the columns and rows of a table with two entries, crossed, in which the information is presented according to one or more segmentation variables and calculated after compiling the contingency tables. [18, 27]. The steps taken to evaluate the results of the questionnaire through the χ2 test are: the formulation of the null hypothesis, which determines the causal link between the two variable-questions; choosing the significance threshold, determining the number of degrees of freedom of the table, according to the formula (r-1)*(c-1). The theoretical value of χ2 was taken from the distribution table and the results obtained were compared [17, 25], and the existence/non-existence of association between variables was determined; the contingency coefficient C, was calculated to measure the degree of association between the variables of the contingency table [24]. The calculated χ2 was compared with the theoretical χ2 for different probability thresholds and the correlation was established according to the degree of closeness of C to 1.

RESULTS AND DISCUSSIONS

In the 50 communes of Călărași county, 445 NGOs are established, according to the List of NGOs (List of NGOs, published in 2022 [27]. According to the objective pursued, they were in the number of 114 (25.6%), community, 54 sports (12.2%), 37 (8.3%) agricultural and 240 (53.9%) other objectives. Most NGOs are located in Călăraşi municipality (235, respectively 52.8%) and in Oltenita town (48, respectively 10.8%), Lehliu Gară (12, respectively 2.7%) (Table 1). In the four localities where the case study was carried out, as shown in table 2., there are 32 NGOs, most of them in the “community” category, 13 in the “sports” category and “agricultural”-7 and in the category “others” -5.

Modelu commune, being located on the left bank of the Danube river and Borcea branch, represents one of the localities in Romania with a particularly attractive, advantageous and beneficial geographical position [20].

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The current population of Modelu commune is over 10,052 inhabitants, being among the large communes in Romania, with demographic stability.

Located in the central-southern part of Călărași county, Grădiștea commune is located on the north bank of the Danube, west of Călărași municipality, having as a touristic objective, Lake Galățui. According to the last census, the population of the commune is approximately 5,000 inhabitants, increasing by 10% compared to the previous census, as a result of the attractiveness of the commune due to its proximity to the city [14].

Dragalina commune is located in the north of the county, on the border with Ialomița county, and on its territory there are several important road and railway junctions. Also, the Bucharest-Constanța highway passes through the commune. The current population of the commune is about 8,500 inhabitants [11]. Located on the left bank of the Danube and crossed by the Borcea branch, Borcea commune is located in the east of Călărași county, being adjacent to Constanța and Ialomița counties. By size and population of approximately 8,900 inhabitants, it is one of the largest municipalities in the county [4].

Table 1. Size and structure of the number of NGOs, by locality and type of activity, in Calarasi county

Localities	NGOs no	Localities	Total NGO		of which, by activity			
					Community	Sports	Agricultural	Others
	NGO/ local	No	No	%	No	No	No	No
Călărași	235	1	235	52.8	55	25	9	146
Oltenița	48	1	48	10.8	12	5	-	31
Lehliu Gară	12	1	12	2.7	4	-	-	8
Gradiștea, Modelu	10	2	20	4.5	9	4	3	4
Chirnogi	8	1	8	1.8	4	1	-	3
Dragalina, Fundulea	7	2	14	3.1	4	3	1	6
Dorobanțu	6	1	6	1.3	-	1	3	2
Borcea,Budești, Curcani, Dor Mărunt, Mănăstirea, Ștefan Cel Mare	5	7	35	7.9	13	6	6	10
Belciugate, Sărulești	4	2	8	1.8	4	-	-	4
Ciocănești, Cuza Vodă, Dâlga, Independența, Jegălia, Mitreni, Ulmeni	3	8	24	5.5	2	5	11	6
Alexandru Odobescu, Chiselet, Ciocănești, Dichiseni, Dragoș Vodă, Rasa, Răzvani, Roseți, Siliștea, Unirea, Vlad Țepeș	2	11	22	4.9	1	3	3	15
Rest of communes	1	13	13	2.9	6	1	1	5
Total	x	50	445	100.0	114	54	37	240
	x	X	x	100.0	25.6	12.2	8.3	53.9

Source: Processed according to: List of NGOs in Călărași [16].

Table 2. Structure of NGOs in the studied localities

Localities	Total NGO		of which, by activity			
			Community	Sports	Agricultural	Others
	No	%	No	No	No	No
Modelu	10	2.25	6	2	-	2
Grădistea	10	2.25	3	2	3	2
Dragalina	7	1.6	3	2	1	1
Borcea	5	1.1	1	1	3	-
Total Calarasi county	445	100	114	54	37	240
	x	100	25.6	12.2	8.3	53.9

Source: Processed accordign to: List of NGOs in Călărași, http://www.listainstitutii.ro/ong-uri-din-calarasi?act=1&pag=23#[16].

The structure of NGOs in the studied localities by activity is presented in Table 2.

Analyzing the answers to the question "Are there NGOs in the commune?" it is found that the answers are very different between the communes (significance threshold very significant), in the sense that those from Modelu and Grădiștea communes know about the existence of NGOs in the community, those from Dragalina commune, about 50% know these aspects, while those from Borcea commune do not know or do not know about the existence of communities (Table 3).

Table 3. Evaluation of correlation between knowing the existence in the commune of some NGOs and residence commune of the respondents

Commune	**MU**	**Are there NGOs in the commune ?**			**Total**	
		Yes	No	I do not know	No	%
Modelu	No.	64	21	13	98	25.86
Grădistea	No.	61	13	23	97	25.59
Dragalina	No.	42	22	23	87	22.96
Borcea	No.	22	43	32	97	25.59
Total	No.	189	99	91	379	100
	%	49.86	26.12	24.02	100	X
CHIINV (Chi theoretical)	≥	8.53	1.,61	12.57	16.79	22.46
CHIINV (Chi calculated)	16.04					***

Source: Own calculations.

As for the correlation between the age of the respondents and the answers to this question, it was found to be different, respectively, significant. The majority of respondents, 189, respectively, 49.86% answered affirmatively. A number of 190 respondents answered No or I do not know, of which 34 are up to 30 years old and 35 of them are over 61 years old (Table 4).

Table 4. Evaluation of correlation between knowing about the existence in the commune of some NGOs and the respondents age

Age (years)	UM	Are there NGOs in the commune?			Total	
		Yes	No	I do not know	No	%
up to 30	No	32	17	17	66	17.41
between 31-40	No	61	18	27	106	27.9
between 41-50	No	52	28	23	103	27.17
between 51-60	No	27	14	11	52	13.72
over 60	No	17	22	13	52	13.72
Total	No	189	99	91	379	100
	%	49.86	26.12	24.02	100	X
CHIINV (Chi calculated)	15.07			*		

Source:Own calculations.

Table 5. Evaluation of correlation between knowing the existence in the commune of NGOs and the level of respondents education

Education level	**MU**	**Are there NGOs in the commune?**			**Total**	
		Yes	No	I don not know	No.	%
Primary	No	3	1	6	10	2.65
Secondary	No	42	23	21	86	22.69
High school	No	93	59	44	196	51.71
Higher education	No	51	16	20	87	22.95
TOTAL	No	189	99	91	379	100
	%	49.86	26.12	24.02	100	X
CHIINV (Chi calculated)	16.04				**	

Source: Own calculations.

Analyzing these answers, we find out that there is no communication between the generations, an aspect that must be taken into account by the local authorities and especially by the community NGOs and initiated actions for a more effective communication between the young and the elderly. From the information presented in table 5, it is found that there is a correlation between the answers regarding the knowledge of the existence of NGOs in the commune and the level of training of the respondents, the degree of significance is considered as distinctly significant, in the sense that, between the answers there is a significant difference (Table 5).

We find out that more than half of the respondents with higher education answered affirmatively to this question; those with secondary and high school education answered in percentage of 47.87% and those with primary education 30%.

The existence of the community organized in the form of an NGO is evaluated differently, significantly, also by male respondents under 45.6% and female respondents in percentage of 56.4% (Table 6).

Knowing the existence of NGOs in the studied communities is different (very significant) and depending on the professional statute of the respondents (Table 7).

Table 6. Evaluation of correlation between knowing the existence in the commune of some NGOs and respondents gender

Gender	MU	Are there NGOs in the commune ?			Total	
		Yes	No	I do not know	No	%
Male	No	104	70	54	228	60.2
Female	No	85	29	37	151	39.8
TOTAL	No	189	99	91	379	100
	%	49.86	26.12	24.02	100	*
CHIINV (Chi theoretical)	≥	3.21	4.59	5.97	9.19	13.79
CHIINV (Chi calculated)	6.47			*		

Source:Own calculations.

Table 7. Evaluation of correlation between knowing about the existence in the commune of some NGOs and the professional statute of the respondents

Occupation	MU	Are there NGOs in the commune ?			Total	
		Yes	No	I do not know	No	%
Farmer	No	47	18	16	81	21.37
Employee	No	97	52	40	189	49.87
Unemployed	No	7	2	8	17	4.48
No statute	No	31	10	12	53	13.98
Pensioner	No	7	17	15	39	10,30
TOTAL	No	189	99	91	379	100
	%	49.86	26.12	24.02	100	X
CHIINV (Chi theoretical)	≥	13.41	15.97	18.29	23.19	29.57
CHIINV (Chi calculated)	31.07					***

Source:Own calculations.

Affirmative answers of approximately 50% are found among employees, farmers and people without status. Answers of No and I do not know are received by pensioners and employees, totally different categories in terms of their concerns (Table 7).

The answers of I do not know and I do not know correspond to a country-level study that found that few people can define or nominate an NGO, even if many Romanians are members of a community association [5].

Do you think that the existence of organized communities can influence the development of your commune? It was the question that aimed to capture the inhabitants perception of the commune development possibilities through the influence of the activities of NGOs that would support their interests and lead to the cohesion of the commune inhabitants.

Table 8. Evaluation of correlation between NGOs existence and possibility of commune development

Commune	MU	Do you think that the existence of NGOs could led to the development of the commune?				Total	
		Very much	Much	Little	Not at all	No	%
Modelu	No	17	10	29	42	98	25.86
Grădiştea	No	26	35	30	6	97	25.59
Dragalina	No	73	14	0	0	87	22.96
Borcea	No	39	28	19	11	97	25.59
TOTAL	No	155	87	78	59	379	100
	%	40.89	22.95	20.58	15.58	100	x
CHIINV (Chi theoretical)	≥	12.19	14.61	16.23	21.64	27.83	
CHIINV (Chi calculated)	246.8					****	

Source: Own calculations.

Analyzing the collected data, it appears that there is a significant differentiation (***), of the degree of appreciation of the link between the development of the commune and the existence of NGOs, from a statistical point of view, is considered to be distinctly significant (Table 8).

It should be noted that the inhabitants of Modelu and Grădiștea communes, which have the largest number of NGOs in the commune, among the 4 communes studied, least appreciate the development of the commune as a result of the existence and activity of NGOs, while 100% of Dragalina commune residents and 69% of Borcea commune residents greatly appreciate the positive influence of these organized communities on the development of their commune.

Table 9. Evaluation of correlation between the existence of NGOs and possibility of commune development, depending on the respondents age

Age (years0	MU	Do you believe that the existence of NGOs can lead to the commune development?				Total	
		Very much	Much	Little	Not at all	No	%
up to 30	No	21	19	13	13	66	17.41
between 31-40	No	62	24	14	6	106	27.9
between 41-50	No	41	26	21	15	103	27.17
between 51-60	No	18	12	12	10	52	13.72
over 60	No	13	6	18	15	52	13.72
TOTAL	No	155	87	78	59	379	100
	%	40.89	22.95	20.58	15.58	100	X
CHIINV (Chi theoretical)	≥	20.42	23.49	26.16	31.96	39.17	
CHIINV (Chi calculated)	43.36					***	

Source: Own calculations.

Some of the respondents to the questionnaire stated that they are consulted by the local public authorities, that there is decision-making transparency and many of them actively participated in the implementation of local projects.

The statistical analysis of the answers, taking into account the age of the respondents, in relation to the correlation between the existence of NGOs and the development of the commune, shows that the perception is different, and the differences between the answers are evaluated as very significant (Table 9).

Thus, in the age category 31-40 years, 84 people answered very much and a lot (79.24%) and in the age category 41-50 years 67 respondents (65%) gave the same answer. These two age groups are the ones who appreciate the activity and impact of organized communities on local development.

The least appreciative is the age segment over 60 (very much and much, 19 people, 38%). It should be noted that younger respondents (between 18 and 40 years old) have a different perception of how rural communities should be organized and carry out their activity in the rural area compared to the older ones. In addition, it is more difficult to communicate effectively with older people who are more conservative about community organization in the form of NGOs, associating these forms of organization as belonging to political structures, which they do not consider beneficial for the social development of the community they belong to. Depending on the level of training, the statistical distribution of the answers regarding the correlation between the existence of NGOs and the development of the commune, differences between the answers are recorded, being considered very significant from a statistical point of view. (Table 10).

Table 10. Evaluation of correlation between the existence of NGOs and the possibility of commune development, depending on the respondents education level

Education level	**MU**	**Do you think that the existence of NGOs can lead to the commune development ?**				**Total**	
		Very much	Much	Little	Not at all	No	%
Primary	No	3	2	4	1	10	2.65
Secondary	No	20	27	19	20	86	22.69
High school	No	81	43	39	33	196	51.71
Higher education	No	51	15	16	5	87	22.95
TOTAL	No	155	87	78	59	379	100
	%	40.89	22.95	20.58	15.58	100	x
CHIINV (Chi theoretical)	≥	12.20	14.62	16.88	21.62	27.76	
CHIINV (Chi calculated)	35.59				***		

Source:Own calculations.

As the level of education increases, it is found that the assessments are much more favorable regarding the importance of the activity of non-governmental structures in the community, seen as an opportunity for the development of the commune. From the 242 favorable reviews 188, respectively, 77.68% belong to respondents with high school and higher education. These appreciations confirm the statement that "development does not begin with goods, but with the education, organization and discipline of people"[2]. Analyzing the gender distribution, the difference is statistically significant. Those who most appreciate the importance of organized communities and their impact on rural development are men (60.1%), it being known, however, that the rural mentality, the rural family model is centered on male power, the woman being the one who takes care of the children and household (39.9%) (Table 11).

Table 11. Evaluation of correlation between the existence of NGOs and the possibility o commune development, depending on respondents gender

Gender	**MU**	**Do you believe that the existence of NGOs can lead to the commune development?**				**Total**	
		Very much	Much	Little	Not at all	No	%
Male	No	87	50	46	45	228	60.20
Female	No	68	37	32	14	151	39.80
Total	No	155	87	78	59	379	100
	%	40.89	22.95	20.58	15.58	100	x
CHIINV (Chi theoretical)	≥	4.59	6.15	7.76	11.28	16.18	
CHIINV (Chi calculated)	8.31			*			

Source: Own calculations.

Regarding how they perceive the transparency and involvement in the decision-making process of the organized communities that support their interests, there are significant differences between the responses. That is precisely why NGOs must take into account these differences and, through the activity carried out, devise a strategy to promote the effective and inclusive participation of all residents, regardless of gender, age, education, ethnicity in the local decision-making process , to make him an integral part of the community.

The evaluation of the communities according to the professional status of the respondents is statistically very significant, the affirmative categories of very much and a lot being 62% to 69% (Table 12).

Table 12. Evaluation of correlation between the existence of NGOs and the possibility of commune development depending on professional statute of the respondents

Occupation	MU	Do you believe that the existence of NGOs can lead to the commune development?				Total	
		Very much	Much	Little	Not at all	No	%
Farmer	no	32	25	15	9	81	21.37
Employee	no	92	40	31	26	189	49.87
Unemployed	no	4	5	5	3	17	4.48
No statute	no	21	13	13	6	53	13.98
Pensioner	no	6	4	14	15	39	10.30
TOTAL	no	155	87	78	59	379	100
	%	40.89	22.95	20.58	15.58	100	x
CHIINV (Chi theoretical)	≥	20.42	23.48	26,24	31.88	39.18	
CHIINV (Chi calculated)	48.58					***	

Source: Own calculations.

The professional category that makes an exception from a very good appreciation of the correlation between the existence of NGOs in the commune and the development of the commune is that of pensioners who appreciate this link in proportion of 25.6%.

Further studies could investigate these differences in more detail so that NGOs can offer specific solutions to inhabitants perception of the importance of civil society role in rural development.

CONCLUSIONS

The evolution of civil society, at national and international level, it is the guarantee that the future will demonstrate the important role of these organizational structures both locally nationally and at the international level. Thus, the role of civil society in rural development will become more importantly, its organizations actively participating in everything that is undertaken at the local, national, regional and international level.

In this sense, from the discussions held with the representatives of the local public authority, to whom we brought to their attention the fact that a significant part of the rural population not only does not know about the existence of organized communities at the level of the commune of which they are a part, but they also do not know the meaning of the terms and, even more so, the activity of community NGOs, we noted that the aim is to establish partnerships for the elaboration of local strategies, the adaptation of policies to specific conditions and to support a sustainable development.

From the discussions we had with NGO representatives, we noticed that they started to be consulted by the public authorities when developing and adopting strategies for a balanced and sustainable development, under the conditions of adequate environment protection. In this context, the establishment of partnerships between civil society and local and national authorities aims to combat poverty, prevent conflicts and protect human rights.

Through the prism of the fact that citizens have the opportunity to express their points of view and their commitment to the economic and social development of the community in which they live, through civil society organizations, we highlight their important role in creating a European democratic model, as factor of change in the rural environment

It should be noted that the inhabitants of Modelu and Grădiștea communes, which have the largest number of NGOs in the commune, among the 4 communes studied, least appreciate the development of the commune as a result of the existence and activity of NGOs, while 100% of Dragalina commune residents and 69% of Borcea commune residents greatly appreciate the positive influence of these organized communities on the development of their commune.

Transparency and media coverage of the activity of these organizations is thus required, because, although they exist and function, their activity is not known at the local level. Through their participatory level, NGOs can support the development of human resources in rural area, through training and counseling actions to assist the unemployed workforce in order to reduce unemployment and exploit opportunities on the labor market. They can also carry out educational programs for children and young people from the rural area, by organizing public events, respectively, meetings, shows, concerts, conferences and symposia with cultural-educational themes.

In order to support young people in order to complete their studies, NGOs can involve parents in actions to combat school absence; they must be made responsible regarding the important role of education and culture in the formation of children.

NGOs can organize camps and creative centers for children and young people, on various themes, such as literature, theater, music, film, folk dances, ancestral customs. The NGOs that form partnerships in the rural area can ensure the access of members of rural communities to professional training courses, information seminars, counseling and dissemination of information of real interest for the rural environment, employment services and mediation services.

At the same time, they can support the local public authorities in providing the necessary spaces for these activities. Long-term partnerships between NGOs and local public authorities can lead to the implementation of actions to stimulate entrepreneurial culture and sustainable development in rural areas and to the continuous promotion of equal opportunities for unoccupied social categories in rural areas, such as: young people, women or middle-aged people, offering skills applicable in personal, family businesses, enterprises and small farms.

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RECENT DEVELOPMENTS IN VEGETABLE PRODUCTION IN THE WORLD AND TÜRKİYE

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Abstract

In this study, the developments in global and Turkish vegetable production were examined during the period of 1980-2021, and the position and importance of Türkiye in vegetable production was emphasized. The study covers 22 vegetable species which were important in terms of production potential. Significant increases in vegetable production area and quantity have been observed globally and in Türkiye throughout the period. Increases in vegetable production have also been observed in Türkiye with the increase in productivity. In Türkiye, except for some species, the vegetable yield was above the global average. Türkiye is an important producer country in terms of vegetable production, particularly for vegetables such as tomatoes, peppers, eggplants, cucumbers, beans, lettuce, cabbage, zucchini, leeks, spinach, onions, and garlic. Therefore, it is recommended to implement proposals to increase producer income and productivity in vegetable production in Türkiye.

Key words*: *vegetables, vegetable production, production area, vegetable yield, Türkiye, world

INTRODUCTION

The vegetable sector, which is one of the most important sub-components of the agricultural sector, directly affects the continuity of human life by producing plant-based carbohydrates, proteins, and vitamins that are essential for people's basic needs [4]. Moreover, the vegetable sector is an essential industry that contributes to the country's economy by serving as a source of raw material for the food industry that processes vegetables and by supporting foreign trade [3].

Due to certain characteristics that Türkiye possesses, there are advantages and disadvantages in vegetable production. The most significant advantages include the ecological suitability of many regions for vegetable production, the experience of producers in vegetable production, and higher income obtained compared to other product groups. The disadvantages, on the other hand, are the small scale of enterprises and the lack of specialization in this field, inadequate use of advanced technology in enterprises, and low levels of education and input usage among producers [5]. In addition to this, excessive use of artificial chemical inputs in world vegetable production in recent years has caused chemical residues and Türkiye has gained an advantageous position for vegetable production thanks to its soils that have not yet been contaminated with chemicals [14].

More than 50 vegetable species that can be grown in the temperate and subtropical climate zones are producible in Türkiye's ecology [15]. Production is focused more intensively on some of the species that are both heavily consumed domestically and exported. Vegetable types such as tomatoes, peppers, onions, cucumbers, eggplant, cabbage, pumpkins and carrots are widely produced in Türkiye.

In Türkiye, the total area cultivated in 2020 (excluding grassland and pasture) was 23,145,000 hectares. This value represents an 18.73% decrease from 1980. The share of vegetable production areas in the total agricultural land has ranged between 1.74% and 3.06% from 1980 to 2020. In 2020, the share of vegetable production areas in the total agricultural land was 2.93%. Vegetable production areas have increased by 36.97%, from 495,000 hectares in 1980 to 679,000 hectares in 2020. The trend has followed a fluctuating but rising course over the years. While the total agricultural land in Türkiye has decreased, it has been found that the vegetable production areas have increased. This can be attributed to producers who opt for vegetable production as it generates more income compared to other crops.

In contrast, the share of vegetable production areas in the total agricultural land has been continuously increasing worldwide.

In 1980, the share of vegetable production areas in the total agricultural land was 1.80%, which has risen to 3.68% in recent years (Fig 1).

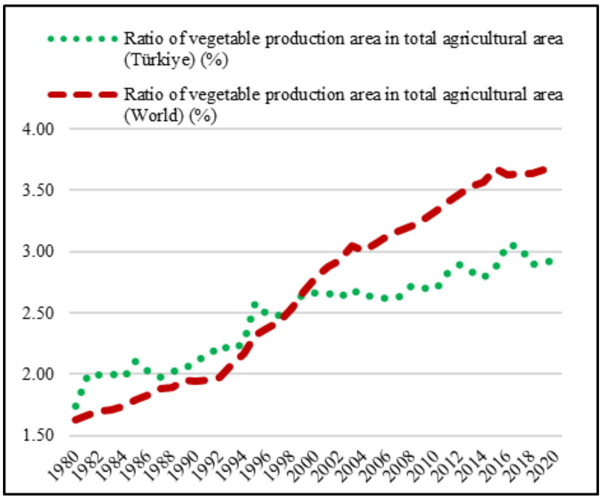

Fig. 1. Ratio of vegetable production areas in total agricultural areas
Source: [6].

In this study, it was aimed to examine the developments in the world and Türkiye's vegetable production from the past to the present and to reveal the production potential of Türkiye in terms of world vegetable production.

MATERIALS AND METHODS

The study refers to the main vegetable products in the world: onions and shallots (dry), tomatoes, peas (green), cabbages, okra, cucumbers and gherkins, chillies and peppers (green), eggplants, green garlic, asparagus, other beans (green), pumpkins (squash and gourds), cauliflowers and broccoli, lettuce and chicory, carrots and turnips, green corn (maize), spinach, broad beans and horse beans (green), onions and shallots (green), string beans, leeks and other alliaceous vegetables, artichokes, other vegetables (fresh n.e.c.) covers its products.

Statistical data on 23 different vegetable crops were obtained from FAO and various national and international publications on the subject. Within the scope of the study, the development of vegetable production in the world and Türkiye was analyzed for the period 1980-2021. Indices were calculated for these data and the values obtained were interpreted.

RESULTS AND DISCUSSIONS

Development of vegetable production in the world

Production areas

When the developments in world vegetable production were evaluated between 1980 and 2021, the vegetable production area, which was 24 million 565 thousand hectares on average between 1980-1985, increased by 132.58% during the analyzed period and rose to 57 million 133 thousand hectares on average between 2016-2021.

According to the average for 2016-2021, onions and shallots (dry) rank first with a rate of 9.30% in the vegetable production areas, followed by tomatoes with a rate of 8.73%, and green peas with a rate of 4.41% in third place.

Cabbages (%4.25), okra (%4.23), and cucumbers and gherkins (%3.77) follow them respectively. The rate of other vegetables (fresh n.e.c.) was 35.78%.

During the examined periods, the increase in production areas occurred respectively in okra by 313.50%, asparagus by 291.88%, spinach by 289.66%, onions and shallots (dry) by 215.54%, and green peas by 208.58%.

The production area of string beans decreased by 12.00%. It was determined that the production areas of vegetables (primary) increased by 132.58% (Table 1).

Table 1. Development of vegetable production areas in world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Hectare	Percent (%)	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare	Percent (%)	
Vegetables Primary	*24,564,900*	*100.00*	*28,323,298*	*33,056,273*	*41,932,727*	*47,403,550*	*53,892,480*	*57,132,922*	*100.00*	*232.58*
Onions and shallots (dry)	1,683,739	6.85	1,866,262	2,327,306	2,958,892	3,850,163	4,565,555	5,312,941	9.30	315.54
Tomatoes	2,561,079	10.43	2,846,134	3,167,457	3,864,483	4,228,071	4,744,086	4,987,597	8.73	194.75
Peas (green)	816,240	3.32	902,666	1,139,271	1,575,526	1,918,688	2,281,598	2,518,738	4.41	308.58
Cabbages	1,593,553	6.49	1,709,509	1,945,035	2,466,959	2,249,096	2,396,401	2,429,417	4.25	152.45
Okra	584,353	2.38	720,436	837,326	875,192	1,004,591	1,844,421	2,416,294	4.23	413.50
Cucumbers and gherkins	1,103,637	4.49	1,185,635	1,439,956	1,959,904	1,926,198	2,106,273	2,153,651	3.77	195.14
Chillies and peppers (green)	992,348	4.04	1,109,912	1,273,884	1,612,140	1,748,099	1,915,161	1,990,262	3.48	200.56
Eggplants	772,404	3.14	848,545	1,034,381	1,536,839	1,748,594	1,844,216	1,905,942	3.34	246.75
Green garlic	673,369	2.74	769,055	856,468	1,060,497	1,256,142	1,419,648	1,587,731	2.78	235.79
Asparagus	400,627	1.63	535,407	740,764	1,068,321	1,366,102	1,471,074	1,569,968	2.75	391.88
Other beans (green)	688,506	2.80	873,495	1,145,510	1,378,074	1,438,153	1,514,203	1,561,582	2.73	226.81
Pumpkins (squash and gourds)	876,666	3.57	931,356	1,103,628	1,412,946	1,623,129	1,847,372	1,624,938	2.84	185.35
Cauliflowers and broccoli	459,815	1.87	572,256	718,907	863,901	1,039,213	1,233,303	1,355,834	2.37	294.87
Lettuce and chicory	466,112	1.90	527,700	666,952	869,874	1,086,999	1,165,448	1,218,767	2.13	261.48
Carrots and turnips	551,125	2.24	629,330	775,939	1,004,972	1,147,466	1,164,138	1,110,444	1.94	201.49
Green corn (maize)	768,282	3.13	903,214	1,016,212	1,081,807	1,116,856	1,138,459	1,131,875	1.98	147.33
Spinach	235,435	0.96	311,444	451,462	684,289	807,430	891,172	917,394	1.61	389.66
Broad and horse beans (green)	169,824	0.69	196,329	186,989	199,437	248,070	265,487	263,523	0.46	155.17
Onions and shallots (green)	139,560	0.57	159,760	179,091	204,291	231,281	226,492	219,468	0.38	157.26
String beans	183,819	0.75	182,416	217,978	224,223	235,455	208,750	161,759	0.28	88.00
Leeks and other alliaceous vegetables	57,996	0.24	72,900	92,505	98,892	118,953	129,423	133,409	0.23	230.03
Artichokes	114,840	0.47	113,870	113,343	120,707	127,392	124,112	119,816	0.21	104.33
Other vegetables (fresh n.e.c.)*	8,671,573	35.30	10,355,668	11,625,912	14,810,564	16,887,411	19,395,687	20,441,576	35.78	235.73

*n.e.c. not elsewhere classified
Source: [6].

Production quantity

World vegetable production increased by 244.26% from 325 million 272 thousand tons to 1 billion 119 million 789 thousand tons. In terms of world vegetable production, tomatoes ranked first with a share of 16.28% (Table 2).

Table 2. Development of vegetable production in world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Tons	Percent (%)	Tons	Tons	Tons	Tons	Tons	Tons	Percent (%)	
Vegetables Primary	*325,272,326*	*100.00*	*400,454,493*	*498,546,576*	*677,797,372*	*840,600,405*	*1,013,969,590*	*1,119,789,214*	*100.00*	*344.26*
Tomatoes	58,919,615	18.11	70,918,405	83,606,998	109,036,996	136,820,217	165,805,304	182,336,163	16.28	309.47
Onions and shallots (dry)	24,813,683	7.63	29,691,262	37,796,403	50,957,759	69,929,906	85,362,303	100,100,142	8.94	403.41
Cucumbers and gherkins	14,400,289	4.43	16,570,655	22,785,766	37,178,007	51,988,886	71,507,863	86,766,059	7.75	602.53
Cabbages	38,350,845	11.79	39,319,720	44,318,090	64,273,062	64,815,905	68,926,497	71,179,818	6.36	185.60
Eggplants	9,139,054	2.81	10,888,325	17,085,178	27,430,607	36,296,466	48,029,348	55,456,640	4.95	606.81
Carrots and turnips	11,325,849	3.48	13,485,813	17,412,488	22,235,647	30,329,882	37,629,516	40,285,208	3.60	355.69
Chillies and peppers (green)	8,499,893	2.61	10,450,780	14,045,373	21,191,581	26,844,007	31,338,283	35,403,479	3.16	416.52
Spinach	3,334,769	1.03	3,883,108	6,034,291	9,785,849	16,215,854	22,796,271	29,509,848	2.64	884.91
Green garlic	4,799,190	1.48	6,094,073	8,154,737	11,267,698	18,306,550	24,221,905	27,061,359	2.42	563.87
Lettuce and chicory	8,965,317	2.76	10,875,358	14,380,313	18,720,843	23,413,417	25,280,531	26,846,818	2.40	299.45
Cauliflowers and broccoli	6,652,137	2.05	8,763,455	12,501,893	15,911,729	19,066,342	23,016,008	25,366,564	2.27	381.33
Pumpkins (squash and gourds)	8,781,262	2.70	10,302,145	13,621,231	17,638,932	21,117,267	24,332,596	23,917,060	2.14	272.36
Other beans (green)	4,382,077	1.35	5,557,299	7,774,627	10,655,485	17,087,620	21,298,959	23,104,989	2.06	527.26
Peas (green)	5,827,090	1.79	6,650,018	8,821,758	11,786,300	14,158,856	17,321,901	19,738,947	1.76	338.74
Green corn (maize)	5,505,756	1.69	6,810,111	8,158,321	9,733,015	10,728,757	10,967,193	10,649,866	0.95	193.43
Okra	2,688,532	0.83	3,419,266	4,988,882	5,446,058	6,448,804	8,996,784	9,864,399	0.88	366.91
Asparagus	1,385,716	0.43	1,845,730	2,946,507	4,874,528	6,989,232	8,085,225	8,432,120	0.75	608.50
Onions and shallots (green)	2,073,231	0.64	2,474,744	3,076,994	3,590,772	4,301,327	4,486,273	4,539,422	0.41	218.95
Leeks and other alliaceous vegetables	801,819	0.25	1,267,350	1,635,048	1,624,008	2,020,817	2,151,552	2,143,695	0.19	267.35
Broad and horse beans (green)	901,003	0.28	1,023,504	988,619	1,155,035	1,565,526	1,735,444	1,706,404	0.15	189.39
Artichokes	1,147,073	0.35	1,266,471	1,196,780	1,263,589	1,401,980	1,486,307	1,483,332	0.13	129.31
String beans	1,223,532	0.38	1,265,414	1,600,500	1,842,334	2,093,119	1,913,837	1,546,574	0.14	126.40
Other vegetables (fresh n.e.c.)	101,354,595	31.16	137,631,484	165,615,778	220,197,537	258,659,670	307,279,690	332,350,308	29.68	327.91

Source: [6].

This was followed by onions and shallots (dry) with 8.94%, cucumbers and gherkins with 7.75%, cabbages with 6.36%, eggplants with 4.95% and carrots and turnips with 3.60%.

The increase in production quantity compared to the average of 1980-1985 was 784.91% for spinach, 508.50% for asparagus, 506.81% for eggplant, 502.53% for cucumbers and gherkins and 463.87% for green garlic. It was determined that the production quantity of vegetables (primary) increased by 244.26% (Table 2).

Yield

In order to meet the nutritional demands of the world's expanding population, which was projected to exceed nine billion by 2050, the current rates of agricultural productivity were unlikely to be sufficient to achieve this objective [12]. In this regard, effective methods should be developed to improve crop breeding in order to increase yield [13].

The world average vegetable yield increased by 48.18% from 13,226 kg to 19,598 kg per hectare. Compared to the 1980-1985 average, the yields of cucumbers and gherkins increased by 209%, eggplant by 145.98%, green garlic by 139.40%, other beans (green) by 132.77%, spinach by 112.67% and chillies and peppers (green) by 107.65% in 2016-2021. The average yields for 2016-2021 were 40,290 kg/ha for cucumber and cucumber, 36,305 kg/ha for carrot and turnip, 36,558 kg/ha for tomato, 32,162 kg/ha for spinach, 29,299 kg/ha for cabbage and 29,088 kg/ha for eggplant. It was determined that the yield of vegetables (primary) increased by 48.18% (Table 3).

Table 3. Development of vegetable yield in world

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	(1980-1985 = 100)
Vegetables Primary	*13,226*	*14,134*	*15,072*	*16,130*	*17,716*	*18,808*	*19,598*	*148.18*
Cucumbers and gherkins	13,039	13,976	15,793	18,930	26,964	33,914	40,290	309.00
Carrots and turnips	20,532	21,449	22,429	22,105	26,421	32,363	36,305	176.82
Tomatoes	22,971	24,903	26,369	28,187	32,328	34,942	36,558	159.15
Spinach	15,123	12,466	13,349	14,180	20,052	25,558	32,162	212.67
Cabbages	24,056	23,018	22,781	25,959	28,826	28,762	29,299	121.80
Eggplants	11,825	12,832	16,537	17,845	20,871	26,031	29,088	245.98
Lettuce and chicory	19,229	20,583	21,567	21,485	21,540	21,692	22,029	114.56
Onions and shallots (green)	14,855	15,482	17,180	17,566	18,593	19,826	20,689	139.27
Cauliflowers and broccoli	14,458	15,304	17,365	18,414	18,347	18,655	18,709	129.40
Onions and shallots (dry)	14,724	15,907	16,233	17,209	18,152	18,706	18,847	128.00
Chillies and peppers (green)	8,567	9,434	10,976	13,121	15,351	16,364	17,791	207.65
Green garlic	7,120	7,912	9,510	10,578	14,455	17,053	17,046	239.40
Leeks and other alliaceous vegetables	13,817	17,310	17,683	16,454	16,992	16,625	16,070	116.30
Pumpkins (squash and gourds)	10,007	11,063	12,326	12,461	13,009	13,171	14,862	148.51
Other beans (green)	6,356	6,360	6,780	7,710	11,867	14,057	14,796	232.77
Artichokes	9,985	11,116	10,559	10,468	11,002	11,980	12,381	124.01
String beans	6,706	6,937	7,341	8,214	8,890	9,177	9,535	142.19
Green corn (maize)	7,176	7,528	8,021	8,989	9,607	9,635	9,393	130.90
Peas, green	7,134	7,352	7,764	7,490	7,377	7,588	7,836	109.84
Broad and horse beans (green)	5,330	5,218	5,291	5,777	6,306	6,540	6,483	121.64
Asparagus	3,461	3,448	3,965	4,528	5,116	5,494	5,371	155.21
Okra	4,599	4,742	5,942	6,225	6,413	5,125	4,103	89.22
Other vegetables (fresh n.e.c.)	11,662	13,289	14,247	14,840	15,312	15,836	16,258	139.42

Source: [6].

Development of vegetable production in the Türkiye

Production areas

When the developments in vegetable production in Türkiye were evaluated between 1980 and 2021, the vegetable production area, which was 543,224 hectares in the average of 1980-1985, increased by 26.90% in the period analyzed and increased to 689,357 hectares in the average of 2016-2021.

According to the average of 2016-2021, tomatoes ranked first with 25.53%, pumpkins (squash and gourds) ranked second with 13.80%, chillies and peppers (green) ranked third with 11.99%. These were followed by onions and shallots (dry) (9.45%), other beans (green) (6.51%) and cucumbers and gherkins

(4.77%). The share of other vegetables (fresh n.e.c.) was 4.40%.

The increase in production areas during the periods under review was 493.15% for asparagus, 461.90% for other vegetables (fresh n.e.c.), 275.91% for cauliflowers and broccoli, 260.08% for pumpkins (squash and gourds) and 231.41% for lettuce and chicory. Production areas of some vegetable crops decreased. This decrease was 71.12% in green garlic, 56.96% in leeks and other alliaceous vegetables, 51.74% in onions and shallots (green), 49.21% in eggplants (Table 4).

Table 4. Development of vegetable production areas in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Hectare	Percent (%)	Hectare	Hectare	Hectare	Hectare	Hectare	Hectare	Percent (%)	
Vegetables Primary	*543,224*	*100.00*	*569,296*	*646,965*	*699,636*	*676,115*	*673,831*	*689,357*	*100.00*	*126.90*
Tomatoes	112,350	20.68	149,839	176,668	207,324	194,267	185,845	175,988	25.53	156.64
Pumpkins (squash and gourds)	26,417	4.86	20,958	19,134	16,318	37,100	64,479	95,122	13.80	360.08
Chillies and peppers (green)	47,667	8.77	48,333	60,415	73,440	77,342	79,163	82,626	11.99	173.34
Onions and shallots (dry)	74,215	13.66	78,735	102,493	98,102	68,757	63,545	65,150	9.45	87.79
Other beans (green)	49,395	9.09	49,417	54,031	56,796	54,104	51,643	44,855	6.51	90.81
Cucumbers and gherkins	38,050	7.00	41,167	44,803	45,011	42,797	38,601	32,881	4.77	86.42
Cabbages	34,064	6.27	29,116	30,364	29,908	27,074	25,553	26,822	3.89	78.74
Lettuce and chicory	6,599	1.21	11,100	14,752	19,985	22,318	21,214	21,870	3.17	331.41
Eggplants	41,000	7.55	36,433	33,330	32,837	28,655	24,896	20,824	3.02	50.79
Spinach	17,896	3.29	16,852	17,868	20,656	20,490	18,053	16,456	2.39	91.96
Cauliflowers and broccoli	3,411	0.63	3,783	4,225	4,928	7,060	9,109	12,822	1.86	375.91
Peas (green)	6,167	1.14	6,421	7,448	8,262	9,206	10,846	11,000	1.60	178.38
Carrots and turnips	6,767	1.25	6,611	7,893	7,706	11,661	11,536	11,059	1.60	163.43
String beans	8,667	1.60	4,723	5,401	5,889	8,013	8,931	8,529	1.24	98.41
Onions and shallots (green)	16,833	3.10	17,750	15,608	15,528	12,564	9,739	8,123	1.18	48.26
Leeks and other alliaceous vegetables	17,417	3.21	13,281	12,609	12,571	10,759	8,502	7,496	1.09	43.04
Okra	6,783	1.25	6,146	6,703	7,422	7,877	7,024	5,230	0.76	77.10
Broad and horse beans (green)	7,944	1.46	8,578	6,654	5,961	6,432	5,643	4,878	0.71	61.41
Green garlic	15,064	2.77	12,700	12,580	13,183	11,812	12,488	4,350	0.63	28.88
Artichokes	1,107	0.20	1,116	1,251	1,972	2,776	2,557	2,863	0.42	258.73
Asparagus	12	0.00	4	3	3	3	24	72	0.01	593.15
Other vegetables (fresh n.e.c.)	5,400	0.99	6,233	12,733	15,837	15,050	14,443	30,343	4.40	561.90

Source: [6].

Production quantity

From the early 2000s to the present, there has been a significant increase in the total vegetable production in Türkiye. The increase can be attributed to factors such as the use of new technologies, conscious farming practices, the inclusion of disease-resistant vegetable species in the production program, changes in greenhouse production technologies, the introduction of high-yield greenhouse vegetable species in the production program, developments in seedling production, and the impact of grafted seedling production technology [14]. In Türkiye, there were studies showed that the yields of vegetables produced using greenhouse production technologies and therefore the total vegetable production per enterprise were high [2] [7] [9] [10] [11]. Türkiye's vegetable production increased by 168.83% from 9 million 396 thousand tons to 25 million 261 thousand tons (Table 5).

In terms of vegetable production in Türkiye, tomato ranks first with a share of 50.57%. Tomato was half of the total vegetable production. It was followed by chillies and peppers (green) with 10.54%, onions and shallots (dry) with 8.71%, cucumbers and gherkins with 7.40%, eggplants with 3.34%, cabbages with 3.21% and pumpkins (squash and gourds) with 2.47% (Table 5).

According to the average of 1980-1985, asparagus was the most important crop among vegetables with an increase in production. Asparagus increased 21.33 times in the relevant period. Other vegetables (fresh n.e.c.) increased 8.43 times, lettuce and chicory 6.57 times, carrots and turnips 5.62 times, cauliflowers and broccoli 5.01 times, artichokes 5.01 times, chillies and peppers (green) 4.19 times and tomatoes 3.27 times.

Production of green garlic decreased by 51.92%, leeks and other alliaceous vegetables by 25.01%, broad and horse beans (green) by 15.39% and onions and shallots (green) by 5.37% (Table 5). The significant increase in cauliflower and broccoli production in recent years can be attributed to the growing demand from consumers for functional food and product quality, as well as the higher prices these vegetables can command on the market compared to other types of cabbage [1].

Table 5. Development of vegetable production in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	Tons	Percent (%)	Tons	Tons	Tons	Tons	Tons	Tons	Percent (%)	
Vegetables Primary	*9,396,638*	*100.00*	*12,132,714*	*15,018,085*	*18,872,714*	*20,565,219*	*22,308,720*	*25,261,064*	*100.00*	*268.83*
Tomatoes	3,908,333	41.59	5,533,333	6,766,667	8,971,833	10,168,726	11,448,406	12,773,544	50.57	326.83
Chillies and peppers (green)	635,000	6.76	815,167	1,047,833	1,573,667	1,793,597	2,080,585	2,662,473	10.54	419.29
Onions and shallots (dry)	1,074,167	11.43	1,409,167	2,000,000	2,153,333	1,931,923	1,891,878	2,201,198	8.71	204.92
Cucumbers and gherkins	602,500	6.41	860,000	1,198,333	1,690,520	1,726,310	1,764,661	1,870,569	7.40	310.47
Eggplants	677,500	7.21	732,500	792,833	941,667	874,620	821,272	844,212	3.34	124.61
Cabbages	625,333	6.65	673,833	688,333	717,500	682,185	720,756	810,262	3.21	129.57
Pumpkins (squash and gourds)	369,167	3.93	357,167	355,583	347,667	382,674	421,320	624,586	2.47	169.19
Carrots and turnips	107,500	1.14	164,000	231,740	264,067	510,689	586,748	603,757	2.39	561.63
Other beans (green)	345,000	3.67	409,833	448,667	498,333	564,573	622,593	583,936	2.31	169.26
Lettuce and chicory	76,583	0.82	147,167	228,667	329,167	424,663	433,063	502,816	1.99	656.56
Cauliflowers and broccoli	59,167	0.63	65,333	78,667	89,167	149,184	199,767	296,148	1.17	500.53
Leeks and other alliaceous vegetables	302,500	3.22	312,667	313,000	303,167	283,482	235,948	226,849	0.90	74.99
Spinach	129,333	1.38	143,333	170,167	207,667	230,009	216,417	223,002	0.88	172.42
Onions and shallots (green)	143,333	1.53	168,833	222,833	218,500	188,418	152,276	135,632	0.54	94.63
Peas (green)	36,167	0.38	36,500	43,500	56,333	90,208	103,567	107,571	0.43	297.43
String beans	61,667	0.66	33,167	37,583	42,667	58,498	77,728	87,167	0.35	141.35
Green garlic	98,917	1.05	90,667	99,917	106,767	103,773	109,050	47,559	0.19	48.08
Broad and horse beans (green)	48,667	0.52	61,333	51,333	45,000	46,691	39,964	41,177	0.16	84.61
Artichokes	7,750	0.08	11,040	15,933	26,383	34,332	32,666	38,790	0.15	500.52
Okra	23,083	0.25	21,500	23,583	28,833	38,135	34,439	31,947	0.13	138.40
Asparagus	23	0.00	18	16	14	12	99	484	0.00	2,133.09
Other vegetables (fresh n.e.c.)	64,949	0.69	86,157	202,896	260,463	282,514	315,521	547,388	2.17	842.80

Source: [6].

Table 6. Development of vegetable yield in Türkiye

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index (1980-1985 = 100)
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	
Vegetables Primary	*17,292*	*21,287*	*23,188*	*26,973*	*30,453*	*33,101*	*36,694*	*212.20*
Tomatoes	34,715	36,881	38,279	43,250	52,460	61,551	72,756	209.58
Cucumbers and gherkins	15,819	20,837	26,687	37,518	40,432	45,724	58,420	369.31
Carrots and turnips	16,172	24,899	29,337	33,898	43,487	51,014	54,711	338.31
Eggplants	16,619	20,189	23,981	28,681	30,558	33,023	41,184	247.81
Chillies and peppers (green)	13,387	16,851	17,331	21,387	23,201	26,285	32,360	241.73
Onions and shallots (dry)	14,451	17,890	19,460	21,943	28,243	29,896	33,800	233.89
Leeks and other alliaceous vegetables	17,521	23,607	24,831	24,114	26,403	27,761	30,327	173.09
Lettuce and chicory	12,108	13,077	15,486	16,460	19,024	20,411	23,020	190.13
Cauliflowers and broccoli	17,463	17,269	18,601	18,199	21,039	21,938	23,053	132.01
Cabbages	18,356	23,198	22,681	24,007	25,210	28,208	30,807	167.83
Green garlic	6,569	7,158	7,952	8,115	8,817	8,752	12,664	192.78
Onions and shallots (green)	8,548	9,491	14,272	14,084	14,988	15,646	16,738	195.80
Spinach	7,349	8,495	9,517	10,049	11,252	11,994	13,582	184.82
Artichokes	7,141	10,166	12,517	13,401	12,382	12,768	13,557	189.86
Other beans (green)	7,124	8,291	8,305	8,769	10,438	12,071	13,021	182.79
String beans	7,108	7,025	6,953	7,243	7,301	8,700	10,313	145.09
Peas (green)	5,989	5,686	5,830	6,804	9,720	9,549	9,783	163.35
Broad and horse beans (green)	6,378	7,146	7,717	7,550	7,256	7,082	8,474	132.86
Asparagus	1,882	4,271	4,482	4,083	3,806	3,884	5,456	289.81
Pumpkins (squash and gourds)	13,994	17,291	18,722	21,406	10,413	6,636	6,588	47.07
Okra	3,403	3,504	3,522	3,873	4,839	4,913	6,129	180.13
Other vegetables (fresh n.e.c.)	11,972	13,509	15,807	15,941	17,458	19,648	16,931	141.43

Source: [6].

Yield

In Türkiye, the average yield of vegetables has increased by 112.20% between the relevant periods, rising from 17,292 kg/ha to 36,694 kg/ha. Compared to the average from 1980-1985, the yield of cucumbers and gherkins has increased by 269.31%, carrots and turnips by 238.31%, asparagus by 189.91%, and eggplants by 147.81% in the years 2016-2021. However, the yield of pumpkins (squash and gourds) has decreased by 52.93%. Tomatoes rank first in terms of yield, with 72,756 kg per hectare, followed by cucumbers and gherkins with 58,420 kg/ha, carrots and turnips with 54,711 kg/ha, and eggplants with 41,184 kg/ha (Table 6).

Türkiye's contribution to world vegetable production

The leading countries in world vegetable production were China, India, USA and Türkiye. While China and India produce vegetables to feed their own populations, the USA and Türkiye produce vegetables both to feed their own populations and to generate export revenues.

Among the world's vegetable production, Türkiye ranks second in the world in three types of vegetables. These vegetables were cucumbers and gherkins, chillies and peppers (green) and leeks and other alliaceous vegetables. It ranks third in two vegetable types (tomatoes and spinach) and fourth in two vegetable types (eggplant and other beans (green)) (Table 7).

Table 7. Türkiye's position in world vegetable production

Vegetables	Türkiye's rank in world vegetable production	Number of countries producing vegetables in the world	Major countries in vegetable production
Vegetables Primary	*4*	*194*	*China, India, USA, Türkiye, Viet Nam, Nigeria*
Tomatoes	3	168	China, India, Türkiye, USA, Italy, Egypt
Onions and shallots (dry)	5	139	India, China, Egypt, USA, Türkiye, Pakistan
Cucumbers and gherkins	2	133	China, Türkiye, Russian, Ukraine, Mexico, Uzbekistan
Cabbages	11	147	China, India, Republic of Korea, Russian, Ukraine, Indonesia
Eggplants	4	93	China, India, Egypt, Türkiye, Indonesia, Iran
Carrots and turnips	14	128	China, Uzbekistan, USA, Russian, Germany, United Kingdom
Chillies and peppers (green)	2	126	China, Türkiye, Indonesia, Mexico, Spain, Egypt
Spinach	3	65	China, USA, Türkiye, Japan, Kenya, Indonesia
Green garlic	27	102	China, India, Bangladesh, Egypt, Spain, Republic of Korea
Lettuce and chicory	8	105	China, USA, India, Spain, Italy, Japan
Cauliflowers and broccoli	7	95	China, India, USA, Spain, Mexico, Italy
Pumpkins (squash and gourds)	6	121	China, Ukraine, Russian, USA, Spain, Türkiye
Other beans (green)	4	104	China, Indonesia, India, Türkiye, France, Thailand
Peas (green)	12	82	China, India, Pakistan, France, USA, Algeria
Okra	16	50	India, Nigeria, Mali, Sudan, Pakistan, Côte d'Ivoire
Asparagus	26	48	China, Peru, Mexico, Germany, Spain, Italy
Onions and shallots (green)	9	46	China, Mali, Japan, Republic of Korea, Tunisia, New Zealand
Leeks and other alliaceous vegetables	2	56	Indonesia, Türkiye, Belgium, France, Republic of Korea, China
Broad and horse beans (green)	13	56	Algeria, Egypt, China, Poland, Tunisia, Mexico
Artichokes	8	29	Italy, Egypt, Spain, Algeria, Peru, China
String beans	5	18	USA, Morocco, Mexico, Philippines, Türkiye, Argentina
Other vegetables (fresh n.e.c.)	33	181	China, India, Viet Nam, Nigeria, Philippines, Nepal

Source: [6].

Türkiye's share in world vegetable production varied between 2.20% and 3.03% in the period. Türkiye's largest share in world vegetable production was leeks and other alliaceous vegetables.

Türkiye accounts for 10.58% of the world production of leeks and other alliaceous vegetables. It was determined that Türkiye's share in the world production of leeks and other alliaceous vegetables followed a decreasing trend. Other major crops in which Türkiye has a high share in world vegetable production were chillies and peppers (green), tomatoes, string beans, onions and shallots (green), artichokes and pumpkins (squash and gourds).

As a general comment, it was determined that Türkiye's share in the world's primary vegetable production tends to decrease.

Table 8. Ratio of Türkiye's vegetable production to world vegetable production

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021
	Percent (%)						
Vegetables Primary	*2.89*	*3.03*	*3.01*	*2.78*	*2.45*	*2.20*	*2.26*
Leeks and other alliaceous vegetables	37.73	24.67	19.14	18.67	14.03	10.97	10.58
Chillies and peppers (green)	7.47	7.80	7.46	7.43	6.68	6.64	7.52
Tomatoes	6.63	7.80	8.09	8.23	7.43	6.90	7.01
String beans	5.04	2.62	2.35	2.32	2.79	4.06	5.64
Onions and shallots (green)	6.91	6.82	7.24	6.09	4.38	3.39	2.99
Artichokes	0.68	0.87	1.33	2.09	2.45	2.20	2.62
Pumpkins (squash and gourds)	4.20	3.47	2.61	1.97	1.81	1.73	2.61
Other beans (green)	7.87	7.37	5.77	4.68	3.30	2.92	2.53
Broad and horse beans (green)	5.40	5.99	5.19	3.90	2.98	2.30	2.41
Onions and shallots (dry)	4.33	4.75	5.29	4.23	2.76	2.22	2.20
Cucumbers and gherkins	4.18	5.19	5.26	4.55	3.32	2.47	2.16
Lettuce and chicory	0.85	1.35	1.59	1.76	1.81	1.71	1.87
Eggplants	7.41	6.73	4.64	3.43	2.41	1.71	1.52
Carrots and turnips	0.95	1.22	1.33	1.19	1.68	1.56	1.50
Cauliflowers and broccoli	0.89	0.75	0.63	0.56	0.78	0.87	1.17
Cabbages	1.63	1.71	1.55	1.12	1.05	1.05	1.14
Spinach	3.88	3.69	2.82	2.12	1.42	0.95	0.76
Peas (green)	0.62	0.55	0.49	0.48	0.64	0.60	0.54
Okra	0.86	0.63	0.47	0.53	0.59	0.38	0.32
Green garlic	2.06	1.49	1.23	0.95	0.57	0.45	0.18
Other vegetables (fresh n.e.c.)	0.06	0.06	0.12	0.12	0.11	0.10	0.16
Asparagus	0.00	0.00	0.00	0.00	0.00	0.00	0.01

Source: [6].

Annual rates of increase in vegetable production in Türkiye and the world were analyzed. In Türkiye, the vegetables with the highest annual increase rates were asparagus (135.24%), other vegetables (fresh n.e.c.) (27.34%), lettuce and chicory (16.01%), carrots and turnips (15.26%) and artichokes (11.26%). Broad and horse beans (green), onions and shallots (green), leeks and other alliaceous vegetables and green garlic had a negative growth in Türkiye's average.

The vegetables with the highest production growth rate in the world were spinach (24.10%), cucumber and gherkins (15.07%) and eggplant (14.92%). In the related period, negative growth was detected only in string beans in the world.

Table 9. Annual rate of increase in vegetable production in the world and Türkiye (%)

Vegetables	Türkiye	World	Vegetables	Türkiye	World
Vegetables Primary	*5.01*	*7.09*	Pumpkins (squash and gourds)	2.72	4.73
Asparagus	135.24	13.77	Other beans (green)	1.67	12.08
Other vegetables (fresh n.e.c.)	27.34	6.84	Spinach	1.62	24.10
Lettuce and chicory	16.01	5.23	Okra	1.30	7.88
Carrots and turnips	15.26	7.12	Cabbages	1.22	2.39
Artichokes	11.26	0.41	Eggplants	0.67	14.92
Chillies and peppers (green)	10.31	8.89	String beans	0.41	-0.01
Cauliflowers and broccoli	10.15	7.98	Broad and horse beans (green)	-0.20	2.43
Cucumbers and gherkins	6.62	15.07	Onions and shallots (green)	-0.23	3.26
Tomatoes	6.40	6.17	Leeks and other alliaceous vegetables	-0.69	4.72
Peas (green)	5.67	6.68	Green garlic	-1.25	13.41
Onions and shallots (dry)	3.82	8.95			

Source: Own calculation from FAOSTAT data.

Agricultural gross value and vegetable gross value

Supply and demand elasticity of agricultural products were low. Vegetable prices decrease during periods of increased production, especially since fresh vegetables have short storage periods and were perishable [8]. This situation causes vegetable prices to fluctuate over the years. The gross production value obtained from agriculture and vegetables was also affected by these price fluctuations.

In 2020, the total gross value of global agricultural production was approximately 3.98 trillion dollars. In Türkiye, this value was 69.6 billion dollars, which corresponds to a share of 1.75% in the world. This rate fluctuates between 1.54% and 1.93% over the years examined, indicating a volatile structure.

The gross value of world vegetable production in 2020 was approximately 482 billion dollars. In Türkiye, this value was 1.19 billion dollars, which corresponds to a share of 2.47% in the world. This rate has been decreasing over the years, ranging from 2.38% to 3.71% (Fig. 2).

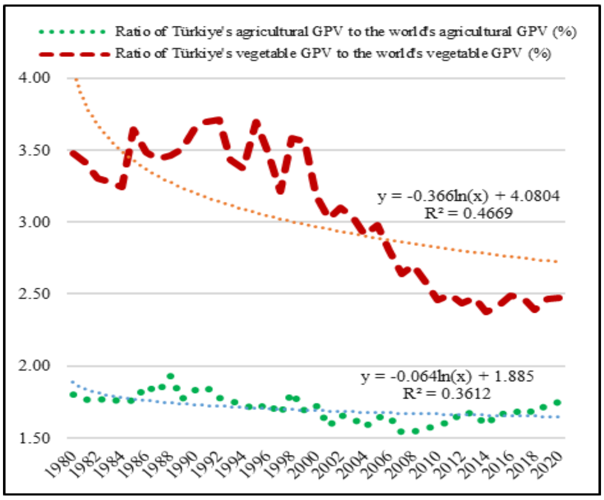

Fig. 2. Ratio of Türkiye's agricultural and vegetable GPV to world's agriculture and vegetable GPV
Source: Own calculation from FAOSTAT data.

The share of gross value of vegetable production in the total world agricultural production value varies between 6.59% and 12.22%. This rate has been increasing globally and was realized as 12.12% in 2020.

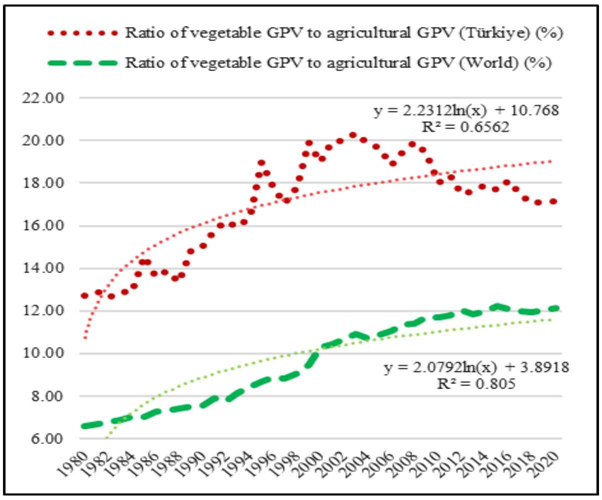

Fig. 3. Ratio of vegetable GPV to agricultural GPV
Source: Own calculation from FAOSTAT data.

In Türkiye, this rate varies between 12.62% and 20.34%. There was an increasing trend between 1980 and 1995, a fluctuating trend between 1996 and 2008, and a decreasing trend since 2009 (Fig. 3).

CONCLUSIONS

Türkiye holds a prominent position globally in terms of vegetable production. Especially the Mediterranean and Aegean regions are the most suitable areas for vegetable cultivation. Türkiye is among the leading countries in the production of various vegetables such as tomatoes, peppers, eggplants, cucumbers, beans, lettuce, cabbage, zucchini, leeks, spinach, onions and garlic.

Overall, Türkiye's yield was above the world average for the main vegetable types examined. However, for five vegetable types (spinach, green garlic, onions and shallots (green), pumpkins (squash and gourds), and other beans (green)), the average yield was below the world average.

To increase both producer income and productivity, the following recommendations can be made:

Conduct further research on the growing conditions and cultivation techniques for the five vegetables with lower than average yields, to determine ways to improve their productivity.

Introduce new and more efficient production methods, such as the use of high-yield seed varieties, improved irrigation systems, and modern agricultural technologies, to increase overall productivity.

Provide training and education to farmers on new and improved production methods, as well as on the latest market trends and demands, to help them make informed decisions and improve their competitiveness.

Encourage the use of environmentally friendly practices and sustainable farming techniques, such as crop rotation and the use of organic fertilizers, to reduce input costs and improve soil health, which can lead to higher yields and improved quality.

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FOREIGN TRADE STRUCTURE OF VEGETABLE SECTOR: DEVELOPMENT PROCESS IN THE WORLD AND TÜRKİYE

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Abstract

This study aims to examine the development of the vegetable trade and develop recommendations to increase exportation. It was determined that vegetable exports from the world and Türkiye were on an increasing trend between the periods analyzed (1980-2021). Approximately 6.19% of the vegetables produced worldwide are exported annually. In Türkiye, this rate was 7.03%. Türkiye ranks 12th in world vegetable exports and has an average of 684 million dollars surplus in foreign vegetable trade. Türkiye is an important exporter of vegetables such as tomatoes, chillies and peppers (green), pumpkins (squash and gourds), cucumbers and gherkins, carrots and turnips, eggplants and green garlic. Some recommendations have been developed to maintain and improve this position. The study's main recommendations are the development of agricultural technologies, more investment in vegetable production, branding and marketing, entering new markets, regulation in tax policies, and increasing education-information activities.

Key words: *vegetables, vegetable trade, foreign trade, export, import*

INTRODUCTION

Türkiye has the potential for year-round production of various vegetables both in the field and in the greenhouse in terms of soil and climatic conditions. Türkiye ranks 4th in the world regarding vegetable production after China, India and USA. It ranks 12th in terms of vegetable exports [7]. In order to preserve the vitamin content of vegetables, they should be consumed immediately after harvest, usually as fresh vegetables [11]. Supply channels, which allow products to be purchased at the desired place, time and manner, fulfill an important marketing function by ensuring that vegetables are consumed fresh. In addition, the marketing structure of vegetables is shaped depending on the development level of the countries [2].

During the process of globalization, significant changes have taken place in world trade. Countries have sought to restructure their foreign trade policies in an increasingly competitive environment. As a result, with the influence of the World Trade Organization (WTO), tariffs and quotas restricting trade have decreased. Thus, a more liberalized environment has emerged in international trade between countries [1]. In light of these developments, world trade has accelerated and competition among countries has increased.

This research aims to analyze the developments in the foreign trade of vegetables in the world and Türkiye from past to present and to develop suggestions for increasing Türkiye's export potential in terms of world vegetable foreign trade.

MATERIALS AND METHODS

The study selected vegetable species and groups traded in the world and in Türkiye and from which economic income is obtained. These are tomatoes, frozen vegetables, avocados, chillies and peppers (green), mushrooms and truffles (dried and canned), onions and shallots (dry), lettuce and chicory, cucumbers and gherkins, green garlic cabbages, cauliflowers and broccoli, pumpkins (squash and gourds), carrots and turnips, asparagus, other beans (green), spinach, eggplants, peas (green), leeks and other alliaceous vegetables, onions and shallots (green), other vegetable juices, artichokes and other vegetable products (fresh or dry or preserved). Statistical data were obtained from Food and Agriculture Organization (FAOSTAT) and various national and international publications. Within the scope of the study, the development of foreign trade in vegetables in the world and Türkiye was analyzed from 1980 to 2021. Indices were calculated for these data and the values obtained were interpreted.

RESULTS AND DISCUSSIONS

Development of vegetable trade in the world

Agricultural production is generally carried out to increase countries' self-sufficiency or get a larger share of trade. In this context, countries have included practices that disrupt the effective functioning of agricultural markets. After the 1980s, money, capital and trade started to be liberalized worldwide in line with the "globalization" process. Exports and imports of agricultural products increased significantly in the 1990s as the World Trade Organization's (WTO) multilateral trade negotiations spurred the globalization process [12]. It was determined that there was a significant increase in the world's total foreign trade, agricultural trade and fruit-vegetable foreign trade in the 1980-2021 period. The world's total exports increased by 870.19%, from 1 trillion 926 billion dollars to 18 trillion 681 billion dollars. World total imports increased by 862.55%, from 1 trillion 968 billion dollars to 18 trillion 947 billion dollars. Agricultural exports increased by 586.33% from 215 billion 25 million dollars to 1 trillion 476 billion dollars. Agricultural imports increased by 547.50%, from 234 billion 304 million dollars to 1 trillion 517 billion dollars. Fruit-vegetable exports increased by 938.88%, from 26 billion 357 million dollars to 273 billion 822 million dollars. Fruit-vegetable imports increased by 803.86%, from 31 billion 28 million dollars to 280 billion 456 million dollars. Vegetable exports increased by 1,054.51% from 7 billion 270 million dollars to 83 billion 931 million dollars. Vegetable imports increased by 857.30% from 8 billion 579 million dollars to 82 billion 125 million dollars (Table 1).

Table 1. Development of trade in the world

Product group	Trade	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021
		1,000 dollars						
Total trade	Export	1,925,538,194	2,930,800,324	4,625,970,094	6,266,653,408	12,339,678,261	17,718,993,402	18,681,335,313
	Import	1,968,457,431	3,009,176,482	4,677,218,192	6,376,391,047	12,583,299,677	17,804,424,953	18,947,485,322
Agricultural products	Export	215,024,798	281,183,634	401,431,231	433,669,657	798,313,760	1,288,873,826	1,475,785,164
	Import	234,303,587	304,325,346	417,134,847	457,271,157	835,371,627	1,325,229,204	1,517,110,600
Fruit and vegetables	Export	26,357,315	42,481,451	64,233,182	74,218,829	135,841,617	213,505,476	273,821,628
	Import	31,028,485	50,809,621	71,546,731	81,191,433	145,497,543	220,938,804	280,455,576
Vegetables	Export	7,269,851	13,065,321	20,539,885	24,724,820	45,109,568	66,400,121	83,930,900
	Import	8,578,785	14,813,812	21,772,881	25,964,843	45,673,657	66,229,236	82,124,654
		Index (1980-1985 = 100)*						
Total trade	Export	100.00	152.21	240.24	325.45	640.84	920.21	970.19
	Import	100.00	152.87	237.61	323.93	639.25	904.49	962.55
Agricultural products	Export	100.00	130.77	186.69	201.68	371.27	599.41	686.33
	Import	100.00	129.89	178.03	195.16	356.53	565.60	647.50
Fruit and vegetables	Export	100.00	161.18	243.70	281.59	515.38	810.04	1,038.88
	Import	100.00	163.75	230.58	261.67	468.92	712.05	903.86
Vegetables	Export	100.00	179.72	282.54	340.10	620.50	913.36	1,154.51
	Import	100.00	172.68	253.80	302.66	532.40	772.01	957.30
		Annual rate of increase (%)*						
Total trade	Export	-0.47	10.48	7.94	6.25	6.28	1.39	6.49
	Import	0.00	10.68	7.31	6.36	5.89	1.44	6.48
Agricultural products	Export	-1.79	7.39	4.65	3.32	9.50	3.28	6.00
	Import	-1.48	6.97	3.56	3.48	9.20	3.44	6.34
Fruit and vegetables	Export	-0.25	11.42	4.23	4.64	9.77	5.04	4.28
	Import	0.37	11.21	2.03	4.47	8.77	5.15	4.67
Vegetables	Export	-0.21	13.87	4.22	5.83	8.77	2.90	4.37
	Import	0.40	12.68	2.07	4.83	8.23	2.87	4.77

Source:*Own calculation from FAOSTAT data [7].

The annual rates of increase in world trade were analyzed. The highest annual increase rates in total world trade were in the average years of 1986-1991. Compared to the average

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of 1980-1985, there was a negative increase in total world exports. In the same period, the rate of increase in imports was low. In the analyzed periods, foreign trade growth rates fluctuated in terms of all indicators (Table 1).

World's vegetable exports

Unlike other agricultural products, fresh vegetables cannot be stored for a long time, so domestic prices fall rapidly during periods of increased supply. In these periods, an excess supply of fresh vegetables is exported and domestic prices are prevented from falling. In this respect, it is important that fresh vegetables can be exported [8].

When the developments in world vegetable exporting were evaluated between 1980 and 2021, the vegetable export value, which was 7 billion 270 million dollars on average between 1980-1985, increased by 11.54 times during the analyzed period and rose to 83 billion 930 million dollars on average between 2016-2021. According to the average for 2016-2021, tomatoes rank first with a rate of 11.23% in vegetable exporting, followed by frozen vegetables with a rate of 9.50%, and avocados with a rate of 7.34% in third place. Mushrooms and truffles (dried and canned) (%7.20), chillies and peppers (green) (%6.76), and onions and shallots (dry) (%4.14) follow them, respectively. The rate of other vegetable products (fresh or dry, or preserved) was 31.10%. During the examined periods, the increase in export values occurred respectively in spinach by 105.85 times, avocados by 77.69 times, peas (green) by 32.05 times, chillies and peppers (green) by 29.64 times, and green garlic by 28.44 times (Table 2).

Table 2. Development of vegetable export in the world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	1,000 dollars	Percent (%)	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	Percent (%)	
Vegetables Primary	*7,269,851*	*100.00*	*13,065,321*	*20,539,885*	*24,724,820*	*45,109,568*	*66,400,121*	*83,930,900*	*100.00*	*1,154.51*
Other vegetable products (fresh or dry or preserved)	3,348,709	46.06	5,370,137	7,769,989	8,863,027	16,199,995	22,959,116	26,104,285	31.10	779.53
Tomatoes	1,017,046	13.99	1,673,239	2,553,590	3,225,440	6,039,959	8,551,915	9,429,202	11.23	927.12
Vegetables frozen	453,696	6.24	1,143,843	1,969,038	2,624,195	4,666,509	6,601,761	7,970,517	9.50	1,756.80
Avocados	79,259	1.09	135,240	212,755	376,761	1,060,994	2,385,834	6,157,862	7.34	7,769.27
Mushrooms and truffles (dried and canned)	444,909	6.12	995,043	1,374,428	1,384,671	2,319,244	3,583,825	6,043,272	7.20	1,358.32
Chillies and peppers (green)	191,402	2.63	527,870	1,169,705	1,736,553	3,296,496	4,553,869	5,673,883	6.76	2,964.38
Onions and shallots (dry)	357,428	4.92	509,897	885,942	976,171	1,834,045	2,910,549	3,478,864	4.14	973.30
Lettuce and chicory	295,206	4.06	607,277	894,570	1,022,516	1,824,761	2,345,781	2,840,641	3.38	962.26
Cucumbers and gherkins	317,396	4.37	530,329	801,463	908,559	1,696,418	2,185,385	2,712,135	3.23	854.50
Green garlic	105,771	1.45	189,612	378,922	538,421	1,127,683	2,412,834	3,007,629	3.58	2,843.54
Cabbages	114,826	1.58	202,382	395,483	431,091	763,666	1,289,327	1,850,847	2.21	1,611.88
Cauliflowers and broccoli	112,758	1.55	229,644	421,111	485,814	831,858	1,171,349	1,506,461	1.79	1,336.01
Pumpkins (squash and gourds)	56,490	0.78	161,864	320,371	424,563	441,868	914,706	1,377,006	1.64	2,437.60
Carrots and turnips	115,454	1.59	194,663	302,609	388,607	767,180	1,123,985	1,411,067	1.68	1,222.19
Asparagus	86,106	1.18	227,030	416,114	489,524	658,479	1,048,572	1,346,825	1.60	1,564.16
Other beans (green)	39,096	0.54	97,377	176,582	246,772	494,236	738,110	914,637	1.09	2,339.48
Spinach	4,319	0.06	12,448	29,569	49,889	106,763	221,071	457,176	0.54	10,585.63
Eggplants	40,706	0.56	76,178	131,083	171,479	339,209	470,841	538,493	0.64	1,322.88
Peas (green)	11,763	0.16	35,253	67,784	89,308	166,596	326,827	376,987	0.45	3,204.76
Leeks and other alliaceous vegetables	10	0.00	52,638	113,177	129,301	242,359	300,803	316,162	0.38	600.63*
Onions and shallots (green)	28,869	0.40	30,175	59,366	79,960	123,368	164,120	232,028	0.28	803.72
Other vegetable juices	25,236	0.35	27,725	46,210	35,608	42,941	75,699	126,182	0.15	500.02
Artichokes	23,398	0.32	35,459	50,028	46,591	64,943	63,844	58,742	0.07	251.05

*Index (1986-1991 = 100)

Source: [7].

World's vegetable import

World vegetable imports increased by 957.30%, from 8 billion 579 million dollars to 82 billion 125 million dollars. Regarding world vegetable imports, tomatoes ranked first, with a share of 11.53%. This was followed by frozen vegetables at 9.78%, avocados at 8.24%, chillies and peppers (green) at 7.04%, mushrooms and truffles (dried and canned) at 4.65% and onions and shallots (dry) at 4.11%. The increase in import value compared to the average of 1980-1985 was 582.86 times for leeks and other alliaceous vegetables, 75.93 times for avocados, 41.23 times for spinach, 27.34 times for other vegetable juices and 22.93 times for pumpkins (squash and gourds) (Table 3).

Table 3. Development of vegetable import in the world

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index (1980-1985 = 100)
	1,000 dollars	Percent (%)	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	Percent (%)	
Vegetables Primary	*8,578,785*	*100.00*	*14,813,812*	*21,772,881*	*25,964,843*	*45,673,657*	*66,229,236*	*82,124,654*	*100.00*	*957.30*
Other vegetable products (fresh or dry or preserved)	3,977,587	46.37	5,964,437	7,893,520	8,900,994	15,370,516	21,658,365	25,107,171	30.57	631.22
Tomatoes	1,217,874	14.20	1,902,666	2,727,756	3,358,827	6,110,383	8,717,983	9,465,834	11.53	777.24
Vegetables frozen	451,266	5.26	1,294,454	2,146,763	2,809,865	4,810,858	6,687,174	8,032,438	9.78	1,779.98
Avocados	89,155	1.04	199,161	270,307	454,758	1,227,943	2,681,610	6,769,651	8.24	7,593.15
Chillies and peppers (green)	294,281	3.43	657,142	1,189,780	1,788,007	3,382,860	4,746,002	5,778,061	7.04	1,963.45
Mushrooms and truffles (dried and canned)	439,217	5.12	1,001,848	1,431,247	1,499,728	2,165,820	2,893,578	3,821,127	4.65	869.99
Onions and shallots (dry)	422,616	4.93	568,355	982,552	1,077,292	1,910,687	2,957,538	3,373,182	4.11	798.17
Cucumbers and gherkins	370,505	4.32	641,099	816,773	892,928	1,672,305	2,338,136	2,814,462	3.43	759.63
Lettuce and chicory	347,005	4.04	698,971	973,943	1,111,824	1,935,305	2,525,838	2,845,925	3.47	820.14
Green garlic	148,822	1.73	232,258	463,096	569,805	1,042,876	2,105,935	2,789,143	3.40	1,874.15
Cabbages	145,675	1.70	285,348	586,323	631,757	986,347	1,612,190	2,148,567	2.62	1,474.91
Asparagus	79,327	0.92	256,565	451,200	531,507	870,426	1,257,242	1,556,385	1.90	1,961.99
Pumpkins (squash and gourds)	63,556	0.74	124,127	346,138	458,938	757,266	1,132,917	1,457,434	1.77	2,293.14
Carrots and turnips	130,248	1.52	211,040	329,455	432,580	783,295	1,129,625	1,325,125	1.61	1,017.39
Cauliflowers and broccoli	131,830	1.54	258,310	357,480	390,814	651,786	937,635	1,258,214	1.53	954.42
Other beans (green)	94,179	1.10	168,142	248,189	330,439	698,686	907,208	1,059,936	1.29	1,125.45
Other vegetable juices	17,070	0.20	23,128	30,088	35,414	52,589	120,929	466,736	0.57	2,734.27
Eggplants	50,535	0.59	82,437	122,965	155,203	327,540	498,023	558,580	0.68	1,105.34
Spinach	9,491	0.11	17,041	27,955	54,025	126,689	231,367	391,332	0.48	4,123.12
Peas (green)	24,007	0.28	68,873	114,326	169,518	284,295	376,716	442,031	0.54	1,841.27
Leeks and other alliaceous vegetables	778	0.01	56,544	124,699	182,133	290,349	413,996	414,741	0.51	53,285.74
Onions and shallots (green)	44,844	0.52	53,533	88,220	81,446	151,879	226,808	177,925	0.22	396.76
Artichokes	28,919	0.34	48,334	50,108	47,043	62,958	72,425	70,656	0.09	244.33

Source: [7].

Table 4. The ratio of vegetable export quantity to production quantity in the world (%)

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index (1980-1985 = 100)
Vegetables Primary	4.17	4.48	5.03	4.89	5.46	5.68	6.19	148.33
Leeks and other alliaceous vegetables	0.00	5.55	9.37	11.45	12.45	13.16	14.04	252.94
Chillies and peppers (green)	4.03	5.79	7.09	6.83	7.89	9.52	10.67	265.02
Onions and shallots (green)	4.29	3.23	5.04	6.61	5.61	6.19	10.45	243.87
Broad and horse beans (green)	-	-	-	-	-	3.29	9.79	297.80*
Lettuce and chicory	5.09	6.47	7.33	7.24	7.08	7.88	8.82	173.30
Green garlic	2.88	3.90	5.66	8.57	9.24	8.02	8.64	299.78
Onions and shallots (dry)	7.10	7.29	8.09	7.65	8.21	8.07	8.14	114.55
Carrots and turnips	3.83	4.61	5.12	5.27	5.99	6.24	7.31	191.03
Pumpkins (squash and gourds)	1.93	3.12	3.36	3.46	2.33	3.88	7.02	363.84
Cauliflowers and broccoli	4.45	4.48	4.92	5.04	5.07	5.13	5.66	127.25
Asparagus	2.69	4.33	4.76	3.97	3.58	4.20	5.08	188.85
Tomatoes	3.46	3.35	3.79	3.77	4.28	4.59	4.44	128.53
Cabbages	1.03	1.29	1.95	1.60	2.17	3.00	3.64	354.17
Cucumbers and gherkins	5.50	5.56	5.37	4.03	3.79	3.50	3.53	64.25
Other beans (green)	1.61	2.34	2.29	2.49	2.43	2.41	2.75	171.26
Artichokes	3.67	3.57	4.49	3.95	3.58	2.72	2.51	68.28
Mushrooms and truffles	2.08	4.27	5.74	4.18	2.49	1.83	1.72	82.95
Green corn (maize)	0.15	0.35	0.77	0.76	1.01	1.26	1.64	1,071.62
Peas (green)	0.44	0.95	1.09	1.16	1.19	1.44	1.46	333.88
Other vegetables (fresh n.e.c.)	1.25	0.97	0.91	0.85	1.13	1.13	1.12	89.47
Eggplants	1.01	0.97	0.90	0.90	1.04	0.97	1.11	109.90
Spinach	0.44	0.73	0.85	0.77	0.58	0.63	0.81	183.27
Okra	-	-	-	-	-	0.00	0.21	12,774.48*
String beans	-	-	-	-	-	0.00	0.00	258.42*

*Index (2010-2015 = 100)

Source: [7].

The ratio of vegetable export quantity to production quantity in the world

The share of vegetable exports in vegetable production varies between 4.17% and 6.19%. It was determined that the share of vegetable exports in vegetable production increased by 48.33%. In the world, 14.04% of leeks and other alliaceous vegetables, 10.67% of chillies and peppers (green) and 10.45% of onions and shallots (green) were exported between 2016 and 2021. In addition, 4.44% of tomatoes, 7.31% of carrots and turnips, 7.02 % of pumpkins (squash and gourds) and 8.64% of green garlic were exported (Table 4).

Development of vegetable trade in the Türkiye

There are studies analyzing the development of vegetable foreign trade between various periods in Türkiye [3] [4] [5] [6] [10].

It was determined that there was a significant increase in Türkiye's total foreign trade, agricultural foreign trade and fruit-vegetable foreign trade in the 1980-2021 period. Türkiye's total exports increased 30.52 times from 5 billion 696 million dollars to 173 billion 870 million dollars. Türkiye total imports increased by 23.79 times from 9 billion 503 million dollars to 226 billion 125 million dollars. Agricultural exports increased by 703.53%, from 2 billion 294 million dollars to 18 trillion 486 billion dollars. Agricultural imports increased 34.27 times from 454 million dollars to 15 trillion 559 billion dollars. Fruit-vegetable exports increased by 727.16%, from 950 million dollars to 7 billion 859 million dollars. Fruit-vegetable imports increased by 422.03 times from 3.4 million to 887 million dollars. Vegetable exports increased 14.32 times from 103 million dollars to 1 billion 391 million dollars. Vegetable imports increased by 51.72 times from 1.8 million to 92.5 million dollars (Table 5).

Table 5. Development of trade in Türkiye

Product group	Trade	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021
	1,000 dollars							
Total trade	Export	5,696,412	11,247,706	19,881,149	32,663,767	93,936,593	142,414,634	173,869,786
	Import	9,503,462	16,456,542	33,910,654	50,564,717	144,474,118	227,332,007	226,124,939
Agricultural products	Export	2,294,423	2,906,651	4,092,590	4,102,227	7,768,067	14,906,127	18,436,351
	Import	454,079	1,388,454	2,887,365	3,125,861	6,547,479	12,606,080	15,559,412
Fruit and vegetables	Export	950,152	1,487,760	1,976,269	2,121,918	4,191,750	6,888,107	7,859,282
	Import	3,401	24,653	93,486	150,565	441,993	887,141	1,435,343
Vegetables	Export	103,084	291,069	387,081	428,277	937,101	1,390,906	1,476,395
	Import	1,789	3,142	5,941	13,897	31,482	74,687	92,518
Index (1980-1985 = 100)*								
Total trade	Export	100.00	197.45	349.01	573.41	1,649.05	2,500.08	3,052.27
	Import	100.00	173.16	356.82	532.07	1,520.23	2,392.10	2,379.40
Agricultural products	Export	100.00	126.68	178.37	178.79	338.56	649.67	803.53
	Import	100.00	305.77	635.87	688.40	1,441.92	2,776.18	3,426.58
Fruit and vegetables	Export	100.00	156.58	208.00	223.32	441.17	724.95	827.16
	Import	100.00	724.88	2,748.77	4,427.08	12,995.96	26,084.72	42,203.57
Vegetables	Export	100.00	282.36	375.50	415.47	909.07	1,349.30	1,432.23
	Import	100.00	175.65	332.14	776.93	1,760.07	4,175.58	5,172.47
Annual rate of increase (%)*								
Total trade	Export	28.91	13.72	13.08	12.53	10.28	4.38	9.68
	Import	7.24	14.92	18.72	8.50	7.41	1.95	6.11
Agricultural products	Export	3.23	10.28	8.33	0.40	12.29	6.52	8.84
	Import	20.13	18.71	22.45	3.19	10.24	4.21	11.31
Fruit and vegetables	Export	-0.06	6.65	9.67	1.56	9.57	4.20	7.86
	Import	266.35	45.53	35.90	-5.36	47.23	10.11	11.07
Vegetables	Export	32.01	13.36	8.34	4.07	15.07	-0.55	9.55
	Import	-	-8.98	35.24	-5.69	27.18	10.04	5.39

Source: *Own calculation from FAOSTAT data [7].

Türkiye's vegetable export

When the developments in Türkiye vegetable exporting were evaluated between 1980 and 2021, the vegetable export value, which was 291 million 69 thousand dollars on average between 1986-1991, increased by 5.07 times during the analyzed period and rose to 1 billion 476 million dollars on average between 2016-2021. According to the average for 2016-2021, tomatoes rank first with a rate of 20.17% in vegetable exporting, followed by chillies and peppers (green) with a rate of

8.79%, and frozen vegetables with a rate of 5.74% in third place. Pumpkins (squash and gourds) (%3.08), cucumbers and gherkins (%2.90), and onions and shallots (dry) (%2.48) follow them, respectively. The rate of other vegetable products (fresh or dry or preserved) was 53.01%. During the examined periods, the increase in export values occurred respectively in avocados by 149.72 times, pumpkins (squash and gourds) by 94.16 times, tomato juice by 54.54 times, other beans (green) by 48.01 times, and asparagus by 25.67 times (Table 6).

Table 6. Development of vegetable export in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index
	1,000 dollars	Percent (%)	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	Percent (%)	(1986-1991 = 100)
Vegetables Primary	*103,084*	*100.00*	*291,069*	*387,081*	*428,277*	*937,101*	*1,390,906*	*1,476,395*	*100.00*	*507.23*
Other vegetable products (fresh or dry or preserved)	57,697	55.97	164,001	266,001	282,820	499,723	679,713	782,612	53.01	477.20
Tomatoes	21,252	20.62	23,659	36,713	53,053	234,731	415,523	297,741	20.17	1,258.45
Chillies and peppers (green)	1,115	1.08	11,589	21,931	23,439	53,821	76,997	129,774	8.79	1,119.85
Vegetables frozen	295	0.29	10,466	20,332	27,812	56,026	58,451	84,770	5.74	809.95
Pumpkins (squash and gourds)	72	0.07	484	1,146	1,761	8,168	28,627	45,525	3.08	9,415.75
Cucumbers and gherkins	163	0.16	7,121	6,449	6,230	35,090	65,113	42,855	2.90	601.83
Onions and shallots (dry)	16,529	16.03	16,989	19,409	17,198	18,138	23,435	36,605	2.48	215.47
Eggplants	387	0.38	1,024	1,404	2,354	5,143	11,228	15,127	1.02	1,476.97
Carrots and turnips	848	0.82	1,186	1,845	3,588	7,672	8,874	14,253	0.97	1,202.11
Mushrooms and truffles (dried and canned)	281	0.27	50,356	5,729	5,008	7,520	9,094	8,049	0.55	15.98
Cabbages	357	0.35	398	975	899	1,631	2,485	4,108	0.28	1,031.30
Leeks and other alliaceous vegetables	0	0.00	1,029	2,632	2,519	3,752	4,767	3,157	0.21	306.70
Green garlic	3,672	3.56	2,015	1,642	174	145	216	2,468	0.17	122.49
Lettuce and chicory	29	0.03	106	262	387	1,950	2,167	2,461	0.17	2,325.04
Cauliflowers and broccoli	92	0.09	159	45	83	469	657	2,077	0.14	1,310.30
Tomato juice	0	0.00	34	110	323	702	977	1,836	0.12	5,453.96
Other beans (green)	229	0.22	25	150	543	1,089	1,117	1,208	0.08	4,800.66
Avocados	0	0.00	5	19	9	28	20	724	0.05	14,972.41
Broad and horse beans (green)	0	0.00	0	0	0	0	665	610	0.04	91.78*
Spinach	7	0.01	18	12	15	795	978	354	0.02	2,022.86
Peas (green)	0	0.00	45	56	35	50	39	19	0.00	41.70
Asparagus	0	0.00	2	2	-	11	44	51	0.00	2,566.67
Artichokes	1	0.00	16	7	7	2	1	14	0.00	89.36
Onions and shallots (green)	57	0.06	343	211	23	447	169	0	0.00	-

*Index (2010-2015 = 100)

Source: [7].

Türkiye's vegetable import

Türkiye's vegetable import value, which was 74 million 687 thousand dollars on average between 2010-2015, increased by %23.87 during the analyzed period and rose to 92 million 518 thousand dollars on average between 2016-2021. Regarding Türkiye vegetable imports, green garlic ranked first with a share of 8.42%. This was followed by onions and shallots (dry) at 6.01%, vegetables frozen at 5.27%, mushrooms and truffles (dried and canned) at 2.23%, avocados at 2.16% and tomatoes at 1.61%. The rate of other vegetable products (fresh or dry or preserved) was 72.20%. The increase in import value compared to the average of 2010-2015 was 17.89 times for onions and shallots (dry), 7.82 times for avocados, 5.21 times for tomatoes, and 2.93 times for cucumbers and gherkins (Table 7).

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Table 7. Development of vegetable import in Türkiye

Vegetables	1980-1985		1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021		Index
	1,000 dollars	Percent (%)	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	Percent (%)	(2010-2015 = 100)
Vegetables Primary	1,789	100.00	3,142	5,941	13,897	31,482	74,687	92,518	100.00	123.87
Other vegetable products (fresh or dry or preserved)	1,781	99.56	2,351	4,399	12,449	21,816	47,328	66,799	72.20	141.14
Green garlic	0	0.00	64	64	466	2,462	6,650	7,794	8.42	117.21
Onions and shallots (dry)	6	0.32	444	136	30	49	311	5,564	6.01	1,789.12
Vegetables frozen	0	0.00	175	845	685	5,962	15,733	4,877	5.27	31.00
Mushrooms and truffles (dried and canned)	0	0.00	32	66	52	122	1,280	2,061	2.23	161.08
Avocados	0	0.00	1	10	11	132	255	1,994	2.16	781.96
Tomatoes	0	0.00	29	38	12	29	286	1,492	1.61	521.68
Artichokes	0	0.01	2	1	18	145	956	917	0.99	95.94
Chillies and peppers (green)	0	0.00	7	69	36	12	206	408	0.44	197.82
Asparagus	0	0.00	0	2	0	60	275	179	0.19	65.19
Lettuce and chicory	0	0.00	9	54	63	216	560	134	0.14	23.95
Cucumbers and gherkins	0	0.00	8	21	5	7	39	114	0.12	292.74
Pumpkins (squash and gourds)	0	0.00	1	1	0	433	464	67	0.07	14.38
Cabbages	0	0.00	0	17	0	1	339	65	0.07	19.16
Eggplants	0	0.00	7	204	34	5	51	32	0.03	62.11
Carrots and turnips	0	0.00	0	3	2	6	7	9	0.01	138.24
Tomato juice	0	0.00	1	9	2	24	2	10	0.01	433.33
Broad and horse beans (green)	0	0.00	0	0	0	0	0	9	0.01	-
Leeks and other alliaceous vegetables	0	0.00	0	20	2	0	2	0	0.00	-
Peas (green)	0	0.00	0	12	4	0	0	0	0.00	-
Spinach	0	0.00	0	0	0	0	15	0	0.00	2.19
Cauliflowers and broccoli	0	0.00	0	0	2	2	3	1	0.00	35.29
Onions and shallots (green)	2	0.11	12	7	0	0	0	0	0.00	-
Other beans (green)	0	0.00	0	4	24	0	0	1	0.00	-

Source: [7].

Türkiye's vegetables trade balance

Türkiye's foreign trade balance in vegetables has increased during the years (1980-2021). Türkiye had a foreign trade surplus of 132 million 620 thousand dollars in 2001.

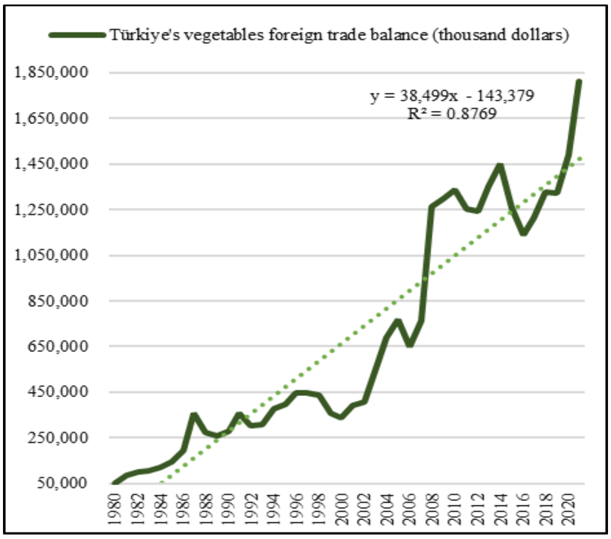

Fig. 1. Türkiye's vegetables foreign trade balance (thousand dollars)
Source: Own calculation from FAOSTAT data [7].

In 2021, it increased by 35.72 times and a foreign trade surplus of 1 billion 810 million dollars was realized. In the analyzed period, the foreign trade surplus averaged 684 million dollars (Fig 1).

The share of vegetable exports in vegetable production varies between 3.32% and 7.03%. It was determined that the share of vegetable exports in vegetable production increased by 111.92%. In Türkiye, 13.74% of carrots and turnips, 11.43% of pumpkins (squash and gourds) and 8.81% of onions and shallots (dry) were exported between 2016 and 2021. In addition, 4.16% of tomatoes, 4.72% of chillies and peppers (green), 3.36% of cucumbers and gherkins and 2.99% of eggplants were exported (Table 8).

Mushrooms and truffles, cauliflowers and broccoli, cabbages, lettuce and chicory, other beans (green), spinach, peas (green), artichokes, onions and shallots (green) are almost all vegetables for domestic consumption.

Table 8. The ratio of vegetable export quantity to production quantity in the Türkiye (%)

Vegetables	1980-1985	1986-1991	1992-1997	1998-2003	2004-2009	2010-2015	2016-2021	Index (1980-1985 = 100)
Vegetables Primary	*3.32*	*4.30*	*4.13*	*4.33*	*5.92*	*6.57*	*7.03*	*211.92*
Carrots and turnips	4.43	4.31	3.43	8.87	8.39	9.13	13.74	318.46
Pumpkins (squash and gourds)	0.09	0.43	0.65	0.97	2.85	9.63	11.43	12,866.63
Onions and shallots (dry)	10.56	10.68	6.99	6.28	6.92	7.43	8.81	83.46
Asparagus	12.67	26.67	11.81	1.39	64.26	4.38	4.94	38.99
Green garlic	7.26	4.96	2.76	0.20	0.19	0.21	4.89	67.34
Chillies and peppers (green)	0.35	2.18	2.74	2.31	3.30	3.50	4.72	1,335.57
Tomatoes	2.59	2.20	1.43	1.89	3.48	4.87	4.16	160.28
Cucumbers and gherkins	0.08	1.36	0.96	0.86	3.33	4.96	3.36	67.74
Eggplants	0.21	0.29	0.29	0.43	0.70	1.73	2.99	1,451.51
Broad and beans (green)	-	-	-	-	-	0.66	2.65	402.59*
Leeks and other alliaceous vegetables	-	1.07	2.30	3.04	3.13	3.78	2.50	233.29**
Other vegetables (fresh n.e.c.)	20.00	5.12	3.41	5.24	7.18	4.64	2.26	11.30
Mushrooms and truffles	1.83	19.36	30.91	12.82	4.24	1.80	1.45	7.49
Cauliflowers and broccoli	0.62	1.06	0.16	0.23	0.48	0.62	1.44	230.88
Cabbages	0.32	0.24	0.44	0.39	0.62	0.86	1.18	365.15
Lettuce and chicory	0.13	0.44	0.21	0.16	0.51	0.61	0.84	645.86
Other beans (green)	0.17	0.01	0.03	0.14	0.16	0.16	0.25	150.85
Spinach	0.02	0.05	0.02	0.02	0.37	0.46	0.21	949.50
Peas (green)	0.00	0.19	0.20	0.09	0.05	0.03	0.05	1,237.97
Artichokes	0.01	0.18	0.05	0.04	0.00	0.00	0.02	345.73
Onions and shallots (green)	0.16	1.27	0.41	0.06	0.38	0.19	-	0.00

*Index (2010-2015 = 100), **Index (1986-1991 = 100)

Source: [7].

Türkiye's contribution to the world vegetable trade

The leading countries in world vegetable exports were China, Mexico, Spain, Netherlands, Italy and USA. Türkiye ranks 12th in the world for primary vegetable exports.

Türkiye ranks sixth in the world in three types of vegetable exportation. These vegetables were eggplants, chillies and peppers (green) and cucumbers and gherkins. It ranks eighth in one vegetable type (tomatoes) and fourteenth in two vegetable types (carrots and turnips and green garlic).

Table 9. Türkiye's position in world vegetable export

Vegetables	Türkiye's rank in world vegetable export	Number of countries exporting vegetables in the world	Major countries in vegetable export
Vegetables Primary	*12*	*191*	*China, Mexico, Spain, Netherlands, Italy, USA*
Pumpkins (squash and gourds)	4	123	Spain, Mexico, New Zealand, Türkiye, Netherlands, USA
Eggplants	6	111	Spain, Netherland, Mexico, USA, Iran, Türkiye
Chillies and peppers (green)	6	131	Spain, Mexico, Netherland, Canada, USA, Türkiye
Cucumbers and gherkins	6	105	Spain, Mexico, Netherland, Canada, USA, Türkiye
Tomatoes	8	134	Mexico, Netherlands, Spain, Morocco, France, Canada
Carrots and turnips	14	98	China, Netherland, USA, Spain, Belgium, Italy
Green garlic	14	110	China, Spain, Argentina, Netherlands, France, Chile
Onions and shallots (dry)	15	114	Netherlands, India, China, Mexico, USA, Spain
Cauliflowers and broccoli	19	95	Spain, Mexico, USA, Italy, France, China
Broad and horse beans (green)	20	95	Mexico, Spain, Kenya, Netherlands, Guatemala, Morocco
Spinach	25	83	China, USA, Italy, Mexico, Spain, Netherland
Artichokes	25	46	Spain, France, Italy, Egypt, Tunisia, USA
Cabbages	28	110	China, USA, Mexico, Netherlands, Spain, Italy
Other beans (green)	28	116	Morocco, China, Netherlands, Guatemala, Mexico, France
Lettuce and chicory	30	101	Spain, USA, Mexico, Netherland, Italy, China
Other vegetables (fresh n.e.c.)	41	143	Italy, Netherlands, China, Mexico, Spain, Ethiopia
Asparagus	44	71	Mexico, Peru, USA, Netherland, Spain, Italy
Peas (green)	54	87	Guatemala, Netherlands, USA, Peru, France, Mexico
Leeks and other alliaceous vegetables	86	8	Netherlands, Belgium, China, Spain, France, Mexico
Okra	-	7	Kenya, Jamaica, Oman, Bangladesh, Tonga, Saint Lucia
Onions and shallots (green)	-	47	New Zealand, France, Netherlands, Morocco, Germany, Indonesia
String beans	-	1	Guyana

Source: [7].

It also ranks fourth globally in pumpkin (squash and gourds) exports (Table 9).

The types of vegetables that are widely traded in the world are tomatoes, which are exported by 134 countries, and chillies and peppers (green), which are exported by 131 countries.

The leading countries in world vegetable imports were USA, Germany, United Kingdom, France, Netherlands, and Canada. In terms of primary vegetable imports, Türkiye ranks 76th in the world.

Türkiye ranks eleventh in the world in artichokes importation. Türkiye is not in an important position in the import of other types of vegetables. The widely traded vegetables in the world are green garlic, imported by 189 countries, and cabbages, imported by 170 countries (Table 10).

Table 10. Türkiye's position in world vegetable import

Vegetables	Türkiye's rank in world vegetable import	Number of countries importing vegetables in the world	Major countries in vegetable import
Vegetables Primary	76	195	USA, Germany, United Kingdom, France, Netherlands, Canada
Artichokes	11	86	France, Italy, Belgium, Switzerland, Germany, USA
Green garlic	58	189	Indonesia, USA, Brazil, Malaysia, Germany, France
Asparagus	63	135	USA, Germany, Netherlands, Canada, United Kingdom, France
Chillies and peppers, green	76	165	USA, Germany, United Kingdom, Canada, France, Netherlands
Pumpkins, squash and gourds	81	137	USA, France, Germany, United Kingdom, Netherlands, Japan
Tomatoes	81	169	USA, Germany, France, United Kingdom, Russian, Netherlands
Broad and horse beans, green	85	110	USA, Italy, Germany, Spain, United Kingdom, France
Eggplants	86	112	Germany, USA, France, United Kingdom, Canada, Iraq
Cucumbers and gherkins	95	133	USA, Germany, United Kingdom, Netherlands, Poland, Iraq
Spinach	104	112	Canada, USA, United Kingdom, Germany, Mexico, Netherlands
Lettuce and chicory	112	162	Germany, USA, Canada, United Kingdom, France, Italy
Leeks and other alliaceous vegetables	120	127	Germany, Japan, France, USA, Spain, Netherlands
Peas (green)	121	131	USA, Netherlands, Belgium, United Kingdom, Canada, Germany
Carrots and turnips	134	159	Germany, USA, Canada, Viet Nam, Russian, France
Cabbages	141	170	USA, Canada, China, Germany, Malaysia, Netherland
Other vegetables, fresh n.e.c.	146	178	Germany, China, USA, France, Somalia, Canada
Onions and shallots, dry	160	169	USA, Viet Nam, Malaysia, United Kingdom, Canada, Germany
Cauliflowers and broccoli	-	153	United Kingdom, Canada, USA, Germany, Malaysia, France
Other beans, green	-	144	USA, United Kingdom, Spain, Netherlands, France, Canada
Okra	-	13	USA, Algeria, Qatar, Somalia, Congo, South Sudan
Onions and shallots, green	-	78	Côte d'Ivoire, Brazil, Germany, Belgium, Italy, Lao PDR
String beans	-	1	Guyana

Source: [7].

Contribution of the vegetable sector to trade

The share of agricultural exports in the total world export value varies between 5.94% and 11.50%. This ratio follows a decreasing trend in the related years. The average was 8.31%. In Türkiye, this rate varies between 6.01% and 62.30%. This rate followed a decreasing trend and was realized at 10.55% in 2021 (Fig 2). Although total exports have increased over the years, the share of agricultural exports has decreased. The reason for this is the increase in the share of this sector in total exports with the development of the industrial sector in Türkiye.

In addition, the leading sector in Türkiye's total exports is agriculture-based industries. The share of these industries in total exports was approximately 30% [9].

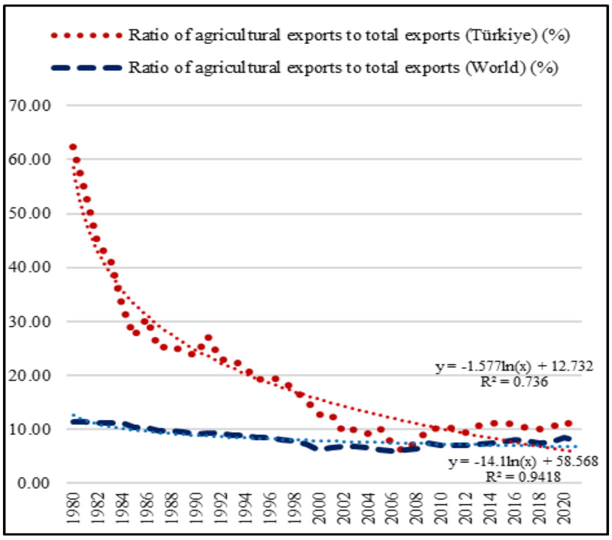

Fig. 2. Ratio of agricultural exports to total exports
Source: Own calculation from FAOSTAT data [7].

The share of vegetable export value in the world of agricultural exports varies between 0.02% and 0.07%. The average was 0.04%. In

Türkiye, this rate varies between 2.79% and 14.33%. There was an increasing trend between 1980-1987 and 2002-2009, a decreasing trend between 1987-2001 and since 2009. The average was 9.12% (Fig 3).

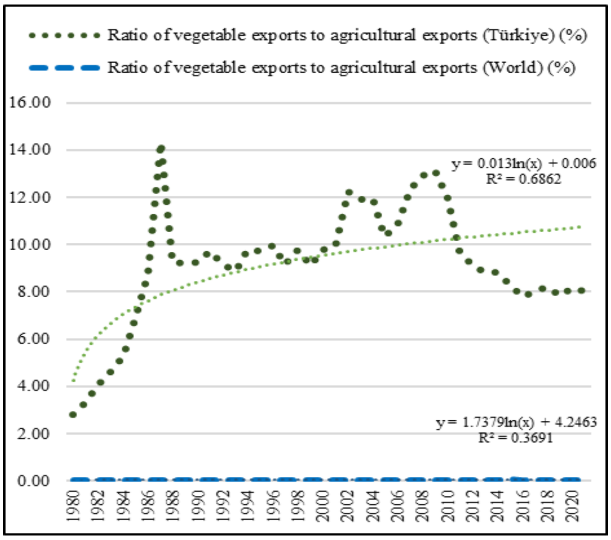

Fig. 3. Ratio of vegetable exports to agricultural exports
Source: Own calculation from FAOSTAT data [7].

The share of agricultural imports in the total world import value varies between 6.03% and 12.26%. This ratio follows a fluctuating trend in the related years. The average was 8.63%. In Türkiye, this rate varies between 3.04% and 10.17%. There was a fluctuating upward trend between 1983-1995 and 2007-2021, a decreasing trend between 1996-2006. The average was 6.34% (Fig 4).

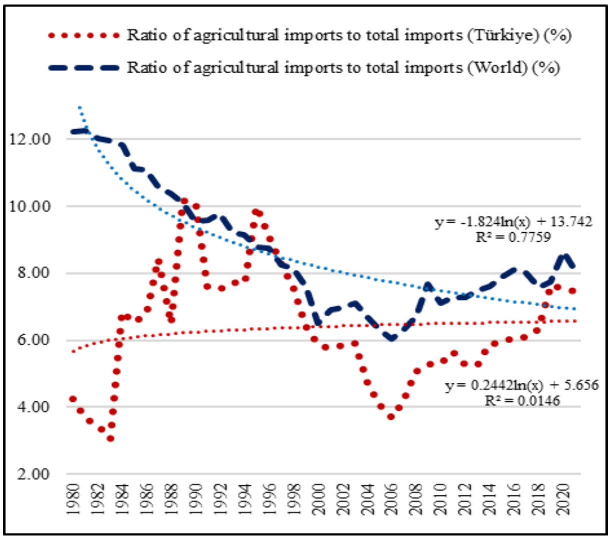

Fig. 4. Ratio of agricultural imports to total imports
Source: Own calculation from FAOSTAT data [7].

The share of vegetable imports in world agricultural imports varies between 0.03% and 0.07%. The average was 0.04%. In Türkiye, this rate varies between 0.00% and 1.70%. The average was 0.43% (Fig 5). It was determined that the rate of vegetable imports among agricultural imports was very low.

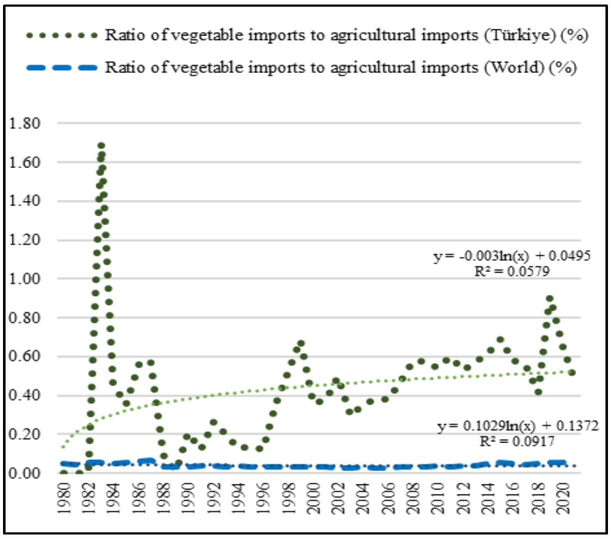

Fig. 5. Ratio of vegetable imports to agricultural imports
Source: Own calculation from FAOSTAT data [7].

CONCLUSIONS

Türkiye is an important country in terms of global vegetable production and exports. Türkiye's potential for vegetable production and exports has been very high from the past to the present. To ensure the continuity and improvement of this potential, the following recommendations can be developed.

Developing agricultural technologies: Türkiye can increase the efficiency of vegetable production by investing more in farm technologies. This can increase the country's vegetable exports by reducing production costs, offering competitive export prices, and improving product quality.

More investment in vegetable production: Investments such as modernizing facilities, improving production processes, increasing product quality, and developing storage systems in vegetable production can increase Türkiye's vegetable exports.

Branding and marketing: To increase Türkiye's vegetable exports, producers need to invest more in branding and marketing activities. More control over producing quality products, packaging, labeling, branding, distribution, and marketing processes can increase Türkiye's vegetable exports.

Entering new markets: Türkiye should open up to new markets for vegetable exports. It may be possible to diversify vegetable exports by entering markets in countries with increasing demand worldwide.

Tax policies: Reducing customs duties on vegetable exports can make export prices more competitive.

Education and information: Education and information programs can be organized to help vegetable producers and exporters in Türkiye meet the requirements for export. This can help producers become more aware of vegetable exports.

These recommendations can be an important step for increasing Türkiye's vegetable exports.

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ANALYSIS OF INHIBITING FACTORS OF THE TENDENCY OF RURAL YOUTH TO SELF-EMPLOYMENT IN RURAL AREAS OF IRAN- CASE STUDY OF SARAVAN

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Abstract

The employment of the youth is among the most critical problems in macroeconomic planning and a serious concern for politicians. This research aims to determine the factors underpinning self-employment barriers of the youth in rural areas of Saravan. For this purpose, data on 200 rural youths were collected by using a self-made questionnaire and were subjected to exploratory factor analysis. Based on the findings, the main impediments of self-employment among the rural youth in the study site included economic-educational, infrastructural, personality, and support factors whereas economic-educational and infrastructural factors were the most significant factors.

Key words*: *barriers, self-employment, exploratory factor analysis, Saravan

INTRODUCTION

The role of employment as an important factor in the dynamics of human life is undeniable, and there is no doubt that young people play an important role in this regard [1, 2]. The youth constitute an important part of the workforce in urban and rural communities [3, 29]. Also, they are considered the most important capacities to advance the development goals of the countries [24, 3]. Youth employment is a global challenge and one of the most important political concerns given the facts that there is presently over 64 million unemployed youth around the world and that 145 million young workers live in poverty. In society, many of the youth will become successful workforce, but a few will face serious problems and some will not be able to reach their goals [15, 21, 28].

Individual characteristics such as age, gender, ethnicity, and parental status are all effective in youth employment and should be included in the analysis of youth employment [8, 28]. There is also a direct relationship between the characteristics of the youth in an area and employment [12, 16, 8].

In areas that are struggling with more deprivation and risks, there is more despair about youth employment [31, 8]. Saravan is no exception to this rule. The low level of human and social capital aggravates the lack of employment and makes many jobs unattainable in the labor market [11, 6]. In this situation, self-employment is capable of reducing poverty and social exclusion [11]. The labor market has mainly been characterized by an increase in the number of self-employed workers in recent years [20, 5, 9, 7, 10]. In many countries, creating suitable conditions for people's self-employment is an important policy goal that brings about entrepreneurial benefits and its ultimate goal is to increase people’s welfare [14]. Due to the important role of self-employment in the economic development of countries, it has received more attention from economists. From a macroeconomic perspective, the unemployment rate increases, wages decrease, and welfare subsequently decreases during economic recessions, so self-employment is the best solution to avoid the consequences of unemployment [19].

Many studies have been conducted on employment, but few have examined the barriers to youth employment. In the research about entrepreneurship obstacles in rural areas of Marvdasht, Panahi et al (2015) concluded that two groups of factors played crucial roles in entrepreneurship development in these areas. One was related to the internal factors in the village, such as entrepreneurs' lack of management skills, weaknesses in providing effective technical and vocational training, ambiguous investment priorities, the lack of technical infrastructure in the village, etc., and the second was related to the factors pertaining to the functioning of the economic system (inflation, recession, etc.) which had created many problems for entrepreneurship development [26]. Samian and Movahedi (2017) focused on employment barriers in small rural businesses and showed that the most important barriers to employment development included infrastructure and executive factors, policy and legal factors, and technical and individual factors [27].

Kovyazina et al. (2017) investigated disability as a psychological barrier to employment in Russia. In Russia, there was a misconception regarding the physical disability of people as a psychological barrier for employers [17]. Ax et al. (2020) reported that gender discrimination was the most important obstacle to women's employment [4]. Forsyth et al. (2019) showed that individual resilience as a strong coping mechanism improved employment [13]. According to Mugumbate and Gray (2017), gender affects employment not only directly but also through interaction with other demographic variables [22]. Nolan and Barrett (2018) addressed the potential role of employment as a macroeconomic variable in the economic growth and development of countries as well as the welfare of society and tried to identify the limitations and obstacles affecting the employment of young people in society [23].

The purpose of the present study was to investigate the factors affecting rural youth self-employment in Saravan.

MATERIALS AND METHODS

Exploratory Factor Analysis (EFA)

EFA is a multivariate interdependence statistical method that is mainly used to define the underlying factors (structures) among a relatively large number of observed variables (items) [30]. (Shankar et al., 2019). This technique can be used to identify data structures in questionnaires, simplify data if necessary, and simplify questionnaire variables to a smaller number of extracted dimensions [19]. In this paper, the EFA method was used to extract the effective factors of the rural youth's self-employment barriers in Saravan.

The factor analysis is a six-step process that is displayed in Figure 1.

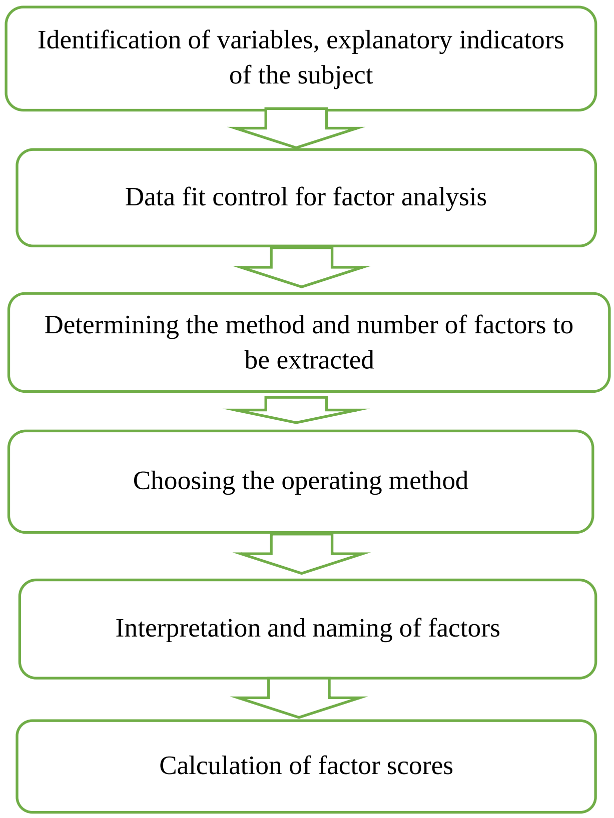

Fig. 1. The process of exploratory factor analysis (EFA)

Source: Adapted after Zebardast (2016) [32].

Kaiser-Meyer-Olkin (KMO) and Barlett's Test

For factor analysis to be valid, the KMO and Bartlett's tests must be performed to ensure that the primary variables are strongly correlated. Specifically, the KMO test mainly determines whether the values are sufficiently distributed in the factor analysis measurement sample, so a minimum KMO coefficient of

0.8 is required [25, 19]. (Pallant, 2013; Lo et al., 2020). Bartlett's test checks whether the correlation matrix is an identity matrix, in which case EA will not be significant [19]. (Lo et al., 2020).

RESULTS AND DISCUSSIONS

The research studied 200 rural youths. Table 1 summarizes the results for the demographic characteristics of the studied community. The age range of the respondents was from 20 to 35 years. The age range of 20-25 years accounted for the largest percentage. Also, the majority of the participants (86%) were male and the remaining (14%) were female. The educational level of, most participants was at the bachelor's level. Most of them were also single.

Table 1. The demographic characteristics of the studied community

Demographic variable		Frequency	Percentage
Age (years)	Less than 20	11	5.5
	20-25	121	60.5
	25-30	51	25.5
	30-35	17	8.5
Gender	Male	172	86.0
	Female	28	14.0
Education	Diploma	45	22.5
	College	30	15.0
	Bachelor	115	57.5
	Master degree	9	4.5
	PhD	1	0.5
Marital status	Single	119	59.5
	Married	81	40.5

Source: results of the research.

KMO and Bartlett's test

The impediments to self-employment of the rural youth in Saravan were identified using the factor analysis method in the SPSS software package. The numerical value of KMO and Bartlett's test were calculated to control data fitness. Table 2 summarizes the results of Bartlett's test and the numerical value of the KMO criterion, supporting the overall suitability of the samples for factor analysis. The significance level of Bartlett's test was 0.000, which rejected the null hypothesis about the independence of the variables in the correlation matrix from one another at a significance level of 5%. As such, the implementation of factor analysis was confirmed. Also, the KMO criterion had a numerical value of 0.917, reflecting data suitability for factor analysis.

Table 2. Bartlett's test and the numerical value of KMO

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.917**
Bartlett’s Test of Sphericity Approx. Chi-Square	1,827.881
Df	171
Sig.	0.000

Source: results of the research.

Determining the method and number of factors

In the first run of the software, the extractable factors were figured out by principal component analysis, but the period of the factors was not asked for. Kaiser's criterion was first employed to determine the number of factors that should be extracted for the dataset in this analysis. Based on this criterion, only factors with eigenvalues of 1 or more were accepted as possible sources of variations in the data. Table 3 shows the extracted factors and their percentage changes. In this table, the first block contains three columns labeled Initial Eigenvalues corresponding to the eigenvalues of the correlation matrix. The eigenvalue is a value of the variance of the total test that is estimated by a specific factor, and the total variance for each test is equal to 100%. The eigenvalue for the first factor was equal to 7.689. Table 3 shows that the eigenvalues of four factors were greater than 1. Other special values for the following factors are also listed in the total column. The second column, labeled variance %, is the percentage of the variance of that factor from the total variance, which is obtained by dividing the eigenvalue of that factor by the number of tests.

The four components that had eigenvalues greater than 1 accounted for only 63.37% of the total variance (cumulative % column), which was small for four components. Therefore, these factors collectively represented 63.37% of the variance in the data in the present research. The second block contains three columns labeled Extraction

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Sums of Squared Loadings, which are the sum of the coefficients of the factors that were not rotated.

Table 3. The factors extracted and the percentage of their variations

Component	Initial Eigenvalues			Extraction Sum of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Of Variance %	Cumulative	Total	Of Variance %	Cumulative	Total	Of Variance %	Cumulative
1	7.689	40.469	40.469	7.689	40.469	40.469	4.125	21.711	21.711
2	2.145	11.289	51.758	2.145	11.289	51.758	3.197	16.826	38.537
3	1.248	6.567	58.325	1.248	6.567	58.325	2.531	13.322	51.860
4	0.958	5.044	63.325	0.958	5.044	63.325	2.187	11.509	63.369
5	0.781	4.113	67.482						
6	0.749	3.945	71.426						
7	0.652	3.431	74.857						
8	0.569	2.993	77.850						
9	0.563	2.963	80.813						
10	0.490	2.577	83.390						
11	0.484	2.550	85.939						
12	0.436	2.296	88.235						
13	0.423	2.226	90.461						
14	0.400	2.107	92.568						
15	0.333	1.751	94.319						
16	0.311	1.638	95.957						
17	0.280	1.472	97.429						
18	0.256	1.348	98.777						
19	0.232	1.223	100.000						

Source: result of the research.

The third block contains three columns labeled Rotation Sums of Squared Loadings and is related to solving the rotated factor and distributing the variance among the uniform factors. The first factor captured a larger share of the variance.

Selection of the factor rotation method

To determine the type of rotation of the factors (orthogonal or diagonal), factor analysis with diagonal rotation was first performed by using the direct oblimin method, and the matrix of correlation coefficients between the factors was extracted. The results of this matrix showed that there was no reason for the factors to be correlated and the rotation of the factors should be orthogonal. After factor analysis was conducted, four factors were extracted and their relationship with 19 indicators of self-employment obstacles of rural youth was determined (Table 4). The output shows the rotated matrix of components, which includes the factor loadings of each of the variables in the remaining four factors after rotation. The higher the value of these coefficients, the greater the role of the corresponding factor in the total changes of the desired variable.

Table 4. Age factors and their factor loadings

	Component			
	1	2	3	**4**
X1		0.657		
X2		0.793		
X3		0.734		
X4		0.733		
X5	0.600			
X6		0.584		
X7			0.560	
X8			0.712	
X9			0.800	
X10			0.719	
X11			0.626	
X12	0.588			
X13	0.720			
X14	0.771			
X15	0.695			
X16				**0.560**
X17				**0.601**
X18				**0.713**
X19	0.613			

Source: results of the research.

Interpretation and naming of factors

According to the relationship of the extracted factors with the indicators of rural youth self-employment barriers in Table 4, the extracted factors were named according to the characteristics of the indicators and research literature based on Table 4.

Table 5. The extracted factors, factor loadings, and their names

Factor name	factor loading	Indicator
Economic-educational	0.600	Lack of entrepreneurship education
	0.588	Inability to provide collateral for the loan
	0.720	The complexity of financial aid
	0.771	Inability to provide initial capital
	0.695	Lack of financial aid
	0.613	Absence of technical training centers
Infrastructural	0.657	Lack of physical infrastructure
	0.793	Insecurity of capital in the village
	0.734	Lack of specialized support centers
	0.733	Lack of access to technology
	0.584	Lack of entrepreneurial consulting centers
Personality	0.560	Lack of self-employment skills
	0.712	Lack of experience
	0.800	Low self-confidence
	0.719	Low level of cooperative culture
	0.626	Lack of experience in starting an economic activity
Support	0.560	Lack of support for creative youth’s projects
	0.601	Government’s inattention to rural entrepreneurship
	0.713	Complexity of self-employment laws

Source: results of the research.

Based on the results of data analysis, it was observed that there were four factors including economic-educational, infrastructural, personality, and support factors that hindered the self-employment of rural youth in this county. The economic-educational and infrastructural factors were the most important.

Saravan is one of the deprived counties of the big province of Sistan and Baluchistan. This county does not have the potential to attract capital from other counties of the province since it is a dead end and is located on the borderline. The main source of income for the people of this county is activities related to the border. Due to long droughts, agriculture is not very prosperous in this region. Due to the lack of required infrastructure, the industry has no place in the employment of the people. The results obtained from this research showed that effective educational centers play a significant role in preparing young people to create self-employment. However, young people in this region are unfortunately deprived of such training in the field of entrepreneurship.

A basic problem in the rural areas of Saravan is widespread poverty. Poverty is an obstacle to providing capital to start economic activities. Therefore, providing initial capital for the general youth is a fundamental problem for the youth. In addition, most villagers have either no job or a job related to traditional farming, so they can hardly provide collateral for taking loans from banks. So, one of the most important obstacles to self-employment, according to the respondents, is the inability to provide collateral for a loan. A major problem in the county is the complexity of bureaucracy for granting loans, even small loans, which has reduced people's willingness to receive loans. This problem is more important in the Saravan region due to the widespread belief that bank loans are haram as was mentioned by the respondents as one of the main obstacles. One of the most important problems of Saravan is, in general, the lack of industrial infrastructure, which is a double problem in the rural areas of this region, and this will hinder the start of any economic activity. Due to the dispersion of population in this area and the low population of villages in this region, investment is facing high risk. This is why the lack of investment security was stated as one of the main obstacles to self-employment in this region. One of the fundamental problems in the county is the lack of specialized centers to support entrepreneurial ideas of rural youth due to its remoteness. If the young people in the rural areas of this county can start an economic activity, they may face major problems at the very beginning of their activity due to the lack of experience, and this will prevent their development or cause the closure of their economic activity.

CONCLUSIONS

Entrepreneurship especially in rural areas should be considered as a multifaceted phenomenon, which is determined by social, economic and cultural factors. In the social sphere, it is considered through the individual characteristics of a person (talent, intelligence, the ability to learn and use acquired knowledge, to make risky decisions), in the economic and cultural sphere, it is perceived through the quality of labor resources and the organizational culture of the enterprise (creativity, innovation, market orientation, making a profit, behavior, rules of ethics and etiquette) [32].

The research derived the factors affecting the self-employment of young people by using EFA. The extracted barriers to the self-employment of the rural youth were divided into economic-educational, infrastructural, personality, and support factors among which the economic-educational and infrastructural factors were the most important. Therefore, the rural youth can be motivated to engage in self-employment by providing them with financial support as it would provide initial capital to create jobs. Also, suitable infrastructure for the market, including proper access to information technology, specialized centers for entrepreneurship training, and investment security in villages should be provided.

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EFFECTS OF PRODUCTION PARAMETERS ON RICE OUTPUT IN THE KETU NORTH DISTRICT OF THE VOLTA REGION, GHANA

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Abstract

This article investigated the effects of production parameters on thecultivation of rice in the Ketu North District of Ghana. Out of 1,024 farmers, 290 rice farmers were chosen to take part in the study using a two-stage sampling procedure. A structured interview schedule was used to collect primary data from 285 respondents resulting in a response rate of 93%. A translog stochastic frontier production function with a model for inefficiency effects was employed in data analysis, using the Maximum Likelihood Method.Land area under cultivation, fertilizer input, irrigation cost, and equipment were identified as the major input factors that significantly influenced yield of rice in the Ketu North District. Also, results indicated 0.642 returns to scale; which implies that an aggregate increase in inputs results in a less than proportionate increase in the yield of rice in the study area. This indicates a decreasing returns to scale. The findings of this study would guide governments and civil society organisations to understand where public investments can best be directed to boost rice production in Ghana. Increased rice output would raise farmers' income and improve their livelihood security. Also, increased output of rice will help reduce rice imports to save foreign exchange and strengthen the local currency. Finally, the findings of this study would fill the gaps in literature and contribute to knowledge.

Key words: *irrigation scheme, return to scale, production, stochastic frontier analysis*

INTRODUCTION

In Ghana, rice comes next to maize as an important cereal grain staple food and its consumption has risen over the years as a result of increase in population, growth in cities, and consumer habit change [1, 26, 20, 10, 18, 8]. Rice production in Ghana satisfies about 30 to 40 percent of domestic demand with an accompanying rice import bill of $400million annually [23,14,12]. The over reliance on rice imports has been a challenge for policymakers, especially after a significant hike in food prices in 2008. The government's flagship programme, Planting for Food and Jobs continue to yield results [19]. Under the estimate for Planting for Food and Jobs (PFJ), the overall land area under rice cultivation in Ghana was to be increased from 239,340 ha to 260,000 ha by 2020 [24, 13]. Furthermore, 30,000 ha of the current area under rice cultivation in Ghana was occupied by Planting for Food and Jobs in 2017, there were official plans to increase coverage to 124,628 ha in 2018 and then to 198,380 ha in 2019. If the results displayed in 2017 remained consistent throughout the programme, a major increase in rice output is anticipated.

Similarly, the continued expansion of the area under irrigation is expected to increase the per hectare output of rice. While poor farm mechanisation and improper post-harvest facilities have posed a challenge to most smallholder rice farmers in the country, government's effort to modernise and enhance production is expected to alleviate these issues. Since the demand for rice is expected to increase in subsequent years, it will be necessary to sustain rice production gains achieved between 2013 and 2017 to turn Ghana into a sustainable, food-secure rice-producing country. This can be achieved through the enhancement of the efficiency of rice farmers.The inability of domestic rice producers to meet local demand is as a result of rice farmers' production inefficiency [15]. Performance at the farm level is achievable in two distinct ways: either by increasing output with a given set of inputs or by reducing costs to produce a prescribed amount of output [21]. The previous concept is called technical efficiency which is a yard stick for a firm's ability to produce the highest possible output from a given set of inputs under the existing level of technology. Rice is a widely produced food crop and its cultivation serves as a source of livelihood for a lot of people in the Ketu North District. Yet, not much research has been carried out to determine the productivity of rice farmers; especially farmers cultivating rice on the irrigation scheme at Weta. The aforesaid reasons inform this research to be conducted to investigate the effects of some inputs on rice yield. This would impact government policy decisions. Generally, the study aims at evaluating the effects of production inputs on the yield of rice in the Ketu North District.

The specific objectives are: to estimate the effects of production inputs on the yield of rice in the study area and to work out the production output elasticities. The undermentioned research questions guide the study: 1. How do production inputs impact the yield of rice in the district? 2. What are the output elasticities in rice production? The following hypothesis will be tested:H_0: Production inputs haveno substantial impact on the yield of rice. H_1: Production inputs have substantial impact on the yield of rice. The scope of the study is delimitedted to investigating the effects of production parameters on the yield of rice on the Irrigation Scheme only. It did not include other rice farmers outside the irrigation scheme. Also, it focused on only the effects of production inputs on output; excluding the effects of socioeconomic factors. Most of the respondents involved in this study were illiterates or had only primary education and hence could not keep accurate production records. Also, as a result of the high illiteracy rate, all the items on the structured interview schedule had to be translated into the local language of the respondents. Production technology was also held constant. All the above could negatively affect the validity of the data collected as well as the accuracy of the results obtained.

MATERIALS AND METHODS

The study used a two-stage sampling to pick the participants. The accessible population was 1,024 rice farmers on the Weta irrigation scheme. The rice farmers were put into 11 sections on the scheme. Out of the eleven, six sections were randomly picked at the first stage. Using the proportionate random sampling method, 290 rice farmers were chosen from the six sections at the second stage to constitute the study sample. A list of randomly chosen numbers was generated within a given range. Rice farmers with the randomly chosen numbers were identified and interviewed. The sample size was determined from the sample size determination table of Krejcie& Morgan [17]. Only 285 rice farmers, out of the 290, were however accessed, yielding a response rate of 98.3 percent. A structured interview schedule, containing both open-ended and close-ended questions was used to collect data relating to socio-economic characteristics of rice farmers as well as input and output quantities.

Pre-Testing of Instrument

The instrument was pre-tested prior to data collection. This made it possible for the researchers to confirm the appropriateness of response categories and farmers' understanding of items on the instrument, thus enabling corrections to be made where necessary. The reliability of the instrument was estimated at 0.75, using the Cronbach's alpha reliability coefficient. According to Cohen, Manion and Morrison [7], the minimum standard of internal consistency which is acceptable is 0.70. Therefore, the 0.75reliability coefficient is high; meaning, the individual items or sets of items on the instrument would yield results consistent with the overall instrument.

Data Collection Procedure

Data were gathered by the researchers and three field assistants during the 2021 cropping season. The choice of the field assistants considered their levels of education and their ability to communicate very well in the local language of the farmers. The researchers visited the study area to inform the rice farmers and all other stakeholders, namely; the Ketu North District Director of Agriculture, the Irrigation Scheme Manager and the Sectional Heads about the study, a month earlier than the data collection date. A three-day training workshop was organised to train the field assistants on skills of interviewing and to explain to them, the items on the instrument. A week prior to data collection, the study area was visited the second time to reach an agreement on the date and duration for data collection with the rice farmers and their Sectional Heads. Data was gathered for a period of two months.

Description of Variables

Output: This refers to the overall yield or total product of rice during the cropping season, measured in kilograms per hectare.

Land: It is the total area of the farmland under rice cultivation, this variable was measured in hectares. The amount of land used was expected to have a positive effect on output.

Labour: This includes both family and hired labour, was measured as person-days per hectare of farm from land preparation to harvesting. It was expected that labour will have a positive influence on output.

*Equipment:*The cost of farm tools and machinery involved in the production process. It is measured in Ghana Cedis (GH₵) per hectare. The use of equipment was anticipated to increase output.

Seed: This represents the quantity of rice seeds planted and was measured in kilogram (kg) per hectare. The plant population or output of rice is influenced by the quantity of seeds planted per hectare of land.

Pesticide: The quantity of agrochemicals (fungicides and insecticides) used, and was measured in litres per hectare. Its influence on output could be positive or negative.

Weedicide: This is the quantity of chemicals applied to control weeds before and after planting. It was measured in litres per hectare of farmland. Like pesticides, the use of weedicides can influence output positively or negatively.

*Fertilizer:*The amount of fertilizer applied on rice plots in kilograms per hectare during the cropping season. It was expected that fertilizer would have a positive influence on yield.

Irrigation cost: This was measured as the amount (in Ghana Cedis) spent on irrigation per hectare per cropping season. This was expected to increase output.

Model Specification

The translog functional form was adopted to , to compute output level such that it will be consistent with the theory of production function after preliminary testing for the most appropriate functional form of the model under the available data set using the generalised likelihood ratio test [25]. The null hypothesis tested was that the Translog functional form does not fit the data more than the Cobb-Douglas. The generalised likelihood-ratio test statistic takes the form

$$LR = -2\left[\, In\{L(H_0)\} - In\{L(H_1)\}\right] \;..(1)$$

where:

$L(H_0)$ and $L(H_1)$ are the null and alternative hypotheses values of the likelihood function respectievly.The translog production function is given as:

$$InY_i = \beta_0 + \sum_{i=1}^{8} \beta\, Inx_i + \frac{1}{2}\sum_{i=1}^{8} Inx_i \sum_{j=1}^{8} \beta_{ij}\, Inx_j + (v_i - u_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where:

Y_i is the output of rice (kilograms) produced by the i^{th} farmer; x is a set of eight input categories namely: land area (hectares), labour (person-days), seed (kilograms), weedicides (litres), pesticides (litres), equipment (GH₵), fertiliser (kilograms) and irrigation cost(GH₵);

β denotes the unknown parameters to be estimated; v_i denotes a random error that captures the stochastic effects that are beyond the farmer's control; u_i is the one-sided non-negative error representing inefficiency in production.The Maximum Likelihood Estimation (MLE) method was used to obtain the estimates for equations (2) in this study, using the computer programme,'R' by the simultaneous estimation procedure propounded by Reifschneider &Stevenson [22] and subsequently by Battesse & Coelli [3]. The MLE approach is defined as the value of the parameter that maximises the probabilityof randomly drawing a particular sample of observations [5]. It makes some distributional assumptions about the two error terms. Thus, it helps to model the impact that external factors may have on the distribution of the inefficiencies. The MLE is preferred to other estimators such as the ordinary least squares and the corrected ordinary least squares because it is asymptotic. That is, it has many desirable large sample properties. With the MLE, a value is chosen for β such that the value makes the observations the most likely observations and that there is a high concord between the model and the observations. This makes the method more unique, nearly unbiased with a large sample, and consistent as it brings the estimated parameter very close to the true value of the parameter. Aside the estimate of the β value, the ML estimation also generates the gamma (γ) value. The gamma computes the total variation of observed output from the frontier output. It is expressedthe error associated with inefficiency (σ_u^2) divided by the total variation in the model (σ^2).The total variation of the model is given as the sum of the variance of the error associated with inefficiency (σ_u^2) and the errors associated with the stochastic noise, σ_v^2, that is:

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \qquad (3)$$

The gamma estimate is specified as:

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \qquad (4)$$

Gamma (γ) takes a value between zero and one, that is, 0<= γ <=1. Variations in the observed output are attributed to inefficiency factors if the gamma value is equal to one. On the other hand, deviation from the frontier output is entirely attributed to statistical noise (random factors) if the gamma value is equal to zero[4, 6]. Therefore, results would be equal to that of the ordinary least square results if the parameter gamma becomes zero whereas the noise term is irrelevant if the value of gamma equals one.

RESULTS AND DISCUSSIONS

The results of the likelihood ratio test shown in Table 1 give a p-value of 0.05676 which is statistically significant at the 10 percent level of significance, implying the rejection of the Cobb-Douglas functional form.

Table 1. Likehood Ratio Test

Model	Log-likelihood value	Degree of freedom	Chi-square	P- value
Cob-Douglas	-18.9452			
Translog	4.4345	33	46.76	0.05676**

** denotes significance at 10%.
Source: Field survey data, 2021

Table 2 gives the summary statistics of farmer-specific characteristics and production variables. As can be seen from Table 2, on average, rice farmers on the irrigation scheme had farming experience of 19 years, with a minimum of 2 years and a maximum of 36years.

The mean years of formal education was 5 years with a minimum of zero and a maximum of 13 years. Also, the mean extension contact was twice a year. This is extremely low; considering the relevance of extension in agriculture.

The low extension contacts mean that not much information gets to the farmers in the form of innovations and technologies. Furthermore, Table 2 also shows that on average, rice farmers on the Weta Irrigation Scheme produced 6,059.9kilograms of rice per hectare with an average of 1.66hectares of land, 275kilograms of seeds , 492.33b kilograms of fertilizer ,21.15litres of weedicide,16.98litres of pesticide, 625person days of labour, GH¢608.50 worth of irrigationfacilities and GH¢40.75 worth of equipment per hectare. The minimum yield of rice was 3,250kilograms/hectare and the maximum was 22,000kilograms/hectare.

The large variation in rice output in the study area can be attributed to variations in their levels of technical efficiency.

Table 2. Summary Statistics of Production Parameters and Farmer-Specific Characteristics

Variable	Minimum	Maximum	Mean	Standard deviation
Output (kg/ha)	3,250.00	22,000.00	6,059.85	4,082.75
Land area (ha)	0.80	4.00	1.66	1.77
Fertilizer (kg/ha)	187.50	1,000.00	492.33	163.55
Seed (kg/ha)	75.00	600.00	275.00	101.88
Pesticide (litres/ha)	2.50	40.00	16.98	7.78
Weedicide (litres)/ha	10.00	35.00	21.15	6.38
Labour (person days/ha)	195.00	1,350.00	625.01	282.95
Irrigation cost (GH¢/ha)	150	1240	608.50	236.65
Equipment (Gh¢/ha)	17.50	70.00	40.75	12.05
Farming experience (years)	2.00	36	18.58	1.77
Years of formal education (years)	0.00	13.00	5.58	3.58
Extension contacts (number)	0.00	6.00	2.34	1.77

Source: Field survey data, 2021.

Table 3 indicates the results of MLE for the translog production function parameters. Results indicates that only inputs of land area under cultivation, equipment, fertilizer and irrigation costs were statistically significant at 5 percent. This implies that, among the eight inputs, only land, equipment, fertilizer, and irrigation cost were important factors that had significant effects on rice yield. The other inputs, namely; labour, seed, weedicide, and pesticide were not significant factors that influence the yield of rice.Among the significant inputs, however, only equipment cost has a negative sign. The negative sign on equipment cost implies that an increase in equipment cost would result in a decrease in rice output. In other words, rice output in the district would increase when equipment cost decreases. This finding is contrary to that of Ayalwe et al. [2] that equipment cost contributed positively to rice output in selected rice-growing districts in Ghana. The negative sign could be due to the use of heavy equipment such as tractors and power tillers by the rice farmers on small land holdings. This is because heavy farm equipment such as tractors and tillers could not be utilised efficiently on small landholdings such as 0.8 hectares. Moreover, it was found that most of the farmers had too many equipment relative to the size of their farms. Therefore, this equipment could not be put to optimum use and could result in increasing average cost.Fertilizer input has a positive sign and this implies that an increase in fertilizer quantity in the study area would increase the yield of rice. This finding confirms that of Rahman et al. [21] and Das & Hossain [9] who found fertilizer to be significant with a positive coefficient among marginal, small, and medium-scale rice farmers in Bangladesh. The finding also confirms that of Konja, Mabe&Alhassan [16]. Also, the variable, land is significant with a positive sign. This implies that if the land area under cultivation is increased, rice ouput will also increase significantly.Again, this finding confirms the finding of Konja, Mabe&Alhassan [16] who found an increase in the land area under cultivation (farm size) would cause rice output to increase among rice farmers in the Northern Region of Ghana. Also, irrigation cost was significant with a positive sign. This indicates that an increase in irrigation cost would increase output. This could be explained by the fact that the amount paid for irrigation was proportional to the total land area under rice cultivation in the study area,which contributed positively to output. These findings confirm that of Rahman et al. [21] who discovered land area under cultivation and irrigation cost to be significant and positively contributed to theoutput of rice among marginal, small, medium, and large-scale rice farmers in Bangladesh. Hence, the null hypothesis that input factors have no significant effect on rice output is rejected in favour of the alternative hypothesis.

In the case of the squared values of the input variables, none of them was significant. However, three of them, namely land, fertilizer, and irrigation cost had positive signs while the remaining five inputs had negative signs. The squared values in a translog model show the long-term effects of the input variables on output. For instance, the fact that land and land squared were both positive impliesthat both in the short and long term, an increase in cultivation land would lead to an increase in output.

Table 3. MLE for the Translog Frontier Production Function Parameters

Variable	Parameter	Coefficient	Standard error	Z – value
Intercept	β_0	0.3745***	0.01147	3.2651
ln(mland)	β_1	0.4421**	0.2267	1.9501
ln(mlabour)	β_2	- 0.0509	0.0735	- 0.6928
ln(mseed)	β_3	- 0.0320	0.0824	- 0.0185
ln(mweedicide)	β_4	- 0.0014	0.0771	-0.0185
ln(mpesticide)	β_5	-0.0915	0.0704	- 1.2986
ln(mequipment)	β_6	- 0.1415**	0.0804	-1.7592
In(mfertilizer)	β_7	0.1460**	0.0796	1.8343
ln(mirrigation)	β_8	0.3722**	0.2158	1.7248
½ [In(mland)] ^{2}	β_9	4.0325	2.5886	1.5578
½ [ln(mlabour)]^2	β_{10}	-0.4927	0.3277	-1.3774
½ [ln(mseed)] ^{2}	β_{11}	-0.4819	0.4463	-1.0797
½[ln(mweedicide)]^2	β_{12}	-0.5294	0.4882	-1.0846
½ [lnmpesticide)] ^{2}	β_{13}	-0.1739	0.1390	-1.2424
½[ln(mequipment)]^2	β_{14}	-0.8909	0.5639	-1.2424
½ [ln(mfertilizer)] ^{2}	β_{15}	0.2037	0.4236	0.4810
½ [ln(mirrigation)]^2	β_{16}	-2.2893	1.7236	-1.3282
ln(mland)*ln(mlabour)	β_{17}	-0.6767	0.7013	-0.9649
ln(mland)*ln(mseed)	β_{18}	-1.4844*	0.6942	-2.1383
ln(mland)*ln(mweedicide)	β_{19}	0.0178	0.8931	0.0199
ln(mland)*ln(mpesticide)	β_{20}	0.2296	0.3181	0.7218
ln(mland)*ln(mequipment)	β_{21}	0.9574	0.9948	0.9624
ln(mland)*ln(mfertilizer)	β_{22}	-0.4546	0.7729	-0.5881
ln(mland)*ln(mirrigation)	β_{23}	-2.8567	1.7729	-1.6098
ln(mlabour)*ln(mseed)	β_{24}	0.4329	0.2725	1.5885
ln(mlabour)*ln(mweedicide)	β_{25}	0.1598	0.3252	0.4915
ln(mlabour)*ln(mpesticide)	β_{26}	-0.0202	0.2059	-0.0983
ln(mlabour)*ln(mequipment)	β_{27}	-0.2544	0.3709	-0.6858
ln(mlabour)*ln(mfertilizer)	β_{28}	-0.0283	0.3723	-0.0761
ln(mlabour)*ln(mirrigation)	β_{29}	0.4979	0.6004	0.8293
ln(mseed) *ln(mweedicide)	β_{30}	-0.5679**	0.3155	-1.7998
ln(mseed)*ln(mpesticide)	β_{31}	0.1011	0.1643	0.6155
ln(mseed)* ln(mirrigation)	β_{34}	1.5351*	0.6115	2.5104
ln(mweedicide)*ln(mpesticide)	β_{35}	-0.0239	0.2084	0.1148
ln(mweedicide)*ln(mequipment)	β_{36}	0.6058**	0.3686	1.6473
ln(mweedicide)*ln(mfertilizer)	β_{37}	0.2742	0.3086	0.8889
ln(mweedicide)*ln(mirrigation)	β_{38}	0.0224	0.7602	0.0295
ln(mequipment)*ln(mfertilizer)	β_{39}	0.1992	0.3035	0.6564
ln(mequipment)*ln(mirrigation)	β_{40}	-1.3375**	0.7098	-1.8844
ln(mfertilizer)*ln(mirrigation)	β_{41}	0.1897	0.6354	0.2986
Variance parameters Sigma squared Gamma Log likelihood value	 σ^2 = γ = =	 0.0973*** 0.9191*** 4.4345		

***, **, *indicates significance at 1%, 5%, 10% respectively.

Source: Field survey data, 2021.

This finding is contrary to that of Donkoh, Ayambila&Abdulai [11] who found that a continuous increase in land area under cultivation would lead to a decrease in the output of rice on the Tono irrigation scheme both in the short and long term.

Also, an increase in fertilizer and irrigation cost would result in an increase in output both in the short and long term since the square of these variables are positive. Also, a negative sign on labour and labour squared shows that outputdeceases in both short and long runs when labour is increased. Similarly, an increase in seed rate, weedicide, pesticide, and equipment cost would lead to a decrease in output.

The interaction terms explain the substitutability or complementarity of the variables. A parameter with a positive sign implies that the two variables are complementary, while a parameter with a negative sign means that the two variables are substitutes. From Table 3, the statistically significant parameters with a positive sign are the interactions between seed and irrigation cost at 5 percent, and weedicide and equipment at 10 percent. Those with negative signs are land and seed at 5 percent; seed and weedicide at 10 percent and equipment and irrigation at 10 percent. The positive sign on the interactions between seed and irrigation cost implies that seed was complementary to irrigation therefore the two inputs would be more productive when used together. Weedicide use was also complementary to equipment usage.The implication is that a combination of the two inputs jointly contribute positively to output.

Conversely, seed substituted for land and weedicide while equipment and irrigation costs were substitutes. The implications are that interactions between these pairs of inputs gave less productive results when used together.

Diagnostic Statistics

Table 3 indicates that the estimate of sigma-squared (σ^2) value of 0.097, is statistically significant at 0.1 percent. This indicates a good fit and the accuracy of the specified distributional assumption of the composite error term. The gamma value (γ) measures inefficiency in the variance parameter and assumes a value of zero to one. From Table 3, the computed gamma was approximately 0.92 or 92 percent. This means that 92 percent of the variations in rice output were due to inefficiency of the rice farmers. The results of the diagnostic statistics therefore, confirm the relevance of the stochastic parametric production function and the MLE Method.

Elasticity of Output

Determining the elasticity is important for the estimation of the responsiveness of output to input. Table 4 gives the output of the translog production function. It can be observed from Table 4 that theinput elasticity of land area under cultivation was 0.44. This means that a 1 percent increase in land area under cultivation would increase yield of rice by 0.44 percent. Also, a 1 percent increase in the quantity of fertilizer would increase output by 0.14 percent and a 1 percent increase in irrigation cost would increase output by 0.37 percent. However, coefficients of elasticity of labour, seed, weedicide, pesticide and equipment were negative. The implications are that a 1 percent increase in labourand quantity of seed planted would decrease output by 0.05 and 0.03 percent respectivelty.A percentage increase in the quantity of weedicide would decrease output by 0.001 percent; a 1 percent increase in the quantity of pesticide and cost of equipment would decrease output by 0.09 and 0.14 percent. Moreover, all the inputs used in the production of rice in the study area were found to be inelastic; a 1 percent increase in each input resulted in less than proportionate increase in output.

Table 4. Elasticity of output and return-to-scale

Input variable	Elasticity	Return-To-Scale (RTS)
ln(mland)	0.442	0.642
ln(mlabour)	-0.051	
ln(mseed)	-0.032	
ln(mweedicide)	-0.001	
ln(mpesticide)	-0.092	
ln(mequipment)	-0.142	
In(mfertilizer)	0.146	
ln(mirrigation)	0.372	

Source: Field survey data, 2021.

Furthermore, the return-to-scale indicated in Table 4 is 0.642. The return-to-scale of the technology is given by the sum of the elasticities of all the inputs. If all inputs are varied by the same proportion, the return-to-scale shows the percentage by which output would increase. The return-to-scale of 0.642 is less than one and indicates a decreasing return

to scale. The implication is that if all inputs are proportionally increased by 1 percent, rice yield would increase by only 0.642percent. It is a decreasing return to scale
because the relative increase in output is less than the relative increase in the aggregate input quantity. This suggests that farmers were producing at the irrational stage of production.

Policy Implications

1. Land tenure reforms to increase land area under cultivation would increase output.
2. Fertilizer subsidy policy of government, together with creation of an enabling environment for individuals to make fertilizer available to farmers would increase fertilizer use leading to a rise in output.
3. Government policy that provides irrigation facilities, makes water available for all year round production, increasing output.

CONCLUSIONS

The significant input factors affecting the output of rice in the study area were land area under cultivation, fertilizer input, irrigation cost and equipment. Among these, only equipment affected rice output negatively while land area under cultivation, fertilizer, and irrigation cost positively influenced output. Also, the returns to scale was estimated at 0.642, implying that the rice farmers were producing at decreasing returns-to-scale, that is, a one percent increase in all inputs yielded less than a proportionate increase in output**.** Based on the findings,the study recommends that the land area under irrigation should be expanded and the Irrigation Authority should provide adequate irrigation facilities to scale up farmers' land holdings on the irrigation scheme to increase output. In addition, the Ministry of Food and Agriculture shouldadopt appropriate measures such as introducing a fertilizer subsidy that will ensure the availability of fertilizers at affordable rates to farmers. This would increase fertilizer use resulting in increased yield. Furthermore, farmers should be educated on the optimum use of equipment to increase output.

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THE IMPACT OF INFORMATION POLLUTION IN THE POULTRY SECTOR ON CONSUMERS: THE CASE OF TURKEY

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Abstract

The poultry sector provides numerous benefits in the social, economic, and health domains, but is currently facing a major issue: information pollution. It is among the sectors most affected by information pollution globally, a phenomenon fueled by the rapid advancement of communication technologies. Information pollution has become a major challenge of our time, causing harm to the consumer market through its negative impact on consumer perceptions and behaviors. Turkey is an interesting case for studying the impact of information pollution on poultry consumers, as it is among the top 10 countries in poultry production and exports, and experiences intense information pollution in the sector. The primary objective of this study is to examine the impact of information pollution on Turkish poultry consumers and to explore potential solutions to this problem. The study surveyed 384 consumers from Ankara and İzmir and found that consumer perceptions and views of poultry differ significantly from those of the producer companies and the Turkish Ministry of Agriculture and Forestry. A significant proportion of respondents reported reducing their poultry consumption after hearing negative news. The groups most likely to reduce their consumption are women, housewives, and people over the age of 55. Given its significant and serious impact on consumers, efforts must be made to address this issue.

Key words**:** *information pollution, misinformation, poultry, chicken, consumer*

INTRODUCTION

The poultry sector contributes to food security [49], helps rural development [1, 38], plays a role in diminishing poverty in rural areas thanks to the income it creates for small-scale farmers [30], helps increase quality of life by ensuring the production of a generous amount of food at a low price [26], meets several needs, including energy, high-quality protein and basic micronutrients [33], contributes considerably to employment, both directly and together with its sub-sectors [34], and serves as the fastest-growing agricultural sub-sector, especially in developing countries [33], all of which make it a highly significant sector. The lower prices when compared to most other types of meat, short production cycles and high feed conversion ratio make both chicken meat and the poultry sector even more valuable [43]. All of these factors in combination ensure the poultry sector provides countries with highly significant social, economic and healthy-diet-related opportunities.

That said, the poultry sector is today facing the significant problem of information pollution, and can be counted among the sectors that have been most affected by the information pollution phenomenon around the world [8, 12, 35, 41, 42], nurtured by the rapid developments in information and communication technologies. As a result, information pollution has become one of the leading problems of the age in which we live [28]. In general terms, information pollution is defined as “the presence of useless, harmful, malicious or unwanted messages and the spread of these messages to the extent that they have significant negative impacts on society” [10], and it is a significant area of study in literature.

In addition to “information pollution,” other terms such as “information overload” [21, 36], and “infollution” [14, 39] are also used to refer to the phenomenon, while terms commonly found in literature include “misconception” [8, 12] “misperception” [25], “misinformation” [3] “disinformation” [18] and “fake news” [41], among others. As these concepts have similar meanings and are frequently used interchangeably, it has been suggested that "problematic information" be used as an umbrella term to cover all [32].

Information pollution is a significant problem that can have a negative impact on the individual given the wealth of unregulated information to which they are subjected, leading them to experience stress and anxiety [17], to suffer from attention deficit and impatience [7], as well as mental exhaustion. As a result, people may start avoiding information as a reaction [27]. The widespread use of the Internet and social media has increased the prevalence of information pollution, which has now permeated almost every field. In information pollution, information may be shared in the belief that it is true, or spread intentionally to trick other people as a source of fun. It has been determined that consumers are less satisfied with their decisions and experience more complicated emotions when making their decisions if they are exposed to information overload and pollution while making a purchase [11]. The COVID-19 pandemic has proven once again how significant a problem information pollution is, with information pollution having a negative impact on individuals in several aspects [6, 48]. One of the areas most affected by information pollution is the consumer market, given how consumers' perceptions and behaviors can be negatively affected by it. Fake news and information pollution are significant problems that misguide consumers, harming both marketing activities and brands [13, 19].

Turkey is considered an interesting case for an investigation of the impact of information pollution on poultry consumers, being among the top 10 countries in terms of poultry production and exports [24], and the intense information pollution in the poultry sector that has a significant impact on the country's poultry sector [2, 4, 22, 37, 50]. Print and visual media in Turkey, in particular, frequently run negative stories about chicken and poultry production. Such stories have made various claims, including "consuming poultry is bad for health," "eating poultry leads to cancer," "there is an excessive use of hormones and antibiotics in poultry production," "chickens are fed drugs to make them grow faster" and "poultry consumption leads to early-onset puberty in children" [9]. The Ministry of Agriculture and Forestry, as well as poultry producers, have stated that these stories have no scientific basis, and are simply not true [9, 45]. Fighting the problem of information pollution related to the poultry sector in Turkey is a priority issue for the Ministry of Agriculture and Forestry, and various strategic plans have been drawn up to address the issue as an important problem that needs to be resolved [44, 46].

The potential for the rapid spread of fake news makes it a highly pertinent issue that should be subject to further study [40]. It has been emphasized that such sensitive groups as children, teenagers and older adults, in particular, should be protected from the impacts of information pollution and misinformation [6]. The impact of the perceptions and knowledge of consumers about poultry on their poultry consumption habits and behaviors is yet to be fully understood, given the lack of research in the field [23]. Furthermore, literature contains very few studies investigating the impact of the negative news about poultry that appear in the media, and the effect of people's perceptions and ideas about poultry on consumption [5, 22]. The main objective of this study is to investigate the impact of information pollution, a significant problem in the poultry sector, on Turkish consumers, and to discuss what needs to be done to resolve this information pollution problem. As secondary objectives of the study, it is intended to determine the problem areas in the perception of consumers regarding the consumption of poultry, and to identify their sources of information and how much trust they place in them. The study will clarify the areas of concern related to the poultry sector among consumers, will present their thoughts on some of the more common perceptions, and will determine the groups affected by information pollution. The study will thus serve as a valuable source of information for future studies in this field, which are currently lacking.

MATERIALS AND METHODS

The Turkish poultry sector is mostly concentrated in regions with numerous poultry houses and in areas close to the largest markets. From a geographical point of view, the Aegean and Central Anatolian regions record the greatest per capita consumption in Turkey [20], due to the respective presence of İzmir and the capital city Ankara, both of which are densely populated cities. As two of the three largest cities in Turkey, İzmir and Ankara record significant production and consumption through the many poultry producers in their vicinity. It is for this reason that İzmir and Ankara were selected for the consumer survey devised for this study, with the main study material comprising the data collected from consumers living in the two cities.

In cases where p and q probability values are not known and no data is available to determine the sample volume, a p value of 0.50 is recommended to ensure the largest sample size, as was the case in the present study [16, 31]. Proportional sampling methods are commonly used in consumer and market surveys, especially when there is no information about the characteristics of the population (variance) [15, 31]. Accordingly, the following approach was adopted for the calculation of the sample volume, based on the formula:

$$\mathrm{n} = \frac{t^2pq}{d^2}$$

where:
n= Sample volume
t: value corresponding to a 95% confidence interval
p: probability of the event in question occurring
q: probability of the event in question not occurring
d: acceptable margin of error

The p value was taken as 0.50 to reach the maximum sample volume, and the sample volume was found to be 384 with 95% confidence and a 5% margin of error.

The consumer surveys were proportionally distributed based on Ankara and İzmir’s populations over the age of 18 years. Accordingly, surveys were conducted with 211 and 173 consumers in Ankara and İzmir, respectively (Table 1).

Table 1. City Populations and Surveys’ Proportional Distribution

City	Population	Population over 18 years old	%	Sample Volume
Ankara	5,445,026	3,895,027	54.96	**211**
İzmir	4,279,677	3,192,114	45.04	**173**
Total	9,724,703	7,087,141	100.00	**384**

Source: Turkish Statistical Institute, 2017 [47].

A logistic regression model was developed for the consumers who accessed news from the media or from other resources regarding the harmful effects of poultry consumption (GMO, use of hormones etc.). In the model, consumption status after seeing negative news about poultry (whether or not consumption has decreased) was defined as a dependent variable, and a Binary Logistic Regression model was used, with the aim being to identify the factors that led to a decrease in poultry consumption after seeing negative news about poultry. The aim was thus to determine the factors leading to a decrease in consumption, to identify the bodies of consumers who are affected by negative news about poultry, and to detect which consumer type is more likely to consume less poultry after hearing such negative news. Basic statistical techniques and procedures, such as frequency distributions, arithmetic means and percentage calculations, were used for the descriptive statistical analyses.

RESULTS AND DISCUSSIONS

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A total of 384 consumers participated in the study, of which 51.8 percent were female and the remaining 48.2 were male. When grouped according to geographical region, it was found that most of the respondents were born in the Aegean and Central Anatolia regions, accounting for 70.6 percent of the total. Furthermore, 54.7 percent were born in cities, 31 percent in district centers and 14.3 percent in villages. Of the consumers, 48.7 percent were between the ages of 18 and 35, while the ratios of single and married participants were similar (50.8 percent single and 49.2 percent married). In terms of education level, 57.3 percent had a bachelor's degree, and 32.3 percent were high school graduates. Of the total, 54.9 percent were employed, while students and the retired accounted for 19 percent and 15.4 percent, respectively (Table 2).

Table 2. Socio-demographic Characteristics of Consumers

	Count	%
Gender		
Male	185	48.2
Female	199	51.8
Place of Birth (Geographical Region)		
Central Anatolia Region	137	35.7
Aegean Region	134	34.9
Mediterranean Region	14	3.6
Black Sea Region	25	6.5
Eastern Anatolia Region	20	5.2
South Eastern Anatolia Region	25	6.5
Marmara Region	20	5.2
Overseas	9	2.4
Place of Birth (Administrative Unit)		
Village	55	14.3
District Center	119	31.0
City Center	210	54.7
City of Residence		
Ankara	211	54.9
İzmir	173	45.1
Age		
18-35	187	48.7
36-55	119	31.0
55 and above	78	20.3
Marital status		
Single	195	50.8
Married	189	49.2
Education		
Lower than high school	40	10.4
High school graduate	124	32.3
Bachelor's degree and above	220	57.3
Occupations		
Student	73	19.0
Housewife	33	8.6
Employed	211	54.9
Retired	59	15.4
Unemployed	8	2.1
Personal Monthly Income		
<700 $	267	69.5
≥700 $	117	30.5
Monthly Income of the Household		
<700 $	137	35.7
≥700 $	247	64.3

Source: Author's survey data.

The ratio of consumers with a monthly personal income of < 700 $ was 69.5 percent, while 64.3 percent had a monthly household income of ≥ 700 $ (Table 2).

Of the consumers, 76.3 percent defined their health status as good; and 20.6 percent stated that they followed a healthy diet, while 56.5 percent stated that they followed a healthy diet to a reasonable extent. Of the total, 86.5 percent stated that they had no food allergy; 79.9 percent said that they exercised regularly; 63.3 percent said that they read labels and product info when purchasing a food product; and 66.9 percent were non-smokers. Those who lacked trust in the poultry sector accounted for 54.4 percent of the total, while 35.4 percent said they trusted the sector to a reasonable extent. When asked about how much they thought they knew about the breeding, sheltering and feeding conditions of industrial chickens, 49.2 percent stated that they had no knowledge of these issues, while 44.3 percent stated that they had a moderate level of knowledge (Table 3).

Table 3. Characteristics of the attitude and behavior of consumers on various issues

	Count	%
Health status		
Poor	7	1.8
Moderate	84	21.9
Good	293	76.3
Healthy diet		
I do not follow a healthy diet	88	22.9
I follow a healthy diet to some extent	217	56.5
I follow a healthy diet	79	20.6
Food allergy		
I have a food allergy	52	13.5
I have no food allergies	332	86.5
Regular exercise		
I exercise regularly	77	20.1
I do not exercise regularly	307	79.9
Reading labels while purchasing food products		
I read labels	243	63.3
I do not read labels	141	36.7
Smoking status		
I smoke	127	33.1
I do not smoke	257	66.9
Trust in the poultry sector		
I do not trust	209	54.4
I moderately trust	136	35.4
I trust	39	10.2
Level of knowledge about the breeding, sheltering and feeding conditions of industrial poultry		
I have no knowledge	189	49.2
I have a moderate level of knowledge	170	44.3
I am knowledgeable	25	6.5

Source: Author's survey data.

When asked whether they had been exposed to any news in the media or from other resources about the possible harm associated with the consumption of poultry due to such factors as hormones, antibiotics, GMOs, etc., 93.8 percent stated that they had, while only 6.2 percent said that they had not.

These findings indicate that such news reaches a significant proportion of consumers (Table 4).

An analysis of consumption rates after having seen news about the possible harm associated with the consumption of poultry revealed that for 35 percent of the consumers, their consumption habits did not change, while 65 percent stated that they consumed less poultry. The fact that almost two-thirds of consumers consumed less poultry after seeing such news indicates the extent to which negative news affects consumer choice (Table 5).

Table 4. Consumer access to news in the media or from other sources reporting on the harm associated with poultry consumption

Consumer access to news on the harm associated with poultry consumption	Count	%
Yes, I had been exposed	360	93.8
No, I had not been exposed	24	6.2
Total	**384**	**100.0**

Source: Author's survey data.

Table 5. Change in consumption habits after having seen news in the media or from other sources about the harm associated with poultry consumption

Consumption habits	Count	%
My consumption habits did not change	126	35.0
I consumed less poultry	234	65.0
Total	**360**	**100.0**

Source: Author's survey data.

When asked whether they would consume more poultry if they were absolutely certain that poultry is bred in healthy conditions and that the consumption of poultry was not harmful to health, 78.1 percent of the respondents stated that they would consume more poultry, while 21.9 percent stated that they would not. These figures suggest that there is a large group of people who may start consuming greater amounts of poultry if their health-related concerns about poultry were to be eliminated (Table 6).

Table 6. Changes in consumption habits if poultry was confirmed to be healthy

Consumption habits	Count	%
I would consume more poultry	300	78.1
I would not consume more poultry	84	21.9
Total	**384**	**100.0**

Source: Author's survey data.

The respondents were presented with a series of common perceptions and problematic information related to the consumption of poultry, and were asked whether they agreed with the statements or not, with the additional options of "I do not know" or "I am not sure". Accordingly, a significant proportion of the consumers were of the opinion that feeding poultry with feed based on GMOs was harmful to those consuming poultry (79.2%), that chickens are given drugs to make them grow faster (75%), that hormones were used in the breeding of poultry (74.2%), and that the reason why it is possible to breed and slaughter poultry within 45 days is due to the use of antibiotics and hormones (70.1%). Such institutions and organizations as the Ministry of Agriculture and Forestry, and BESD-BİR – Association of Poultry Meat Producers and Breeders – claim that such statements are not true. They state that poultry is not given drugs that induce growth, claiming that rapid growth is achieved through breeding, broilers being high-yield hybrid species that have been produced through natural hybridization [9, 45]. It was thus concluded that most consumers either do not agree with, or are unaware of the statements made by the Ministry of Agriculture and Forestry and BESD-BİR. The consumers agreed with other presented statements, though to a lesser extent, including the suggestion that eating poultry can increase the risk of cancer (34.4%), can lead to early puberty in children (39%) and can change the hormonal structure of humans (39.3%). As another significant finding, 85.4 percent of the consumers were of the opinion that more studies are needed to investigate the harms/benefits of consuming poultry, meaning that a substantial proportion of consumers want to see more research into these subjects (Figure 1).

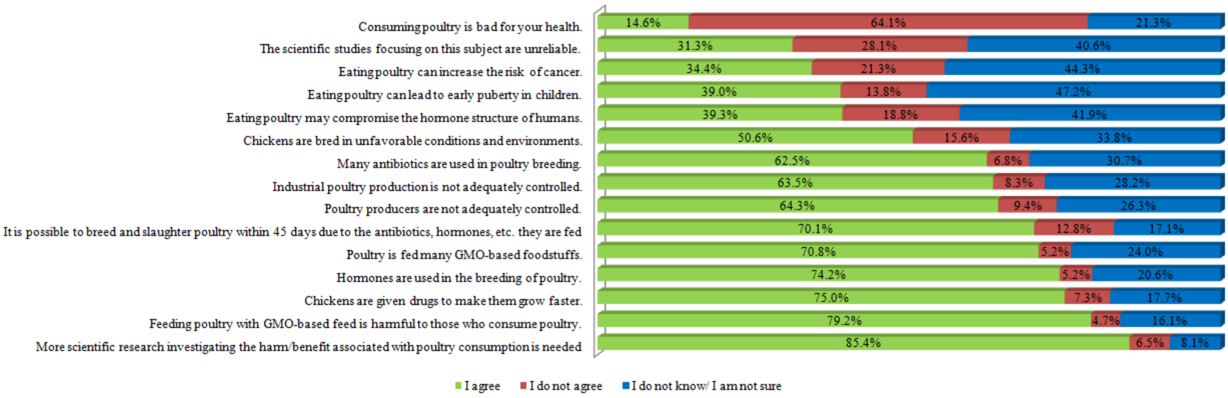

Fig. 1. Consumers' opinion about some common perceptions related to the consumption of poultry
Source: Author's survey data.

An analysis of the sources of information about poultry and poultry consumption revealed the top three sources for consumers to be television (88%), websites (73.7%) and social media (61.2%).

Only 27.1 percent of the consumers said that their sources of information were medical doctors, while the rate of those who cited academicians as their sources of information was 21.4 percent.

The Ministry of Agriculture and Forestry (13.8%) and the Ministry of Health (13%), on the other hand, ranked very low on the list of information sources (Table 7).

Table 7. Information sources about poultry and poultry consumption

Information sources	**Count**	**%**
Television	338	88.0
Websites	283	73.7
Social Media (Facebook. Twitter. Instagram etc.)	235	61.2
Friends	164	42.7
Newspapers	155	40.4
Family	127	33.1
Medical doctors	104	27.1
Academicians	82	21.4
Radio	70	18.2
Poultry producer firms	56	14.6
The Ministry of Agriculture and Forestry	53	13.8
The Ministry of Health	50	13.0
Magazines	50	13.0
Farmers producing poultry in the villages	50	13.0
Books	41	10.7
Farmers producing poultry for the sector	21	5.5

Source: Author's survey data.

The top three sources of information in which the consumers placed their trust on the issue of poultry were academicians (3.58), medical doctors (3.58) and family (3.36).

Their level of trust in contracted farmers producing poultry for the sector (2.50) and poultry producer firms (2.30), on the other hand, was found to be extremely low.

The fact that the level of trust towards all sources of information varies between 2.30 and 3.58 indicates that the level of trust placed by consumers in all sources of information is generally low (Table 8).

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Table 8. Levels of trust in information sources

Information Sources	**1**	**2**	**3**	**4**	**5**	**Likert scale mean**
Academicians	17	24	112	178	53	3.58
Medical doctors	13	37	106	169	59	3.58
Family	14	42	147	152	29	3.36
Books	21	37	169	136	21	3.25
Farmers producing poultry in the villages	32	56	162	108	26	3.10
Friends	23	63	175	112	11	3.06
Ministry of Health	74	56	108	117	29	2.92
Ministry of Agriculture and Forestry	81	52	125	99	27	2.84
Magazines	43	70	196	68	7	2.80
Newspapers	50	68	189	68	9	2.78
Websites	53	110	146	63	12	**2.66**
Television	64	106	139	67	8	**2.60**
Social Media (Facebook, Twitter, Instagram etc.)	68	118	133	55	10	**2.53**
Radio	71	107	150	49	7	**2.51**
Farmers producing poultry for the sector	87	89	145	52	11	**2.50**
Poultry producer firms	111	102	118	47	6	**2.30**
1=I do not trust at all, 5=I trust completely						

Source: Author's survey data.

Table 9. Variables in logistic regression model, and characteristics thereof

Variables	**Variable Characteristics**
Dependent Variable	
Changes in consumption after seeing negative news about poultry	Nominal Scale: My consumption did not change I started consuming less poultry
Independent Variables	Variable Characteristics
Gender	Male, Female
Place of Birth (Geographical Region)	Central Anatolia, Aegean, Mediterranean, Black Sea, Eastern Anatolia, Southeastern Anatolia, Marmara, Overseas
Place of Birth (Administrative Unit)	Village, District Center, City Center
City of Residence	Ankara, İzmir
Age	18–35, 36–55, 55 and above
Marital status	Single, Married
Education	Lower than high school, High school graduate, Bachelor's degree and above
Occupations	Student, Housewife, Employed, Retired, Unemployed
Personal monthly income	< 700$, ≥ 700$
Monthly income of the household	<700$, ≥ 700$
Health status	Poor, Moderate, Good
Healthy diet	I do not follow a healthy diet, I follow a healthy diet to some extent, I follow a healthy diet
Food allergy	I have a food allergy, I have no food allergies
Regular exercise	I exercise regularly I do not exercise regularly
Reading labels while purchasing food products	I read labels, I do not read labels
Smoking	I smoke, I do not smoke
Trust in the poultry sector	I do not trust I moderately trust I trust
Level of knowledge about the breeding, sheltering and feeding conditions of industrial poultry	I have no knowledge I have a moderate level of knowledge I am knowledgeable

Source: Author's survey data.

A logistic regression model was developed for consumers who have seen news in the media or from other sources regarding the harmful effects of poultry consumption (GMO, use of hormones etc.). In the model, consumption status after seeing negative news about poultry (whether consumption decreased or not) was defined as a dependent variable. A Binary Logistic Regression model was then applied identify define the factors that led to a decrease in consumption of poultry after the exposure of consumers to negative news about poultry. Table 9 presents the model variables and their characteristics.

In the logistic regression model presented in Table 9, the first category of each variable was taken as the reference category of the categorical independent variables. Similarly, in the dependent variable, the reference category is the first category, i.e. no change in consumption. The results of the model created based on a binary logistic regression analysis are presented in Table 10.

Table 10. The results of the model created based on a binary logistic regression analysis

Variables	B	S.E.	Wald	Sig.	Exp(B)
Gender (Female)* **	**.959**	**.315**	**9.291**	**0.002**	**2.610**
Place of Birth (Geographical Region)			3.565	0.828	
Place of Birth (Aegean)	.128	.387	.109	0.742	1.136
Place of Birth (Mediterranean)	-.786	.791	.987	0.320	.456
Place of Birth (Black Sea)	-.132	.557	.056	0.812	.876
Place of Birth (Eastern Anatolia)	-.873	.630	1.916	0.166	.418
Place of Birth (Southeastern Anatolia)	-.114	.527	.047	0.829	.892
Place of Birth (Marmara)	-.028	.696	.002	0.968	.973
Place of Birth (Overseas)	.285	1.001	.081	0.776	1.330
Place of Birth (Administrative Unit)			1.115	0.573	
Place of Birth (District Center)	.420	.444	.892	0.345	1.521
Place of Birth (City Center)	.157	.421	.140	0.709	1.170
City of Residence (İzmir)	-.043	.346	.016	0.901	.958
Age*			**4.707**	**0.095**	
Age (36-55)	.252	.363	.482	0.488	1.287
Age (55 and above)**	**1.568**	**.726**	**4.671**	**0.031**	**4.799**
Marital Status (Married)	.391	.352	1.231	0.267	1.478
Education			1.211	0.546	
Education (High School Graduate)	.101	.543	.035	0.852	1.107
Education (Bachelor’s Degree and Above)	.470	.560	.704	0.401	1.600
Occupations			6.690	0.153	
Occupations (Housewife)*	**1.222**	**.718**	**2.901**	**0.089**	**3.395**
Occupations (Employed)**	**1.087**	**.469**	**5.381**	**0.020**	**2.966**
Occupations (Retired)	1.144	.833	1.885	0.170	3.138
Occupations (Unemployed)	-.109	.901	.015	0.904	.897
Personal Monthly Income (≥700 $)	-.300	.396	.574	0.449	.741
Monthly Income of the Household (≥ 700$)	.127	.347	.134	0.715	1.135
Health Status			4.263	0.119	
Health Status (Moderate)	1.600	1.053	2.307	0.129	4.954
Health Status (Good)	.987	1.048	.888	0.346	2.684
Healthy Diet*			**5.189**	**0.075**	
Healthy Diet (I follow a healthy diet to some extent)	.576	.350	2.697	0.101	1.778
Healthy Diet (I follow a healthy diet)**	**1.068**	**.476**	**5.039**	**0.025**	**2.908**
Food Allergy (I have no food allergies)	-.172	.429	.160	0.689	.842
Regular exercise (I do not exercise regularly)	-.149	.374	.159	0.690	.861
Reading Labels While Purchasing Food Products (I do not read labels)	-.070	.307	.051	0.821	.933
Smoking (I do not smoke)*	**-.507**	**.300**	**2.861**	**0.091**	**.602**
Trust In the Poultry Sector* **			**18.536**	**0.000**	
Trust In the Poultry Sector (I moderately trust)	-.372	.311	1.431	0.232	.689
Trust In the Poultry Sector (I trust)* **	**-2.091**	**.486**	**18.535**	**0.000**	**.124**
Level of knowledge about industrial poultry * **			**16.237**	**0.000**	
Level of knowledge about industrial poultry (I have a moderate level of knowledge)* **	**1.245**	**.310**	**16.135**	**0.000**	**3.474**
Level of knowledge about industrial poultry (I am knowledgeable)	.348	.603	.333	0.564	1.416
Constant	-2.813	1.288	4.766	0.029	.060
Model prediction success	74.4%				
−2 log likelihood	353.418				
Cox & Snell-*R* Square	0.269				
Nagelkerke-*R* Square	0.370				
Hosmer & Lemeshow test	4.822; p=0.776				

Source: Author’s survey data.

The results of the analysis reveal that such variables as gender, age, healthy diet, smoking, trust in the poultry sector, and the level of knowledge about industrial poultry are all statistically significant.

It should be noted that not every sub-category of a variable may necessarily be statistically significant. Furthermore, variables with some statistically significant sub-categories compared to the reference category may not be statistically significant when considered from the perspective of the whole variable. Accordingly, even though the occupation category was found not to be statistically significant as a whole, such sub-categories as housewife and employed were statistically significant when compared to the reference category of students.

With a 0.01 percent significance level, gender is a significant variable. After seeing negative news about poultry, more female participants started consuming less poultry than the male reference category, to a statistically significant degree. To be more specific, after seeing negative news about poultry, women are 2.61 times more likely to reduce their consumption of poultry than the reference category, i.e. males.

The age variable was also found to be statistically significant in the model. It was determined that people over the age of 55 reduced their consumption of poultry more than the participants in the reference age category, i.e. 18-35 years of age, to a statistically significant degree, after seeing negative news about poultry. More specifically, when compared to those aged 18–35, people over the age of 55 are 4.79 times more likely to consume less poultry after seeing negative news.

When considered as a whole, the occupation variable provided no statistically significant results in terms of the changes in consumption of poultry after seeing negative news. In the individual sub-categories, however, such sub-categories as housewife and employed provided statistically significant results when compared to the reference sub-category, i.e. student. According to the results of the analysis, after seeing negative news about poultry, housewives and employed people are respectively 3.39 and 2.96 times more likely to consume less poultry when compared to students.

The healthy diet variable is also statistically significant in terms of reducing the consumption of poultry. Accordingly, after hearing negative news, people who follow a healthy diet are 2.90 times more likely to reduce their consumption of poultry than those who do not follow a healthy diet.

In the model, smoking has a 10 percent significance level. After hearing negative news, non-smokers are 1.66 times more likely not to change their poultry consumption habits than smokers. This is an interesting finding, which can be associated with the perception among non-smokers that they are less likely to get sick since they do not smoke, and so are less concerned about consuming poultry. In other words, compared to non-smokers, smokers reduced their consumption of poultry after seeing negative news, to a statistically significant degree, which can be associated with concerns about their health due to smoking.

A negative correlation is identified between trust in the poultry sector and reducing poultry consumption after hearing negative news. After hearing negative news, those who trust the poultry sector were found to be 8.06 times more likely not to reduce their consumption of poultry than those who do not trust the sector.

The level of knowledge about industrial poultry has a statistically significant impact on the reduction in consumption of poultry after hearing negative news about poultry. Accordingly, when compared to those with no knowledge of the issue, those with a moderate level of knowledge about poultry are 3.47 times more likely to reduce their consumption of poultry. This is a striking result, suggesting that the group of people with a moderate level of knowledge, after seeing negative information about poultry, choose to reduce their consumption. This finding highlights the significance of information sources, and through which sources consumers obtain their information.

CONCLUSIONS

One of the most prominent findings of the present study is that the perception and thoughts of consumers about poultry differ from those is reflected by the producer companies and the Ministry of Agriculture and Forestry in general.

Of the participating consumers, 93.8 percent reported seeing news on the media or from other sources about the possible harm associated with the consumption of poultry due to such factors as hormones, antibiotics, GMOs, etc. Both this rate and the level of influence on consumers are pretty high. Accordingly, 65 percent of the consumers reported consuming less poultry after seeing such news stories. On the other hand, 78.1 percent stated that they would consume more poultry if they were sure that it was safe, meaning that there is a large consumer group who would be willing to consume more poultry if their trust in the poultry sector and its production methods could be secured.

Even though both producer companies and the Ministry of Agriculture and Forestry deny that poultry are given hormones to help them grow faster, and despite statements confirming that hormones are not used in Turkish poultry farming, 74.2 percent of the respondents believe that hormones are used in poultry breeding. Similarly, even though the Ministry of Agriculture and Forestry and producer firms claim that the rapid growth of poultry is achieved through breeding, and that the broilers are a high-yield hybrid species that have been produced through natural hybridization, 75 percent of consumers were of the opinion that chickens are given drugs that make them grow faster, and that those medications were the main reason behind their rapid growth. It is clear that the beliefs of consumers about the use of antibiotics, hormones, rapid growth methods and GMOs in the poultry sector differ considerably from the views and reports of company representatives and the Ministry of Agriculture and Forestry. A significant proportion of consumers have concerns about the possible negative impacts of the consumption of poultry on human health. Accordingly, some consumers are of the opinion that negative impacts can be seen, while a significant number state that they are unsure of the potential for negative impacts, or claimed they had no idea about the subject.

For consumers, the top three sources of information about poultry were television (88%), websites (73.7%) and social media (61.2%). Only 27.1 percent of consumers claimed that their primary sources of information were medical doctors, while the rate of those who gave academicians as their sources of information was 21.4 percent. This may be due to the limited access of consumers to academicians and medical doctors as sources of information, the lack of access to platforms where these two groups share information, or the lack of effort among these two groups in providing sufficient and frequent information about the subject. The trust placed by consumers in their sources of information varies between 2.30 and 3.58, which is not that high in general. Accordingly, the top three sources of information in regards to consumer trust were academicians (3.58), medical doctors (3.58) and family (3.36). In the light of these findings, it is obvious that there is a need for academicians and medical doctors to carry out scientific studies into poultry, the effects of consuming poultry, and other subjects that are of concern to consumers. The resulting data should then be shared with the public, given that 85.4 percent of the respondents were of the opinion that more studies were needed to investigate the harm/benefit associated with poultry consumption. The elimination of information pollution in the sector could be achieved if academicians and medical doctors more frequently shared scientifically supported, proven, and accurate information with consumers on such platforms as television, websites and social media.

The logistic regression analysis revealed that women, housewives and people over the age of 55 are more likely to consume less poultry after hearing negative news, being the groups most affected by such news stories. As such, any scientific studies and comprehensive research carried out should be shared with these specific groups as a priority. It should not, however, be a one-way transfer of information, but should rather take the form of mutual communication. In cases where it is obvious that consumers have been misinformed, it is important to make sure that competent people convey accurate information to consumers. When it comes to issues in which consumers have high concerns and doubt the information they are given, and the long-term impacts of which have not been demonstrated scientifically, the industry needs to take consumers' concerns into consideration and consider switching to another production system that can meet consumer demands.

The findings of the present study suggest that a large number of consumers are moving away from poultry consumption, meaning that the sector will suffer in economic terms. Conducting long-term scientific studies and increasing the number of studies focusing on controversial areas will provide many benefits to consumers, producers and the poultry sector alike. Furthermore, the creation of large working groups with the involvement of consumer representatives, researchers, academicians and sectoral shareholders for discussions of controversial issues, and the announcement of their activities on different media may be beneficial in eliminating information pollution and correcting false information, and may support the comprehensive investigation of controversial subjects.

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LAND RENTS IN THE MEDITERRANEAN REGION: A SAMPLE STUDY FROM TÜRKİYE

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Abstract

In this study, factors in field crops affecting land rents are examined in the province of Antalya, in the Mediterranean Region of Türkiye. Wheat, barley, cotton and maize are chosen, and production cost data for these crops and land rents for the years 2001-2019 are used in the analyses. It is found that in Antalya, according to the crops selected, land rents are generally at a level which allowed tenants to make a profit, but that in some years, this is not possible because of a reduction in net income. Fluctuations in net income negatively affect the economic sustainability of agricultural farmers. An examination of the factors affecting land rents prices showed that in the short and long terms, diesel fuel or fertilizer support and production costs had a positive effect on land rents. Difference payment support caused an increase in land prices in the short term, and in the long term had a negative effect on rent prices. Net income caused a land rents reduction in the short term, but in the long term it caused an increase.

Key words**:** *land rents, net income, production costs, panel ARDL.*

INTRODUCTION

Land, which is the basic production factor in agricultural production, and rent, the net income from the land, are among the topics most discussed by economists. From the point of view of economics, rent is the share which the soil, as a means of production, takes from production, or the payment for use of the land for a certain time as the price of the land [26; 40]. Rent appears as the net rental payment when a landowner rents his land out, and from the point of view of the person working the land expresses the net income. The net income of the land shows the highest limit which can be paid as rent for the land in order for production to be economically sustainable.

In economics, there are two basic approaches to the source and emergence of rent: the classical and neoclassical approach and the Marxist approach. Many studies have been conducted on the concept of net income and the factors determining land rents and the value of land [11, 12, 14, 15, 18, 19, 21, 22, 23, 28, 29, 32, 33, 40, 44, 47, 48]. Adam Smith says that land rent is set by the landlord, but on the other hand he says that it will be determined by the power to pay of the farmer, and the factor determining the farmer's power to pay is the average price of the crop. Ricardo emphasizes the fertility of the soil when defining rent. The value of the land is connected to production costs because production is started on less fertile soil as the value of the land cannot be increased [14, 23, 26, 32].

In many studies of production costs, it is seen that land rent has an important share in production costs [1, 5, 10, 20, 41, 42, 45]. The ability of a producer who works the land to make a profit is dependent on his ability to have an income above the cost of production including land rent. For this, unit product prices must be above unit costs. In this way, economic profit will be positive, and what will determine this is that if the net income obtained from the land (rent) is given as land rent, how much greater it is than the rentals payment which the land will bring. If the owner is working the land, the net income passes directly to the landowner, but if the land is rented out, the rental payment is determined by an agreement of the two parties in accordance with supply and demand, and constitutes the rental income obtained by the landowner [29]. Calculation of net income allows the farmer to assess the state of the land, and determines a limit to his offer of a rental price for the land which he can pay [14, 31].

Land rental is significantly different in different countries, and this difference is seen not only in the proportion of rented land, but also in whether whole farms or small plots are rented. In agricultural farms, short and medium term rental decisions are made according to evaluation, and long term decisions are made according to expectations, the opposite of purchasing decisions [28]. In Türkiye, rental agreements are generally made on a plot basis, orally, and for a year, and all the risk is taken on by the tenant. For this reason, the annual net income obtained from land varies, affected by different factors from the point of view of the tenant. In this study, net income on the basis of selected important crops and the development of land rents are examined in Antalya, a province of Türkiye which has important agricultural potential, and an attempt was made to determine the production factors affecting rental.

MATERIALS AND METHODS

The main material for this study consists of the production cost data for wheat, barley, maize and cotton and land rents in the province of Antalya in the Mediterranean Region of Türkiye. The study considered land rents for the years 2001-2019 and cost data from the Provincial Agriculture and Forestry Directorate. First, an investigation was made of the relation between the net income obtained when the landowner worked the land himself and net rental income, and economic profit. Economic profit was found using equation 1, and equation 2 was used to find the net income obtained by the landowner for use of the land (land rent). Because there are no expenses such as property tax to be paid by the landowner, the provision of rent is accepted as the field rent in the direct product cost tables.

Economic profit = Gross Product Value (GPV) – Total expenses

Land net income = GPV – expenses other than land rental payment

Net income, expenses other than land rental and the effect on rent of supports are examined with the panel ARDL model with the aim of determining the factors affecting land rent. In order to examine the possible effects on the rental price of support given to agriculture, the difference payment support paid for the above-mentioned crops and diesel fuel and fertilizer support are used in the analyses.

Cross-sectional dependence test

Among the variables considered in the study, cross-sectional dependence is examined, and advanced econometric methods such as the unit root test, cointegration tests and homogeneity analyses are used. In order to determine whether or not cross-sectional dependence is among the variables, the Breusch and Pagan (1980) [7] CDLM1 test (LM1), the Pesaran (2004) [37] CDLM2 (LM2) test, the Pesaran (2004) [37] CDLM test (CD) and the Pesaran, Ullah and Yamagata (2008) [38] CDLMadj (LMadj) tests are used. This meant that the H0 hypotheses of the tests did not contain cross-sectional dependence between series.

Panel unit root test

In order to determine whether the values considered in the study included unit root, the Im-Pesaran Shin (IPS) unit root test is used. The IPS test is an analysis developed on a hypothesis in which variables taken as panel data have a heterogeneous parameter. The H0 hypothesis of the result of the IPS test states that it is a unit root. The IPS unit root test is as follows (IM et al., 2003) [24]:

$$\boldsymbol{\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{k=1}^{\rho_i} \theta_{i,k} \Delta y_{it-k} + \alpha_{i,t}\delta_t + \varepsilon_{it}}$$

Panel cointegration test

In order to test whether there is co-integration between the variables in the study, the Pedroni and Kao Co-Integration tests is applied to the panel data set. When the panel data set has a heterogeneous structure, Pedroni (1999) [34] recommends various co-integration tests. These models, under the H0 hypothesis that there is no co-integration, present four Panel test statistics and three group test statistics. The Pedroni Co-Integration Test affects multiple explanatory variables. In this way, it is accepted as a powerful method [3]. Kao (1999) [25] created a co-integration test using the co-integration test and the Expanded Dickey-Fuller and Dickey-Fuller tests [2, 46].

Autoregressive distributed lag bound test

In order to be able to estimate models containing time series, the condition is sought that all variables should be stable at the same level. Bringing the variables into a stable state by taking the first rank differences causes a loss of information in the long term.

The model to overcome this is the Autoregressive Distributed Lag Bound (ARDL) Test model. This model has many advantages: it can be applied to stable variables at different levels; it gives the analysis a dynamic quality by including necessary delay lengths in the model; it allows comparison of short and long term parameters of the error correction (VEC) model obtained as a result of ARDL, and because Autocorrelation is kept under control, the problem of endogeneity does not arise.

The panel ARDL model depends on the mean group (MG) estimator and the pooled mean group (PMG) model. The MG estimator takes the unweighted mean of the long term parameters.

The MG estimator places no constraint on ARDL parameters. Not allowing certain variables to be the same among units forming the panel is a shortcoming of the MG estimator. This shortcoming is eliminated by using the PMG estimator. In this way, it can allow the panel ARDL to have homogeneity in the long term and heterogeneity in the short term [4].

Thus, in order to determine which of these two models should be used, it is recommended by Pesaran et al. (1999) [35] that the Hausman test be conducted in order to test the homogeneity of the parameters in the long term.

The basic ARDL model is as follows:

$$\boldsymbol{\Delta lnY_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta lnY_{t-i} + \sum_{j=1}^{q_m} \delta_j^m \Delta LnX_{t-j}^m + \lambda_0\, lnY_{t-1} + \lambda_m X_{t-1}^m + v_t}$$

where: Y is the dependent variable, X is the independent variables, β0 is the constant term, ν is the well-behaved error term (the full random variable), α and δ are short term parameters, λm and λ0 are long term parameters [36].

After solving the ARDL model, the conditional error correction model is estimated for the independent variables X with the help of the following formula:

$$\boldsymbol{\Delta lnY_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta lnY_{t-i} + \sum_{j=1}^{q_m} \delta_j^m \Delta LnX_{t-j}^m + \phi ECT_{t-1} + v_t}$$

The error correction model is calculated with the inclusion again in the model of the calculated errors (ECT) in the previously calculated ASDL model as an independent variable. A negative ECT parameter value (ϕ) indicates a short term balance relationship. Also, ϕ shows long term balance adjustment speed [39]. The half-life value can be calculated with this parameter value:

$$t_{1/2} = \frac{\ln(0.5)}{\phi}$$

RESULTS AND DISCUSSIONS

Net income, land rent and economic profit

The land rents of the crops examined in Antalya province declined in real terms in 2013 and 2016, and their share in costs also fell. Cotton and maize rents also fell in 2019, and between 2001 and 2019, the share of land rents in production costs fell by between 15% and 59%.

It is seen from Figure 1 that land rents in Antalya are generally at a level compared to crops that allow tenants to make a profit, but because net income is reduced in some years, this is not always possible. When the landowner is renting out his land or when the tenant is renting land, it is expected that the capital used in production will leave a share which will allow its protection with an average profit equal to the capital used in the region [40]. Otherwise, it is not possible for there to be a demand for rental of the land. The highest rent that the tenant can pay is as much as net income [30], but in this case the tenant's profit is zero. Therefore, the tenant is obliged to take profit and risk into account when determining the rent [14]. Factors determining supply and demand create the final rent, and the farmer must take this into account and estimate what level of rent his competitors are willing to pay. Calculation of the net income of the land shows the landlord the maximum level in determining rent. However, the effect of an entrepreneurial personality and land with the same characteristics bring about a willingness to pay differently, the tenant does not give the whole of the net income of the land to the landowner, and the distribution of this between tenant and landowner varies according to regions [14].

Fig. 1. The relation between net income, rent and profit
Source: Special calculations from the data of the Directorate of Agriculture and Forestry.

In determining the rental payment, many factors concerning the type of farming and regional competition have an effect. Renting the whole of a farm or just a part of it and the duration of the rental agreement are affecting factors [14, 28, 29]. On the one hand the rental payment is related to the net income to be obtained by the tenant, while on the other it is related to how much other potential tenants will pay according to the competition in the area [23]. In agricultural production, all risks and opportunities in land rental belong to the tenant, and a fall in yield or a strong reduction in crop prices harms the tenant's income and liquidity. When rental prices are set above base values, risks and opportunities which arise because of changes in yield and crop prices are taken on by the tenant and the landowner together [43].

In agricultural production, income is significantly affected by fluctuations in yield and crop prices. When other conditions remain the same, increasing crop prices increase the expectations of income of the producer, and increase readiness to bear high costs [6]. However high income expectation is, demand is just as high, and rental prices increase [11]. Habermann and Breustedt (2009) [22] researched regional rental differences in Germany using Agricultural Structure Questionnaires, and found that the income of a well-run farm raised the rental price by 10%, and that this value affected neighboring farms, so that they also showed an increase of 7%. Regional differences in rent prices are explained by natural conditions and different farming structures and characteristics related to this, and it has been found that regional competition plays an important role. In a study using a regional econometric approach, Habermann and Ernst (2010) [23] concluded that wheat yield, the share of sugar beet and potatoes, the density of cattle, and the share of perennial culture and horticulture had a positive effect on land rent. Doll and Klare (1996) [11] reported that the main determinant of land rents is natural fertility, and that in multiple regression analysis, 70-80% of the variation in land rents is explained by fertility. Garvert (2017) [14] stated that net income had a significant effect on the land rents of farms, and that for this reason, rent variation between farms and developments in rents over time explained price increases. There are many studies showing that there is a significant positive relationship between support and land prices. It is reported that a 10% increase in support creates a 3.3% to 5% increase in land prices, and a 10% increase in support creates a 6% increase in land rents [14, 22].

Panel ARDL findings

Before passing to the analysis stage, we examined the descriptive statistics obtained in the study, the Variance Inflation Factor (VIF), and the Pearson correlation matrix (Table 1; Table 2). In the model, the land rent is taken as the dependent variable, and the independent variables are, in order, net income (n_income), non-land-rent production cost (cost), difference payment support (sup), and diesel fuel and fertilizer support (soilfr). In examining the results of the Variance Inflation Factor (VIF) for each variable in order to test the problem of multicollinearity between the independent variables, it is seen that there is no multicollinearity between the variables, and that the values are much lower than 5. For this reason, the variables given above are indeed independent of each other and can therefore be accepted as independent variables. It may be said that the independent variables have an effect on land rents.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
rent	95.0000	17.4238	9.4279	4.5707	53.8922
net income	95.0000	79.9045	62.3767	1.0000	251.9317
cost	95.0000	113.321	89.9593	17.2032	344.1855
sup	95.0000	38.7938	77.7359	0.0000	561.8029
soilfr	95.0000	3.7650	2.4907	0.0000	11.6385

Source: Authors' statistical analysis results.

Table 2. Variance Inflation Factors of the Variables

Variable	VIF	1/VIF
n_income	1.26	0.7917
cost	1.62	0.6159
soilfr	1.47	0.6789
sup	1.39	0.7183
Mean VIF	1.44	

Source: Authors' statistical analysis results.

The Pearson correlation coefficient relating to the variables evaluates the degree to which the variables considered act together or separately from one another. It is understood that all of the variables had a statistically significant positive relationship with land rent (Table 3). In particular, it is seen that there is a strong 86.22% correlation between land rent and the variable of non-land-rent cost. No statistically significant correlation is found between the variable of net income and the variable of non-land-rent cost and difference payment support. Also, no statistically significant difference is detected between difference payment support and fertilizer and diesel support.

According to the results shown in Table 4, the H0 hypothesis is rejected according to the statistics of each test. Cross-sectional dependence is found between series. In short, an effect emerging in one of the crops considered is reflected in the other crops.

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Table 3. Results of Correlation Coefficient between Variables

	Rent	n_income	cost	sup	soilfr
rent	1				
n_income	0.2363*	1			
Pearson corr. Sig.(2-tailed)	0.0212				
cost	0.8622*	0.1582	1		
Pearson corr. Sig.(2-tailed)	0.0000	0.1257			
sup	0.4763*	0.0577	0.5238*	1	
Pearson corr. Sig.(2-tailed)	0.0000	0.5784	0.0000		
soilfr	0.3352*	0.4555*	0.3953*	0.1293	1
Pearson corr. Sig.(2-tailed)	0.0009	0.0000	0.0001	0.2118	

Source: Authors' statistical analysis results.

Table 4. Results of the Cross-sectional Dependence Test of the Variables

	LM1	LM2	LMadj	CD
rent	51.009 (0.000)	9.170 (0.000)	9.031 (0.000)	6.706 (0.000)
n-income	78.128 (0.000)	15.234 (0.000)	15.095 (0.000)	8.421 (0.000)
cost	55.159 (0.000)	10.098 (0.000)	9.959 (0.000)	6.033 (0.000)
sup	96.448 (0.000)	19.330 (0.000)	19.191 (0.000)	8.698 (0.000)
soilfr	151.464 (0.000)	31.632 (0.000)	31.494 (0.000)	12.269 (0.000)

Source: Authors' statistical analysis results.

Firstly, unit root test is performed with regard to the variables considered in the study, as shown in Table 5. The IM-Pesaran-Shine (IPS) unit root test is set up as models including stable and trend. According to the results of the IPS unit test, the net income and sup variables are calculated as static The IPS unit test results are calculated as stationary at the “n_income ” and “sup” adaptations in the relative fixed model. All the shapes considered in the fixed and trend model could not meet the stationarity condition at the level.

It provides integrating the stationarity condition to the I(1) degree in fixed, constant and trend models. This will show that the panel ARDL method can be applied in the analysis of series with different levels of stationarity conditions.

The presence of cointegration between the variables is examined in Table 6 with the help of Pedroni panel Cointregration [34] and Kao Cointregration [2, 3] analyses.

Table 5. Panel Unit Root Test Results

	Individual intercept				Individuel intercept and trend			
	Level		First difference		Level		First difference	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
rent	-0.8831	0.1886	-4.4934	0	-0.003	0.4988	-3.7724	0.0001
net income	-1.6858	0.0459	-5.3322	0	0.6631	0.7464	-4.4906	0
cost	-1.2173	0.1117	-2.8993	0.0019	-0.0219	0.4913	-1.4544	0.0729*
Sup	-2.4466	0.0072	-5.1792	0	-0.8414	0.2001	-5.7953	0
Soilfr	-1.2237	0.1105	-2.8797	0.002	1.4292	0.9235	-2.6756	0.0037

* The first-order difference is stationary at the 10% significance level.
Source: Authors' statistical analysis results.

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Table 6. Panel Cointegration Test Results

Petroni		
	Statistic	Prob.
Panel v-Statistic	0.2936	0.3845
Panel rho-Statistic	0.2996	0.6178
Panel PP-Statistic	-1.5881	0.0561
Panel ADF-Statistic	-1.3652	0.0861
	Statistic	Prob.
Group rho-Statistic	1.0122	0.8443
Group PP-Statistic	-2.3001	0.0107
Group ADF-Statistic	-2.4542	0.0071
Kao		
	t-Statistic	Prob.
ADF	-3.89626	0.0000

Source: Authors' statistical analysis results.

According to the results obtained, in Pedroni cointergration analysis, the extra-group PP and ADF test results and also the intra-group PP and ADF test results showed the presence of a long term cointegration. According to Kao Cointegration analysis, it showed the presence of a cointegration at a level of 1% between series.

The parameters relating to the variables considered can be estimated both in the short term and the long term with both the Pooled Mean Group Estimator (PMG) and the Pooled Group Estimator (MG). The Hausman homogeneity test is used to find which model to use for analysis (Table 7). The chi squared value obtained according to the Hausman homogeneity test is calculated to be 2.03. Because the model is not symmetrical, the predictive power of the PMG model is stronger than the estimator of the MG model, and is calculated to give a consistent result.

Table 7. Homogeneity Test Results

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
		Mg	pmg	Difference S.E.
L. n_income	0.009566	0.003837	0.0057286	
L.cost	0.119078	0.076435	0.0426426	0.0532358
L.sup	-0.00392	0.007682	-0.0115989	0.0593037
L.soilfr	-0.33538	0.057062	-0.3924377	0.3088116
chi2(4)				2.03
Prob>chi2				0.73

Source: Authors' statistical analysis results.

Table 8. ARDL Long Term Scaled Coefficient Values

Variable	Coefficient	Standardized Coef.	Elasticity at Means
n_income	0.065	0.430	0.298
cost	0.061	0.578	0.394
sup	-0.045	-0.367	-0.099
soilfr	0.724	0.191	0.156

Source: Authors' statistical analysis results

When the two delayed Panel ARDL models are examined according to the dependent variable of the farms’ rental costs as an independent variable in the study (Table 8), it is found that the values of the parameters of long term net farm income, non-land-rent costs, difference payment support and fuel and fertilizer support are significant at a level of 1%. It is calculated according to mean elasticities that net income (0.298%), non-land-rent cost (0.394%), and fuel and fertilizer support (0.156%) increased land rent in a positive direction. It is found that difference payment support fell in the long term (0.999%). It is found that in the short term, net farm income had a negative effect, but that a delayed value of difference payment support and fertilizer and fuel support had a positive effect.

In the ARDL short term error correction model, the ECT value (0.8256) is calculated to be negative and significant (Table 9). This value which is obtained shows that 82.56% of deviation from balance in the short term are eliminated in one year. The half-life of the deviations is 0.8389, and 50% of deviations from balance in the short term (0.8389*12) are eliminated in approximately ten months. It can be said that the effect of a change in independent variables lasted up to ten months. (1. Short term balance relationships relating to the crops considered are given in detail in the Appendix.).

Table 9. Panel ARDL/PMG Estimate Results

	LogL	AIC	BIC*	Specification
1	-140.389	4.692	6.387	ARDL(1, 0, 2, 2, 2)
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
n_income	0.065	0.002	27.192	0.000
cost	0.061	0.004	15.058	0.000
sup	-0.045	0.002	-17.970	0.000
soilfr	0.724	0.057	12.614	0.000
Short Run Equation				
ECT	-0.826	0.219	-3.765	0.001
D(n_income)	-0.032	0.009	-3.381	0.002
D(n_income (-1))	-0.038	0.019	-1.955	0.058
D(cost)	0.056	0.029	1.936	0.061
D(cost(-1))	0.004	0.020	0.186	0.854
D(sup)	0.055	0.040	1.376	0.177
D(sup(-1))	0.039	0.023	1.706	0.097
D(soilfr)	0.642	0.475	1.351	0.185
D(soilfr(-1))	1.408	0.747	1.885	0.068
C	6.963	2.630	2.648	0.012
@TREND	-0.505	0.166	-3.042	0.004
Mean depend var	0.140	S.D. dependent var		5.341
S.E. of regress.	4.825	Akaike info crit.		4.198
Sum squard resid	838.152	Schwarz criterion		5.784
Log likelihood	-140.389	Hannan-Quinn crt.		4.839

Source: Authors' statistical analysis results.

There are many investigations in studies in the literature of whether agricultural support affects land prices, and it has been found that the way the supports are applied and the determination of the rules are very important. In particular, it has been seen in many studies that land-based support by the EU and direct payment support have changed the rates of capitalization [8, 9, 16, 17, 27].

Generally in the literature, when land-dependent supports are directed to the landowners rather than the farmers, even though it is said that these do not affect land prices, it has been found that on rented land, the landowners benefit from the supports to different extents [13, 18].

It is seen from the model findings obtained that particularly fuel and fertilizer support raised the land rent in the long and short terms, but that difference payment support caused a rise in rents in the short term but a fall in the long term. Of these two supports which are considered, it is estimated that the application and rules of the fuel and fertilizer support should be reviewed. Correct and effective supports will enable the correct use of government resources.

Worldwide and local changes in agricultural policies also have an effect on land saving structure in agriculture, and these changes take agriculture to a more dynamic structure in the face of competition. In Türkiye, while generally ownerships farms maintains their importance, an increase is seen in the numbers of those farming the land by rental. When it is thought that this increase will continue, rental contracts and rental determination processes will gain more importance in the future. This activity will be greater in areas where agricultural production potential is high and where technology is more widely used. In this study, the province of Antalya is chosen because it has a dynamic structure about agricultural activities, and work is carried out to determine the factors affecting rents by examining the development in land rents. An increase in demand for agricultural crops for food and non-food reasons and stability in land supply generally cause an increase in prices. At the same time, in order for it to be possible to carry out rental economically, it is necessary that both the tenant and the landowner be left with a certain amount of profit. Net income is an important indicator of the growth capacity of an economically sustainable farm level.

The long-term profit amount within the farm strategies determines the growth ability of agricultural enterprises. Fluctuations in net income may create the possibility of reducing the power of economic sustainability. Because in rental all of the risk belongs to the tenant, net income is also important in determining the tenant's profit level.

CONCLUSIONS

In this study, it is found that rents in Antalya province are generally at a level at which the tenant could make a profit. Factors affecting land rent are examined with the panel ARDL model, and according to the results of the analysis, both in the long term and in the short term the variable of fuel and fertilizer support is found to have a positive effect on land rent prices. Producer costs showed a similar characteristic.

However, while difference payment support caused an increase in rental prices in the short term, in the long term it is found to have a negative effect on rental price increases. Net income causes a reduction in rent in the short term, but in the long term it causes an increase in rental prices.

In conclusion, net income determines the tenant's level of profit, and in general rental is seen to be a profitable activity with the crops examined. It is found according to the result of the panel ARDL that net income, of the factors affecting rental, in the long term had a significant and positive (0.298%) effect on land rent, but a negative effect in the short term. It is found that the fuel and fertilizer support also increased land rent in a positive direction (0.156%). The negative effect of net income on rents in the short term may be related to the change in fertility and prices and the fact that crop decisions cannot be changed in the short term. It can be said that in the long term the idea that a good income can be obtained increases rent prices.

According to the results of analysis, fuel and fertilizer support has created an increase in land rent prices in the short and long term, and a need is shown for more research on the application and regulation of support.

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Appendices /Appendix A

Barley				
Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT	-0.74419	0.081873	-9.08956	0.0028
D(n_income)	-0.02635	0.001682	-15.6686	0.0006
D(n_income(-1))	-0.06412	0.001536	-41.7313	0.0000
D(cost)	0.01303	0.004285	3.040746	0.0558
D(cost(-1))	-0.06849	0.012842	-5.33283	0.0129
D(sup)	0.034592	0.001591	21.74565	0.0002
D(sup(-1))	0.025559	0.001197	21.34821	0.0002
D(soilfr)	0.002705	0.190452	0.014202	0.9896
D(soilfr(-1))	0.375754	0.504042	0.745483	0.5101
C	5.671884	16.87033	0.336205	0.7589
@TREND	-0.41228	0.126554	-3.25772	0.0472
Wheat (Irrigated land)				
Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT	-1.493	0.000	-5930.454	0.000
D(n_income)	-0.055	0.000	-22531.690	0.000
D(n_income(-1))	-0.071	0.000	-47886.550	0.000
D(cost)	0.131	0.000	11937.790	0.000
D(cost(-1))	0.017	0.000	4090.705	0.000
D(sup)	0.096	0.000	8455.230	0.000
D(sup(-1))	0.005	0.000	989.994	0.000
D(soilfr)	0.577	0.004	141.105	0.000
D(soilfr(-1))	2.547	0.005	482.362	0.000
C	12.413	0.307	40.455	0.000
@TREND	-0.993	0.000	-4406.643	0.000
Wheat (Dry land)				
Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT	-1.087	0.046	-23.625	0.000
D(n_income)	0.001	0.000	3.317	0.045
D(n_income(-1))	-0.051	0.000	-242.510	0.000
D(cost)	0.121	0.002	57.957	0.000
D(cost(-1))	0.024	0.001	16.379	0.001
D(sup)	0.182	0.005	38.024	0.000
D(sup(-1))	0.129	0.002	65.496	0.000
D(soilfr)	2.177	0.328	6.639	0.007
D(soilfr(-1))	3.695	1.375	2.686	0.075
C	0.694	2.090	0.332	0.762
@TREND	-0.146	0.014	-10.650	0.002
Cotton				
Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT	-0.604	0.047	-12.942	0.001
D(n_income)	-0.042	0.001	-59.275	0.000
D(n_income(-1))	-0.038	0.001	-53.417	0.000
D(cost)	-0.002	0.005	-0.306	0.780
D(cost(-1))	0.052	0.003	14.854	0.001
D(sup)	-0.052	0.021	-2.549	0.084
D(sup(-1))	0.018	0.019	0.935	0.419
D(soilfr)	-0.610	0.405	-1.508	0.229
D(soilfr(-1))	-0.377	0.979	-0.384	0.726
C	13.737	55.362	0.248	0.820
@TREND	-0.781	0.466	-1.677	0.192
Mais				
Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT	-0.19946	0.006034	-33.0547	0.000
D(n_income)	-0.03866	0.000135	-286.964	0.000
D(n_income(-1))	0.035752	8.49E-05	421.0249	0.000
D(cost)	0.015719	0.000208	75.40692	0.000
D(cost(-1))	-0.00472	0.000195	-24.1821	0.000
D(sup)	0.013045	1.23E-05	1063.839	0.000
D(sup(-1))	0.017593	1.58E-05	1110.413	0.000
D(soilfr)	1.061813	0.089389	11.87855	0.001
D(soilfr(-1))	0.797621	0.074563	10.69726	0.002
C	2.298975	2.783858	0.825823	0.470
@TREND	-0.19035	0.014681	-12.9658	0.001

Source: Authors' statistical analysis results.

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DEVELOPMENT OF INNOVATIVE TECHNOLOGIES IN ENVIRONMENTAL AND GENETIC RESEARCH FOR AN EFFICIENT CEREALS PRODUCTION UNDER THE CONDITIONS OF CLIMATE CHANGE IN UKRAINE

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Abstract

The purpose of the article is multi-year research and analyze of the dynamics of cultivated areas, production volumes and yield of cereal crops in Ukraine, in the context of world cereals production and export. Ukraine's prospects on the world cereals market have been established thanks to the formation of ways to adapt the production of wheat, barley and maize to the conditions of climate change. Graphically illustrated data of the State Statistics Service of Ukraine on cultivated areas, production volumes and yield of cereal crops in Ukraine, data of the Food and Agriculture Organization of the United Nations on world cereals production and export. It was established that the production of cereal crops in Ukraine during 1990–2021 increased by 69% – from 51.0 to 86.0 million tonnes thanks to an increase in maize production almost 9 times – from 4.74 to 42.1 million tonnes due to the growth of its of cultivated areas by 4.5 times – from 1.23 to 5.52 million hectares. During 2008–2022, the world production of cereals increased by 32%, and the world export of cereals increased by 76%. At the same time, the transformation of the structure of cultivated areas, climatic changes and the war of the rf against Ukraine led to the yield of cereal crops being much lower than the potentially possible level. For effective cereals production, a number of adaptation measures are proposed to overcome the negative impact of climate change, which consist in the use of innovative technologies in environmental and genetic research, which ensure the cultivation of high-yielding varieties and hybrids of cereal crops that are resistant to drought, diseases and pests, as well as the optimization of cultivated areas with the introduction of scientifically based crop rotations and organic technologies.

Key words**:** *production of cereal crops, cultivated areas, innovative technologies, climate changes, Ukraine*

INTRODUCTION

Cereals production is the basis of the food base and security, export potential and foreign exchange earnings of any country. Cereals is a strategic food product for the population, a valuable raw material for the processing industry, and a fodder basis for animal husbandry. Therefore, today the strategic goal of the development of the cereals industry is the implementation of innovative technologies that will ensure highly productive and competitive cereals production [32]. The concentration of the latest scientific-technical achievements in such technologies will contribute to the realization of the potential productivity of varieties and hybrids of cereal crops in different soil-climatic conditions [8]. Thus, for the improvement of environmental and genetic research, it is important to development the implementation of innovative technologies, with ensure the promising formation of genotypes of cereal crops resistant to stress factors, the increase of their structural and functional organization and adaptive potential, especially in conditions of climate change [18; 19].

The relevance of the study increases in connection with the full-scale attack of the rf on Ukraine, when there were risks of an increase in world food prices and causing people to starve in many countries of the world. Therefore, today, the solution of global social problems of humanity based on the use of innovative technologies is an effective factor, especially in the conditions of environmental, economic, energy and food crises, which were caused by climate changes and military actions of the rf.

An in-depth study of this important scientific and technological direction in agrarian science of Ukraine has not been comprehensively investigated, although some publications cover it in fragments. In particular, the establishment of the effective action of soil protection technologies and computer modeling for the intensification of agrarian production in Ukraine and the world in the second half of the 20th – the beginning of the 21st centuries are given in the scientific works of I. Borodai, O. Hloba, N. Kovalenko, S. Yehorova [8; 9; 10; 11; 12]. Short statements about information technologies can be found in collective monographs of the institutions of higher education [30; 33] and scientific research institutions [18; 19]. The production of cereal crops and the factors of intensification of cereals production are analyzed: in Ukraine [1; 32] and Romania [24; 25; 26; 27]. However, in order to develop effective measures aimed at stabilizing cereals production and increasing the efficiency of the cereals industry, taking into account the global challenges and threats of today, further analysis of the functioning of the cereals market of Ukraine is necessary.

The purpose of the article is to research and analyze the world cereals production and export, as well as to establish the prospects of Ukraine on the world cereals market thanks to the development of the use of innovative technologies in environmental and genetic research for the formation of ways to increase the efficiency of the production of wheat, barley, and maize in Ukraine under conditions of climate change.

MATERIALS AND METHODS

The article uses a large array of information from scientific publications of the National Academy of Sciences of Ukraine, the National Academy of Agrarian Sciences of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine. Statistical information from the State Statistics Service of Ukraine, Food and Agriculture Organization of the United Nations databases was used. Thanks to the comparative analysis and the calculation-constructive method, trends of long-term changes in the main indicators of the study were revealed: providing the population with arable land; world production and export of cereal; of cultivated areas, production and yield of wheat, barley and maize in Ukraine. The dynamics of the indicated indicators in Ukraine and the world during 1990–2022 are graphically illustrated.

The factors of disruption of the structure of cultivated areas are established and meteorological conditions are described, which affected the insufficient level of potential growth of yield and production of cereal crops in Ukraine. Attention is focused on the directions of development of innovative technologies, which, when used in environmental and genetic research, ensured the effective production of cereal crops in Ukraine under conditions of climate change. Thanks to the abstract-logical method, conclusions were formulated and a number of adaptation measures were proposed to overcome the negative impact of climate change and other negative manifestations.

RESULTS AND DISCUSSIONS

The dynamic growth of the world population is one of the global trends that causes a constant increase in food consumption. Therefore, solving the problem of providing the population with food is a priority task and a strategic direction of the economic policy of each country, aimed at ensuring its food and national security. According to the theory of the famous English economist T. R. Malthus (1766–1834), the population of the planet is growing all the time and soon there will not be enough agricultural lands to feed humanity [16]. In particular, during 1950–2022, the population of the planet increased by more than 3 times and amounted to 8 billion peoples (Fig. 1). At the same time, during this period, the area of lands suitable for growing agricultural crops remained almost unchanged, which in 2022 amounted to about 1.6 billion hectares. However, during this period, the world area of arable lands per person, which in 1950 was 0.60 hectares, decreased by 67%. According to UN forecasts, the global population will increase to 9.6 billion peoples in 2050, which will reduce the supply of productive land resources to 0.17 hectares. This will lead to a significant increase in demand for food products, including cereals products. At the same time, to ensure a normal standard of living of the population, at least 0.50 hectares of arable lands per person is needed [20]. Thus, with a general decrease in the provision of arable lands to the population, the food problem can be solved thanks to the intensification of agrarian production based on the introduction of scientifically based technologies that ensure the reduction of the negative impact on the environment and the preservation of natural resources, as well as satisfy the consumers of the world market with high-quality agricultural products [24; 25; 26; 27].

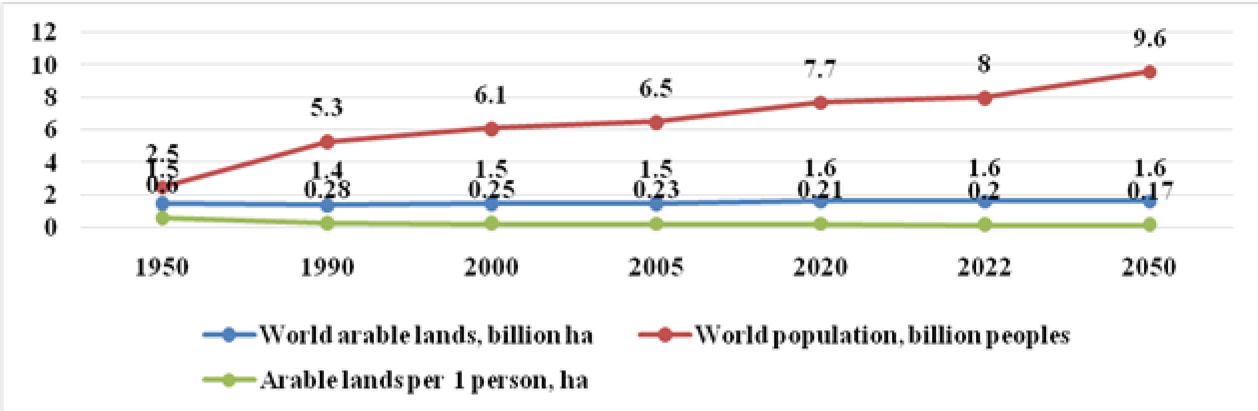

Fig. 1. Dynamics of providing the world population with arable lands, 1950–2050
Source: Own design based on the data from [20].

With the increase in the number of the world population, the global consumption of cereals is steadily growing, which is one of the factors in increasing the volume of its production and export. In particular, during 2008–2022, there is a tendency to increase world cereals production by 32%, which in 2022 amounted to 2 791.3 million tonnes. During this period, world cereals exports increased by 76% and amounted to 480.3 million tonnes in 2022 (Fig. 2). Such a tendency to increase the production and export of cereals in the world indicates the ability to satisfy the demand for cereals products even for the expected annual increase in the population of the planet by 60 million peoples in the next 30 years.

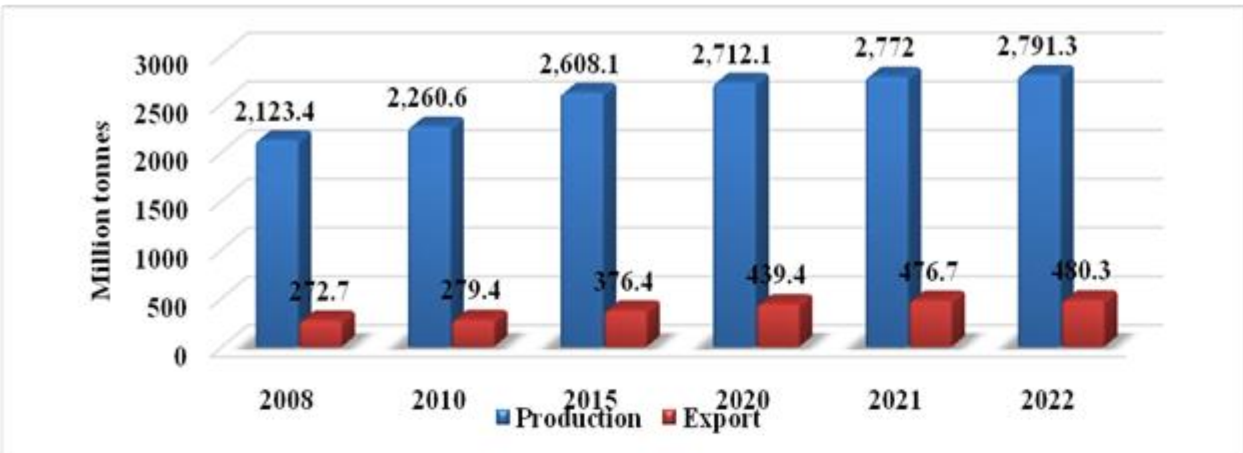

Fig. 2. Dynamics of world cereals production and export, 2008–2022
Source: Own design based on the data from [20].

Currently, the trends caused by negative factors, which are capable of restraining the further increase in global cereals production, have intensified. One of them is global climate change, recognized by the world community as one of the long-term factors that significantly worsen the cultivation of cereal crops and require coordinated actions by all countries of the world. For example, the duration and intensity of winter periods are decreasing, droughts and manifestations of other natural elements are becoming more frequent – droughts, dust storms, downpours, hail, frosts, freezing, icing, floods, flooding and inundation, which are associated with climate changes [32]. Reducing the duration and intensity of the winter period, reducing the number of frosty days and the depth of soil freezing, lead to early activation, reproduction and spread of harmful organisms [8]. Thus, with the preservation of the existing rates of warming, the probability of phytosanitary destabilization of agroecosystems, accompanied by the appearance of new groups of harmful organisms, increases. In addition, due to climate changes, there is an increase in erosion processes and landslides [12]. Therefore, an increase in cereals production in the face of global climate change is possible thanks to the introduction of scientifically based technologies for growing high-yielding varieties and hybrids of cereal crops that are resistant to drought, diseases and pests.

Some negative impact on the world cereals market occurred as a result of the application of restrictive measures to contain the spread of the COVID-19 pandemic. In particular, due to the disruption of logistics chains, losses were caused in the process of world cereals production. It should be noted that after several years of the COVID-19 pandemic, at present the world's food security is facing a new crisis in the food market. The cost of fuel, fertilizers and plant protection products increased, which caused the risks of a 22% increase in food prices and the starvation of tens of millions of people in many countries of the world [20]. In this context, innovative technologies in environmental and genetic research are called to support the effective production of cereal crops, which will ensure the solution of global social problems of humanity, especially in the conditions of environmental, economic, energy and food crises caused by climate change.

Currently, the growth of world demand for cereals has led to an increase in Ukraine's position in the world ranking. According to the results of 2022, Ukraine managed to maintain the status of one of the main exporters of cereals, entering the top five in the world. In particular, Ukraine took fifth place in the world ranking for the export of wheat, third – barley, and fourth –maize. In addition, Ukraine remained in the top ten producers of the main cereals products in the world and took the seventh position in the production of wheat, fourth – barley, sixth – maize [20].

Analyzing the dynamics of cultivated areas of agricultural crops in Ukraine for 30 years, it can be stated that they were extremely unstable and changed significantly over the years. In particular, during 1990–2021, the cultivated area of cereal crops increased by 8.9% – from 14.6 to 15.9 million hectares (Fig. 3).

When choosing an agricultural crop for sowing, agrarians note the following factors: profitability, the presence of stable demand and the level of prices on the market. Therefore, during this period, there were significant changes in the structure of crops of the grain group. In particular, due to high competition on the foreign market, the sown area of wheat decreased by 6.5% – from 7.58 to 7.09 million hectares, and barley by 9.2% – from 2.73 to 2.48 million hectares. Instead, high-yield corn for grain became the main grain crop in Ukraine, the sown area of which increased 4.5 times – from 1.23 to 5.52 million hectares [22]. This transformation has also been driven by global climate change and the use of high-quality seeds, fertilizers, plant protection products, etc.

During this period, the cultivated areas of technical crops increased 2.5 times – from 3.75 to 9.25 million hectares, thanks to the expansion of sunflower and rapeseed.

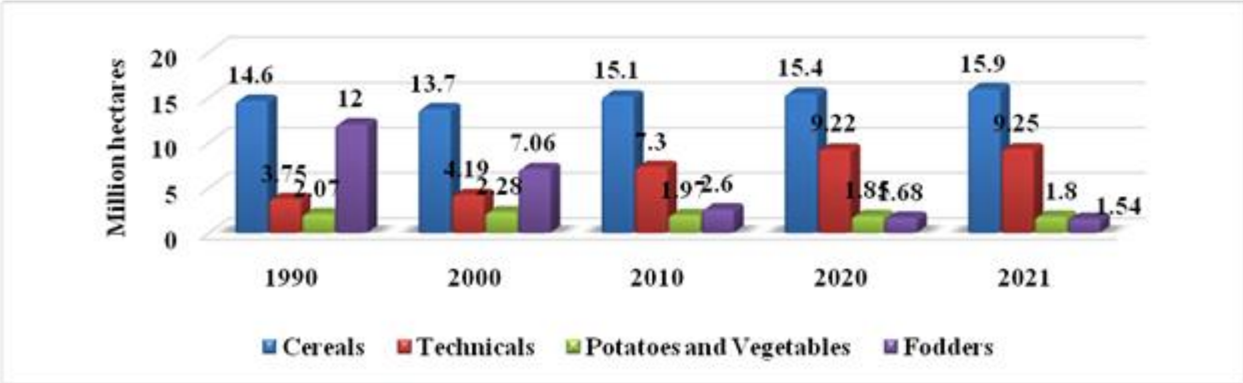

Fig. 3. Dynamics of cultivated areas of agricultural crops in Ukraine, 1990–2021
Source: Own design based on the data from [22].

The cultivated areas of potatoes and vegetables remained almost stable, decreasing by 13.1% – from 2.07 to 1.80 million hectares. However, the cultivated areas of fodder crops tended to reduce from 12.0 to 1.54 million hectares. Such a rapid decrease, by almost 8 times, caused a reduction in the planting of maize for silage and green fodder, perennial and annual grasses.

So, over the past 30 years, there have been significant changes in the structure of cultivated areas of various groups of crops: cereals, technicals, and fodders. This led to a violation of the use of optimal precursors and periods of returning cereal crops to the previous place of cultivation in crop rotations, which reduces their productivity due to a reduction in moisture reserves in the soil, a decrease in its fertility level, an accumulation of infectious diseases, the spread of specific weeds and pests [8].

At the beginning of the 21st century, the agrarian production of Ukraine, thanks to the developed genetics and technologies of growing agricultural crops, along with the introduction of scientifically based crop rotations, achieved success in obtaining high productivity indicators of cereal crops [32]. At the same time, during 1990–2021, Ukrainian agrarians managed to increase the national production of cereal crops by 69% – from 51.0 to 86.0 million tonnes only thanks to the increase in the production of maize per cereal from 4.74 to 42.1 million tonnes due to a significant increase in cultivated areas of this culture (Fig. 4).

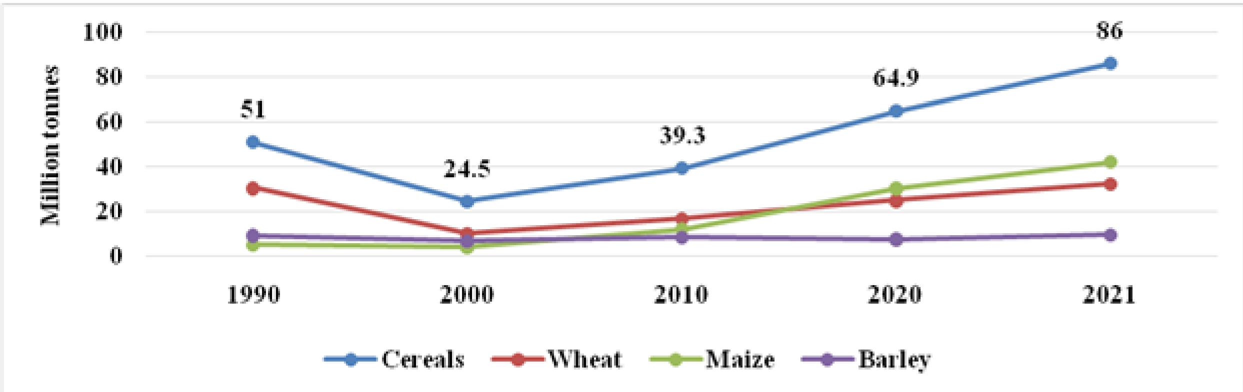

Fig. 4. Dynamics of cereal crops production in Ukraine, 1990–2021
Source: Own design based on the data from [22].

However, non-observance of scientifically based crop rotations due to excessive cultivation of maize per cereal caused a violation of the environmental balance of natural landscapes of Ukraine and increased erosion processes in the soil, which reached the highest level in the world. Such an unjustified transformation had a negative impact on the yield of cereal crops. In particular, over 30 years, this indicator increased only 1.5 times – from 3.51 to 5.39 t/ha (Fig. 5). During this period, wheat productivity increased by only 29% – from 3.52 to 4.53 t/ha, barley by 9% – from 3.51 to 3.82 t/ha, which is significantly lower than the potentially possible level.

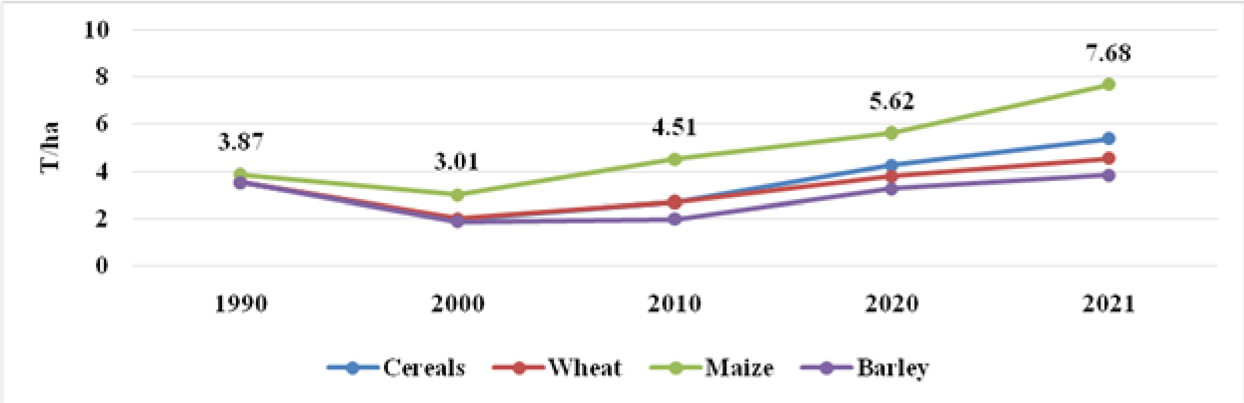

Fig. 5. Dynamics of cereal crops yield in Ukraine, 1990–2021
Source: Own design based on the data from [22].

Therefore, agrarians need to reorient themselves to the implementation of scientifically based crop rotations with effective saturation, placement and ratio of crops, taking into account soil and climatic conditions and the specialization of farms, which ensure the use of optimal rates of application of organic and mineral fertilizers, siderates, post-harvest crops, biohumus, as well as application of differentiated tillage [11]. The main principle of construction and development of scientifically based crop rotations in Ukraine is the placement of wheat, maize, barley and other cereal crops after scientifically based predecessors, observing periods of return to the previous place of cultivation [1]. This ensures an increase in the level of soil fertility, productivity and preservation of the environment.

In 2022, 51 million tonnes of cereal crops were harvested in Ukraine with a yield of 4.7 t/ha from an area of 10.9 million hectares, which is 94% of the total area of crops [21]. This is the lowest figure in the last ten years, which was negatively affected by several factors such as: weather conditions – rainy summer and autumn; the inability of some agrarian producers to optimize the application of fertilizers for plant protection products; lack of elevators, which forced to leave part of the maize crop to winter in the field. In 2023, the situation may worsen significantly due to shortages and high prices for fuel, mineral fertilizers, and plant protection products. This will force Ukrainian agrarians to apply less fertilizers and plant protection products, which will lead to a decrease in the yield of agricultural crops, but to a healthier environment and higher quality agri-products.

To solve these problems, a number of adaptation measures have been proposed to overcome the negative impact of climate change which consist in the use of innovative technologies in environmental and genetic research.

In the second half of the 20th century, economic-mathematical modeling began to be widely used to establish the functional and quantitative determination of environmental and genetic systems at all levels of the organization [2; 3; 4]. In particular, they developed linear economic-mathematical models that provide solutions to optimization problems based on the use of the simplex method, which consistently improves their solution [10]. One-dimensional correlation and regression models were used, with the help of which the parameters of cereal crops variability were determined for each individual genetic trait [8].

The use of correlation and regression models in environmental and genetic research remains relevant to this day. For example, in genetic studies of the dependence of maize cultivation on systematic environmental changes, for the evaluation of pre-selected better samples, the connection between its various adaptive features and properties is revealed [29].

An important role in effectively ensuring the integrity of the growth and development of cereal crops is played by an approach that consists in the complex application of various types of correlation – genomic, morphological and functional [15]. For example, to establish factors that cause dependence between morphological-genetic features of winter wheat, determine the value of each factor for the occurrence of dependence, as well as the leading component.

Thanks to the joint research of Ukrainian and Moldovan scientists, a regression model was built to establish the level of adaptability of different genotypes of winter wheat and maize to environmental conditions – the complex influence of air temperature and lighting [17]. The synergistic effect of these factors has been established: the smaller one of them, the stronger the influence of the other.

The use of cluster, factor and discriminant models expanded the systematic research of genetic mechanisms of radiation transformation of cereal crops based on the influence of small doses of radiation on their structural-functional organization and adaptive potential. It was established that irradiation in small doses has the greatest effect on the organization of processes of epigenetic control of the formation and development of signs of the reproductive and generative spheres of barley, as well as its productivity [28].

System analysis using multidimensional models solves a more complex problem – assessment based on the aggregate manifestation of quantitative signs and system properties: nature, state, specifics of the genetic organization of processes that occur with cereal crops [14].

At the beginning of the 21st century, methods of system analysis to solve the problems of adaptability and resistance of cereal crops to stress factors are becoming widely developed. In particular, the features of the combined effect of radiation and toxic factors on the growth and development of cereal crops are determined thanks to the application of non-linear economic-mathematical models [5].

It can be concluded that using the achievements of molecular genetics and systems engineering, the development of environmental and genetic research is taking place. In particular, the system processes that take place at all stages of the formation of cereal crops are expanding, including self-organization, self-development, and self-regulation. The application of economic-mathematical modeling and computer technologies significantly accelerates the obtaining of quantitative and qualitative research results.

Of great importance is the use of geoinformation technologies, which were formed and continue to development on the basis of the achievements of the system of scientific knowledge: mathematics and statistics, informatics and programming, economic-mathematical modeling, cartography and ecology, monitoring of agrophytocenoses, remote sensing, aerospace research of ecosystems, GPS technologies, computer graphics and others [33].

In the second half of the 20th century, automated design systems began to be used. In 1981, the American Environmental Systems Research Institute (ESRI), which is now one of the leaders in the geoinformation technology industry, created the most widespread and developed "ArcGIS" software [6]. Thanks to its additional modules, consideration of characteristics and interpretation of spatially distributed data is provided for visualization and analysis of processes occurring in agroecosystems. It supports relational Database Management Systems (DBMS), has developed business graphics – view form, tabular form, diagram form, which creates professionally designed cartographic information [10].

In the mid-1990s, thanks to the technical capabilities of the "ArcGIS" software, the use of geoinformation technologies in environmental and radiological research expanded. In particular, Ukrainian scientists have developed model-analytical geoinformation technology that analyzes and provides forecasts of pollutant migration in cereal crops [5]. Its main information components were the physical-chemical and biochemical characteristics of pollutants, as well as natural and anthropogenic environmental conditions, including the nature of the surface, angles of inclination, mechanical and chemical composition of soil rocks, characteristics of cereal crops, and others. The analysis of these characteristics ensured the definition of the main blocks of the economic-mathematical model – indicators of the rate of introduction and removal of pollutants [30].

At the beginning of the 21st century, Ukrainian scientists began the joint application of geoinformation technologies and remote sensing technologies, which were created on the basis of the American computer programs "Noaa", "Landsat" and the French "Spot" [7]. Their importance lies in the comprehensive use of the information base: based on satellite images, aerial photography and remote sensing, cartographic information, image decoding materials, and experimental research. In particular, they predict and assess the consequences of natural disasters: floods, storm warnings and destruction, detection and monitoring of cyclones, control of forest fires, the risks of which increase with climate changes, both in Ukraine and in the world [23].

With the use of methods of geoinformatics and mapping, remote sensing and indication, the use of reclamation systems is optimized [12]. In the context of the international Ukrainian-Dutch project "Watermuk", modern geoinformation technologies are being created for effective management of irrigation in arid conditions, both in Ukraine and the world [10].

To determine the influence of environmental conditions on the optical properties of cereal crops, using the "Rapid Eye" satellite, ground spectral analysis data are obtained [31]. In particular, the spectral characteristics of vegetation cover are revealed as vegetation indices of brightness and redness. Favorable conditions for the growth and development of cereal crops are characterized by smaller values of the spectral brightness coefficients, and when the conditions deteriorate, an increase in their redness is noted. On their basis, with the use of geo-environmental, geodynamic, landscape-environmental methods and geoinformational mapping, a system of local anti-erosion zoning of lands is being developed [13].

Thus, thanks to geoinformation technologies, modeling and forecasting of pollution of agroecosystems is carried out, dependencies between the level of pollution and the development of cereal crops are determined, harmful substances are monitored and measures are planned to reduce the risks of their negative impact on agrophytocenoses.

CONCLUSIONS

It has been established that with the increase in the number of the world population to 8 billion peoples in 2022, the global consumption of cereals is steadily increasing, which is one of the factors in increasing the volume of its production and export. In particular, during 2008–2022, there is a tendency to increase world cereals production by 32%, which amounted to 2,791.3 million tonnes in 2022, and world cereals exports by 76%, which amounted to 480.3 million tonnes in 2022. Despite military actions rf, Ukraine managed to maintain its status as one of the main exporters of cereals, entering the top five in the world in 2022.

During 1990–2021, the production of cereal crops in Ukraine increased by 69% – from 51.0 to 86.0 million tonnes due to an increase in the production of maize per cereal almost 9 times – from 4.74 to 42.1 million tonnes due to the growth of its cultivated areas by 4.5 times – from 1.23 to 5.52 million hectares. Due to high competition on the foreign market, wheat cultivated areas decreased by 6.5%, barley – by 9.2%. Cultivated areas of technical crops increased 2.5 times – from 3.75 to 9.25 million hectares, thanks to the expansion of sunflower and rapeseed. At the same time, the cultivated areas of fodder crops decreased by almost 8 times – from 12.0 to 1.54 million hectares due to a sharp decrease in the sowing of maize for silage and green fodder, perennial and annual grasses.

The transformation of the cultivated areas led to the violation of the use of optimal predecessors and periods of return of cereal crops to the previous place of cultivation in crop rotations. In addition, due to climatic changes, prolonged droughts, dry spells, dust storms, rising air temperatures, lack of precipitation and other manifestations of the elements occurred. Therefore, during 1990–2021, the yield of cereal crops in Ukraine increased only 1.5 times – from 3.51 to 5.39 t/ha, wheat yield by 29% – from 3.52 to 4.53 t/ha, barley by 9% – from 3.51 to 3.82 t/ha, which is significantly lower than the potentially possible level.

A number of adaptation measures are proposed to overcome the negative impact of climate change, which consist in the use of innovative technologies in environmental and genetic research for the effective cultivation of high-yielding varieties and hybrids of wheat, barley and maize, resistant to drought conditions and harmful organisms.

In the second half of the 20th century, with the expansion of the use of economic-mathematical modeling in Ukraine, the development of such technologies took place. At the beginning of the 21st century, the cooperation of Ukrainian scientists with foreign scientists significantly expanded their use. Together with Moldovan scientists, non-linear, correlational and regression models are being developed for the effective growth, development and functioning of cereal crops in conditions of climate change. Thanks to innovative research, the use of the achievements of molecular genetics and system engineering – genetic and environmental – became the most effective in Ukraine.

An example of effective international cooperation was the confirmation by Ukrainian scientists of the effectiveness of geoinformation software products developed by American and French scientists. In particular, to analyze and provide forecasts of the migration of pollutants in agroecosystems.

Thanks to the combination of the use of geoinformation technologies and remote sensing technologies, the directions of environmental and radiological research of cereal crops in the conditions of climate change are expanding. Their use contributes to forecasting and prevention of natural disasters and reducing the risks of negative effects of harmful substances in agrophytocenoses. Thanks to the joint research of Ukrainian and Dutch scientists, geoinformation technologies have been developed to improve the efficiency of irrigation systems when growing cereal crops in arid conditions.

Wide use of innovative technologies in environmental and genetic research has ensured the promising formation of stress-resistant genotypes of cereal crops with increased adaptive potential, especially in conditions of climate change. Their cultivation, along with the optimization of cultivated areas, the use of scientifically based crop rotations and organic technologies, will ensure highly productive and competitive production of cereal crops in different soil and climatic conditions of Ukraine and the world.

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APPLICATION OF MODERN BIOTECHNOLOGICAL AND GENETIC METHODS IN THE SYSTEM OF PRESERVING THE GENE POOL OF THE UKRAINIAN BROWN DAIRY BREED

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Abstract

The authors investigated the possibility of using modern biotechnological methods for obtaining in vitro embryos from females of the local breed with the desired complex genotype by the A2A2/BB beta- and kappa-casein, cryopreservation and long-term storage in the system of preserving the gene pool. During the first stage of work, 27 oocytes–cumulus complexes (OCCs) were obtained from the ovaries of heifers, of which 66.7% were selected as suitable for in vitro cultivation, and from the ovaries of cows - 69.2% of oocytes–cumulus complexes (45 of the 65 obtained oocytes–cumulus complexes) were suitable for further cultivation. Our cytogenetic analysis of heifer egg cells showed that 33.3% (9 out of 27 cultured oocytes–cumulus complexes) of cells were at the metaphase II stage of meiosis, and 66.7% had chromosomal disorders. The second stage involved the fertilization of egg cells matured outside the body. During this stage, it was found that the level of zygote formation on average reached 23.8%, and further cultivation also provided in vitro fragmentation of embryos at the level of 22.2% (10 embryos from 63 inseminated eggs). It was found that the overall level of embryo formation after fertilization of egg cells of cows matured outside the body was 33.3%. For the conservation and rational use of breeding (genetic) resources of cattle at the cellular level, it is necessary to create cryobanks of gametes for long-term storage in order to further sell them for reproduction.

Key words: *gene pool, oocytes–cumulus complex, embryo, semen dose*

INTRODUCTION

There are still many local breeds of farm animals in the world, despite the fact that only a few specialized and highly productive breeds dominate the commercial sector. Unfortunately, state-of-the art and advanced technologies and effective breeding programs further reduce the competitiveness of local breeds. As a result, highly productive breeds are increasingly replacing local breeds, which leads to a decrease in the population of local breeds and even the threat of their extinction, and this places scientists before the challenge of developing measures to preserve genetic diversity [7; 8; 14]. This, in turn, requires scientific institutions, higher educational institutions of agricultural profile and veterinary laboratories to develop measures to study and identify valuable adaptive and productive traits of native animals [13].

Recently, dairy cattle breeding has increased the requirements for the quality characteristics of milk. According to the results of research, scientists have found that cow milk usually contains two main types of beta-casein – A1 and A2 [6, 9]. It is proven that researchers have found a possible link between milk consumption and certain diseases, such as type 1 diabetes, cardiovascular disease, Sudden Infant Death Syndrome, schizophrenia and autism, gastrointestinal diseases, prostate cancer, and other diseases [1].

It is shown that cattle of local breeds are characterized by a higher frequency of the desired A2A2 genotype compared to specialized dairy breeds [3, 4].

Successful conservation of breeds should take into consideration the biological, industrial, and cultural aspects that affect them. To be successful, all three aspects should be considered [12, 2].

Conservation and development strategies based on quantified strengths and weaknesses should be developed to preserve native breeds. Conservation of local breeds should include improving their genetic potential and managing breeds for future use. Effective management of local cattle resources includes identification, characterization, evaluation, documentation, and storage. To create regional banks of genetic resources, it is necessary to involve breeders, communities, public organizations and other stakeholders in conservation programs. As a rule, one of the three main conservation strategies for farm animal breeds is followed. The first two are in situ and ex situ in vivo preservation of live offspring. The third strategy involves preserving biological material (embryos, semen, etc.) in cryobanks.

Cryopreservation plays an auxiliary role in the conservation and improvement of breeds.

Within the existing local breed management system, the strategy should simultaneously ensure both the breed preservation and improvement. Restoration of the structure can provide two thousand semen doses from 15-30 stud bulls and 300 embryos with the same number of males and females.

Within the existing local breed management system, the strategy should combine genetic improvement and conservation. To restore the cattle population, it is necessary to preserve about 2,000 doses of frozen semen each from 15-30 bulls, and 300 embryos with the same number of males and females.

It is possible to ensure biological diversity by preserving other biomaterials (blood, tissues, stem cells). It is believed that if it is not possible to preserve the breed *in situ*, another *ex situ in vivo* conservation strategy should be used[13].

Sumy Region, located in the North-Eastern Ukraine, is almost the only region of Ukraine where local brown cattle, represented by the Lebedyn and Ukrainian Brown dairy breeds, are stored. The main breeding area of these breeds is Sumy and Okhtyrka Districts of Sumy Region.

The aim of the research was to develop a scheme for preserving the Brown cattle in the North-Eastern Region of Ukraine using biotechnological and genetic methods.

MATERIALS AND METHODS

The research was conducted on the regional breeding farms for breeding the Brown cattle, in the Sumy State-Owned Breeding Center. The object of the study was follicular oocytes obtained from the ovaries of animals at Nadiia Experimental Agricultural Farm State-Owned Enterprise of the Institute of Agriculture of the North-East of the National Academy of Agrarian Sciences of Ukraine located in. Donors of oocytes–cumulus complexes (OCCs) were three heifers and five cows of the Ukrainian Brown dairy breed. The ovaries were delivered to the reproduction biotechnology laboratory of M. V. Zubets Institute of Animal Breeding and Genetics of the National Academy of Agrarian Sciences from the slaughterhouse of Nadiia EAF of NAAS 6 hours after the animals were slaughtered in a thermos with sterile saline solution (0.9% NaCl) at a temperature of +32–38°C. Oocytes were obtained by cutting visible antral follicles with a blade, after which they were washed with the Dulbecco's medium (Sigma-Aldrich D 5773) with 1 U/mL of heparin (Biochemi) and 40 U/mL of gentamicin, caught with a Pasteur pipette and washed three-four times in the medium 199 (Sigma-Aldrich M 2520), which contained 10% pre-inactivated fetal calf serum (Sigma F 7524), and evaluated by morphological features through the microscope (MBS-9 USSR).

Oocytes with homogeneous fine-grained ooplasm, intact transparent shell, dense or partially loosened cumulus were used for cultivation. Maturation of OCC outside the body was carried out in quadrilateral plates

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(Costar) for 24 hours at a temperature of +38.5°C and 5% CO_2 content in an incubator, in medium 199 with 20% pre-inactivated estrus serum of cows, 2.0 mm of sodium pyruvate, 2.92 mm of calcium lactate, 40 mcg/ml of gentamicin. After maturation outside the body, the egg cells were fertilized *in vitro*. Cryopreserved ejaculated germ cells of a stud bull were used for fertilization of Final 1008 of the Lebedyn breed (blood capacity Lebedyn40.6/Swiss59.4). Semen capacitation was performed with heparin (100 U/ml) according to the methodology of Parrish J.J. et al. [10]. Separation of germ cells from seminal plasma and diluent was carried out by the swim-up method.

Before insemination, oocytes matured outside the body were partially released from the surrounding cumulus cells by mechanical means (pipetting through a smaller diameter pipette). Co-incubation of egg cells and germ cells was carried out in a thermostat at a temperature of +38.5°C and 5% CO_2 content in the air, in drops of Fert.-TALP medium. After 18 hours of co-incubation, the zygotes were washed from adhering germ cells and transferred to a CDM medium for further cultivation. The zygote culture medium was supplemented with 20% fetal calf serum. After further 96-hour cultivation, the embryos underwent morphological evaluation, and the embryos not corresponding to the stage of development were selected for cytogenetic analysis.

Genotyping was carried out for cattle of the Ukrainian Brown dairy breed of 7 stud bulls (Sumy State-Owned Breeding Center) and 8 cows and heifer kept on the farm of Nadiia Experimental Agricultural Farm State-Owned Enterprise of the NAAS Institute of Agriculture of the North-East. Genotyping was carried using the appropriate method [3; 5].

RESULTS AND DISCUSSIONS

The current state of the Brown cattle in the North-Eastern Region of Ukraine is characterized primarily by a rapid decline in the number of cows (Fig. 1) and the complete absence of live stud bulls in the breeding centers of Ukraine.

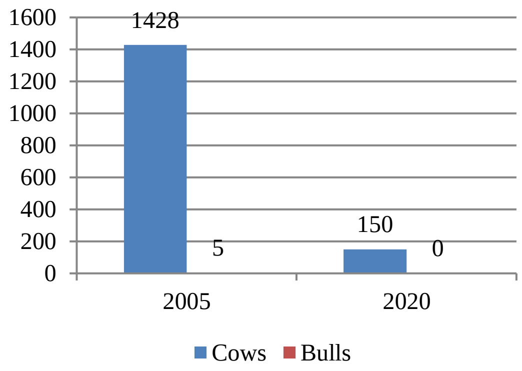

Fig. 1. Population of the experimental breed cattle in breeding farms and centers, heads
Source: Own research.

Only small reserves of semen of bulls crossbred with the Swiss breed (intermediate genotypes during the creation of the breed (Table 1)) give hope for its preservation.

Table 1. Reserves of stud bull semen in the Sumy State-Owned Breeding Center

Line	Stud bull	Conditional blood relationship, %*	Semen reserves, thousand doses
Elehanta 148551	Final 1008 A2A2/BB	L40.6/S59.4	4.5
	Murat 79 A1A1/AA	L12.5/S87,5	2.0
Minus 370	Parom 2075 A1A1/AB	L75/S25	1.5
Bravyi 1510	Rohiz 5002 A1A2/AA	L75/S25	11.0
Balkon 1799	Zaichyk 17000 A1A2/BB	L75/S25	8.9
Suprime 124652	Zalp 17505 A1A1AB	L75/S25	6.2
Balkon 1799	Chystyi 17035 A1A2/AA	L62.5/S37.5	5.8

* blood capacity:- Lebedyn; S –Swiss

Source: Own research.

That is why, as scientists note [11], cryopreserved semen of farm animals, which retains a high ability to fertilize for 25 or more years, is important for the preservation of local domestic breeds of cattle.

Brown cattle are a promising target for conservation and breeding, given their high proportion of preferred beta- and kappa-genotypes. Based on the results of our research, it was found that stud bulls whose semen is stored in the Sumy Breeding Center have a sufficient level of frequency of the desired A2 and B alleles (beta- and kappa-casein, respectively) (Fig. 2).

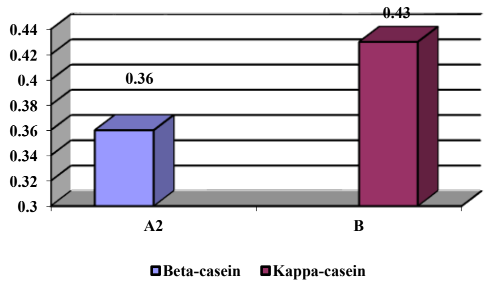

Fig. 2. Frequency of desired beta- and kappa-casein alleles in stud bulls
Source: Own research.

Their use makes it possible to obtain cattle with the desired genotype by A2A2 beta-casein and BB kappa-casein.

However, today the limited number of animals in breeding farms does not ensure their rapid reproduction. We have developed and begun implementing a scheme for organizing the use of biotechnological measures for the conservation of these livestock. According to this scheme, we have studied the possibility of using modern biotechnological methods for obtaining *in vitro* embryos with the desired genotype from heifers and cows of the local breed, cryopreservation and long-term storage in the system of preserving the gene pool of autochthonous breeds. We carried out a complex of works on the organization of obtaining, cultivating and fertilizing eggs cells of heifers and cows matured outside the body, and obtained embryos for further cryopreservation and long-term storage. Experimental Agricultural has the status of a breeding reproducer for breeding cattle (Certificate No. 9289). According to the site class determination data, it was recognized that heifers No. 8012882133, 8012882205, 8011870917 and cows No.No. 5900471930, 5900153371, 5900153352, 5900324430, 8011871058 are animals of the of the studied breed. According to genetic studies, the genotype of these animals by beta- and kappa-casein is A2A2/BB, which makes them particularly valuable in terms of creating micro-populations of dairy cattle with unique qualities. This, in turn, creates prerequisites for the preservation of the local breed. That is why the reproductive material of these animals has been used for biotechnological studies in the system of preserving the gene pool at the cellular level (Table 2).

Table 2. Number of cows and heifers received by OCC

Experiment variants	Number of OCC received				
	total	unsuitable for cultivation		suitable for cultivation	
	n	n	% ±m	n	% ±m
Heifers (n=3)	27	9	33.3[a] ±9.0	18	66.7[a] ±9.0
Cows (n=5)	65	20	30.8[a] ±5.7	45	69.2[a] ±5.7

Source: Own research.

Thus, we obtained 27 OOCs from the ovaries of heifers, of which, according to morphological assessment, 9 (33.3%) were unsuitable for cultivation, and 18 (66.7%) were selected as suitable for cultivation *in vitro*. 65 OCCs were obtained from cows, of which 45 (69.2%) were suitable for further cultivation, and 20 (30.8%) were assessed as unsuitable for biotechnological manipulation.

The next stage of our work was the cultivation of the resulting OCCs, fertilization of egg cells with cryopreserved ejaculated germ cells of stud bulls, and the production of embryos. From the selected oocytes of heifers n=18, from cows, respectively, n=45 were put for cultivation, cultured for 24 hours and fertilized *in vitro*. To obtain embryos *in vitro* with high genetic potential, egg cells were fertilized with cryopreserved ejaculated germ cells of the stud bull Final 1008, whose semen has been stored in the cryobank for more than 30 years, and its complex genotype is A2A2/BB. The use of semen from this stud bull will ensure the production of embryos with the desired A2A2/BB genotype. After defrosting, germ cells showed activity at the level of 65.0%.

As a result of fertilization of egg cells matured outside the body, the level of zygote formation on average reached 20.0% (Table

3). Further cultivation also resulted in the *in vitro* fragmentation at 20.0%.

Table 3. Results of *in vitro* fertilization of egg cells of heifers and cows

Experiment variants	Number of cells to be fertilized *in vitro*	Number of embryos in stages of							
		2 cells		3-4 cells		5-8 cells		9-16 cells	
		n	% ±m	n	% ±m	n	% ±m	n	% ±m
Heifers (n=3)	18	0	0.0^{a}	0	0.0^{a}	0	0.0^{a}	0	0.0^{c}
Cows (n=5)	45	15	33.3^{b} ±7.0	10	22.2^{b} ±6.2	10	22.2^{b} ±6.2	5	11.1^{d} ±4.7
Total	63	15	23.8^{b} ±5.4	10	15.8^{b} ±4.6	10	15.8^{b} ±4.6	5	7.9^{d} ±3.4

Notes: c : d P<0.05; a : b P<0.001, Student's t-test. In this Table, various superscripts indicate the likely difference between the indicators
Source: Own research.

It should be noted that in the case of *in vitro* fertilization of heifers' egg cells after 96 hours of cultivation, the development of embryos outside the body did not occur. According to the results of cytogenetic analysis, 6 cells (33.3%) out of 18 were at the stage of metaphase II of meiosis, and 12 out of 18 (66.7%) had chromosomal disorders.

When studying the formation of embryos after fertilization of mature cow eggs outside the body, the formation of 15 2-cell embryos was observed after 24 hours of cultivation (33.3%). During the next 72 hours of cultivation, embryo fragmentation was observed in 22.2% of cells. After 96 hours of outside the body cultivation of fertilized egg cells obtained from the ovaries of cows, embryo fragmentation was observed in 11.1% of embryos.

The overall level of embryo formation after fertilization of egg cells matured outside the body cows was 33.3% (15 embryos out of 45 fertilized egg cells). It should be noted that the total insemination index of cows is 4.0, which can explain the low yield of embryos outside the body.

The resulting embryos at the early morula stage were frozen by vitrification.

Only embryos of good and excellent quality were used for freezing. Cryopreservation was carried out by immersing straws and embryos in liquid nitrogen using balancing and vitrification solutions. Before freezing, the embryos with the lowest amount of culture medium were transferred to a balancing solution containing 10% glycerol (Sigma G 2025), 20% propanediol (Sigma-Aldrich 16033), and 20% fetal calf serum in Dulbecco's phosphate buffered saline. Cell balancing was carried out for 10 minutes at room temperature. The embryos were then transferred for 30 seconds to a vitrification solution (25% glycerin, 25% propanediol, 20% fetal calf serum in Dulbecco's phosphate buffered saline), pre-cooled to +4°C, placed in 0.25 ml of plastic straw (ART.NR: 13407/3010 Minitube) (Fig. 3) and immersed in liquid nitrogen.

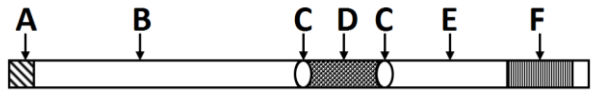

Fig. 3 Scheme of embryo filling in straw for cryopreservation.
A – plug, B – 0.75 m sucrose solution, C – air, D – vitrification solution with the biological object, E – vitrification solution, F – polymer plug
Source: Own research.

It is worth noting that cows had a capacity of 5,500 kg of milk per year with a fat content of 4.25% and protein content of 3.32%, so embryos have a high genetic potential.

Thus, when using complex breeding, biotechnological and genetic methods for obtaining embryos in vitro, it was found that the delivery of ovaries within 6 hours after the slaughter of animals (with the required 1.5-2 hours) affected the level of formation of embryos at the preimplantation stages of development, which was only 11.1%. The use of modern biotechnological methods can provide the essential amount of biological material from animals with high genetic potential and the desired complex genotype by beta- and kappa-casein and more efficiently use such material in the system of preserving the gene pool of breeds based on obtaining embryos in vitro. Thus, our proposed scheme for preserving the Brown dairy breeds using biotechnological and genetic methods includes:

- continuous monitoring of the quality of semen products of stud bulls in the gene pool storage;
- determination of animal genotype by beta- and kappa-casein;
- selection of animals (in case of their culling by age, level of productivity and state of health, the exception is animals with diseases of the reproductive organs);
- obtaining biomaterial (ovaries) and transporting them to the biotechnological laboratory in a set time;
- obtaining an OCC;
- cultivation of obtained OCCs;
- fertilization of egg cells with germ cells of a stud bull;
- embryo obtaining
- cryopreservation and storage of embryos in liquid nitrogen;
- use of embryos to reproduce the population of the local breed.

CONCLUSIONS

Measures have been developed to arrange the use of the modern biotechnological method of cultivation and fertilization of oocytes matured outside the body to obtain *in vitro* embryos cattle with the desired complex genotype while preserving the gene pool of autochthonous breeds.
For the conservation and rational use of breeding (genetic) resources of cattle at the cellular level, it is expedient to create cryobanks of gametes for long-term storage in order to further sell them for reproduction. The results of the research have revealed the need for a deeper study of the biological processes occurring in the animal body, taking into account individual, age and other characteristics, while preserving autochthonous breeds.

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SUSTAINABLE FOOD AS A THREE-DIMENSIONAL SYSTEM

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Abstract

While it has become clear that a system approach is important to improve not only the sustainability of agriculture but also nutrition, the analysis of food systems suffers from overcomplexity. In this context, the aim of the paper was to find ways to reduce the overcomplexity of food systems, using a new system approach which is essential for making our food production and nutrition more sustainable. The method was to structure the sustainability food as a three-dimensional system, by grouping and structuring the scientific approaches existing up to now in the specialized literature, searching and compiling through most of the paper having sustainable food as the main subject. The results were structured by creating a system through a set of four interrelated questions. It argues that the 'how' of food production and consumption, including the 'how much', is as important as the question "what" is produced and consumed. The 'who' dimension is of relevance for the socioeconomic pillar of sustainability, while the 'where' dimension puts our attention to geographical questions.

Key words: *system, target, transformation, food, farming*

INTRODUCTION

Academic interest in sustainable food systems is mounting, as indicated by the exponentially rising graph in Figure 1. This increasing interest is a necessity for solving the most pressing global problems. Obesity and undernutrition, for example, are both due to deficiencies in our food systems, as are 26 per cent of greenhouse gas emissions and 78 per cent of global eutrophication [65]. However, the majority of the large body of literature still does injustice to the system approach. Even the papers with the largest citation numbers often take the perspective of either the production [25, 39, 75] or the consumption side [85, 16, 24]. Decisions about how to organise a farm's production and about how to feed one's family may seem unrelated. The added value of the system approach, however, consists of linking only these perspectives but also those of the pesticide producing company, the dairy factory, the supermarket, fast-food chains and a host of other actors.

Still, the understanding of food systems and their sustainable management suffers from overcomplexity. It may appear as an insolvable contradiction that the many linkages between the actors in the system make a single-actor perspective of limited use, but that these interlinkages are too diverse to be usefully united.

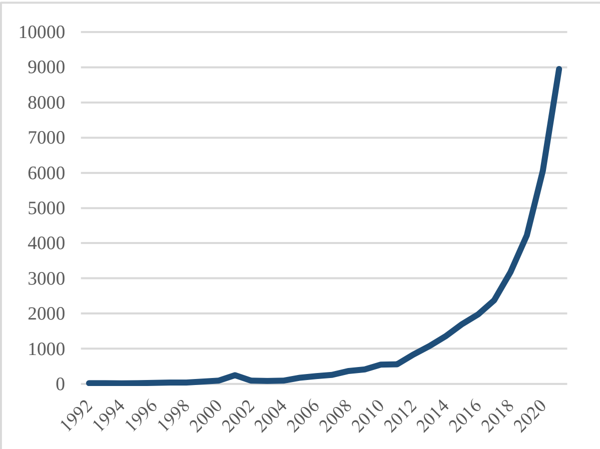

Fig. 1. Annual papers containing the term 'sustainable food system'
Source: Google Scholar.

However, this tension necessitates the development of categorising frameworks. To meet the need to structure the complexity of systems to meaningfully advance in sustainability transitions, both general suggestions of categorisations have been made [37, 30], but also systems applicable to fields like urban planning [67] or energy technologies [54].

This paper builds on the proposal for knowledge structuring by Jerneck et al. [36], our first dimension, and on the 2016 Chicago Consensus on Sustainable Food System Science [15], our second dimension.

In this context, their propositions and our suggested adaptation for sustainable food systems on a global level are targeted in this paper.

MATERIALS AND METHODS

In their seminal publication to structure sustainability science, Jerneck et al. [36] suggested to improve problem-solving capacities by structuring sustainability sciences in three different dimensions. One dimension would involve sustainability challenges, such as land use or biodiversity; the second dimension would distinguish between problem solving and critical research; and the third dimension would introduce the distinction between scientific understanding, sustainability goals and pathways, strategies and implementation.

This framework has been successfully applied, among others, to such issues as urban development [83] and land use planning, where Messerli et al. [50] have summarised Jerneck et al.'s [36] contribution and developed them towards the distinction between system, target and transformation. This categorisation system helps to distinguish between different dynamics in tackling today's food systems and will be used here as well.

For others, however, 'the four main domains of sustainable food systems science can be described as health, economics, society, and the environment' [15]. The latter three categories – the economic, the social and the environmental - are often described as the three pillars of sustainability [51]. Therefore, many scholars (e.g. Drewnowski, 2018), acknowledge the central role of health when defining sustainable food systems [15].

This paper suggests that it additionally helps to structure sustainable food systems if we use four categories of questions that all cover all actors in the food system. These questions are as follows:

-How should we produce, process, trade and consume our food?

-What food should we produce, process, trade and consume?

-Who should produce, process, trade and consume our food?

-Where should we produce, process, trade and consume our food?

While the importance of this third dimensions with the four questions will be justified within the paper, our proposition also implicitly includes omitted questions, and these omissions also need to be motivated. An obvious case for that would be the question of 'when'. Should it not also be important for the sustainability of food systems when food items are produced and consumed?

It seems that this is less the case than for other production systems, such as the energy system. In terms of energy, we make use of resources that were produced millions of years ago. In the food system, however, few items can be stored for more than a few years. Therefore, the possible variation of the timing of production is limited. Other questions concerning 'when', such as the supply of food outside of local seasons, can be subsumed under the question of 'how'.

The omission of the 'why' question is slightly more complex. However, the question why we need a food system at all is answered by our biological needs. The question why it should be sustainable, however, is a question that raises philosophical issues, although they have been mostly tackled independent of the special case of food [57, 64]. Figure 1 illustrates the broad consensus that exists about how sustainability is a global priority for food systems.

There will, of course, be interdependencies among these four remaining questions. The subsequent part of the paper will show if the resulting problems nullify the added value of our approach. Overall, we suggest a structuring system according to Figure 2. The subsequent sections, however, will solely focus on the horizontal axis of the systems because these other two dimensions have already been explored elsewhere.

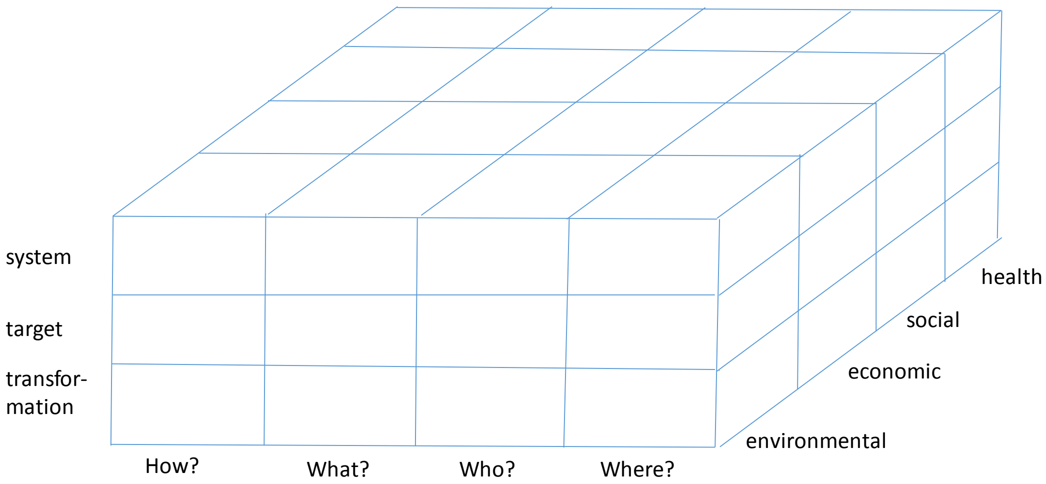

Fig. 2. The three-dimensional system
Source: Authors' own concept.

RESULTS AND DISCUSSIONS

Geography matters: the where

Our degrees of freedom with respect to the 'where' touch both on production and consumption. Starting with the latter, the whereabouts of food consumption are largely determined by today's settlement structures. People eat where they live. However, several studies indicate that eating out is less likely to create sustainable food choices, both in terms of product categories [66] and production methods [6]. Consumers and other actors in the chain seem to devote more attention to sustainability if food is prepared at home.

On the production side, climatic conditions in connection with market forces largely steer agricultural production so that Canadian farmers, for example, are more likely to grow canola than mangoes, whereas the opposite applies to farmers in Mali. However, agricultural subsidies also play a role. By incentivising farmers in wealthier countries to produce more intensely, they increase the environmental footprint of global agriculture [87]. However, as 'support is not systematically biased towards high-emission products', as Laborde et al. [42] remark, the extent of this impact is limited, and an increasing number of agri-environmental schemes partly counterweigh the deteriorating effect of farm subsidies [79]. Other studies on the division of responsibilities for the food system between the global North and the global South illustrate that the emphasis in transformative processes should lie rather on the 'how' than on the 'where' [7].

A number of scholars have considered adapting the location of production to the location of consumption. Choosing between more or fewer closed local food systems has optimistically been said to revitalise communities [21], secure the freshness of food [20] and provide authenticity [80]. Rigorous analyses of such local food systems, however, have indicated that most effects are bidirectional and entail a lot of trade-offs [71] while reducing the available range of food [68]. In their case studies on lamb meat and orange juice, Schlich and Fleissner [69] demonstrate the relative irrelevance of transport and the importance of ecologies of scale. Food miles are, as Edwards-Jones et al. [17] state, a poor indicator of sustainability.

The issue of urban agriculture may be a more decisive component of the 'where' question [48]. Ackerman et al. [1] emphasise the positive social and environmental effects of urban farming. It provides opportunities for community building and has educational benefits [14] while providing green infrastructure and protecting against heat islands [62]. According to a literature review by Nogeire-McRae et al. [56], the impact of urban agriculture on nutritional quality and the economy is, however, less clear.

Finally, the possibility to rate and map the sustainability of food systems is a totally different component of the 'where' dimension. Chaudhary et al. [9], for example, show that the carbon and the blue water footprint of food consumption are inadequately high in many American and European countries, whereas the indexes for food safety, food availability and food adequacy score poorly in such countries as Congo, Haiti, Malawi and Madagascar.

Humans matter: The who

Even more than 'where', the 'who' dimension is not too useful for the consumption side: we are all food consumers. For the production side, however, the ones actively participating in the system in many cases stand out in the way that they belong to the most vulnerable parts of the population. Levitte [45], for example, shows that 75 per cent of all farm workers in the US are Mexican born. Many scholars have documented the precarious labour conditions of immigrant workers in the farming systems of even developed countries. For instance, Arici et al. [4] compared the working conditions of the locally born and immigrants in Italy and Spain, concluding that immigrants faced higher physical demands, poorer working conditions, more exposure to occupational risks, a greater risk of occupational injuries and worse general and mental health.

Such socioeconomic issues also affect self-employed farmers. Even in the richest countries, poverty among farmers may strongly affect the sustainability of food systems [12]. However, the lack of resources for peasants in the Southern hemisphere is an even greater obstacle for food system sustainability. Ségundo-Metay and Bocco [72] have called this group both 'vulnerable and invisible', as they are exploited by both governments and businesses [10]. If peasants are landless, the situation is even worse [49]. While case studies indicate that other parts of the value chain also suffer from issues regarding social sustainability [35, 63], it appears clear that the greatest obstacles for social sustainability in food systems lie in primary production. La Via Campesina [41] reminds us that half of the global population are peasants.

Women are, in general, more vulnerable than men, and the food system is no exception. The strive to empower women includes agriculture, the food industry, retailing and catering [44]. Differing gender norms continue to limit the access to resources that women have [55].

While it is crucial for the socioeconomic pillars of sustainability to protect the vulnerable groups that legitimately earn their living within the food system, it may be even more important to focus on the group that should be protected from becoming part of the production system: children. The International Labor Organisation reports that 60 per cent of all child labourers between 5 and 17 years, or 98 million children in total, work in agriculture, most of them as unpaid family members [33]. While child labour is more prevalent in the global South than the global North [78], it also occurs in advanced countries, such as the US [2]. Protective policy mechanisms that prevent the food produced by the help of children to be traded are still lacking.

The dimension of the 'who' parallels to urban agriculture in the 'where' dimension in the way that the early inclusion of consumers turned 'prosumers' into the basics of the food system increases trust and competences among the non-agricultural population. School food gardens [8] and community supported agriculture [84, 32], for example, may close the gap between food producers and food consumers.

Diet matters: the what

The environmental dimension of sustainability is strongly affected by consumer choices. It applies also for this aspect that the choices by producers and consumers are strongly interlinked. However, political economists usually consider that our market economies are much more demand than supply driven [52], and in the vast majority of countries, it is food consumption trends, not food production trends, that steer the portfolio of the agri-food chain.

Scholars agree that the balance between crop-based and animal-based calories is the core criterion for environmental performance. It has been shown repeatedly that the environmental efficiency of animal products lies several factors below the environmental efficiency of crop products [13, 43, 58]. Thus, the substitution of an animal by crop products offers synergies for several impact categories [23].

In fact, altering the balance between animal-based and crop-based calories can be considered as one of the biggest levers for a systemic improvement of the food system's environmental sustainability. When looking for ways to extend organic agriculture to the entire global farmland, Müller et al. [53] show that the resulting calorie deficiency could be compensated by substantially reducing the share of animal-based products in the diet and by reducing food waste.

Of course, also within the groups of animal- and crop-based food items, the environmental footprint differs. Potter and Röös [61], for example, show that the environmental impact of organic apples lies well below that of conventional bananas. These differences pale, however, when creating an environmentally optimised diet in which animal products play hardly any role, being substituted by a broad range of different crop products [82]. This has led to calls to take into account the different environmental footprints between crop and animal products through taxing the latter [46, 47].

Finally, the packaging of food [27] can play a major role in reducing food waste [86]. With respect to the environmental impact of food, however, Schönberg et al. [70] conclude that the component of food packaging is rather negligible.

Processes matter: the how

The previous part has steered our attention towards the environmental dimension of sustainability. Historically, however, the first attempts to reduce the environmental damage of agricultural production were concerned with the 'how' instead of the 'what' dimension. In particular, generations of environmentalists have pressed for lower nutrient loads [88] and lower pesticide application rates [59] on farmland, which would tackle a large range of environmental variables, from biodiversity to ammonia and phosphate emissions to toxicity.

In recent years, the debates surrounding the intensity of farming have gained a systemic component by extending to a debate between land sparing and sharing. Provided that a certain number of calories are produced, less intensive land uses (through reduced chemical inputs) will require a larger area for cultivation than more intensive production systems. While Phalan [60] emphasises 'that most species will have larger populations if food is produced on as small an area as possible, while sparing as large an area of native vegetation as possible', it is unlikely that there is a right and a wrong side in this debate describing trade-offs. However, it is certainly a merit of this debate that it has shifted attention from the degree of intensity to the degree of eco-efficiency [81, 74].

Agricultural science has brought forward many ways to improve the eco-efficiency of production. They include biological progress, such as improved crop varieties [22], and managerial changes, such as pig feed being adapted to the animal's age [28]. More attention, however, has recently been devoted to the potential of digital solutions in agriculture for improving the efficiency of resource uses. Many scholars hope that the digitalisation of agriculture may improve the spatial targeting of agriculture [19]. To date, however, 'the prospects and effects of digitalisation in the agri-food sector and in agricultural policymaking are uncertain' [18], and the digitalisation of agriculture has created more questions than answers [34]. It may be better to more closely examine the social factors that affect eco-efficiency, such as the lower degree of eco-efficiency for part-time farms [29].

Most issues raised within the pillar of socioeconomic sustainability itself also fall under the category of the 'how'. In this respect, the low income of both peasants and farm employees is one of the most important issues. Christiaensen et al. [11] have shown that involvement in agriculture benefits the poorest of the poor (reflected in the $1/day threshold), but that the non-agricultural sectors do a much better job to lift people above a $2/day income. More strongly related to the 'how' is that there is a broad consensus that labour in agriculture should be voluntary [26], that workers should be allowed to organise in unions [77] and that sustainable food systems should not pose any health hazards to either farmers [73] or consumers [3].

Different production systems may have affect both the environmental and the socioeconomic pillar of sustainability. Bandanaa et al. [5], for example, conclude, based on a case study of Ghana's cocoa production, that organic systems fare better in terms of land degradation, greenhouse gases, profitability, and gender equity than conventional agriculture. Other forms of institutionalisation may also help to increase the sustainability of the food system, as Holt Gimenez and Shattuck's [31] introduction into food movements indicates.

Finally, the 'how' dimension also includes the question of 'how much', leading to two additional issues of great importance to the sustainability of food systems. The first issue is the amount of food that is produced but not appropriately used. Avoiding food waste [38], or valorising it where avoidance is impossible [40], is key for more sustainable food systems. The second is the amount of food that we actually consume. Steiner et al. [76] show how both hunger and obesity are indicators for non-sustainable food systems.

Two attempts in order to simplify the complexity of the food systems have already been made. One was the early distinction between the environmental, economic and social dimension of sustainability, which later extended to health for food realm. The other was Messerli et al.'s [50] distinction between system descriptions, target formulations and transformative research. Figure 3 shows how a few of the relevant research questions, most of them mentioned above in a more general way, make their way into the three-dimensional system.

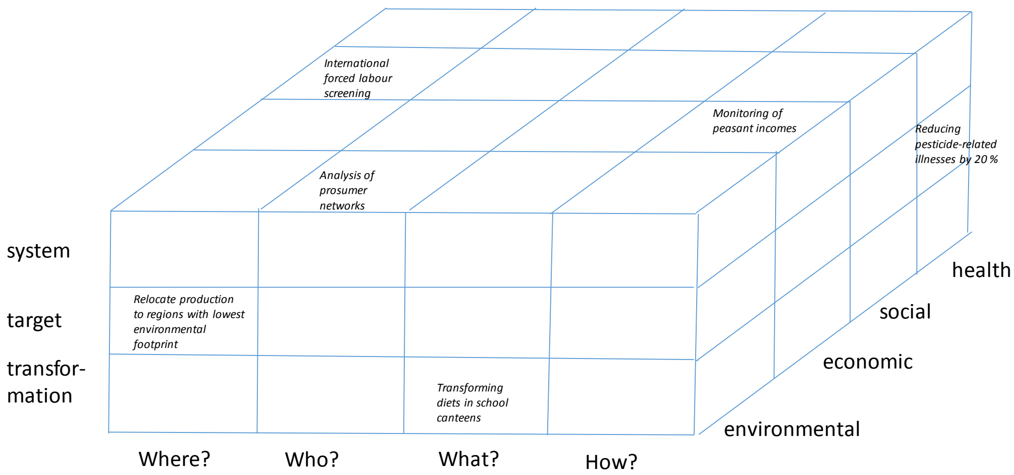

Fig. 3. Examples for research topics in the three-dimensional system
Source: Authors' own concept.

CONCLUSIONS

The increased interest in a system approach is a crucial prerequisite for making our food production and nutrition more sustainable. To fully utilise the potential of a systemic view, however, it will be necessary to find ways to reduce the overcomplexity of food systems, which can range from commercial farms in the American Corn Belt to urban food merchants in African cities.

The three-dimensional system that we proposed underline the main aspects that should be approached in relation with the sustainable food. One side of the system underline the necessity of the international forced labour screening, the importance of prosumer analysis and of peasant incomes monitoring. The second dimension is related with the necessity of reallocating production to regions with the lowest environmental footprint and also with the necessity of taking into account the transformation of the diets within schools. The third dimension, which is more difficult to quantify, is to reduce pesticide related illnesses by 20 %. A thorough, worldwide analysis of forced labour in agricultural production seems to be unrelated to the vegan option in a school canteen. Yet it is still crucial to recognise that both things are part of the same system and that interdependencies may well exist. Eventually, every reader will have to decide by themselves if the system of three different dimensions that includes four guiding questions contributes, together with the two other dimensions introduced above, to reduce the overcomplexity of food systems to contribute to their transformations towards sustainability. In any case, thought models will be needed that shift analytical levels and contribute to the formulation of helpful questions as well as to the identification of appropriate answers.

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SORGHUM, AN ALTERNATIVE IN COMPLEMENTARITY WITH CORN, ADAPTED TO CLIMATE CHANGES. AMZACEA VILLAGE, CONSTANTA COUNTY, ROMANIA

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Abstract

The geographical area between the Danube and the Black Sea, Dobrogea, represents a region with the highest aridity indices. The average precipitation in the period 1961-2016 was 464 mm. Climate changes in recent years have accentuated this phenomenon and, due to this, low production levels of 1-2 tons/ha were achieved on large areas of corn. In the year 2022/2023, over 40,000 ha cultivated with corn in Constanta county were deeply affected by the lack of rainfalls, high temperatures and long and severe drought. In these particularly dry conditions, sorghum becomes an essential alternative. This study aimed to continue the experiments with sorghum hybrids which have been carried out during the last 15 years at SPORT AGRA Ltd from Amzacea Village, Constanta County, in order to adapt the technologies to climate changes. The novelty of this research is that the adapted technologies include, among other things, the following elements: changing the planting period by approximately 25-30 days compared to the recommendations of classical technologies (planting starting from the first decade of May in order to use the moisture in the soil layer at the depth of seed incorporation 4-5 cm.), the use of early hybrids in order to overcome the periods of heat that in this area start from mid-June, the use of technological means of crop protection that include pre- and post-emergent herbicides, seed treatment prior to planting. In these conditions of development of non-irrigated sorghum technology, we propose planting this crop earlier (25-30 days compared to classic technology). In this way, the sorghum will benefit from the water reserve accumulated during the fall of the previous year. The productions of the sorghum hybrids used in the observation research fields were over 10 to/ha in most of the tested hybrids.

Key words: *Sorghum, hybrids, climate changes, technologies, pathogens*

INTRODUCTION

Sorghum is considered one of the oldest cultivated plants, the cultivated form very probably coming from the "domestication" in Africa 5-7000 years ago of the wild species *Sorghum arundinaceum* (Desv.) Stapf. Later, probably between the years 1500-100 B.Ch., Sorghum arrived in India and China, then in the Near East and in the first centuries of our era in the Mediterranean basin. Specialized literature records the culture of sorghum in the 9th century in Zanzibar [8], East India, in Italy in the 13th century. The Americans brought it from Asia - Franklin found some seeds in a brush and cultivated them.
In Romania, the first experiments with Sorghum were carried out at the Valul lui Traian Research and Development Station in 1961. A number of 13 grain sorghum hybrids were tested compared to the HD402 double corn hybrid, the results being exposed in Table 1.
The data from Table 1 show that the sorghum hybrids registered a higher yield than the HD402 corn hybrid. This additional yield varied between + 687 kg/ha and +3,098 kg/ha.
Parallel to the experimentation of a large number of foreign hybrids, the first sorghum improvement research works were initiated at the "Research Institute for Cereals and Technical Plants" Fundulea [14], completed by the approval of the first Romanian sorghum hybrid F31 in 1965 and later the F21, F30 and F32 hybrids.

Table 1. Comparison between HD 402(Maize) hybrid and various sorghum hybrids regarding plant height, vegetation period and yield

Hybrid	Plant height (cm)	Vegetation period (days)	Average production kg/ha	Diff. ±
HD 402 (Corn)	220	132	5,054	0
NK 300	156	143	8,152	+3,098
NK 120	118	128	7,905	+2851
X 3000	109	125	7,646	+2,592
X 3021	129	135	7,611	+2,557
X 3057	170	130	7,476	+2,422
X3007	108	148	7,322	+2,268
NK 310	113	146	7,057	+2,003
NK 230	103	136	6,867	+1,854
NK 145	225	130	6,815	+1,761
NK 135	122	131	6,670	+1,616
NK 135 11	136	145	6,657	+1,603
X 3037	102	145	6,459	+1,405
NK 140	118	138	5,741	+687

Source: Valul lui Traian Research and Development Station for Agriculture, Constanta County [33].

The plant breeding works had several objectives: precocity, low content in tannin and hydrocyanic acid, improvement of tolerance to salinity and soil alkalinity.

The botanical characteristics of this plant and the chemical composition, the carbohydrate juice content led to the creation of the Carmen hybrid for sweetened sorghum and Donaris hybrid for brooms.

In 1943, Italian sorghum was produced in Romania for export.

In 1986, sorghum was cultivated on 90,000 ha carrying out a yield of 1,860 kg/ha (Romania's Statistical Yearbook 1990) [27].

In 2003, a number of 8,765 agricultural holdings cultivated 11,092 ha with sorghum in Romania [21].

In 2003, at the world level, there were 44 million hectares cultivated with sorghum, of which the largest areas in India 10 million hectares (22.72%).

Globally, sorghum has a share of 16% of the total cultivated area with cereals and 25% in the developed countries [4].

Among cereals crops at world level, Sorghum Sp. comes of the 5th position after maize, rice, wheat and barley [25].

In 2017, the world Sorghum production reached 63.9 million tonnes, and the average yield 1,427 kg/ha. The main producers of Sorghum were the USA, Nigeria, Sudan, Mexico, Ethiopia and India [26].

In 2020-2021, it was produced over 60 million tons sorghum. The main producing countries were Nigeria, USA, Sudan and Mexico.

In 2022, an area of 40 million ha was cultivated with this crop [7]. This reflects a decline in cultivated area and also yield decreased in the top producing countries. About 34% of the cultivated area is in India and Sudan, whose sorghum production accounted for 17% of the global output [12].

In the EU, in 2017, sorghum represented only 0.12 % of the world cultivated area with this plant and there were achieved 755 thousand tonnes of grains (1.18 % of the world output).

With 5,580 kg/ha average yield, the EU exceeds 3.81 times the world mean. The main EU producers of Sorghum are: Italy, France, Spain, Romania, Austria, Hungary, and Bulgaria [26].

In the EU in 2022, there were 183,000 ha cultivated with sorghum. From the total EU production, 41% is achieved in France, 34% in Italy, 8% in Hungary and 7% in Romania [32].

In 2023, the largest cultivated areas with sorghum in the EU are in France 51,000 ha and Italy 40,000 ha. The highest production is obtained in Italy, 260,000 tons and France 219,000 tons, while the top yield was registered in Italy 6,500 kg/ha, Greece 5,200 kg/ha and France 4,300 kg/ha [5].

The main aspects of interest for research on sorghum crop are: testing hybrids with high production potential [11], sorghum roots and yield response to soil water status [13, 19, 34]. sorghum root system development compared to maize [28, 30], influence of temperature on sorghum grains germination [24], sorghum tolerance to climate risk [12], adaptation to heat stress of grains crops by sowing in other period to avoid heat and drought [35], sowing from 20 April till 15 May depends on climate [8], sorghum an alternative and a complementary crop for maize in Dobrogea region [15], adaption of sorghum technology to climate change risk [15, 16, 17, 18, 31].

In this context, the purpose of this research work is to develop experiments destined to test the planting period, tolerance to drought conditions and burn, diseases and pests specific to the area, production levels of various sorghum hybrids under the climate conditions where the Commercial Company Sport Agra Ltd. in running its activity, in Amzacea village, Constanta county, Romania.

The results have to provide useful information to the farmer to make the right decision concerning the best hybrids which could produce the highest yield and deserve to be cultivated in the future.

MATERIALS AND METHODS

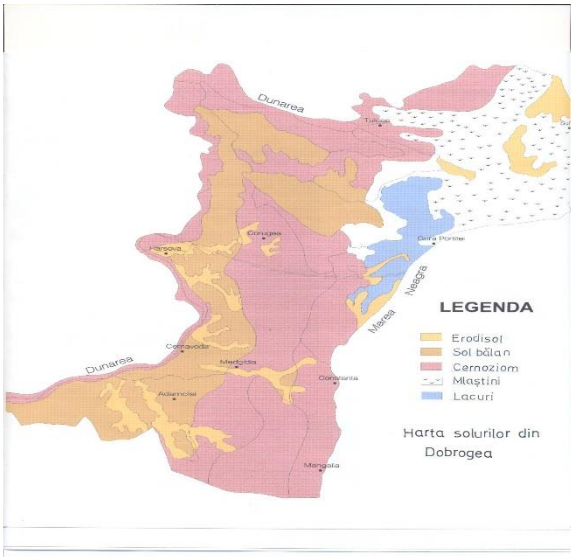
Starting with 2012, the first experiments with various sorghum hybrids in the fields of comparative crops were developed by the Commercial Company Sport Agra Ltd, Amzacea village, Constanta county, aiming at adapting various hybrids to climate changes by testing the planting period [3, 35], tolerance to drought conditions and burn, diseases and pests specific to the area, production levels.

The experimental plots were located on a soil belonging to the Southern Dobrogea plateau.

The soil is represented by cambic chernozem, with a deeper profile than that of other chernozems, a blackish brown soil with a thickness of 40-50 cm, medium texture [6] (Map 1).

The soil nutrient content was: --mobile P index – 72 --N index – 4 --humus – 3.11 --K index – 200 --neutral pH – 7.2.

The climate is deeply temperate continental, with an average annual temperature of 10.7-12.12°C, with a high temperature accompanied by heat between the beginning of June and the end of August.



Map. 1. Soil map in Dobrogea region, Romania
Source: Soil Science Office, Constanta [29].

Dobrogea region has a temperate continental climate. It frequently faced drought, an endemic phenomenon "During dry years, periods of drought can last 60-100 days, sometimes even longer", as affirmed [9].

Among the last 10 years, 5-6 were dry or excessively dry years. The calamity of agricultural crops cost the state budget over 500 billion lei until 2007 [23].

The acceleration of the phenomena of drought, aridity, desertification is the consequence of the negative effects of technological progress and intensive industrialization, and which have determined climate changes, as follows:

High temperatures:

+ 38.5 degrees Celsius - July 27, 1927, Constanta;

+ 42.2 degrees Celsius - August 1945, Cernavoda;

2007- More than 70 days without precipitation with temperatures above 35 degrees Celsius:

36.8 degrees Celsius – June 23, 2007
40 degrees Celsius – July 23, 2007
36.4 degrees Celsius – August 23, 2007.
41.4 degrees Celsius - July 8, 2008, Hirsova
39.6 degrees Celsius - July 8, 2012, Adamclisi
40.4 degrees Celsius - 25 August 2012 Cernavoda,
38.9 degrees Celsius - 16.08.2008, Hirsova,
- July-August 2022, 13 mm. = 62 days
-September 18.5 mm., October 0 mm,

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-November 8 mm.

-52 days Amzacea July – November 8, 2022, only 18 mm [1, 9, 20].

Multiannual average rainfalls and temperatures over 69 years in Constanta County is shown in Table 2.

From Table 2 it is easily to distinguish the differences regarding the amount of precipitations from a month to another and also of the average temperatures, whose average on the whole period of 69 years was:

- 401 mm in case of rainfalls and

-10.8^{0}C in case of temperatures.

The monthly and annual precipitation calendar at Amzacea Meteorological Station in the years 2018-2022 is presented in Table 3. The multiannual average precipitation by agricultural regions in Romania in the period 1961-1990 and 1981-2010 is presented comparatively in Table 4.

Table 2. Multiannual average rainfalls and temperatures over 69 years in Constanta County

Multiannual average over 69 years		
Month	Rainfall	Temperature
I	58.9	-0.6
II	24.0	0.7
III	25.4	4.0
IV	32.1	9.6
V	39.0	15.3
VI	47.8	19.5
VII	33.8	21.7
VIII	33.0	21.2
IX	29.9	17.0
X	34.2	11.8
XI	41.2	6.5
XII	34.7	2.1
Annual Average	401.0	10.8

Source: Valul lui Traian Research and Development Station for Agriculture, Constanta County [33].

The maps 2, 3 and 4 show the distribution in Romania's territory of the temperatures in the periods 1961-1990, 1971-2000 and 1981-2020.

Table 3. The monthly and annual precipitation calendar at Amzacea Meteorological Station in the years 2018-2022

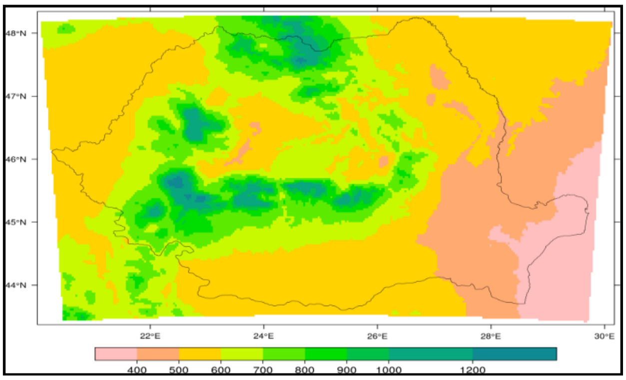
Year	**Monthly precipitations (mm)**												**Total**
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2018	63	120	68	2	92	76	147	0	3	3	57.5	47	678.5
2019	36	8	16	35.5	18	14	44	7	37	44	9.5	27.5	296.5
2020	2	50	16	15	42	24	29	0	31	18.5	21	100	348.5
2021	122.5	34	61.5	35	22	270	18.5	0	40	115	49	92.5	860
2022	19	40	42	46.5	14	45.5	10	3	69.5	0	**26**	**21**	**336.5**
Annual average	48.5	50.4	40.7	26.8	37.6	85.9	49.7	2	36.1	36.1	**32.6**	**57.6**	**503.9**

Source: Amzacea Meteorological Station [1].

Table 4. Comparison concerning the multiannual average precipitation by agricultural regions in Romania in the period 1961-1990 and 1981-2010

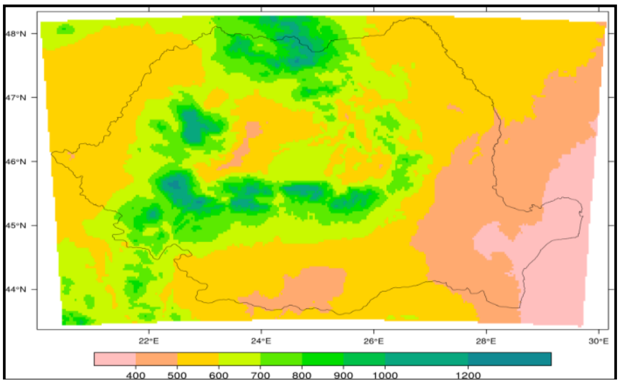
	1961-1990	1981-2010
Dobrogea	417.0mm/y/poor	412.0mm/y/poor
Moldova	576.7mm/y/poor	575.9mm/y/poor
Muntenia	598.2mm/y/poor	575.7mm/y/poor
Oltenia	673.4mm/y/optimum	645.8mm/y/optimum
Crisana	669.3mm/y/optimum	668.4mm/y/optimum
Transilvania	681.5mm/y/optimum	680.0mm/y/optimum
Banat	753.2mm/y/rainy	737.8mm/y/rainy
Maramures	799.2mm/y/rainy	829.1mm/y/rainy

Source: Valul lui Traian Research and Development Station for Agriculture, Constanta County [33].

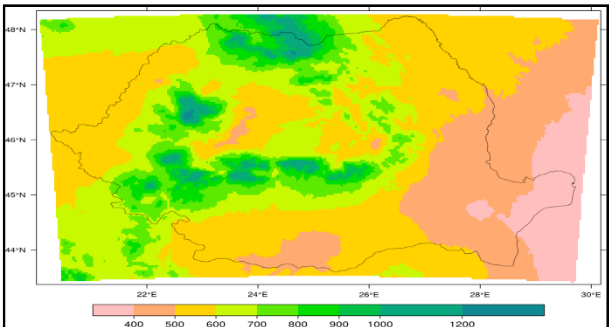


Map 2. The distribution in Romania's territory of the temperatures in the periods 1961-1990

Source: [22].



Map 3. The distribution in Romania's territory of the temperatures in the periods 1971-2000
Source: [22].



Map 4. The distribution in Romania's territory of the temperatures in the periods 1981-2010
Source: [22].

In Constanta county, the main cultivated crops are wheat, barley, maize, sunflower and sorghum as shown in Table 5.
In the interval 2017-2022, the cultivated area in Constanta county declined by 6.54%.
Also, a decrease in the cultivated area was noticed in case of barley, +79.34% and sorghum +10.71%. In case of the other crops it declined.
Average production per surface unit are also presented by each considered crop in Table 5, except barley, whose yield in 2022 versus 2017 increased by 12.4%, in case of all the other crops it was noticed a reduction as a consequence of the lack of irrigation and high temperatures and long and severe droughts in these years.
Sorghum is cultivated on the smallest area in Constanta county, only on155 ha in the year 2022, by 15 ha more than in 2017.
In the analyzed period, Sorghum yield varies between the minimum 843 kg/ha in the year 2020, well known for its long drought and heat waves and 3,860 kg/ha in the year 2021.

Table 5. The cultivated area and yield for wheat, barley, maize, sunflower and sorg in Constanta county in the period 2017-2022

		2017	2018	2019	2020	2021	2022	2022/2017 %
Wheat	Area (ha)	175,969	179,309	181,723	173,253	164,480	162,688	92.45
	Yield (kg/ha)	5,413	5,677	4,748	983	5,086	4,989	92.16
Barley	Area (ha)	37,006	36,213	45,092	54,709	72,091	66,368	179.34
	Yield (kg/ha)	4,475	5,204	4,754	1,065	4,949	5,030	112.40
Maize	Area (ha)	58,045	56,269	63,499	52,517	50,277	58,922	101.51
	Yield (kg/ha)	5,786	8,124	5,628	1,458	5,239	3,788	65.46
Sunflower	Area (ha)	81,318	79,822	86,928	74,538	72,265	74,005	91.00
	Yield (kg/ha)	3,180	3,715	2,660	1,115	3,411	2,381	74.87
Sorghum	Area (ha)	140	210	222	94	308	155	110.71
	Yield (kg/ha)	3,293	2,354	2,428	843	3,860	2,148	65.22
Total Constanta	Area (ha)	474,324	474,344	476,680	459,389	445,674	443,347	93.46

Source: National Institute of Statistics, NIS, 2023, www.insse.ro, Accessed on Oct. 4, 2023 [23].

RESULTS AND DISCUSSIONS

Demonstration plots are presented and commented in this paragraph of the research paper. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2017 are presented in Table 6.

2017 = 12 corn hybrids in testing. Productions varied from 8,351 kg/ha Mylord to 12,027 kg/ha LG 30,315. The corn was harvested on 30 August.

The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2018 are presented in Table 7.

Table 6. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2017

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Alize	Wheat	2,195	220,000	4 April	14 April	10,439	24 August
Foehn	Wheat	2,195	220,000	4 April	14 April	11,504	24 August
Arkanciel	Wheat	2,195	220,000	4 April	14 April	10,336	24 August
Arkanciel	Wheat	2,195	220,000	4 May	16 May	6,900	5 September
Albanus	Wheat	2,195	220,000	4 April	14 April	10,130	24 August
Typhon	Wheat	2,195	220,000	4 April	14 April	8,859	24 August
Armorik	Wheat	2,195	220,000	4 April	14 April	10,645	24 August

Source: Original conception.

Table 7. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2018

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Albanus	Wheat	2,195	240,000	11 April	24 April	10,100	22 August
Foehn	Wheat	2,195	240,000	11 April	25 April	11,000	22 August
Arkanciel	Wheat	2,195	240,00	11 April	25 April	10,669	22 August
Arkanciel	Wheat	2,195	240,000	20 April	28 April	8,634	9 September

Source: Original conception.

2018. The calendar year 2018 accumulated 678.5 mm. of which in the months of full vegetation: May – 92 mm, June – 76 mm, July – 147 mm.
23 corn hybrids were tested with variations in production levels as follows: Mayflower hybrid 12,029 kg/ha and P0023 15,191 kg/ha.
Corn was harvested on September 1.
The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2019 are presented in Table 8.

Table 8. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2019

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Foehn	Wheat	560	250,000	26 March	15 April	6,907	21 August
Alize	Wheat	560	250,000	26 March	15 April	6,844	**Harvest date**
Alize 2	Wheat	560	250,000	15 April	1 May	5,513	21 August
Albanus	Wheat	560	250,000	26 March	15 April	5,323	**Harvest date**
Shamal	Wheat	560	250,000	26 March	15 April	7,034	21 August
Anggy	Wheat	560	250,000	26 March	15 April	6,273	**Harvest date**

Source: Original conception.

The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2021 are presented in Table 9.

Table 9. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2021

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Foehn	Wheat	560	262,000	19 April	2 May	6,428	22 September
Shamal	Wheat	560	262,000	19 April	2 May	6,607	22 September
Alize I	Wheat	560	262,000	19 April	2 May	7,410	22 September
Alize II	Wheat	560	262,000	26 April	10 May	7,053	22 September
Arabesk	Wheat	560	262,000	19 April	2 May	6,339	22 September
Anggy	Wheat	560	262,000	19 April	2 May	7,410	22 September
Belugga	Wheat	560	262,000	19 April	2 May	6,964	22 September
Huggo	Wheat	560	262,000	19 April	2 May	7,500	22 September

Source: Original conception.

On June 12, 2021, at 12:15 p.m., the platform of the observation research field benefited from a torrential rain (75 mm. in 40 minutes) accompanied by hail with disastrous effects. (Photo 1). The sorghum hybrids regenerated from internode 1-2 producing the productions presented in the table. The harvest was delayed (Photo 2).

Photo 1. Torential rainfall with hail at Amzacea on June 12, 2021, 12:15 p.m.
Source: Original.

Photo 2. Regeneration of sorghum crop following the hail from June 12, 2021 to July 30, 2021
Source: Original.

The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2022 are presented in Table 10.

Table 10. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2022

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Anggy I	Wheat	560	262,000	26 March	30 April	7,710	23 August
Anggy II	Wheat	560	262,000	8 April	4 May	7,063	23 August
Huggo	Wheat	560	262,000	26 March	30 April	6,500	23 August
Icebergg	Wheat	560	262,000	26 March	30 April	6,418	23 August

Source: Original conception.

The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2023 are presented in Table 11. Sorghum is one of the cereal plants that I recommend for arid areas, the plant called "desert camel" due to its resistance to drought (Amsalu Ayana et al. 1998) [2].

The botanical features that give it resistance to drought and burning is the fasciculate root that explores the soil layers between 1.25 - 1.40 meters from which embryonic roots with absorbent hairs at 40-60 cm are born. around the plant.

Table 11. The technical sheet demonstration plots for sorghum crop at Sport Agra Ltd, Amzacea in the year 2023

Hybrid	Previous crop	Surface (sqm)	Stand Density	Planting date	Emergence date	Yield kg/ha	Harvest date
Aligator	Wheat	560	262,000	10 April	6 July	1,607	30 August
Beluga	Wheat	560	262,000	10 April	2 July	1,517	30 August
Huggo	Wheat	560	262,000	10 April	5 July	2,679	30 August
Sentinel	Wheat	560	262,000	22 April	20 July	1,071	30 August

Source: Original conception.

The determinations made reflect that the volume of sorghum roots exceeds the volume of a fully developing corn plant. In the absence of precipitation during the growing season, it stops growing, resuming at the first rains.

Sorghum contains 20-40 kg of carbohydrate juice per 100 kg/stalks, which can result in cheaper fuel [4].

It is rich in amino acids and appreciated in human consumption: more than 200 million inhabitants of the planet consume sorghum in various forms. Sorghum is a basic component in fodder rations (grains and silage), and could be used in beer industries, fuel production, etc. Also, it absorbs carbon dioxide from the atmosphere. In all the years of observational research, the preceeding plant was autumn wheat, with special emphasis on weed control. Soils infested with *Sorghum halepense* were excluded.

The soils intended for the observation platforms were plowed at a depth of 23-25 cm. until September 1 and were kept clean of weeds by applying specific mechanical works and glyphosate.

The planting was carried out in all the years of observations using early and semi-early sorghum hybrids, when the soil temperature indicates 8-10ºC at a depth of 7-8 cm, the seeds being incorporated at a maximum of 4 to 5 cm.

The surface of the experimental plots varied: between the years 2013-2018 = 2,195 sqm, and between 2019-2022 = 560 sqm.

Due to the lack of moisture at the depth of incorporation of the seeds, in all the years of observation, following the temperature of the soil at the depth of incorporation of the grains, we changed the "optimal planting periods" as presented in Table 12.

Table 12. Changes in the "optimal planting periods" of sorghum

Year	Hybrid	Planting date	Yield-Kg/ha
2014	Arkanciel	9 April	9,910
2014	Arkanciel	2 May	7,610
2016	Arkanciel	4 April	10,022
2016	Arkanciel	4 May	7,810
2017	Arkanciel	4 April	10,336
2017	Arkanciel	4 May	6,900
2018	Arkanciel	11 April	10,669
2018	Arkanciel	20 April	8,634
2019	Alize	26 March	6,789
2019	Alize	15 April	5,524
2022	Anggy	26 March	7,710
2022	Anggy	8 April	7,063

Source: Own conception.

In the four years of observations 2014-2016-2017-2018, the Arkanciel hybrid planted between April 4-11 compared to the later planting, on 20.04.-02.05.-04.05, achieved higher production levels by 2,035 kg/ha, in year 2018, sown on 20.04., obtained 2,212 kg/ha, sown on 04.05., obtained 2,300 kg/ha, sown on 02.05. of 2014 and 3,436 kg/ha sown on 04.05. of the year 2017.

In order to observe the reaction of the hybrids to the change in the planting period in 2019, 2022, the Alize and Anggy hybrids were sown, as shown in Table 13, from which it can be seen that the hybrid Alize sown on 26.03. achieved a higher production level by 1,265 kg/ha compared to the same hybrid sown on 15.04.

Table 13. Changes in the planting periods for Alize and Anggy hybrids of sorghum

Year	Hybrid	Planting date	Yield-Kg/ha
2019	Alize	26 March	6,789
2019	Alize	15 April	5,524
2022	Anggy	26 March	7,710
2022	Anggy	8 April	7,063

Source: Own conception.

The hybrid Anggy in 2022 was sown on 26.03. and achieved an increase of 647 kg/ha compared to the same hybrid sown on 08.04.

The shape and size of the nutrition space were ensured by planting at a distance of 70 cm. between rows, depending on the quality certificate of each hybrid between 230,000 - 262,000 germinating grains per hectare (at 142 linear cm. 23 - 26 grains = 1 square meter). In the following years, we will carry out observations in order to determine the shape and size of the nutrition space. Compulsorily, before planting in the geographical areas of Dobrogea, the seed must be treated with thiamethoxam 8 l/to. The young sorghum seedling is highly valued by Tanymecus dilaticollis. Gyll., producing real disasters, the carbohydrate juice attracts the insect. Between 60 and 80 kg/ha a.s. were provided with planting. phosphorus and 30 kg/ha a.s. nitrogen 120 kg/ha a.s. were applied to the vegetation together with the mechanical straws. The culture was kept clean of weeds by the pre-emergence application of herbicides based on metolachlor 960 g/l, 1.5

l/ha, and in vegetation based on acid 2.4 D 600g/l, 1 l/ha.

In all the years of observations in the first phenophases of vegetation 2-6 leaves, Iit was noticed that sorghum is a very sensitive plant to weeding, having a slow growth. From this point of view, the herbicides based on 2.4 D acid do not control dicotyledonous weed species under the conditions of Amzacea.

For this reason, on this occasion, the authors suggest the approval of the Ministry of Agriculture and Rural Development of the use of herbicides based on bromoxynil 280 g/l + 2.4-D acid (ester) 280 g/l, 1 l/ha.

Economic results at Sport Agra Ltd Amzacea

Table 13 present the economic efficiency in the year 2017.

Table 14 present the economic efficiency in the year 2019.

Table 13. Economic efficiency of agricultural crops in the year 2017

	Corn	Soybean	Sunflower	Sorghum	Wheat
Mechanical works	316	318	329	269	377
Seed	125	204	149	101	92
Fertilizer	165	74	130	156	188
Pesticides	183	124	156	51	137
Total Cost/ha	789	720	764	577	797
Average Kg/ha	8,364	1,992	3,800	8,859-11,504	7,271
Price/ton	130	299	294	130	164.7
Income	1,087	595	1,117	1,151-1,495	1,197
Profit per ha Leu/Euro 4.65	298	-125	353	574-918	400

Source: Own results.

Table 14. Economic efficiency of agricultural crops in the year 2019

	Corn	Soybean	Sunflower	Sorghum	Wheat
Mechanical works	239	214	192	201	500
Seed	96	64	82	83	111
Fertilizer	266	98	232	133	112
Pesticides	148	71	150	57	111
Total Cost/ha	698	447	656	474	834
Average Kg/ha	7.050	1.433	3.431	7.034	6.690
Price/ton	142	277	279	142	162
Income	1.001	397	957	999	1.083
Profit per ha Leu/Euro 4.65	303	-50	301	525	249

Source: Own results.

Given the increasingly aggressive climate changes and the lack of irrigation, sorghum is a definite alternative to replacing corn in certain geographical areas, in non-irrigated conditions.

In Dobrogea as well as in the Romania Plain, in the south of Moldova, the areas occupied with sorghum will have to ensure the deficit of corn, by increasing the areas occupied with this crop and by increasing production levels.

In recent years, the areas occupied with corn have decreased, in 2022, only 44,300 hectares being sown in Constanta county, of which 13,000 hectares were affected by drought in a proportion of 30-60%, the production achieved being 3,771 kg/ha.

The support linked to this culture would be of real benefit to agricultural producers.

The authors hope that Europe does not turn into a museum of innovation in which the public voice is stronger than the data of scientific research.

In 2015, in Constanta county, 51,495 ha were cultivated with corn, achieving an average production of 765 kg/ha and a total production of 39,393 tons, and in 2016, 39,555 ha with a production level of 883 kg/ha and a total production of 34,927 tons.

In 2020, 33,329 ha were affected by calamity in Constanta county, and in 2022, 13,827 ha. In the current year, the approximately 50,000 ha cultivated with corn in Constanta county were totally or partially calamity.

A simple calculation shows us that in 2016, when a total production of 34,927 tons was achieved, delivery price on 13.09. – 158 Euros (4.4488 lei) = 702.9 lei, 24,550,188 lei were obtained.

If sorghum had been cultivated, 237,330 tons could be produced with an average production level of only 6 tons/ha. 237,330 x 702.9 = 166,819,257 lei, so a loss of 142,269,069 lei - 31,979,200 Euros and the calculations can go further, especially at the level of 2023.

Sorghum is a miraculous plant. It could resist even to hail, not only to drought.

Photo 3. Planting sorghum in 2019
Source: Original.

Photo 4. Demostrative plots in 2018
Source: Original.

Photo 5. Harvesting in 2022
Source: Original.

CONCLUSIONS

The research work was focused of the improvement of technology for cultivating sorghum under the severe climate conditions in Amzacea area, at the agricultural holding Sport Agra Ltd, South Dobrogea Romania, during the period 2017-2022.

The new technologies, based on conventional agricultural system and non -irrigated land, regard the improvement of following aspects:

- Changing the planting period by approximately 25-30 days compared to the recommendations of classical technologies. In this respect, planting should start from the first decade of May in order to use the moisture in the soil layer at the depth of seed incorporation 4-5 cm.

-The use of early hybrids in order to overcome the periods of heat that in Amzacea area start from the middle of the month of June.

-The use of technological means of crop protection that include pre- and post-emergent herbicides, seed treatment prior to planting. Under these conditions of development of non-irrigated sorghum technology, we propose planting this crop 25-30 days earlier compared to classic technology. In this way, the sorghum will benefit from the water reserve accumulated during the fall of the previous year.

-The productions of the sorghum hybrids used in the observation research fields were over 10 to/ha in most of the tested hybrids.

-Sorghum could be successfully used as a complementary crop for maize, taking into account its resistance to drought and hail.

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RESEARCHERS REGARDING THE SITUATION OF THE PIG HERDS IN ROMANIA, THE PRODUCTION OBTAINED AND THE CONSUMPTION OF PORK MEAT IN THE PERIOD 2016-2021

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Abstract

The work aims to analyze both the situation of pig herds, as well as the production and consumption of pork in Romania compared to other EU countries, given that the European Union ranks first in the world in terms of production and 3rd place in the world in terms of pork consumption. The analyzed indicators, which were collected from internal (INSSE) and international (Eurostat) databases, were: pig herds, total pork production, pig herd density; the number of slaughtered animals; consumption of pork. Based on this information, the standard deviation and the coefficient of variation were calculated both for the multi-year average of pig herds and for their density. The analysis highlighted the fact that pig herds have continuously decreased during the analyzed period (the decrease being 27% in 2021 compared to 2015), the reasons being both economic (increasing prices, energy crisis, etc.), but also the impossibility of proper management of outbreaks of Swine Fever Africana that led on the one hand to the slaughter of livestock, and on the other hand to the prohibition or reduction of exports. Regarding the consumption of pork, Romania is below the European Union average, but an increase in consumption is noted from 31.3 kg/inhabitant in 2015 to 37.8 kg/inhabitant in 2021.

Key words: *herds of pigs, production, consumption, import, export*

INTRODUCTION

Pig breeding, along with other categories of domestic animals intended for consumption, represents one of the important branches of agriculture worldwide. According to statistics, obtaining meat production requires 77% of agricultural land globally in 2021, consumes approximately 35% of grain production and emits approximately 15% of greenhouse gases [29], which demonstrates both the important role of this branches of animal husbandry in the economy, as well as its important consumption of resources [28].

On the other hand, the same statistics estimated in 2021 an increase in global pork production of 13% for the next 10 years. It can be seen that the estimated growth rate is much lower than in the previous period, the reasons being multiple. One of these is represented by African Swine Fever, which contributed to the decrease in production, production that will suffer at least until 2023 [21]. Afterwards, it will be possible to return to previous productions, provided that no other vulnerabilities will appear. The country that was estimated to return the fastest to the previous production of African Pigfish was China, while the European Union and the United Kingdom will be the ones where the productions will decrease, taking into account both the economic aspects and the concerns related to the protection of the environment and global warming, phenomena that affect the world worldwide and which were important topics of discussion at the Davos Conference in 2022 [26, 27]. Without taking measures in this direction, both the planet and food security will be strongly disrupted [23].

With the start of the war in Ukraine, other vulnerabilities appeared as a result of the energy crisis or the export crisis. The effect of the increase in the price of energy or the price of feed, there was also an increase in the price of food, including meat.

Globally, in 2022, the increase was approximately 10%, as it appears from an FAO report [27], but at the stock exchanges in Paris or Chicago the price increases were much higher. Only for corn, for example, the price increased by 55% and 31%, respectively. The same FAO report shows that if in 2021 the increase in meat production was 5.4%, in 2022 it was much lower (according to estimates of only 1.4%) [27]. In these conditions, the main countries that faced problems were Spain and China, the 2 largest producers of pork worldwide, but at an individual level each farmer suffered. Another vulnerability was represented by the drought, another effect produced by global warming, which led to the decrease of pig herds and productions. An example is Canada, which in 2021 faced a strong drought. But she is not the only one, because other areas of the world, including Romania, have faced extreme climatic conditions.

Regarding the consumption of pork, they face various concerns from political factors, as well as from consumers. The carbon footprint and the water footprint, which have significant values in the case of raising animals, raise an economic and social problem [22]. Another problem, encountered especially in Europe, is the concern of citizens regarding the security and safety of animals [19], which will certainly influence the consumption of meat, which will decrease. Estimates show that from a consumption of 32.5 kg of pork/capita in 2021, it will reach a consumption of 31.0 kg/capita in 2031, which means a decrease of approximately 0.5%. These decreases will cause a decrease in pork production of approximately 0.8% at the level of the European Union, which will produce almost 22 million tons of pork in 2031 [3]. However, worldwide, pork will still remain the main type of meat consumed [25], and the growth of the planet's population will continue to demand an increasing production, even if there will be a reduction in the weight that meat will have in human nutrition, due to the fact that switching to healthier foods will have a favorable impact on the planet. Another factor that contributed to the increase in consumption was represented by the phenomenon of urbanization, which in turn generated an increase in income [24].

Based on these considerations, research estimates a need for pork that will reach 181 million tons in 2050 [29].

Data recorded worldwide on pork consumption show that in 2021 China is in first place (Hong-Kong with 61 kg/capita, Macao with 52 kg/capita, mainland China with 37 kg/capita per inhabitant), followed by Belarus (41.8 /capita) and the European Union (41.1 /capita).

A characteristic of pig farming in the European Union is the predominantly intensive system, which still requires large areas of agricultural land, but which allows obtaining pork at affordable prices.

Another characteristic is the legislative system that imposes an increased concern on the part of producers for the welfare of animals and for the protection of the environment [20].

MATERIALS AND METHODS

The research involved the analysis of specialized works and data from internal and international databases. The data were processed statistically and were the basis for establishing the results and formulating the conclusions.

The indicators analyzed were: pig herds, pig herd density, total pork production, slaughtered herds, pork consumption, standard deviation and coefficient of variation that were calculated both for the multi-year average of pig herds, as well as for their density. The indicators registered at the national level were compared with those existing at the level of the European Union.

The mentioned indicators were analyzed dynamically, using indices with a fixed base and indices with a chain base:

$$I_{i/0} = \frac{Xi}{X0} \text{ x } 100 \text{..(1)}$$

$$I_{i/i-1} = \frac{Xi}{Xi-1} \text{ x } 100 \text{......................................(2)}$$

in which:
X_0 - initial level
X_1, X_2,..X_n – period level

To establish the frequency of the groups, relative sizes of structure are used, thus determined:

$$g_i = \frac{xi}{\sum_{i=0}^{n} xi} \times 100 \qquad \text{................(3)[2]}$$

where:
x – indicator level

The calculation of the standard deviation and the coefficient of variation was done with the help of Excel, which is based on the following calculation formulas:

$$\sigma = \sqrt{\frac{\sum (x-\bar{x})^2}{(n-1)}} \qquad \text{,,,,,,,,,,,,,,,(4)[1]}$$

$$Cv = \frac{\sigma}{\bar{x}} \qquad \text{...(5)}$$

where:
σ - standard deviation
x – statistical characteristic
Cv – coefficient of variation

RESULTS AND DISCUSSIONS

For the period 2015-2021, the analysis of pig herds, production and consumption of pork was carried out, so that it is possible to follow the way in which this livestock sector has evolved.

The data published by the National Institute of Statistics highlight the fact that the number of heads decreased continuously during the analyzed period, the decreases being 27% in 2021 compared to 2015. Thus, if in 2015 the pig herds numbered almost 5 million heads, in 2021 they have reached approximately 3.6 million heads. The decreases were due both to the fact that domestic production failed to be competitive in relation to imported products, but also to the fact that during this period the most outbreaks of African Swine Fever existing at the level of the European Union were those in Romania, which caused the number of livestock to decrease, due to their slaughter.

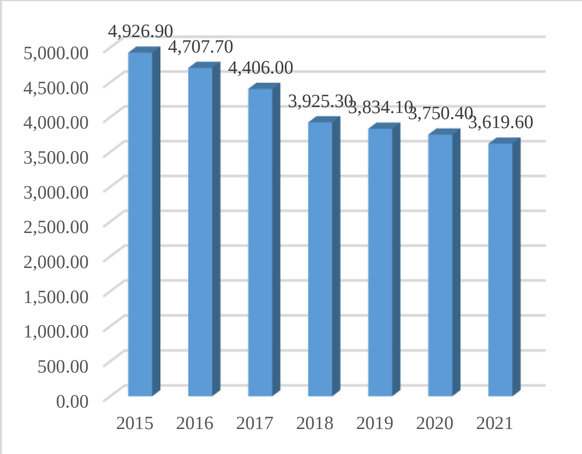

Fig. 1. The situation of pig herds in the period 2015-2021
Source: own processing [11-18].

Taking the year 2015 as a benchmark, we made a ranking of the first 10 countries in the European Union, both in relation to the herds of pigs owned, but also in relation to their density, expressed in heads/100 ha of land. The analysis was carried out for the period 2015-2021, determining both the multi-year average of pig herds, but also the standard deviation and the coefficient of variation (Table 1).

Table 1. Standard deviation and coefficient of variation for multi-year average pig herds

Country	Multi-year average (2015–2022) of pig herds - heads	Deviation Standard	The Coefficient of Variation (%)
Spain	30,987.01	2,064.73	6.66
Germany	26,419.59	1,359.78	5.15
France	13,319.00	401.35	3.01
Denmark	12,818.29	360.78	2.81
Netherlands	11,842.57	520.76	4.40
Poland	11,115.47	583.40	5.25
Italy	8,526.49	86.25	1.01
Belgium	6,172.73	107.37	1.74
Romania	4,167.14	511.43	12.27
Hungary	2,872.83	155.47	5.41

Source: own processing [11-18].

After analyzing the data, it turns out that Romania, although it holds the 9th place in the ranking, is still the country that had the biggest decrease in pig herds. The coefficient of variation had the value 12.27 of the fact that pig herds decreased by 27% in 2021 compared to 2015.

Reductions of 13% were also recorded in the Netherlands and Hungary. The only country where the number of pigs increased is Spain, the increase being 21%.

Regarding the density/100 ha, it can be seen that Romania occupied the 16th place (in the years 2016, 2017, 2018, 2020 and 2021), respectively the 17th place (in the years 2015 and 2019) among the countries of the European Union. For the first 10 countries of the E.U. the density varied between 102 heads/100 ha (Poland) to 1,156 heads/100 ha (Netherlands). The highest value of the standard deviation was 40.12, and the lowest was 1.48, which shows that the most important decrease in density was recorded in the Netherlands (the decrease being 10%), while in Austria there was an increase of the density of 1%. The countries where density decreases were Belgium (-11%), Germany (-13%), Italy (-6%), Poland (-3%) and Romania (-25%), and the countries where the density increased were Denmark (+22%), Ireland (+28%) and Portugal (+15%). The coefficient of variation, which is determined as the ratio between the standard deviation and the density average, highlights the existing situation in the period 2015-2022 (Table 2).

Table 2. Standard deviation and coefficient of variation for multi-year densities (heads/100 ha)

Country	Multi-year average (2015–2022) of density (heads/100 ha)	Deviation Standard	The Coefficient of Variation (%)
Netherlands	1,155.81	40.12	3.47
Belgium	727.60	26.72	3.67
Denmark	538.23	14.46	2.69
Ireland	357.26	23.77	6.65
Spain	252.87	22.56	8.92
Germany	224.50	10.45	4.66
Austria	209.91	1.48	0.71
Portugal	223.10	20.55	9.21
Italy	126.39	2.72	2.15
Poland	101.73	5.37	5.28
Romania	47.91	5.70	11.89

Source: own processing [11-18]

From the analysis of pig herds by development region, it can be seen that although they decreased in all 8 regions, the most significant decreases were recorded in Bucharest-Ilfov, South-Muntenia and North-East (Table 3).

Table 3. Pig livestock by development region, 2015-2021 (heads)

Heads	2015	2016	2017	2018	2019	2020	2021
North-East	525,687	488,421	458,394	447,482	381,248	385,979	428,086
South-East	772,094	739,728	723,825	468,624	482,007	468,669	483,508
South-Muntenia	885,263	832,731	753,815	649,680	583,808	520,812	483,125
South-West Oltenia	620,505	588,082	558,292	519,960	499,081	483,415	469,426
West	952,062	944,369	919,331	914,638	944,700	949,632	851,039
Northwest	663,666	624,440	564,142	526,530	560,871	547,087	541,799
Center	479,522	456,815	400,891	374,579	372,419	382,624	357,377
Bucharest-Ilfov	28,129	33,083	27,324	23,610	10,002	12,144	5,221

Source: own processing [11-18].

The largest share of the total livestock, state for the year 2021, as well as for the year 2015, can be found in the West region (with 19%, respectively 24%), followed by the South-Muntenia region in 2015 (with a weight of 18%) and by the North-West region in 2021 (with a weight of 15%) (Fig. 2 and Fig. 3).

Analyzing the evolution of live weight for pig herds, the same trend of decrease in the analyzed period is found, being 12% in 2021 compared to 2015. In 2021, the number of slaughtered heads decreased by 16% compared to 2015.

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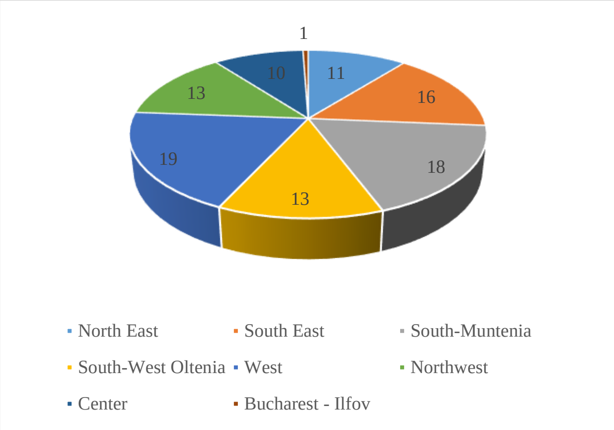

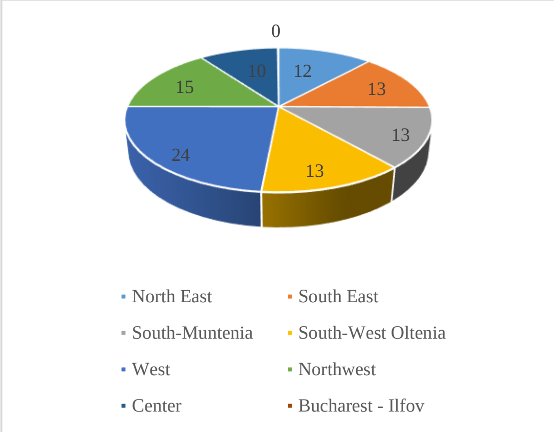

Fig. 2 and 3. The structure of pig herds, by region, in 2015 and 2021
Source: own processing, [11, 18].

Regarding the production of pork used for consumption, it is found that it comes from both domestic production and imports.

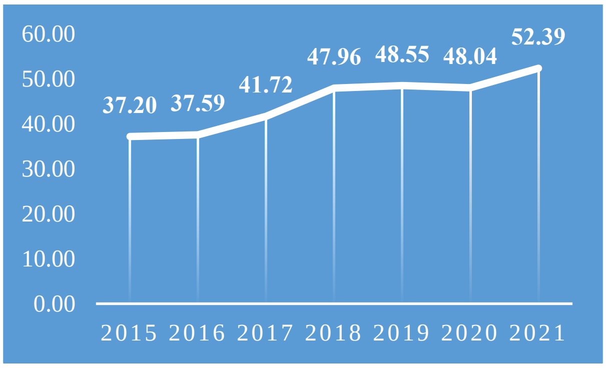

Fig. 4. The evolution of pork imports (% of consumption available)
Source: own processing [4 -10].

As domestic production decreased, the necessary was ensured by imports, which made their share in the total available consumption increase and vary from 37% in 2015, to 48% in 2018 and to 52% in 2021 (Figure 4). Romania is also an exporter of pork, but these exports decreased from approximately 33 thousand tons to 23 thousand tons. At the level of Romania, the consumption availability was approximately 640 thousand tons in 2015, increasing by 21% and reaching almost 772 thousand tons in 2021. Analyzing the average consumption expressed in kg/inhabitant, it is found that the highest consumptions worldwide are recorded in China, in all three regions (Hong Kong, Macao and Mainland), in the European Union and Belarus, with an increase in consumption from 29 kg/inhabitant in 2015 to 41.7 kg/inhabitant in 2021 (Table 4).

Table 4. Evolution of average pork consumption

Country/Region	2015	2016	2017	2018	2019	2020	2021
E.U.	47.1	43.2	43.2	44	42.2	40.6	41.4
China - Mainland	41.4	40.4	40	39.4	31.9	29.4	37.3
China - Hong Kong	71	72.6	77.5	72.3	53.9	58.9	60.5
China -Macao	58.1	62	62.6	60.2	62.5	52.4	51.8
Belarus	29.0	35.1	36.6	38.4	38.4	41.2	41.7
Romania	31.3	32.9	36.1	38.3	38.0	37.3	37.8

Source: own processing [11-18].

Romania registers consumption below the European Union average, but the difference compared to this average decreased significantly in the analyzed period. Thus, if in 2015 the difference was 158 kg/inhabitant, it reached 3.6 kg/inhabitant in 2021.

CONCLUSIONS

As it emerges from the study based on statistical data, it appears that pig herds in Romania have decreased dramatically in recent decades, reaching approximately 3.6

million heads in 2021. Although the capacity of farms is much higher, the main reason that contributed to the reduction of herds is represented by the swine fever which led the slaughter of animals, due to the fact that large farms faced the infection of animals with the African swine fever virus. This had a negative impact from an economic point of view, both on farms as a result of the ban on pork exports from Romania, and on the trade balance.

On the other hand, the increase in prices made many businesses no longer profitable and give up this activity. The reasons that led to the increase in pork costs and prices in the last year were: the European energy crisis; the drought that affected corn production; swine fever and import dependence.

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STUDY ON THE ROLE OF GLOBALIZATION IN GROWING THE MOBILITY OF INTERNATIONAL STUDENTS IN THE LAST DECADE

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Abstract

One of the advantages of the globalization process is that of ensuring the circulation of young people at the global level, ensuring their access to existing learning resources in countries with a developed and recognized higher education system worldwide. Starting from the existing data in various international, community and national databases, in this work we proposed to analyze the mobility situation of undergraduate, master's and doctoral students from the period 2012-2022, with the aim of identifying the countries that are on the first places in the world both in terms of student entry flows and their exit flows. The analysis was carried out starting from indicators such as the number of students leaving for studies, the number of students entering for studies, their growth rate, but also the mobility rate at the entrance or the mobility rate at the exit. The data were processed and analyzed with the help of statistical methods, thus being able to formulate conclusions regarding the situation of student mobility from the last decade, given the identification of solutions regarding the provision of future flows of students for higher education institutions, under the conditions that, globally, the population aged between 20-24 will decrease in areas such as Europe or North America. Under these conditions, the educational institutions recognized for the quality of the programs offered will be able to attract students from countries in Asia or Africa, countries in which both the share of the young population and mobility have increased in the last five years. Among these countries are India, with an increase of over 100%, Vietnam with an increase of 95% or China, with an increase of 33%.

Key words: *education, incoming mobilities, outgoing mobilities, globalization*

INTRODUCTION

Education is one of the priority areas of any country that wants a sustainable economic development, it contributes both to individual development and income growth, but also to the promotion of competitiveness, economic growth and poverty reduction [7, 15, 16]. In the specialized literature, different points of view are presented regarding the relationship between education and economic development. Thus, in 1961 Schultz, and then in 1992 Mankiw et al. they showed that as the degree of specialization of human capital increases, so does labor productivity, which leads to progress [14, 18]. Benhabib and Spiegel believe that education is what contributes to the dissemination of information that can thus influence economic growth [4]. Aghion and Howwit argue that through education and research there is an increase in innovation capacity, which through progress leads to development [2]. Education has an important role in the elaboration and development of social policies, which have a direct impact on increasing the degree of social inclusion, but also in reducing disparities that exist at the regional level. Education can also contribute to increasing social mobility. Through education, the skills acquired can contribute to increasing the standard of living and to the development of society, aspects with an important role in the conditions of a global economy [1, 6].

On the other hand, some authors consider that in the rush to pursue economic growth, innovation, investments, measures are taken at the political level to reduce the funds allocated to education with direct consequences on human capital [21, 13]. To measure the degree to which education can

contribute to economic growth, one of the analyzed indicators is GDP. The percentage of GDP attributed to education financing is directly proportional to the results obtained and the quality of the education system. To the same extent, however, the analysis must be carried out with the total value of the GDP of a country, but also with its value per capita.
The identification of these requirements and the possibility of pursuing some forms of education recognized for their quality and prestige determine mobility among students. In addition to these aspects, an important role in the evolution of mobility was played by globalization, the development of technology, the use of modern learning systems, artificial intelligence, etc. [3, 17].
At the political level, there were measures that in turn contributed to increasing mobility in the education system. Thus, in Europe the first step was represented by the Sorbonne Declaration that preceded the Bologna Process through which the foundations were laid for coordinating and harmonizing the recognition of higher education diplomas through transferable credits, the educational barriers within the different education systems being thus removed [19]. Since 1999, these principles of the Bologna process began to be applied, which continues to evolve and adapt to the continuous modernization requirements of the education system, thus contributing to the increase of student mobility and the development of the regions of the world. Later, a European Area of Higher Education was established, made up of 29 countries. At the moment, the number of these countries is 48, the accession being voluntary and aiming to ensure comparability between the education systems recognized for the high level of quality.

MATERIALS AND METHODS

The work followed the analysis of student mobility, both worldwide and European, starting from the statistical data existing in the databases. The analyzed indicators were: Number of mobilities, Incoming students per countries, Number of outgoing students, mobility balance, mobility rates, etc.
The mobility balance is an important indicator through which the number of higher education students entering and leaving a country and their ratio is compared (the indicator being used at the level of the EHEA countries) with the aim of reducing imbalances related to the existence of knowledge flows.
The indicators that were the basis of the analysis carried out were followed in evolution, based on indices with a fixed base or with a chain base, with the aim of tracking their changes in the period 2012-2020, so that conclusions can be drawn regarding the evolution of the mobility situation in the education system.
Established calculation formulas were used:

$$I_{i/0} = \frac{Xi}{X0} \text{ x } 100 \qquad [9]$$

where:
X_0 - initial level
$X_1, X_2..X_n$ – period level

$$\text{Entry mobility rate} = \frac{\text{Entered students}}{\text{Total students}}\, x\, 100$$

$$\text{Out mobility rate} = \frac{\text{Out students}}{\text{Total students}}\, x\, 100$$

RESULTS AND DISCUSSIONS

Specialized works show that there is a close connection between a country's GDP and its level of education, as well as between the percentage of GDP that is intended to finance the education system [5, 11, 12]. This is justified by the fact that increasing the income of the population leads to obtaining resources that will later be used to finance education, and increasing the level of education is a value-added resource that will contribute to economic development. Along with this economic growth, the process will continue leading to an increase in GDP, thus ensuring the cyclicality and efficiency of this system [8]. Besides these factors, other elements have an important role, such as: employment, unemployment rate, the level of development of a country, etc.Based on the data published by UNESCO in March 2023 (Table 1), it is found that, worldwide, the financing of education from 2012-2022 had percentages between 1.23% (South Sudan, 2014) and 15.74% (Marshall Islands, 2021). It is found that countries belonging to Oceania (Kiribati, Marshall Islands, Micronesia) have a high funding of the education system in relation to GDP, given that the GDP value in 2021 was 1.606 USD/capita (Kiribati), 6.172 USD/capita (Marshall Islands) and 3.571 USD/capita. For its part, Greenland had in 2013 an education funding of 13.34% GDP, in the conditions where the GDP value was 47,536 USD/capita.

A percentage of 7.16% of the GDP was allocated to education financing by New Zealand in 2012 (the value of GDP/capita being USD 39,973).

Table 1. The financing situation of the education system in the period 2012-2022 (% of GDP)

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Austria	5.48	5.55	5.45	5.46	5.48	5.37	5.23	5.22	*	*	*
Belgium	6.26	6.63	6.59	6.45	6.46	6.43	6.38	6.33	*	*	*
Bulgaria	3.48	4.06	4.08	3.92	3.40	4.08	4.05	4.20	*	*	*
Cyprus	5.91	6.47	6.42	6.30	6.12	5.70	5.15	5.21	*	*	*
Croatia	4.78	4.49	4.94	4.93	4.72	3.85	3.90	3.91	*	*	*
Czechia	4.22	4.05	3.97	5.75	5.55	3.81	4.27	4.54	*	*	*
Denmark	7.24	8.49	7.63	7.01	7.48	7.12	7.00	6.91	*	*	*
Estonia	4.72	4.84	4.39	5.14	5.16	4.96	5.24	5.30	*	*	*
Finland	7.15	7.12	7.10	7.03	6.85	6.36	6.28	6.42	*	*	*
France	5.49	5.49	5.49	5.45	5.41	5.45	5.41	5.35	*	*	*
Germany	4.93	4.94	4.92	4.86	4.84	4.87	4.98	5.12	*	*	*
Greece	4.51	4.48	4.29	3.66	3.97	3.48	3.60	3.59	*	*	*
Hungary	4.14	4.19	4.60	4.50	4.62	4.61	4.62	4.23	*	*	*
Ireland	5.75	5.34	4.87	3.76	3.74	3.50	3.39	3.29	*	*	*
Italy	4.06	4.14	4.06	4.07	3.82	4.04	4.26	4.10	*	*	*
Latvia	6.58	7.00	5.28	5.28	4.66	4.37	4.24	4.42	*	*	*
Lithuania	4.76	4.60	4.49	4.23	4.00	3.81	3.89	3.97	*	*	*
Luxembourg	3.88	4.94	3.86	3.77	4.46	3.49	3.66	3.74	*	*	*
Malta	6.35	7.58	7.00	5.02	5.11	4.56	5.14	4.99	*	*	*
Netherlands	5.41	5.53	5.46	5.35	5.48	5.18	5.36	5.16	*	*	*
Norway	7.37	7.49	7.70	7.57	8.03	7.91	7.64	7.94	*	*	*
Poland	4.86	5.02	4.97	4.82	4.66	4.57	4.61	4.68	*	*	*
Portugal	4.95	5.27	5.12	4.89	4.77	5.02	4.68	4.63	*	*	*
Romania	2.82	3.07	3.13	3.11	3.03	3.12	3.32	3.57	3.70	3.44	3.12
Serbia	3.85				3.63	3.71	3.58	3.62	*	*	*
Slovakia	3.86	4.07	4.22	4.58	3.90	3.93	3.95	4.27	*	*	*
Slovenia	5.62	5.41	5.29	4.91	4.79	4.78	4.93	4.90	*	*	*
Spain	4.47	4.35	4.30	4.28	4.23	4.21	4.18	4.23	*	*	*
Sweden	7.54	7.61	7.57	7.44	7.62	7.57	7.64	7.64	*	*	*
Switzerland	4.90	4.91	4.93	5.00	4.98	5.02	4.93	5.09	*	*	*
United Kingdom	5.60	5.53	5.60	5.55	5.42	5.43	5.20	5.25	*	*	*
United States of America	6.28	6.25	6.14	4.95	4.81	5.12	4.93	4.99	*	*	*
Canada	4.69	4.59	4.84	4.74	4.82	4.96	4.89	4.77	*	*	*
Japan	3.65	3.62	3.55	3.27	3.15	3.13	3.08	3.16	*	*	*
Singapore	3.07	2.85	2.92	2.86	2.87	2.77	2.86	2.73	2.70	2.76	2.55
China	3.94	3.71	3.73	3.81	3.76	3.67	3.54	*	*	*	*
China, Hong Kong	3.51	3.76	3.57	3.26	3.29	3.31	3.33	3.81	4.41	4.00	*
China, Macao	3.33	2.05	2.05	3.00	3.10	2.71	2.73	3.06	6.36	*	*
Israel	5.59	5.78	5.70	5.80	5.80	6.01	6.06	6.06	*	*	*
Australia	4.87	5.23	5.16	5.32	5.29	5.14	5.12	5.13	*	*	*
Kiribati (Oceania)	13.38	12.26	12.95	12.11	13.48	13.60	*	*	*	*	*
Marshall Islands (Oceania)	*	*	*	*	15.05	15.07	15.00	9.92	*	15.74	*
Greenland	12.87	13.34	12.80	12.00	11.09	10.93	10.55	10.11	10.18	*	*
Micronesia (Oceania)	11.72	12.34	12.23	12.41	*	12.42	*	10.21	*	*	*
Namibia	9.08	8.60	8.99	9.53	10.31	9.71	9.62	9.32	9.28	10.05	9.52
Faeroe Islands	7.84	8.07	8.17	7.58	7.40	7.85	8.43	7.31	8.04	*	*
New Zealand	7.16	6.70	6.34	6.33	6.41	6.26	6.06	5.16	*	*	*
South Africa	5.52	5.35	5.49	5.48	5.44	5.60	5.64	5.93	6.18	6.56	6.56
South Sudan	1.25	1.02	1.23	1.47	1.57	*	*	*	*	*	*
United Arab Emirates	1.31	1.45	1.54	1.71	1.74	1.64	1.51	3.86	3.98	3.90	*
Cambodia	1.41	1.48	1.57	1.70	1.87	2.10	2.45	2.83	3.00	1.67	*

* lipsa date Source: prelucrare proprie [20].

The education system in the USA was financed in the period 2012-2019 with percentages between 4.81% and 6.28%, given that the GDP value in 2016 and 2012 was USD 57,867/capita and USD 51,784/capita. In Japan, the share of GDP used to finance education was 3.16% in 2019, compared to a GDP/capita of USD 40,458.

The European education system is financed with high shares of GDP in countries such as Sweden (7.44%-7.64%), Norway (7.37%-8.03%), Denmark (6.91%-8.49%) or Finland (6.28%-7.15%), given that in 2021 GDP/capita had values of USD 61,029 (Sweden), USD 89,153 (Norway), USD 68,008 (Denmark) and USD 53,655 (Finland).

In countries like Germany, with a GDP/capita of USD 51,004 in 2021, education was financed between 2012-2019 with percentages between 4.84 and 5.12% of GDP, and France, with a GDP/capita of USD 43,659/capita in 2021 financed education with percentages between 5.35 and 5.49%, in the analyzed period.

Romania with a GDP of USD 14,853/capita in 2021 had the lowest shares of funds granted to education among the European Union countries. In 2012, education was financed with 2.82% of GDP, reaching 3.70% in 2020. However, there is an increase in the share of GDP allocated to the financing of education, a trend also recorded at the level of other EU countries such as Bulgaria, Estonia, Germany, Switzerland. In many other EU states the share of GDP allocated to the financing of the education system decreased in the analyzed period (Croatia, Greece, Ireland, Malta, Slovenia).

If in 2020, worldwide, the number of mobilities was 6,361,963, an increase compared to previous years, in 2021 their number decreased by 12%, reaching 5,571,402. The largest number of mobilities was registered in Europe (2,214,161), followed by Asia (1,225,253), North America (1,211,931), South America (190,423) and Africa (224,480). If in 2000, the number of mobilities was 2.1 million, in the following ten years they increased by 1.6 million reaching 3.7 million, worldwide. The highest growth rate (33.33%) was recorded in the period 2000-2005. In the period 2005-2010 it was 32%, in the period 2010-2015 30%, and in the period 2015-2020 31%. The growth rate in 2019 compared to 2018 was 6%, given that international mobility reached 6.1 million, and in 2020 the growth rate compared to the previous year was 4%.

Globally, it is noted that there has been an increase in the number of students belonging to higher education. At the global level, substantial increases have come from Asia, Africa or South America. There were also increases in Oceania (7) or North America (5%). The only area with a negative impact on the total number of students was Europe, the area where the decrease was approximately 15% and which was due to the decrease in the young population, with a direct impact on the school population.

For the next period of time, specialists' estimates indicate a decrease in the population aged between 20-25 years, which will have a direct impact on the mobility of the student population. Thus, by 2050 in Europe and North America they will hold approximately 5% in this age category, and in South America approximately 7%. In Africa, however, the young population will grow, so that the age group of 20-25 years will represent 33% of the total. Another particularity is given by the young population of Asia, which, although decreasing, will represent 50% of the total in 2050.

Globally, in 2021, four of the world's countries received 40% of the mobilities of higher education students. The first 5 places worldwide were occupied, in this order, by the United States, the United Kingdom, Canada, Germany and Australia. The following places, in a top of the first 10 countries, were occupied by France, China, the United Arab Emirates, Turkey and the Netherlands.

A comparative analysis of student entries from 2015 and 2020 shows that for the countries that held the first 6 places in 2015, no changes occurred in the 5 years. Instead, France dropped from 4th place in 2015 to 7th place in 2020. Although the number of students entered for studies in 2015 was from 239,409, and in 2020 it was 252,444,

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compared to the global number, there was a decrease in the share them.

The United Arab Emirates and Turkey have climbed this ranking. If in 2015 they occupied the 11th and 13th positions, in 2020 they have 3 and 4 places respectively in the ranking, thus reaching among the countries that make up a Top 10 worldwide. Thus, from a number of 73,445 students entered for studies in the United Arab Emirates in 2015, the number of increased to 215,975 students in 2020. In Turkey in 2015, 72,178 students entered for studies, and in 2020 185,047 students.

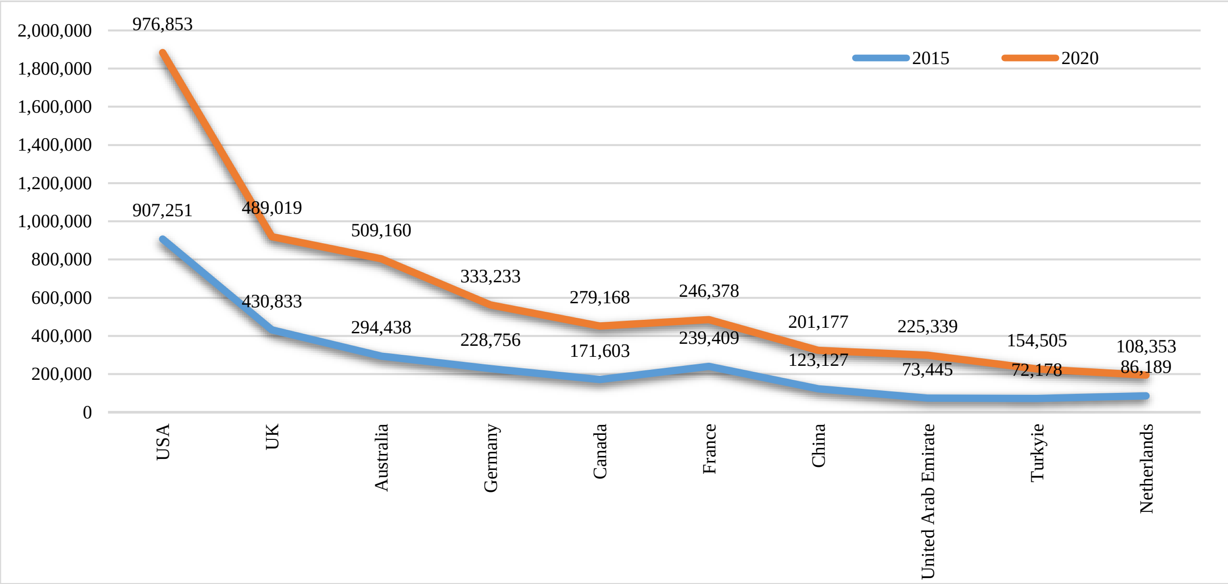

Fig. 1. The situation of student admissions, by country, in 2015 and 2020
Source: own processing [20].

Analyzing the situation of students who went to study in other countries, we find that China, India, Vietnam, Germany, France, USA, etc. are on the top 10 places globally (Fig. 2). Thus, it can be seen that in the period 2015-2020 the countries that had high values of student outflows were Nepal (with an increase of 2.35 times in the five years), India (with a doubling of the number of students leaving for studies), the USA and China (with increases of approximately 30%). However, the Republic of Korea had a negative influence on the number of students who went to study.

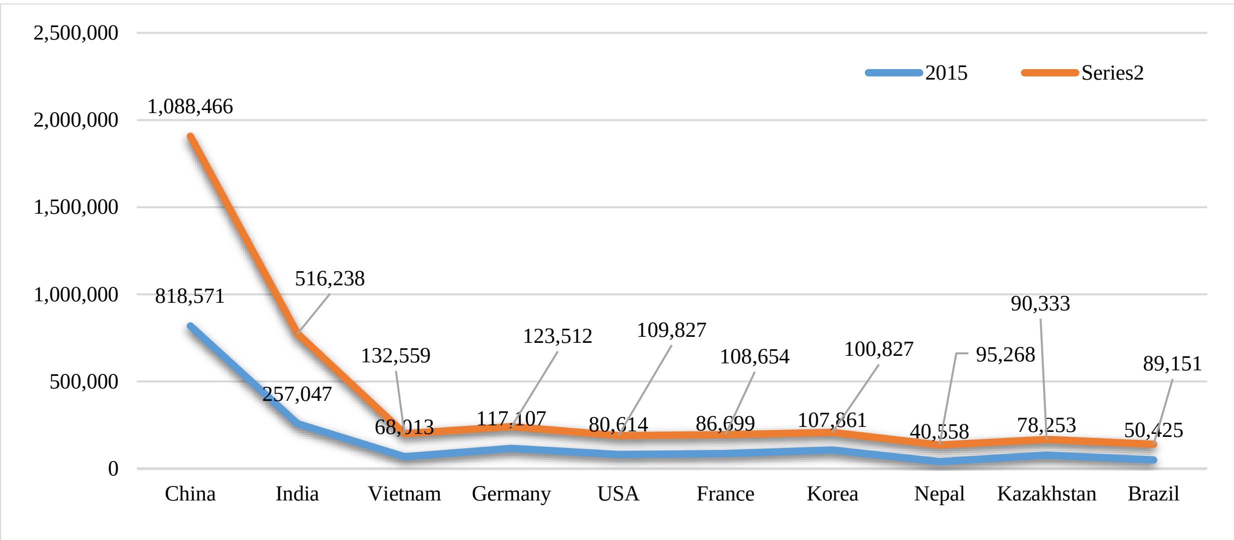

Fig. 2. The situation of the number of students leaving for studies, by country, in 2015 and 2020
Source: own processing [20].

Looking at the current situation in Romania, we can seethat the number of enrolled mobile students from abroad increased during the analyzed period. The number of students in 2015 was 15,329 and the number of students in 2020 was 23,601. At the level of the European Union, the number of students involved in mobility decreased in 2019, the cause being that of the Covid-19 pandemic, which had a direct impact on mobility in all fields, not only in education. Although the education continued online, some of the students gave up their studies.The decrease was 12% in 2019, and in 2020 we can talk about a return, the increase compared to 2019 being 3%.

Compared to the total registered at the level of the European Union, Romania had shares close to 3% (3.12% in 2018, 3.86% in 2019 or 3.62% in 2020).

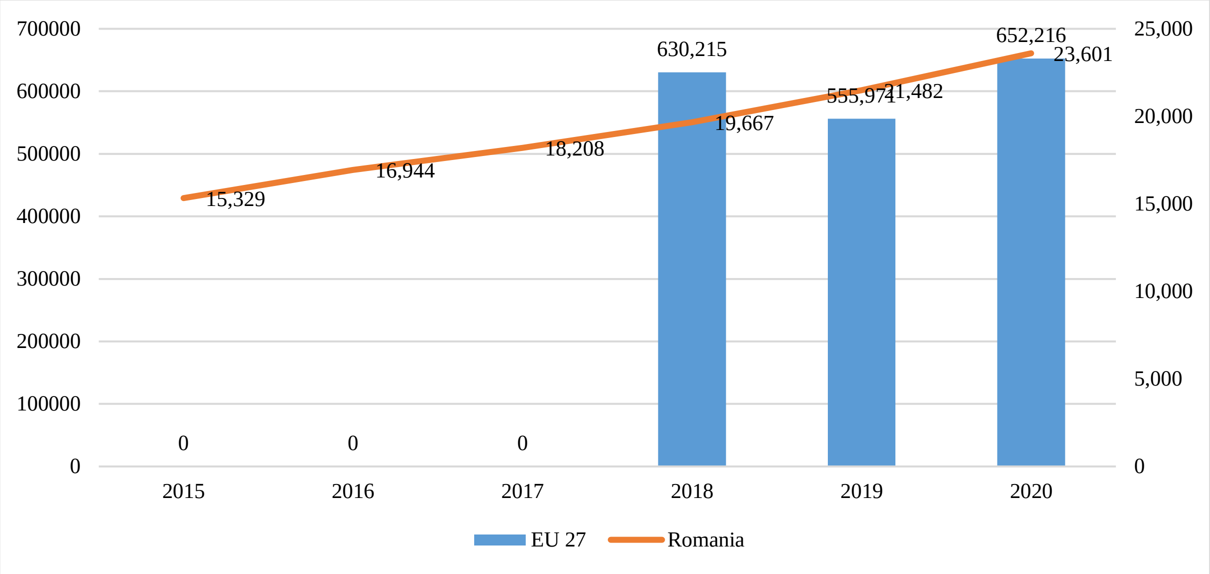

Fig. 3. Mobile students from abroad enrolled by country of origin (Romania)
Source: own processing [10].

At the level of 2021, the mobility flows, both for the departures from the country for studies, as well as the entry of some foreign students to study in Romania were relatively equal, the difference being only 1,074 students resulting from the 32,560 students who left . to studies and the 31,486 students who came to study.

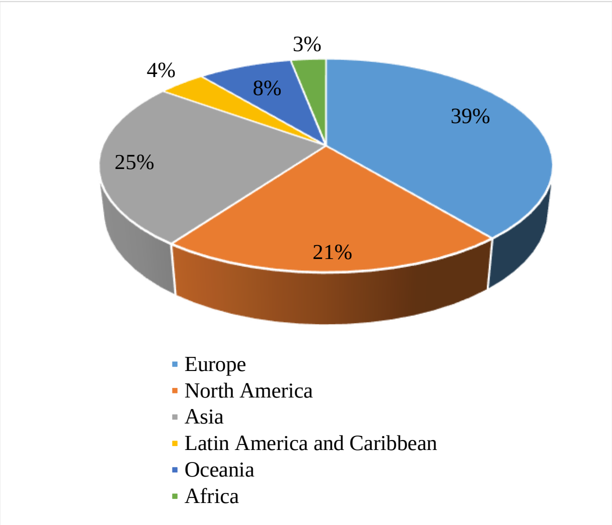

Fig. 4. Structure of mobilities, by destination, in 2021
Source: own processing [20].

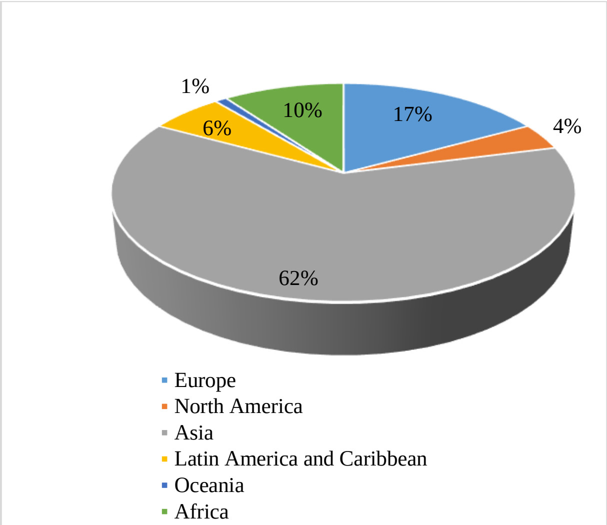

Fig. 5. Structure of mobilities, by origin, in 2021
Source: own processing [20].

The structure of mobilities by destination is shown in Fig. 4 and by origin in Fig. 5.

Of the total number of students who went to study abroad, the largest share (34.26%), i.e. 10,789 study in the United Kingdom. Approximately 9% of them (2,899) follow courses in Germany, and 8% each in Hungary (2,593) and Moldova (2,675). Also, 7% study in France (2,198), 6% in Denmark (1,542), 4% in Spain (1,226) and 3% each in Austria (1,076) and the United States (933).

Under these conditions, the exit mobility rate was 5.8, while the entry mobility rate was 6.0.

In the United Kingdom the number of mobile students abroad being 40,074, determined an Outbound Mobility Rate of 1.5. The total number of mobile students hosted determined an Inbound Mobility Rate of 20.1, as a result of which the number of students was 550,877. The United States had a high Inbound Mobility Rate (15.0) driven by the total number of mobile students hosted (957,475). Instead, the Total number of mobile students abroad was 109,827, and the Outbound Mobility Rate was 1.7. Australia (26.0), Austria (18.0), Belgium (10.4), Canada (18.2), Hong Kong (16.5), Macao (59.3), Czech Republic (15.0), Denmark (10.2), France (9.2), Germany (11.2), Holland (13.3), Switzerland (18.1) much higher than Outbound Mobility Rate.

However, the countries that register Outbound Mobility Rate much higher than Inbound Mobility Rate are Italy (4.2 compared to 2.9), India (1.4 compared to 0.1), Greece (5.0 compared to 2.8).

CONCLUSIONS

At the international level, there is an increase in the number of mobility among students, an increase of approximately 70% recorded in the period 2010-2022.

The most sought after educational programs attract students from all over the world. An important factor is also represented by tuition fees, but it is found that the largest inflows belong to countries such as the United States of America, Canada, Australia, but also to many European countries with a tradition in terms of education (Great Britain, Germany, France). China, for its part, attracts high flows of students interested in bachelor's, master's or doctoral studies.

The students who leave their countries of origin and ensure mobility in university education and who occupy the first places in the world are China, India or Vietnam. Also, the students from the United States of America or Germany are the ones who go to study in other countries than the ones of origin.

Empirical studies show that there is a direct correlation between the level of funding of education within a country and its quality, which makes those systems that benefit from high funding to be sought by international students.

In the medium term, however, as a result of the decrease in the number of young people, in areas such as Europe or America, the functioning and development of higher education systems can be ensured by attracting young people from areas such as Asia or Africa, where the share of young people aged between 20- 24 years will increase in the next period.

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METAVERSE AND THE GLOBAL ECONOMY. METAVERSE AND AGRICULTURE - A BIBLIOMETRIC ANALYSIS

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Abstract

The purpose of this work is to examine the publications in the field of Metaverse with the method of bibliometric analysis. Starting from the Metaverse keyword, the WOS and Scopus databases were searched, identifying a total of 788 publications in WOS and 1,385 publications in Scopus that met the study criteria. The VOSviewer software and the Scopus database were used for the analysis. We used several types of analysis: co-author analysis to identify the descriptive characteristics of the publications. It was found that the largest number was that of scientific works. The number of publications started to increase from 2007, but exploded in 2022. The countries that had the most publications were China, USA, United Kingdom, South Korea and Germany. The University of Zilina, Slovakia, Dimitrie Cantemir University Bucharest, Romania, University of Bucharest, The Institute of Technology and Business in Ceske Budejovice, Czech Republic, University of Craiova, etc. had the most publications among organizations. The analysis of the citations led to the identification of the authors and publications that were the most cited, resulting in the following: Sang-Ming, P.; Young-Gab, K. (2022); Sang-Ming, P.; Young-Gab, K. (2022); Haihan, D; Jiaye, L.; Sizheng, F. (2021), etc. Although the metaverse is not a new concept, it has become a new extension of virtual worlds, starting to be applied more and more in more and more fields (commerce, medicine, tourism, agriculture, etc.). The conclusions of the study will be able to constitute a road map regarding future research that will be more and more complex with the complexity of the Metaverse concept.

Key words: *metaverse, globalization, virtual reality, augmented reality, virtual economy*

INTRODUCTION

The Metaverse has become an increasingly frequently used concept not only in professional fields, but also in domestic ones, which seems to gain more and more importance with the emergence of new generations of consumers, even more so in a world global, inter-connected, in which we can no longer conceive of our existence or in which it is increasingly difficult for us to survive without the existence of this connection that began with the advent of computers, the Internet and continued with the existence of personal devices, immersive space technologies and artificial intelligence [28, 34, 67]. Along with these technological advances, the world we live in has changed and will continue to change, which has led to the emergence of a new paradigm, a new concept called Metaverse, which is starting to be more and more present in everyday life.

The concept is not a new one, IT specialists have been flirting with it for some time and referring to a 3D reality. The phenomenon began to come to the attention of the general public in 2021-2022, when Mark Zuckerberg changed the name of his company Facebook Inc. in Meta Platforms Inc. The first person to use the term is the writer Neal Stephenson, who in 1991 published the novel "Snow Crash" in which he refers to the Metaverse.

In the following we will try to define the Metaverse, as it appears in the specialized literature.

Etymologically, the Metaverse is a post-realized universe, the word "meta" meaning "post", and "verse" coming from "universe". Thus, the Metaverse can be defined as an environment where the physical reality meets

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the digital one, a multi-user environment, which is in continuous, perpetual and persistent change [56]. The first version of Metavers was represented by the existence of interconnected virtual worlds, by the existence of avatars that could transit these virtual worlds and that later included different social networks attracting more and more users, allowing them to communicate in real time. Along with the evolution and transformation of the virtual environment, communication included both virtual reality and augmented reality allowing the sensory interaction of users through digital objects [1].

Mark Zuckerberg considers that the metaverse is the internet brought to life or the internet rendered in 3D, being an internet you are in, and not just looking at [66]. The metaverse is the environment that will shape the future and in which we will begin to spend more time than in the real world [37]. Lee et al. considers that the metaverse is that virtual environment where physical and digital reality meet, as a result of the facilities provided by the existence and convergence of the Internet with Web technologies and Extended Reality [38]. They believe that in order to achieve the metaverse, it is necessary to go through 3 sequential stages, which require the existence of digital twins, digital natives and surreality, i.e. the coexistence of physical and virtual reality. Under these conditions, the metaverse will interconnect all these elements, made up of 15 domains and grouped into 2 important elements, the metaverse eco-system and technology, according to Figure 1.

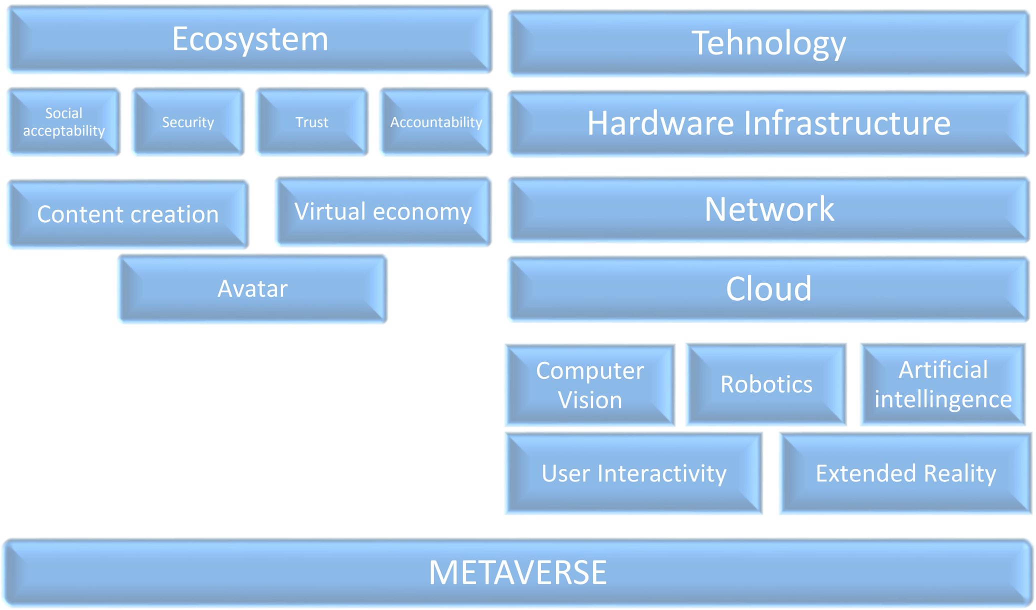

Fig. 1. The structure of the Metaverse
Source: own processing.

Turner considers that the Metaverse is a three-dimensional digital universe, designed through optical illusions so that it is perceived by the human mind as another reality [59]. Combined with the real world, the Metaverse offers people a deeper social meaning, because if it initially focused on the content of the virtual world (games), currently it represents a content-based social interaction environment [7, 32, 49].

Likewise, the Metaverse, even if it is already used, will expand to other areas of the online environment, such as commerce, education, entertainment, tourism, etc. It is estimated that the number of users will reach 1 billion in 2030, and the estimated value of the Metaverse for the next year is 800 billion dollars.

Studies show that only in the field of electronic commerce, Metaverse will bring sales increases of more than 10 times by 2030. If at the present time these sales are approximately 20 billion dollars, they will be able to reach a figure of 200 billion dollars. Also in the field of games, from a current figure of 10 billion dollars, in 2030 revenues will reach over 160 billion dollars [26]. The total revenues made from the metaverse, at the level of 2022, amounted to 45 billion dollars, but they are estimated at 145 billion dollars in 2023 and at over 490 billion dollars in 2030.

The same statistic data shows that if 2009 was the year when Meta platform would start to generate net income, it would be 229 millions of dollars and the revenue would be 777 millions of dollars, in 2022 the net income had reached 23,200 millions of dollars, decreasing by 41% compared to the previous year, under the conditions of a revenue in 2022 of 116,609 millions of dollars and in 2021 the revenue was 117,929 millions of dollars. With the transformation of Facebook into Meta, the number of users has increased significantly. In octomber 2021, the global number of users using Facebook was over 3 billion users, while gaming and esports would have 250 millions of users, followed by global crypto with 220 millions of users. The Decentralized finance capitalize approximate 3.5 millions of users and Blockchain gaming a few under 2.5 millions. 3.0 Web users virtual worlds have been approximate 50,000 [12].

A survey carried out by Petrosyan A. in 2021 among internet users regarding the advantages of the Metaverse highlighted the fact that almost 40% of respondents considered that the virtual environment helped them overcome some obstacles or disabilities, compared to the real world. Also, 37% of the respondents considered that the virtual environment helped them to travel without moving or developing their imagination or creativity. In descending order, they followed: the possibility to connect with other people, to develop skills, to find new opportunities to work, to connect remotely with family, to study online, to be able to express, etc [52]. Certainly the acceleration of this process was favored by the Covid-19 pandemic, which in turn contributed to the development of the skills to use technology and to the increase in the need for interconnection [41].

The market, in turn, began to adapt quickly to the needs of consumers. Thus, many projects in the commercial field have started to use the term "metaverse" in the presentation of their online offers, adding a 3D interface to the IT platforms they were already using and which makes the use of their applications easier or more interactive, even if in fact they do not offer what the metaverse offers, i.e. a navigation in the form of a single set of compatible data sources and services, which would require a more complex technology, which already exists and which allows navigation in the form of avatars.

Thus, Gucci, following a collaboration with one of the Roblox developers, started selling its products in the metaverse; Balenciaga collaborated with the creator of Fortnite and created virtual boutiques; Nike bought RTFKT, a famous brand on the metaverse and will hire virtual designers to create virtual clothes; Adidas bought land on Sandbox (virtual space that uses SAND cryptocurrency); Zara has already planned her future virtual collections. And the examples can continue not only with companies famous for electronic commerce, but also in the field of car, food, entertainment, etc.

Education is another field that has found its place in the metaverse, which can thus prolong its existence and preserve its accessibility [39, 63]. Starting with the video-conference systems that played the role of classrooms during the Covid-19 pandemic and that through the Zoom, Teams, Webex, Google Meet, etc. platforms allowed distance courses to take place in real time [5, 6, 17], but also in the case of educational institutions specialized in e-Learning [2, 9, 42]. Metaverse, however, allows the creation of educational centers or virtual campuses with classrooms, libraries, sports fields, counseling centers, dining halls, where students, teachers, administrative staff can communicate, interact [43, 48, 58], but which can also contribute to improving learning experiences [18, 29, 57]. However, it is the responsibility of the decision-makers, the educators, the parents, but at the same time the virtual designers how they shape and how they use these opportunities in favor of the educable so that they are truly educational [23].

As far as tourism is concerned, the metaverse can be used not necessarily to create virtual visiting experiences, but to choose a tourist destination or to choose an accommodation location or to choose tickets for a festival or maybe just to find the way to the respective tourist objective. Thus, the use of the metaverse is useful not only for the discovery of urban tourism, but also of rural tourism, which benefits from a rich potential that can be exploited through the use of appropriate marketing strategies. These strategies are much easier to apply to the virtual environment, in the metaverse, and this became all the more visible with the outbreak of the Covid-19 pandemic, which changed people's perception not only regarding the way tourism is carried out, but also to other activities, becoming much more dependent on the virtual, but also much more experienced in the use of technology.

Even agriculture, the branch of the econoy that must ensure the food security of the planet and that must physically ensure people's food, the basic physiological necessity [40], can be included in the metaverse by creating avatars of farms that allow farmers to production planning, as well as their commercialization, negotiation, marketing, etc. Steps are already taken in this directive through the use of digitization, precision agriculture, plant biology monitoring, etc. which, through the opportunities brought by you, contributed to the improvement of productions, obtaining benefits and simplifying the work of farmers [4, 14].

All these advances within the Metaverse are possible due to the use of several technologies, which define it and put it into practice: virtual reality which builds a simulated environment and which stimulates different senses (sight, hearing, touch and even smell) [11, 21]; augmented reality that places digital objects in reality, and that even if they do not appear in the physical environment, through devices (phone, tablet, etc.) make them available in space [31]; ioT, that is non-standard computing devices that, by connecting to wireless networks, have the capacity to transmit data and that allow the creation of real-time simulations by interconnecting them in the 3D world [44, 61]; Blockchain technology that fulfills 6 criteria of the metaverse (accessibility, interoperability, value transfer, digital proof of ownership, digital collectivity and governance) [27, 51]; artificial intelligence, so discussed and controversial recently with the appearance of the Bard chatbot, which in a single day led to the drop of Alphabet shares by 8% (100 billion dollars) following the provision of inaccurate information, but which could have capabilities related to NLP mode–s, improved rendering, cyber disease control, etc [15]; cryptocurrencies, as a version of debit or credit cards used in commerce 2.0, and which have traceability, instant transactions, allow direct peer-to-peer payments, have close to zero fees and are instant [50, 53]; NFT which is a digital asset that includes uniqueness, rarity, traceability and which is based on a blockchain network, being unique to the owner, allowing to increase the efficiency of trading, selling or buying digital goods, which reduces the probability of fraud [5, 22].

Therefore, through the metaverse, people will be able to work together, even if they are in different corners of the world, and not only with the help of the Internet, but also within it. Obviously, however, the appearance of the metaverse also comes with countless other questions related to ethics, the protection of personal data, cyber security, the use of bibliometric data [3, 10], but at the same time with other practical questions such as for example: how will the taxation of the incomes that natural persons will obtain through digital avatars be done or where will they be due, or where will social contributions be given and paid, where will the fiscal residence of a digital avatar be, that is so many problems that will have to be solved and which at this moment create unrest, at least for a part of humanity.

MATERIALS AND METHODS

The research methodology assumed both a quantitative and a qualitative analysis regarding the review of the metaverse concept in specialized literature with the aim of identifying the importance that the metaverse has in the development of fields such as business, education, sports, leisure, etc. In order to establish the relevance of the concept in specialized literature, we combined content analysis with bibliometric analysis, with the aim of identifying the knowledge base, but also its evolution [8, 55]. The bibliometric method is used when it is desired to examine the trends in the relevant scientific literature, by revealing the issues related to the studied subject, regarding the most contributing authors, organizations, sources, keywords or publication citations [19].

The information that was the basis of the study was extracted from the ISI Web of Science and Scopus databases, these being some of the most popular publications in the world, and belonging to Clarivate Analytics. The reason for the choice is that they contain publications with a high level of accuracy and strong scientific relevance. Also, the large volume of articles it contains can provide relevant information for the present research. The database was consulted in February 15-16, 2023.

The research framework of the present study is presented in Figure 2.

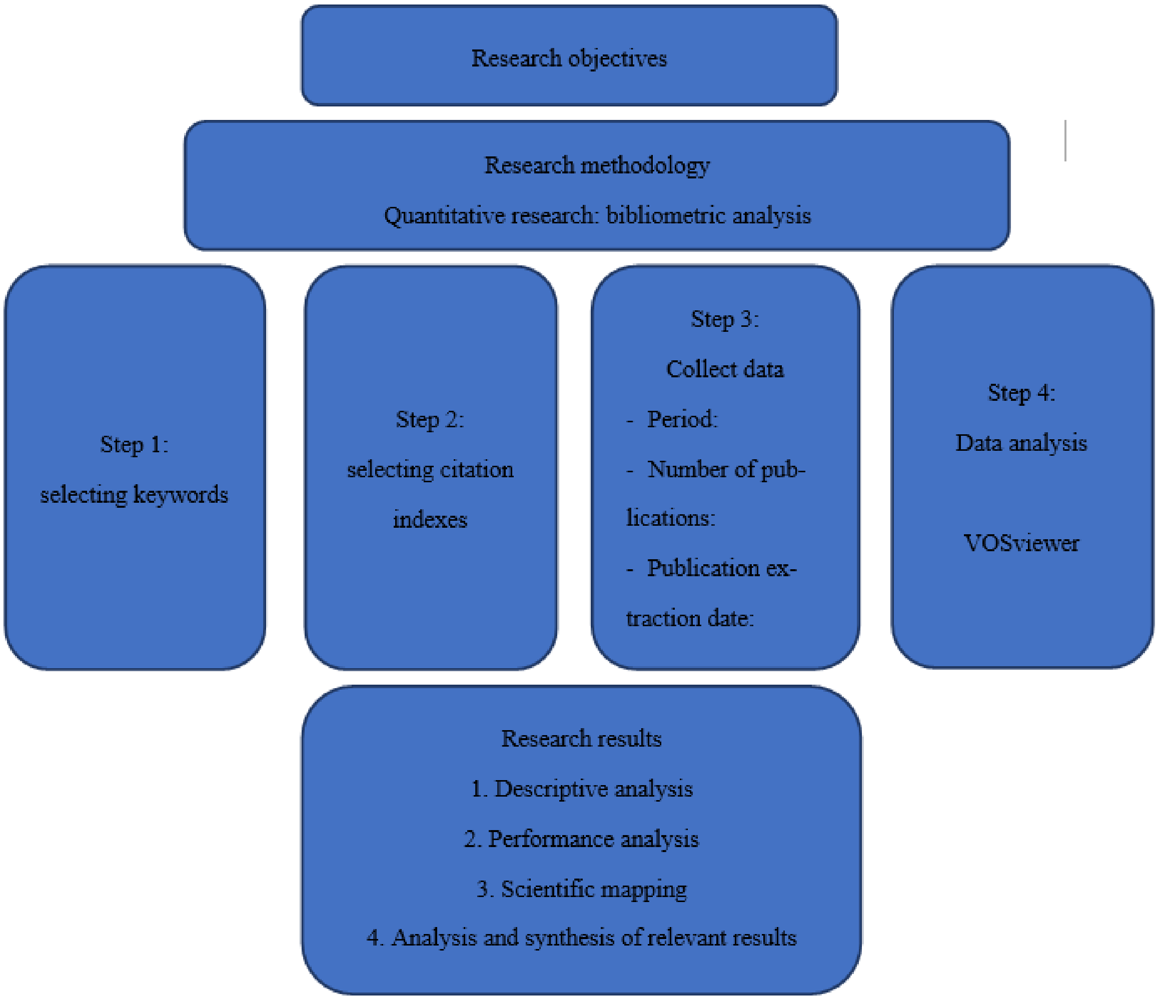

Fig. 2. Outline of the research framework
Source: own processing.

The data analysis was carried out with the help of the VOSviewer program, version 1.6.15, which allows the survey of bibliometric and sociometric networks regarding the performance of articles or specialized works, of authors, organizations, the impact factor, etc. and which allows scientific mapping starting of the conceptual, social and intellectual structure of the collected data and allows the creation of co-occurrence maps and the realization of similarity metrics [60, 62, 64]. This bibliometric representation can be done in three ways: by distance, time or visual. Thus, to identify those networks that are located close to each other, the approach of distance and the strength of association can be used. If the distance between two modes is small, then the respective articles are close or similar, and the association index derives from the co-belonging variables between the nodes or between the references. The key terms used were: “metaverse”, after which we refined the search based on two filters: "language of publication" (English) and "year of publication" to identify information about publications from 1995-2023. As a result, 733 studies were identified in the WOS database and 1,385 studies in the Scopus database, which were analyzed and interpreted with the aim of triangulation, so that a multi-dimensional perspective of the research could be achieved, which would contribute to its validity. The sample from the Scopus database was analyzed through the VOSviewer program. Thus, in Table 1, the selection criteria that were the basis of the current study are presented. Non-English ones were eliminated, resulting from the different types of publications (articles, reviews, etc.) a number of 1,400 publications. The Scopus database has a variety of research fields from which we removed book chapters, resulting in 1,385 articles, reviews, or papers written in English in the field of "Metaverse".

Table 1. Steps of bibliometric analysis

Step	Information	Criterion	Results
Step 1	Datebase Date Index Keyords	WOS; Scopus 16.02.2023 All Metaverse	1,400
Step 2	Language	English	1,385
Step 3	Publication	Article; Reviews; Proceedings Article; Reviews; Proceedings	1,355

Source: own processing.

The data downloaded from the Scopus database were checked to ensure that they were suitable for use in the VOSviewer analysis program, following systematic review steps [47] to ensure both a transparent and rigorous study, but also so that other researchers to be able to validate the results obtained by using the same database [65]. The analysis types, counting methods and trade wind units applied in VOSviewer were presented in Table 2.

Table 2. Types of analysis, counting methods and trade wind units applied in VOSviewer

Web of Sciences Categories	**Frequency**	**Percentage of the sample**
Co-authorship	Full Counting	Authors Countries Organizations
Citation	Full Counting	Documents Organizations Countries
Co-Citation	Full Counting	Cited references Cited authors

Source: own processing.

RESULTS AND DISCUSSIONS

The bibliometric analysis assumed the approach of three aspects, namely: descriptive analysis (1), performance analysis (2) and scientific mapping (3).

Descriptive analysis

A first search within the WOS database for the word "metaverse" highlighted the fact that the number of scientific works in this field is relatively low, i.e. 733 articles published in the period 1995-2023. From 1995 to 2006, the frequency was 1 article per year, and as can be seen from Fig. 3 researches about the metaverse were relatively insignificant until 2022, when their number reached 530, meaning practically 72% of the number of published articles. The survey of the Scopus database resulted in a number of 1,385 scientific works published in the same period, with the peak in 2022 represented by 1,014 works. The subject of the Metaverse began to attract the concerns of researchers in 2022, with the transformation of Facebook into Meta, which, together with Apple, Microsoft and Google, launched new hardware products and software services in a market that had only been niche that year. The success was also accelerated by the new navigation skills in the social or professional environment acquired during the Covid-19 pandemic, which changed not only the way of working, but also of spending free time, purchasing goods, education, etc. Thus, it can be observed that the first wave of studies related to the importance of the Metaverse took place in the period 2007-2014, when Web 2 was developed, followed by the period 2015-2020, when VR and AR technologies were developed, as well as Web 3, and then 2021-2022 the beginning of investments in Metaverse technology. The weight of the number is the same in the case of both databases, although in 2022 the difference is 484, which is why in the future, we will do the bibliometric analysis in relation to the results of the Scopus database.

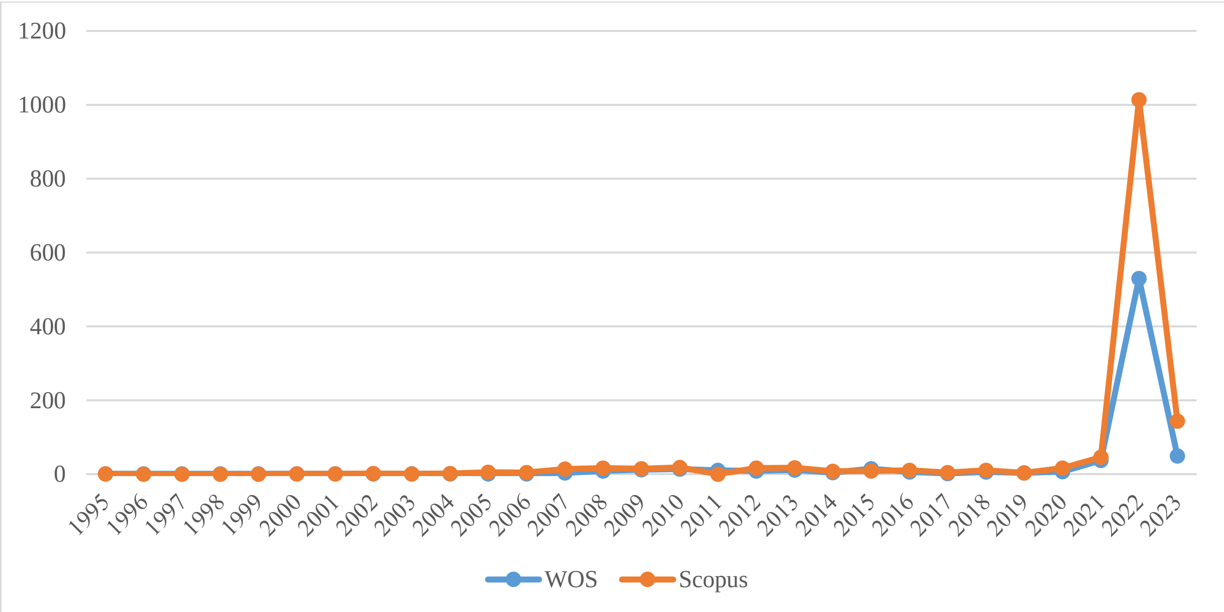

Fig. 3. The evolution of the number of scientific works on metaverse
Source: own processing.

Regarding the type of publication, it is found that most of the works are articles or works supported and published in conferences (90%), while the rest of the researches are chapters in books, editorials, etc. The attractiveness of publication in the first category of sources is justified by the faster publication procedure (Figure 4).

The main categories of scientific articles were grouped in relation to the specifics of their subject, highlighting the fact that almost half of the articles that had Metaverse as their subject were published in magazines, specialized conferences in Engineering (33.07%) or Computer Science (17.17%).

Also, almost 11% of these belong to the social field. The rest of the fields, very varied (mathematics, business, economics, physics, chemistry, agriculture, etc.) represented between 0.34 and 7.5%.

The fact that some of the articles have multidisciplinary approaches, being reported for each category separately, makes their number almost double (Table 3).

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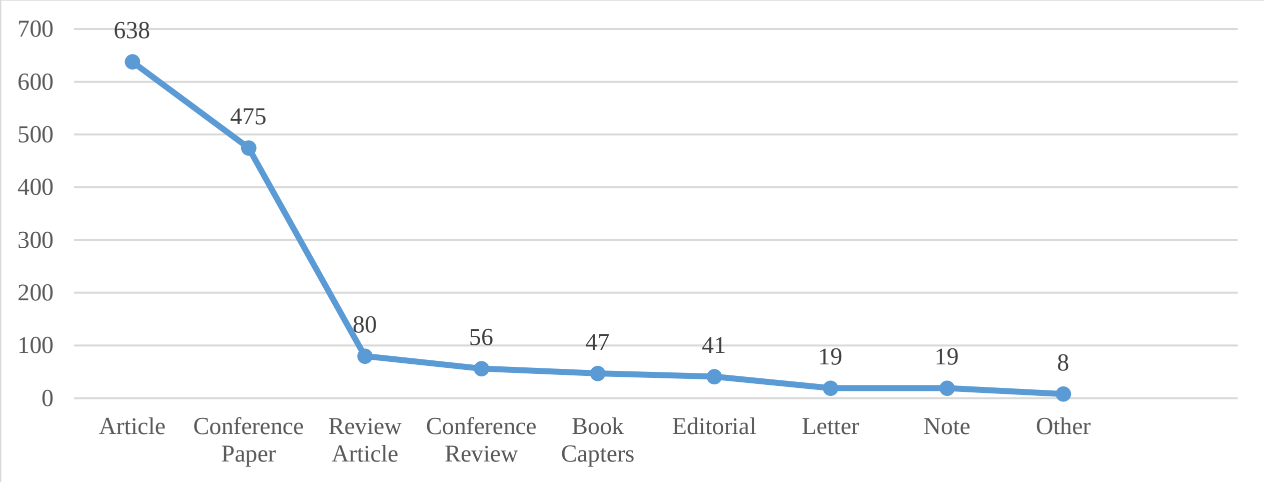

Fig. 4. The evolution of the number of scientific works
Source: own processing.

Table 3. Distribution of publications, by category

Scopus Categories	Frequency	Percentage of the sample
Engineering	882	33.07
Computer Science	458	17.17
Social Science	292	10.95
Matematics	200	7.50
Arts and Humanities	116	4.35
Decision Sciences	116	4.35
Business, Management, Economics	152	5.70
Medicine, Health, etc	135	5.06
Physics, Chemistry, Astronomy	157	5.89
Environmental Science	57	2.14
Agriculture, Veterinary	9	0.34
Other	93	3.49

Source: own processing.

Analyzing the situation of published articles in relation to the type of direct access, it turns out that in the 5 available categories, the articles are distributed as follows: 45% are published in All Open Access, 23% in the Gold category, 18% in the Green category, 10% in the Bronze, and 5% in the Gond Hybrid category, therefore the authors are determined to publish in relation to the facilities offered by the publishers, but also according to the speed of publication.

Table 4. Distribution of publications, according to the type of access

Web of Sciences Categories	Frequency	Percentage of the sample
All Open Access	533	44.90
Gold open	272	22.91
Hybrid Gold	55	4.63
Bronze	115	9.69
Green	212	17.86

Source: own processing.

Performance analysis

The 1,385 articles generated 4,166 citations, most of which were in 2022 (2,954). Thus, based on the sample, the analysis of the distribution of scientific production was carried out, finding that they had 3,202 authors. Those authors who had more than 5 citations and more than 5 published works were selected, resulting in a number of 74 authors. The selected items were 64 organized in 9 clusters, between which 289 links were established. The most cited author had 152

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citations, and the number of his articles was 8, these being cited by 52 authors, of which 24 are part of the 9 clusters. On the other hand, the author with 16 works had 21 citations, also obtaining a very good score. It is remarked that the situation of citations follows the same trend as the number of publications. Therefore, there is an increase in the interest of researchers in the field of the Metaverse and its development possibilities (Figure 5).

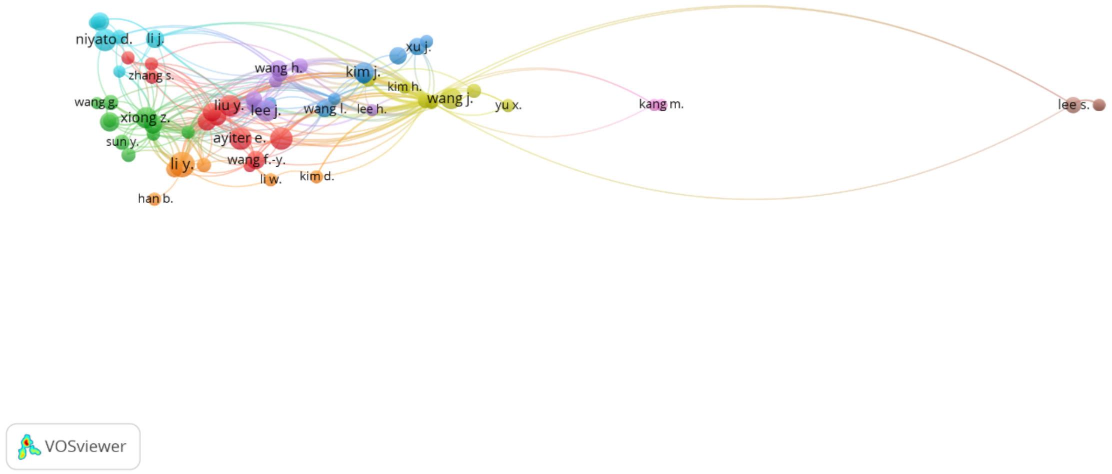

Fig. 5. The evolution of the number of scientific works
Source: own processing.

Scientific cartography

The analysis of the intellectual structure, that is the analysis of co-citations, involved the study of scientific research published in the period 1995-2023 through the VOSviewer program. The first restriction was related to the source of the citation, which took into account those sources with more than 20 citations which resulted in a number of 22,555 sources, and the second restriction was related to the minimum number of citations of a reference citations, which was set to 10. This resulted in a number of 209 sources that were grouped into 6 clusters. The strongest is cluster 2, demonstrating that most citations are related to scientific research published in IEEE, the number of co-citations being 518, through the links established between 205 publications. Also, the works from Sustainability were cited 341 times, through 171 links. In Sensors, scientific works cited by means of other 167 researches were published, the number of citations being 184. It is also noted that the publications are part of the 2021-2023 interval, being recent works and demonstrating the increase of interest in the analyzed subject.

The social structure assumed the analysis of the countries of the co-authors. In this sense, the following preconditions were established starting from the co-authored criterion: the set analysis unit was "countries", and the applied method was "complete counting".

It turned out that the authors come from 109 countries, but introducing as restrictions that the minimum number of published scientific works should be 10, and the number of citations should also be 10, the authors coming from 38 countries were selected.

The results were grouped into 5 clusters, between which 357 links were established.

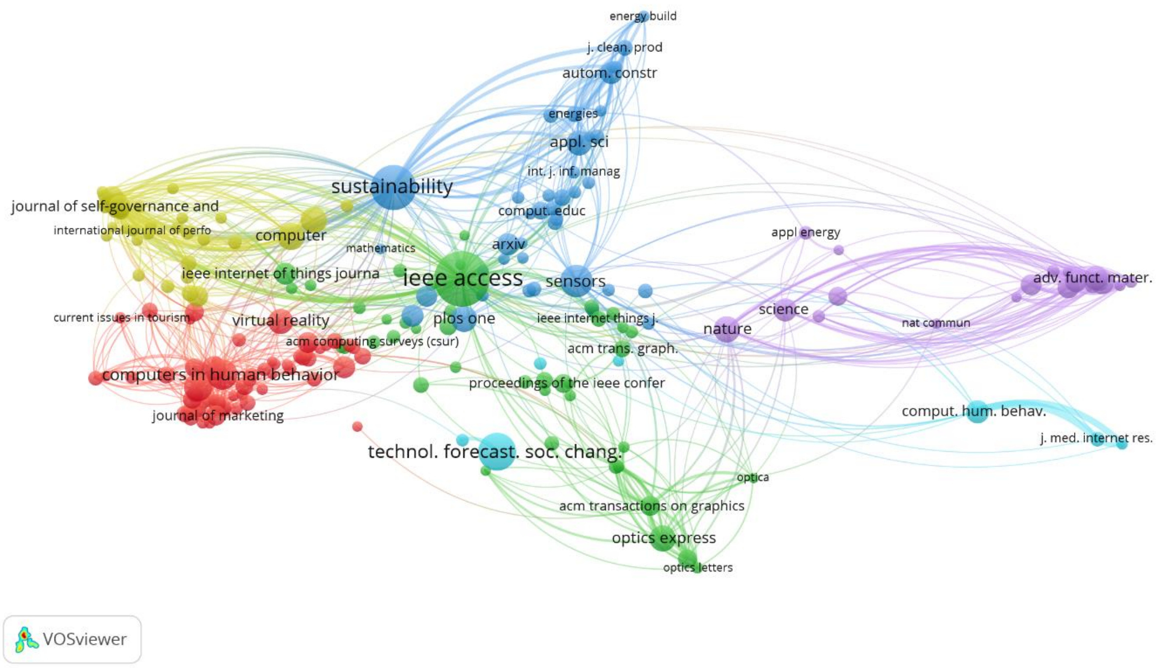

Fig. 6. The evolution of the number of scientific works
Source: own processing.

The country with the highest total strength of the link is China, this being 107, as a result of the 317 researches published and cited 727 times. The number of co-authors is 30. The USA is the second most important cluster, thanks to the 218 scientific works published in the field of the Metaverse that were cited 1,459 times. Within the cluster there are 34 connections, i.e. authors from 34 countries, the total strength of the connection being 81. Next in order is the United Kingdom with a total strength of the connection of 57, South Korea with 34, Singapore and Germany with 32. Romania is on the 17th place in this ranking, with a total power of 16, resulting from the 22 scientific works, cited 112 times. The authors of the citations come from 4 countries (USA, Germany, Slovakia and the Czech Republic). In this way, the scientific importance of the elaborated articles could be evaluated (Figure 7).

The social structure was also analyzed from the perspective of the co-authors' organizations, the method used being "full counting". The restrictions applied were the following: minimum number of documents published by the organization 3, and minimum number of citations by the organization 3. Out of the 2,654 organizations, the number of those that fulfilled these criteria was 29, they being organized in 3 clusters between which 15 links were established, with a total value of the link strength of 29.

The first cluster includes Faculty of operation and economics of transport and communications, University of Zilina, Slovakia, having a number of 7 articles of scientific research cited 49 times and having a total link strength of 12, Dimitrie Cantemir University Bucharest, Romania with 3 published articles, cited 40 times and a total link strength of 4, University of Bucharest, Romania with a number of 4 published articles, cited 46 times and a total link strength of 7 and The Institute of Technology and Business in Ceske Budejovice, Czech Republic.

The second cluster includes the Faculty of operation and economics of transport and communications, University of Zilina, Slovakia and the University of Craiova, the first having a number of 7 scientific research articles cited 49 times and having a total link strength of 12, and the second with a number of 6 articles and 6 citations, with a total link strength of 1.

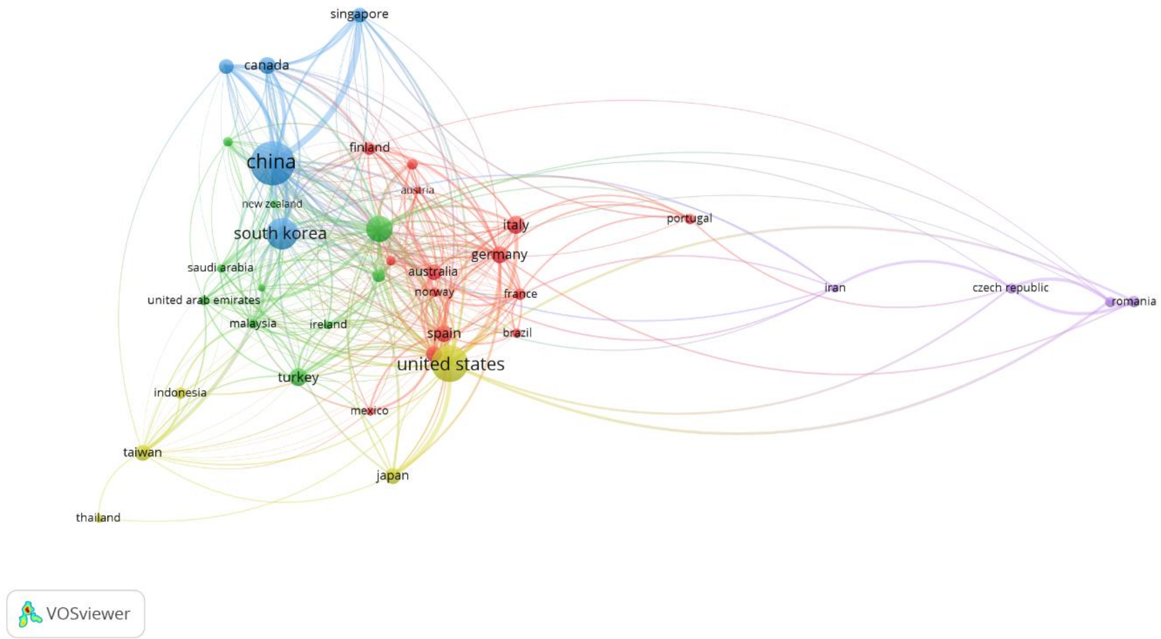

Fig. 7. Map of co-citations, by country
Source: own processing.

The third cluster includes Spiru Haret University, Bucharest, Romania with a number of 5 published works, cited 37 times and a total link strength of 7 and The Institute of Smart Big Data Analytics, New Yorh. It is thus established that there is still no sustained interest of the same researchers regarding the "Metaverse" theme, since only in 29 universities or research institutes there is a number of published works greater than 3 (Figure 8).

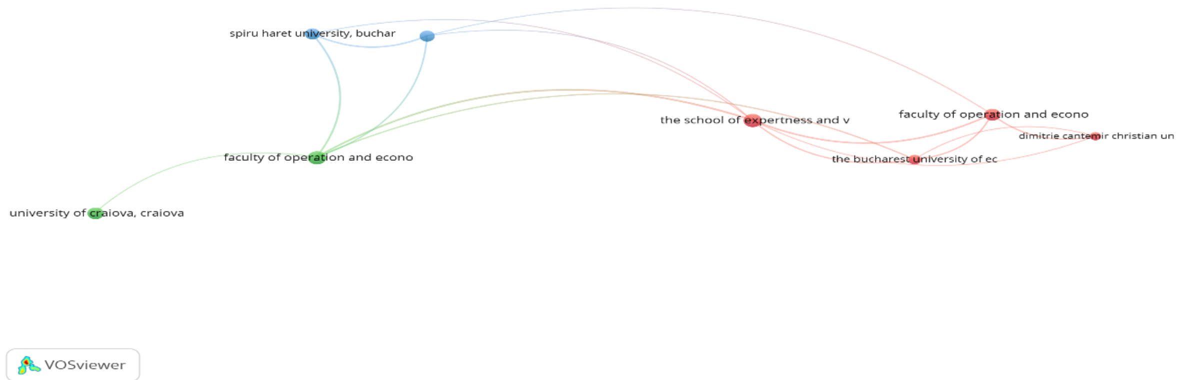

Fig. 8. Map of co-authors, according to organization
Source: own processing.

The conceptual structure assumed the analysis of the co-occurrence of the terms. This was done based on the number of appearances in the Scopus platform, regarding the terms that were most often associated with "metaverse". In the VOSvieer program, the following restrictions were applied: the analysis was performed in the "title of the works" field, resulting in a number of 3,611 words.

The second restriction was also introduced, namely the one related to the minimum number of occurrence of a terms.

It was chosen this number of 10, and the method used was binary counting, resulting in a threshold with the value of 39 terms. The VOSviewer methodology involves the selection of 60% of the most relevant terms, so that the conceptual map shows the 6 clusters and the 81 links established between the 23 terms.

It was found that the main themes associated with Metaver are "second life", having a relevance score of 4.97 and which is in the same cluster as "mataverse technology: with a score of 3.49 and augmented reality".

Another term is "virtual", with a score of 2.15 and "internet" with 1.01, which indicates the technical content of the scientific work. Another cluster highlights the concern of researchers regarding the changes and opportunities that the application of Metaverse technologies can bring to people's lives, based on the discussion of case studies (Figure 9).

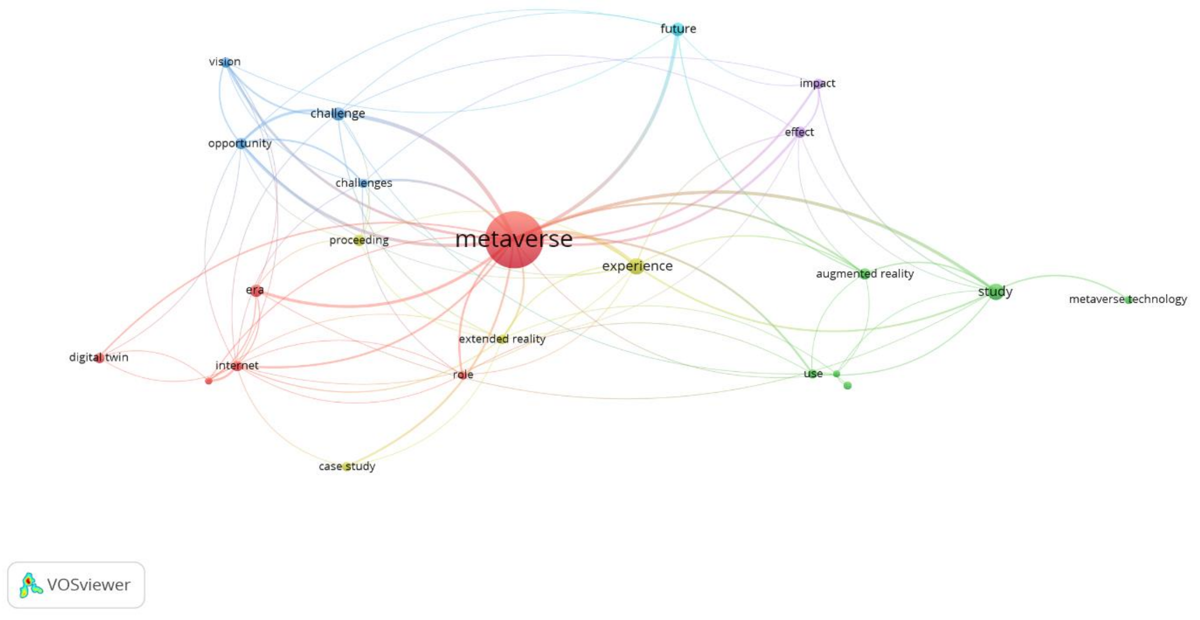

Fig. 9. Co-occurrence map, in relation to keywords
Source: own processing.

In order to determine, on the one hand, the research gaps, and on the other hand, prospective research methods in the field of "Metaverse", the most important scientific research works were analyzed, the results being summarized in Table 4.

For this purpose we used the Scopus database from which we retained Highly Cited Papers from the period 2019-2023, the minimum number of citations being 40.

The search and filters generated 12 articles, which were analyzed from the point of view of the journal, keywords, abstracts and research methodology. Scientific research works are presented in descending order of citations (Table 5).

Table 5. The most important scientific research works

Author(s).	Year of publication	Scope category	The main findings
Sang-Ming, P.; Young-Gab, K.	2022	IEEE Access	The paper presents the concepts and techniques necessary for the realization of the Metaverse, dividing them into three components and three approaches, identifying the limitations and development directions of the immersive Metaverse [55]; The research method is the review of specialized literature; used 357 bibliographic references; has 146 citations
Haihan, D; Jiaye, L.; Sizheng, F.; Zhonghao, L.; Xiao, W.; Wei, C.	2021	MM 2021 - Proceedings of the 29th ACM International Conference on Multimedia	The paper presents the main applications of the metaverse used for the development of social good, proposing a three-layer architecture containing infrastructure, ecosystem and interaction. It also proposes a prototype for a university campus developed in the metaverse and based on blockchain technology [20]; the research methodology involved the review of specialized literature and applied research; used 27 bibliographic references; has 108 citations
Kye, B; Han, N.; Kim, E.; Park, Y.; Jo, S.;	2021	J Educ Eval Health Prof	The paper presents four types of metaverse with the aim of identifying its potential application in the field of medical education through the use of augmented reality and immersion. At the same time, the advantages and disadvantages of using the metaverse are presented [36]; the research methodology involved the review of specialized literature; used 22 bibliographic references; has 72 citations
Dwivedi, Y.K., Hughes, L., Baabdullah, A.M., Ribeiro-Navarrete, S.,Giannakis, M., Al-Debei, M.M., Dennehy, D.,(...),Wamba, S.F.	2022	International Journal of Information Management	The paper presents from a multidisciplinary perspective the aspects related to the role that the metaverse has on the development of society and its various environments, as well as its transformational impact, also proposing a future research agenda, useful for specialists in the field [13]; the research methodology involved the review of specialized literature; used 80 bibliographic references; has 65 citations
Kim, J.	2021	Journal Of Interactive Advertising	The paper presents the place occupied by advertising in the metaverse, starting from the two fundamental areas, the conceptualization and the methodological framework. It also proposes a research agenda in order to develop the role that advertising has in the metaverse [33]; the research methodology involved the review of specialized literature; used 28 bibliographic references; has 55 citations
Xi, N., Chen, J., Gama, F. *et al.*	2022	Inf Syst Front.	The work is based on a case study that tests the use or non-use of XR technologies (augmented reality - AR and virtual reality - VR) and which highlights the fact that both the resources and the operating costs of realities that are mediated by XR are much higher than those of physical reality; the research methodology assumed applied research [65]; used 117 bibliographic references; has 52 citations
Kraus, S.; Kanbach, D.K.; Krysta, P.M.; Steinhoff, M.M.; Tomini, N.	2022	International Journal of Entrepreneurial Behaviour and Research	The work carries out a bibliographic analysis regarding the entrepreneurial path of Facebook. The research involved the investigation of bibliographic resources, both academic studies and other available public information that were analyzed qualitatively, from the point of view of

			content [35]; the research methodology assumed the case study; used 157 bibliographic references; has 50 citations
Haihan, D; Jiaye, L.; Sizheng, F.; Zhonghao, L.; Xiao, W.; Wei, C.	2021	MM 2021 - Proceedings of the 29th ACM International Conference on Multimedia	The paper presents the main applications of the metaverse used for the development of social good, proposing a three-layer architecture containing infrastructure, ecosystem and interaction. It also proposes a prototype for a university campus developed in the metaverse and based on blockchain technology [20]; the research methodology involved the review of specialized literature and applied research; used 27 bibliographic references; has 108 citations
Hollensen, S.; Kotler, Ph,; Opresnik, M.O.	2022	Journal of Business Strategy	The work presents and explains the concept of Metaverse, which according to the authors of the book will revolutionize almost every industry, exemplifying through a case study (Nike - Roblox) how the metaverse works, at the same time explaining consumer behavior in relation to the virtual environment [24]; the research methodology assumed the case study; used 8 bibliographic references; has 45 citations
Nevelsteen, K.J.L.	2018	Computer Animation and Virtual Worlds	The paper aims to sample different technologies in order to define the "virtual world" which is then used to classify advanced technologies. The properties of the different technologies are also presented in order to identify the differences between them [43, 46]; the research methodology involved the review of specialized literature; used 73 bibliographic references; has 45 citations
Rauschnabel, Ph.; Felix, R.; Hinsch, Ch.; Shahab, H; Alt, F.	2022	Computers in Human Behavior.	The work assumes the meaning and definitions of different XR terms, making a classification of them and a correct definition of them (AR, VR) [54]; the research methodology included bibliographic analysis and case study; used 143 bibliographic references; has 45 citations
Heang, G-J.; Cjien, S-Y.	2022	Computers and Education: Artificial Intelligence	The paper aims to find the clearest possible definition of the metaverse and to present its application methods in the educational field, emphasizing the role of AI in education based on the metaverse with the aim of challenging researchers to find new future solutions [22]; the research methodology included bibliographic analysis and case study; used 33 bibliographic references; has 42 citations
Falchuk, B.; Loeb, S.; Neff, R.	2018	IEEE Technology and Society Magazine.	The paper presents the risks faced by each individual in terms of his privacy, along with the development of technology and social engineering, thus drawing attention to the "costs" of the metaverse [16]; used 21 bibliographic references; has 42 citations

Source: own processing.

As can be seen, 7 of the 12 researches are reviews, which shows that although the theme of the matavers is a promising one, it is still at the beginning of the road, requiring more empirical studies and applied research.

Metaverse and agriculture

In the agricultural field, the metaverse is also present, being found under the name agricultural metaverse or AgriVerse and represents a way of real-virtual iteration that can be found in the production and marketing processes of agricultural products that aim not only to increase productivity through reducing costs or replacing reduced resources (for example labor), but also achieving sustainable agriculture.

Table 6. Scientific works in the field of metaverse and agriculture

Author(s).	Year of publication	Scope category	The main findings
M. Kang, X. Wang, H. Wang, J. Hua, P. d. Reffye and F. -Y. Wang	2023	IEEE Access	Starting from plant modeling research, the article analyzes the transition of aquaculture to agriculture based on artificial intelligence (AI) and projects three scenarios regarding the possibility of using AgriVerse, identifying both the opportunities related to its development, as well as its challenges, the advantages and disadvantages of its uses [32]; The research method is the review of specialized literature; used 357 bibliographic references; has 146 citations.
N.A.Jasim, Chaari Fourati, L.	2023	IEEE Access	The work underlines the need to adapt agriculture to modern IoT, Blockchain or UAV technology with the aim of developing it and ensuring food security in the conditions of the decrease in the resources that humanity benefits from. Through the evaluation of the specialized literature regarding the latest innovations in the agricultural field, the authors propose both solutions, but also open new topics to be the starting point for future research related to the application of the metaverse in agriculture [30];
Neethirajan, S	2021	IEEE Access	The paper presents the advantage of using deepfake technologies in the case of their application in determining the health of farm animals, which have the effect of increasing productivity and ensuring the sustainability of the farm. Thus, by means of interactive 3D avatars, the behaviors and emotions of animals can be identified and monitored, aspects that can contribute to the well-being of animals. The work is an exploratory review that highlights the possibility of establishing a link between the metaverse and the agricultural field [45]; the research methodology involved both bibliographic analysis and case study; 67 bibliographic references were used; has 5 citations
Hou, Kun Mean, et al.	2023	Sensors	The work presents the main top technologies that in the coming years will be found in numerous technologies that will be part of everyday life, even if at the moment they seem inaccessible. Thus, the metaverse will be present in the form of digital applications, autonomous vehicles, leading technologies in health or life sciences, up to entertainment and intelligent agriculture. AIoT, IIoT or IoT technologies are those that contribute to the development of the metaverse, digital twins, industry 4.0, etc. The contribution of the article is represented by the analysis carried out with the aim of highlighting the trends and challenges in this field. In the agricultural field, the application of deep learning algorithms has contributed to increasing the yield of crops or reducing water consumption, but also to the detection of plant diseases, the classification of plants or the use of precision agriculture [25]; the paper is a case study regarding the development of an application with use in agriculture; the number of bibliographic references is 79.

Source: own processing.

At the same time, it is a way of modernizing agriculture, of moving to the use of precision agriculture, of intelligent agriculture, of artificial intelligence on a larger scale as a result of the foundation of some functional models of agriculture.

However, the specialized literature has not recorded an important number of researches on this subject, but in the following we will present 4 articles and the current research directions.

Therefore, the metaverse can also be found in the agricultural field, in the practices of intelligent agriculture, precision agriculture, thus contributing to the development of applications that lead to the improvement of agricultural practices, both in the plant and livestock fields.

Another field in which the virtual world makes its presence felt is the food industry and the aspects related to the traceability of food, which is very much based on the blockchain technology applied in the world of the Metaverse, traceability that will not be reduced in importance at the time of the change of social patterns, located in a continuous progress, but will become more and more complete and reliable. In this way, through the Metaverse, by connecting reality with the virtual environment, new experiences will be created, which will make us enjoy both the culinary experiences, but also the social environment that could be different from the real one.

Regarding the research methodology, in addition to the review of the specialized literature, it was also based on case studies or holistic approaches. Thus, the existence of a gap in terms of primary research can be found, a gap that could be completed with studies related to the impact of the use of the metaverse on different environments, its advantages and disadvantages, but also the impact it will have on the future evolution of mankind.

CONCLUSIONS

We consider that the present analysis based on the study of bibliometric data contributes to the development of applied research regarding Metaverse, starting from the fact that longitudinal studies of scientific interest can contribute to the clarification of some research directions in the process of development, considering the actuality of the concept and the modality in which he can change the future. At the same time, the results obtained allowed an objective scientific mapping thanks to the resulting conceptual maps, contributing to the dissemination of previous scientific research, but also to the establishment of trends, mutual concepts, collaborations and citations, identifying the most productive authors, organizations, countries, as well as the most cited sources and documents. There is an increase in interest towards the "Metaverse" concept, especially in recent years, a fact proven by the increase in the number of scientific papers and citations from the years 2022 and 2023. The analysis of the most relevant and important scientific research articles showed that that these are mostly reviews, which highlights the need for the publication of more applied studies. Through this research, we consider that we were able to make an important contribution in the scientific field regarding the theme of the metaverse, as a result of the systematization of existing knowledge, this being one of the few bibliometric analyzes of this concept. Also, through the research, we managed to identify the research gaps in the analyzed field.

Our research highlights the fact that although it followed the analysis of information related to the application of Metaverse in different fields, it has some limitations that must be recognized, among which the fact that the information obtained is limited, as a result of the consulted databases (WOS and Scopus) and the words key that we used in the bibliometric analysis; the fact that the number of published studies is still low, although there is an increase in interest in this field of research. We therefore consider that this study can offer both researchers and practitioners the potential directions for research and investigation of this topic, related to the application of Metaverse in different fields.

Last but not least, it should be emphasized that the implementation of Metaverse can lead to the expansion of business development opportunities, to overcoming time and space barriers, which otherwise cannot be overcome in the real world. Although Metaverse is not a new technology, it is a technology in continuous change and development, on the rise, with an increase in popularity especially among young people and due to the technology that requires certain skills, we note that in many works its advantages are presented, without too much recognition of its shortcomings, vulnerabilities, social and physiological impact of its use, moral principles, cyber security, confidentiality.

The present study shows that Metaverse is a fashionable concept, still at the beginning of the road in many fields, which can simplify our life, but at the same time it can irreparably complicate it. It is a Pandora's box, which if we want to open, we should make sure that we are ready to face its challenges. Or maybe this Pandora's box has already been opened?

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STUDY ON THE SITUATION OF THE BOVINES HERDS IN ROMANIA, THE PRODUCTIONS OBTAINED AND THE CONSUMPTION OF MEAT AND DAIRY IN THE PERIOD 2016-2021

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Abstract

The current work aims to analyze the existing situation in Romania compared to other EU countries, regarding bovines herds, given that this species is one of the ones that causes the highest level of greenhouse gases, with a direct effect on the environment and global warming. This is the reason why the subject has become a priority not only at the community level, but also worldwide. Through the Common Agricultural Policy, important funds have been allocated at the level of the European Union, which will continue to be allocated, not only for the reduction of climate change, but also for the adaptation of the states of the world to these existing climate changes at the global level. Given the path in which animal husbandry influences sustainable development, through the study we have followed both the effective changes, but also the obtained productions, with a direct impact on consumption. It was found that both at the community level, as well as at the national level, there was a decrease in bovines herds in in the period 2016-2020, the reasons being primarily of an economic nature, but equally important being the social and environmental ones. The analysis was carried out starting from the data published by the National Institute of Statistics and Eurostat, data that were then processed and analyzed with the help of statistical methods. Based on these, the conclusions were formulated that show us that in Romania the number of bovines herds decreased by 11% in the period 2016-2021. At the European Union level, Romania ranks 10th in terms of bovines herds and 20th in terms of density/100 ha. Although there are advances in terms of applied technologies or more productive breeds, at the global level the objectives pursued by the reduction of greenhouse gas emissions have not been influenced by these advances, which makes the activity of raising bovines to be considered one with effects negative effects on the environment, but also high consumption of energy and water, which in turn have a negative impact on climate change.

Key words: *bovines, production, consumption, efficiency, greenhouse gases*

INTRODUCTION

In Romania, agriculture is still one of the important branches of the national economy, which contributed according to the existing data at the level of the IV quarter of 2022, together with forestry and fishing, with a weight of 8.6% in GDP formation, causing a decrease of 1.5% of it compared to the previous year [13]. However, the agricultural sector remains poorly integrated in the market economy, due to the fact that it is still a primary sector, its potential being poorly exploited due to factors such as the aging of the workforce, low labor productivity, the large number of holdings agricultural and the increased fragmentation of agricultural lands, etc. [1, 20, 23]. Animal husbandry, as a branch of agriculture, has an important role both at the macroeconomic and microeconomic levels, contributing to the increase of incomes in the rural environment [25]. However, the decline of this sector was affected by numerous problems related to: the decrease in the number of animals, climate changes that had an impact not only on the breeds, but also on the production of fodder, as well as the European legislation regarding animal health [5, 18, 19, 22]. Even the economic and health crises that affected the population worldwide did not have favorable effects on the livestock sector due to the decrease in the consumption of meat, milk and derived products.

Although the animal breeding sector is one that ensures the ever-increasing food needs of the population, there is an important aspect related to this activity, the one related to the emission of greenhouse gases, which has a direct effect on climate change, a current topic that concerns organizations worldwide and which risks threatening not only the well-being of future generations, but also of the present ones, which influence the ecosystems on a planetary level [16, 17].

Studies show that the low productivity of different categories of animals has the effect of increasing the intensity of these gases/animal or per unit of food produced [3, 6]. Based on the observations made, it is found that there is a directly proportional relationship between the quality of food, recorded productivity, but also greenhouse gas emissions. This is why it is important to follow the economic impact of animal breeding [2]. The increase in productivity is linked to the applied technologies, the growing conditions and the environment, the managerial skills of the farmers [21], all these measures contributing on the one hand to reduce pollution, but also to increase economic importance that has the livestock sector [4]. The use of circular models could also contribute to the improvement of all the aspects presented above and at the same time to the development of local or regional business models [15, 26].

MATERIALS AND METHODS

The purpose of the research was to present the way in which cattle herds (bulls and buffaloes) and the productions obtained from their exploitation evolved in the analyzed period 2016-2020. The indicators that reflect the changes recorded in the cattle breeding sector and which were analyzed were: cattle herds (existing at the national level and at the European Union); their density, total milk and meat productions; the number of slaughtered animals. Statistical data taken from the INSSE and Eurostat statistics were used for the realization of this work, which were processed and analyzed so that, based on the research results, conclusions can be drawn regarding the economic importance of this livestock sector.

The indicators were followed dynamically, using the established formula:

$$I^{y}_{t/t'} = \frac{yt}{yt'}\, x\, 100 \quad \text{...............(1) [24]}$$

where:
y - the level of the analyzed phenomenon
t, t' - the moments of time.

To establish the ratio between a certain group and the totality of the analyzed phenomenon, the relative structure sizes are used, which can be calculated both to determine the frequency of the groups, but also to calculate the centralized values of some characteristics, according to the formula:

$$g_i = \frac{xi}{\sum_{i=0}^{n} xi} \text{ x } 100 \quad \text{.............(2) [24]}$$

where:
x – indicator level.

RESULTS AND DISCUSSIONS

The analysis of the indicators that reflect both the situation of livestock and production, tracked for the 2 categories of products obtained (meat and milk) was carried out over a period of 6 years, for the interval 2016-2021.

Starting from the existing situation in the European Union in 2016, we note that Romania is in 10th place in terms of bovines herd. Their number was 2,049.70 thousand heads, which represented only 11% of the total bovines herd in France, 33% of the total herd in Spain and 35% of the total herd in Poland (Fig. 1).

In 2021, Romania occupied the same 10th position, but the number of effective bovines was decreasing by 11% compared to 2016.

The downward trend of livestock numbers is also observed in the case of Belgium (8%), France (9%), Germany (11%), and in the case of the Netherlands (14%).

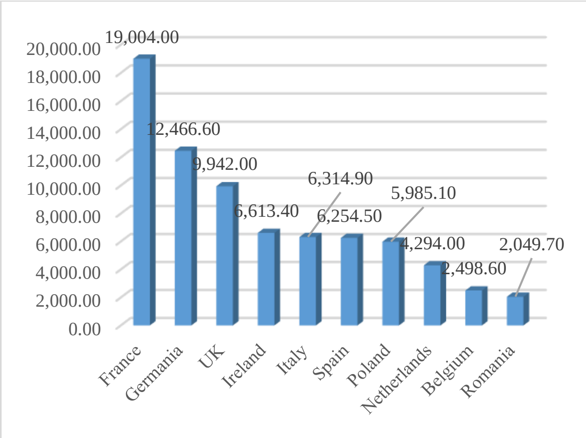

Fig. 1. Top 10 countries according to the number of bovines herds, in 2016 (mii capete)
Source: own processing based on [6].

As a result of the fact that Great Britain left the European Union in 2019, it is not part of the study. The other 5 countries that recorded increases were Ireland and Italy (1%), Spain (5%) and Poland (7%) (Fig. 2).

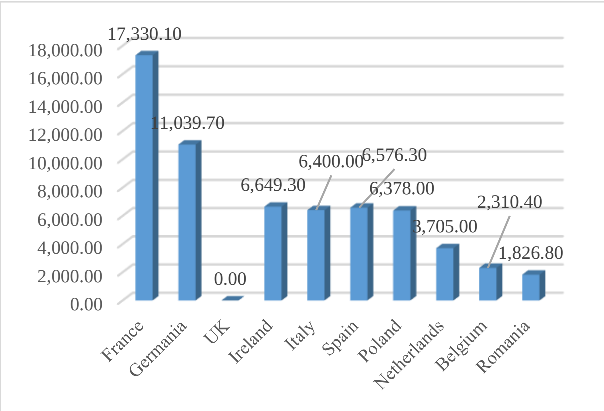

Fig. 2. The situation of the countries with the largest herd of cattle in the EU, in 2021 (thousands of heads)
Source: own processing based on [12].

An aspect that should be noted is the one related to the decrease in density, at the level of all the analyzed countries. The biggest decreases were recorded in the Netherlands (13%), Germany (11%) and Belgium (10%). The smallest decreases in density were recorded in Ireland (1%), Belgium and Austria (2%) and Denmark (4%). In 2016, Romania occupied the 21st place among the countries of the European Union, and in 2022 it occupied the 20th position. Regarding the decrease in density, this was 6% in 2021 compared to 2016, reaching a number of 14.4 heads/100 ha (2016), compared to 15.4 heads/100 ha (2021) (Fig. 3).

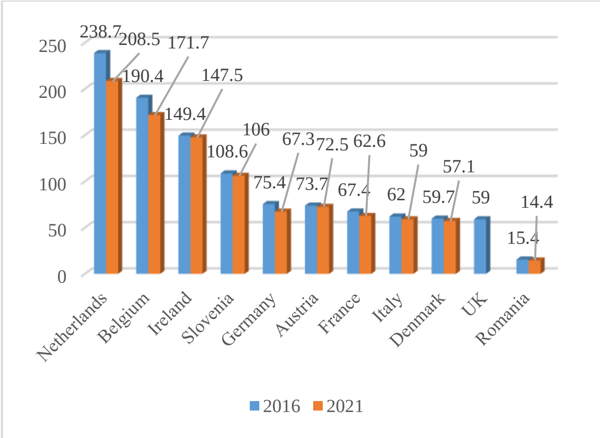

Fig. 3. Evolution of density/100 ha of land (heads)
Source: own processing based on [6, 12]

As I have already shown, bovines herds decreased in Romania between 2016-2021, these decreases being approximately 2% from one year to another, so that in 2021 the decrease was approximately 11% compared to 2016 The same trend can be observed by age categories, the decreases being recorded both in the teurine category and in the buffalo category (Fig. 4).

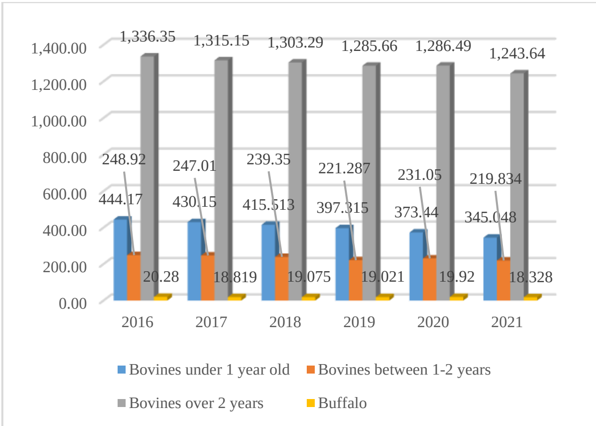

Fig. 4. The evolution of bovines herds, by age groups (thousands of heads)
Source: own processing based on [6-12].

The analysis was carried out both for the production of beef and for the production of milk. It had to be shown that in terms of the share of beef production, it had shares of approximately 14% (2016) and 12% (2021) of the total production obtained in Romania (Fig. 5).

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Fig. 5. The structure of meat production, by category in 2016 and 2017 (%)
Source: own processing based on [6-12].

Milk production in Romania fluctuated between 2016-2021. The highest production was recorded in 2019, when it approached 4 million liters.
And in 2021, the production was 3.9 million liters. The decrease in 2017 and 2018 was 4% compared to 2016. The differences between the production obtained and the consumption of processed products was ensured on the basis of imported products (Fig. 6).

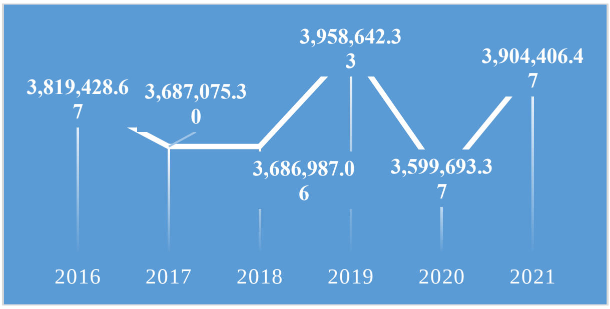

Fig. 6. The evolution of milk production in 2016-2021 (million liters)
Source: own processing based on [6-12].

Table 1. Consumption of milk and dairy products in the period 2016-2021

Category	2016	2017	2018	2019	2020	2021
Milk consumption (thousands of liters)	1,136,102.05	1,115,591.10	1,088,198.02	1,046,593.86	1,080,887.69	1,098,060.62
Sour cream (to)	15,844.29	15,195.15	18,054.31	16,116.72	16,017.48	14,923.07
Butter (to)	541	504.18	553.71	717.87	604.37	1,173.87
Cheeses (to)	242,277.08	214,248.38	211,410.24	189,863.93	188,700.48	175,634.96
Other products (to)	29,456.68	32,065.04	28,889.40	32,501.50	32,388.69	29,639.87

Source: own processing based on [6-12].

With regard to the consumption of milk and milk products, from the data related to the period 2016-2021 it appears that in terms of drinking milk and cheeses, they also recorded a continuous decrease (milk consumption decreased by 3% in 2021 compared to 2016, and the consumption of cheeses decreased by 18% in the same period).
The consumption of a test that has doubled its value (216% in 2021 compared to 2016), and we also observe fluctuations regarding the consumption of cream (Table 1).

CONCLUSIONS

Studies show that raising bovines contributes the highest share of greenhouse gas emissions, but these vary from one country to another or from one region to another as a result of the forage consumed, the breeding systems or the way of use of nutrients [14]. Although there is a direct link between the emissions of these gases and the climate effects, the PAC, which provides support in this direction, does not aim to reduce the number of animals, but to support farmers in finding solutions for the absorption of these gases.
Therefore, a premise of the decrease in the effective number of animals is also this environmental protection objective, which was initially proposed in Kyoto and then continued through the Paris Agreement. Although at a statistical level there have been decreases in these emissions, for example per

liter of milk obtained, these are due to the increase in production as a result of research that led to the improvement of cattle breeds or the modernization of animal husbandry technologies, which were not actually accompanied by an effective decrease in these emissions.

There are other causes that have contributed to the decrease in animal numbers (lack of labor in animal husbandry, the existence of some diseases in animals (spongiform encephalopathy, etc.), the increase in feed prices that lead to a decrease in the profitability of the activity carried out and to a decrease in income for both farmers, as well as for consumers.

These decreases in income among consumers, caused by the economic crisis, the health crisis, etc. led to a decrease in consumption. Regarding the decrease in beef consumption, it was higher due to the fact that the price is much higher than in the case of other species of animals.The new vegetarian or vegan trend, which contributes to a decrease in meat consumption, should not be eliminated either. As far as milk is concerned, there are substitutes here as well, as plant-based milk varieties (soy, almond, etc.) are increasingly sought after, which causes the consumption to decrease.

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ANALYSIS OF THE RELATIONSHIP BETWEEN TOURISM AND THE CIRCULAR ECONOMY: A CRITICAL REVIEW OF THE LITERATURE

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Abstract

Considering the importance that circular economy models have in today's society and the concerns that both decision-makers and other interested parties have regarding this concept, in this paper we have proposed to analyze the relationship between the economy circular and tourism, starting from the fact that this is one of the sectors of activity that is characterized both by a high consumption of water, energy and natural resources, as well as by a large food waste, being also a producer of important CO_2 emissions, as a result of the link it has with road, air, maritime transport, and not only that. The research methodology assumed the review of the specialized literature, being inventoried scientific papers indexed Web of Science, and starting from 2 keywords: "circular economy" and "tourism". From the 340 identified scientific works, following the application of several filters regarding language, title, keywords, 33 publications resulted. By applying a restriction regarding the relevance of these works, assessed on the basis of a minimum number of 3 citations, it was possible to establish a sample of 15 publications that were analyzed, identifying both the results presented by the author/authors, as well as the conclusions and the way in which that they could influences the application of circular economy principles in tourism. The analysis carried out showed us that the number of specialized papers in this field is relatively small, which is why, in order to obtain the most conclusive results regarding the proposed theme, we believe that, considering the importance of the theme, it will be necessary to continue the research on tourism and the circular economy. In this way, it will be possible to identify the solutions that will accelerate the sustainable development of tourism., which could thus meet both the leisure needs of tourists who, in turn, are increasingly concerned with the issue of sustainability, as well as the need to protect the environment, so that we allow future generations to enjoy what the new Planet offers us.

Key words: *circular economy, tourism, development, sustainability, business model*

INTRODUCTION

The term circular economy is not a new one, but it has started to be used more and more often both among specialists and among the general public, with the increase of concerns related to environmental protection and consumption reduction, so that it is not compromises the ability of future generations to meet their own needs [23]. The concept of "circular economy" has been used since 1928 by Leontief in his work "The Economy as a circular flow" and then resumed by Von Bertalanffi in 1937 [12, 26]. Stahel and Reday describe a concept of closing the loop in the economy [22], and in 1980 Pearce and Turner show that the term "circular economy" was used in 1980 describing a closed system through which the interactions between the economy and the environment were ensured [18]. Since the 1990s, the term has been increasingly used. In 1996 Lyle defines the circular economy as "regenerative design" [13]. The Ellen MacArthur Foundation played an important role in the development and promotion of this concept, by advocating and advocating for the need to move to a circular economy, defined as an economy that "aims to redefine growth, focusing on benefits at the level of the entire society and which involves the gradual decoupling of economic activity from consumption of finite resources and the elimination of waste from the system” [5].

Other definitions consider it as a model of economic development based on the ecological circulation of natural materials [7] as a result of the fact that natural resources are limited and that the environment does not have an infinite capacity to absorb waste [2].

The circular economy also means improving eco-efficiency and adopting a 4R approach (R1-reduction, R2-reuse, R3-recycling and R4-recovery) [8] which can be applied both at the micro level (consumers, companies) and at mezzo (industrial parks) or macro (cities, regions, countries, continent) level [11].

Currently, the model has been extended to 10R (R1 - refuse, R2 - rethink, R3 - reduce, R4 - reuse, R5 - repair, R6 - restore, R7 - remanufacture, R8 - reorient, R9 - recycle and R10 – recovery), which applies to business models [17].

The circular economy thus represents an alternative solution to the linear economy which was developed during the economic boom stage and which was based on consumption with a mentality of the type exploitation - manufacture - consumption - disposal, which led both to the depletion of resources and to the appearance of waste that could no longer be controlled. Therefore, the circular economy promotes the principles of reducing or even eliminating waste, reducing pollution, keeping products and materials in use as long as possible, but also regenerating natural systems. It is an economy adapted to the modern consumer, due to the fact that it is more sustainable, that it pays more attention to environmental pollution, that it tries to contribute to the reduction of climate change, which is due to the concerns of the new generations regarding the future of the planet and the future of the generations to come [16].

Concerns related to the circular economy model exist both worldwide and at the level of the European Union. Thus, in March 2020, the European Commission presented an action plan through which it aims at both a sustainable design of products, as well as the reduction of waste and educating citizens and granting new rights in the field of circularity, emphasizing those sectors that have an intense consumption of resources (electronics, textiles, plastics, constructions).

In February 2021, a resolution was adopted that seeks to ensure a neutral economy, without carbon emissions and substances with a harmful effect on human health and the environment, and which calls for the adoption of additional measures that will have the effect of achieving a completely circular economy by 2050. The objective can be achieved under the conditions of the adoption of much stricter rules related to recycling or the consumption of raw materials until 2030.

In March 2022, the European Commission continued measures to accelerate the transition to the circular economy, consisting of promoting sustainable products, but also encouraging consumers to take the step towards the transition to a green economy, to the revision of some regulations regarding construction materials and durable textile materials.

In November 2022, new measures related to packaging were applied and aimed both at improving their design (clear labeling to promote reuse and recycling), but also at the use for their manufacture of plastic materials that have a biological origin, either biodegradable or compostable.

MATERIALS AND METHODS

The research methodology involved a review of scientific papers, articles, studies and research on the relationship between tourism and the circular economy.

The approach started from consulting the existing specialized literature in the Web of Science database.

The database was queried in March 2023. The first word searched was "circular economy", and the second "tourism", the search was carried out in the title, summary, keywords and content.

Only works published in English were analyzed, and the analyzed period was 2005-2023. 340 works resulted, of which only those representing articles, proceeding papers and review articles were selected. The following filtering was done starting from the keywords found in the title, but also in relation to the number of citations (greater than 3). Among the 33 articles that met the first two criteria, a number of 15 articles were selected that were analyzed both from the point of view of the terms, the content, but also in relation to the results obtained and the conclusions formulated.

RESULTS AND DISCUSSIONS

The analysis was carried out starting from 2 keywords "circular economy" and "tourism", resulting in a number of 340 publications written in English and published in the period 2005-2023. Of these, 319 were articles, proceeding papers or review articles. From all of them, we followed only those Web of Science categories with more than 10 scientific researches, resulting in that most articles (129) were published in Environmental Sciencea, in Green Sustainable Science (101), in Environmental Studies (90) and in Hospitality Leisure Expert Tourism (44) (Figure 1).

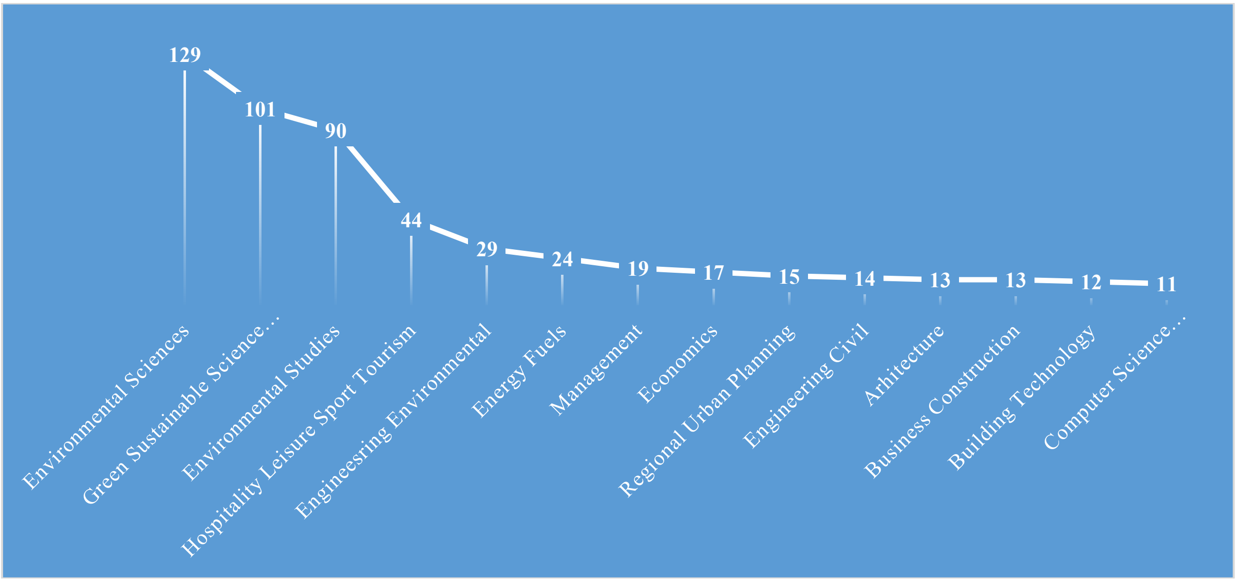

Fig. 1. Number of publications, by Web of Science categories
Source: own processing based on [29].

The number of publications, related to the country of origin, highlights the fact that most of the research that followed the relationship between the circular economy and tourism was carried out in China (58 publications), Spain (43 publications), Italy (31 publications), Portugal (27 publications), Germany and Romania (20 publications) (fig. 2).

The analysis carried out in the Publishers report highlights the fact that MDPI (89 publications), Elsevier (55 publications), Emerald Group Publishing (26 publications) and Iop Publishing Ltd (22 publications) are in first place in terms of authors' preference. This is due to the rapid process of reviewing and publishing articles, which makes the information useful and current.

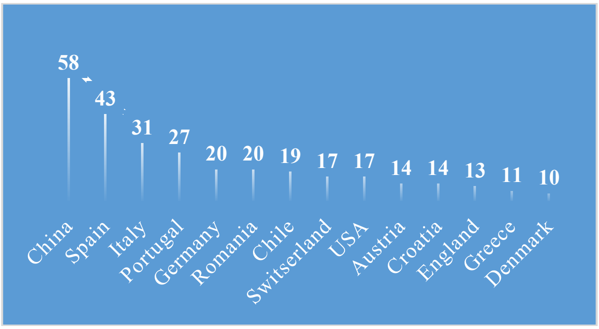

Fig. 2. The number of publications, in relation to the country
Source: own processing based on [29].

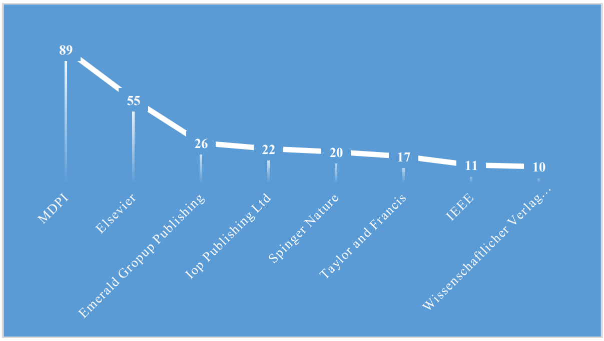

Fig. 3. The number of publications, in relation to Publishers
Source: own processing based on [29].

The review of specialized literature specific to the circular economy and tourism was carried out in March 2023 and provided a number of 33 publications, of which for establishing the sample it was set as a condition that they have a number greater than 3 citations. This resulted in a sample consisting of 15 publications that were analyzed according to content and results obtained (Table 1).

Table 1. Research results regarding the circular economy and tourism

Author	Result	Conclusion	No. citations
Scheepens, A. E. et al. (2017)	It presents an example of the analysis, design and implementation of a sustainable business model in tourism, using a three-dimensional approach (costs, ecological costs, market value - EVR) that validates the methods based on the creation of eco-efficient value and the transition framework circular [21].	The EVR model showed that the diversification of aquatic recreation, although it had a positive economic effect, is unsustainable for the environment	191
Falcone, P.M. (2019)	Starting from a SWOT analysis, the paper inventories the ways of applying the principles related to the circular economy in the area of Apulia, Italy. The purpose of the research was to integrate and combine the waste management method with the obtaining of renewable energy and bioproducts in tourism [6].	The case study identifies the weak points (lack of infrastructure, technology, bureaucracy, etc.) and threats (lack of a coherent policy in the field, social acceptability, etc.) that can endanger the transition to greater sustainability. in the researched area. The conclusions can be the basis for the design of circular economy policies based on tourism.	37
Jones, P. et al. (2019)	Based on the analysis of some scientific papers, the research had two parts. The first allowed the identification of several definitions related to the circular economy, and the second consisted in the presentation of circular economy models applied by companies active in the field of tourism and hospitality. The goal was to multiply successful models. [9].	The work establishes relationships between the concepts of circular economy and natural capital with the aim of finding resilient solutions for the development of the tourism and hospitality industry.	35
Rodriguez, C. et al. (2020)	One of the objectives of the research was to identify the gaps in the specialized literature related to the concept of circular economy. Another objective was to find business models that ensure the synergy between tourism, social inclusion and local development, in the conditions that all these elements can contribute to the development of sustainable tourism [20].	The tourism industry has an important role in the global economy, and that is why more research is needed to contribute to the identification of solutions for the relaunch and promotion of a sustainable tourism.	23
Vargas-Sanchez, A. (2018)	Based on the analysis of specialized literature, the paper identifies the definitions of the circular economy and the barriers that prevent the application of circularity principles in tourism and hospitality [24].	The research demonstrates the need to integrate the principles of the circular economy into the development strategies of SMEs that need funds to support innovation with the purpose of business development. This can be achieved through the development	21

		of partnerships, through the allocation of funds and legislative implementation to contribute to the development of sustainable tourism.	
Camillieri, M.A. (2021)	The paper presents case studies on the way in which catering companies, but also restaurants and cafes located in different urban tourist destinations can take responsible measures to prevent food waste and use recycling practices to contribute on the one hand to reducing food losses and reducing the amount of waste, but also obtaining economic advantages (increasing business profitability, reducing prices for consumers, etc.) [1].	The work identifies solutions to reduce food waste in tourism and hospitality businesses, but also the ways to involve decision-makers, company management, trade unions or professional organizations to promote responsible behavior and support circularity.	13
Del Vecchio et al. (2021)	The paper analyzes new ways of business innovation and value creation through the application of circular economy models, in the context of the practice of smart, digital tourism, affected by the Covid-19 pandemic, with practical implications for managers of tourist destinations and managers of hospitality companies [4].	Through the case study of Ecobnb, a company that promotes green tourism, smart tourism promotion solutions were identified (digital technology, customization of offers based on big data analysis, diversification of products and services, etc.).	12
Joshi, S. et al. (2020)	Through the AHP-TOPSIS method applied in the analysis of agritourism clusters, the paper identified and ranked the key elements of the application of the circular economy in agritourism with the aim of determining the performance of this branch of tourism. It has been demonstrated that the attractiveness of the tourist destination comes first in terms of decisions related to the application of circularity, followed by community contributions and then by sustainable practices. Both the advantages of building these clusters based on circular economy are identified, as well as the limits of the study. These were due to a rather limited geographical coverage [10].	The authors demonstrate the fact that the increase in performance recorded at the level of agro-tourism clusters can be achieved in relation to the importance given to the application of circular economy principles.	10
Manniche, J. et al. (2021)	The authors had as their objective both the identification of the potential integrator of the circular economy for the development and promotion of sustainable tourism practices, as well as the presentation of a circular business model developed within a hotel in Denmark. [15].	The work demonstrates the fact that tourism, through its relations between host and guests, has a much greater potential for transformation, and this potential is not only due to the circular economy, but also to other integrative factors.	
Zorpas, A.A. et al. (2021)	The work highlights the impact that the tourism industry has on the environment, through the large amounts of waste produced, not only	The promotion of the circular economy is based on taking political and social measures and the encouragement of local tourism	7

	on the environment in general, but especially on biodiversity. For the implementation of circular models in tourism, a paradigm shift is needed [28].	businesses are identified (tax exemptions, tax reductions, granting of loans or financial guarantees, access and financial support), but also the taking of digitization measures (gamification, applications, software, etc.) to contribute to the reduction of pollution.	
Xu, A. et al. (2022)	The research identifies the existence of a gap between the assessment of sustainability in tourism, from a theoretical and practical point of view. Another contribution is represented by the index system used to improve the concept of greening in the tourism industry. [27].	The study combines the LE model with the DPSIR model for promoting and implementing the circular economy in tourism.	4
Ma, X.H. et al. (2016)	Starting from the fact that renewable energy ensures the application of the principles of the circular economy, the work presents the method of its use in tourism [14].	The obtained results demonstrate the fact that the implementation of renewable energy systems in tourism constitutes a feasible model of circular economy.	4
Owais, K. et al. (2022)	The paper assesses the attitude of 256 small and medium-sized tourism enterprises regarding the circular economy models applicable to them. The applied model is PLS-SEM, demonstrating that although the intentions towards this concept are positive, most of them do not have finality due to the gap determined by different contextual factors [19].	The study identifies some of the measures that can contribute to the realization of circular tourism and that relate to the dynamic capacities of SMEs.	3
Vatansever, K. et al. (2021)	The research identifies, evaluates and ranks the barriers in the tourism industry that prevent the transition process to a circular economy. Starting from a series of semi-structured interviews applied to tourism experts and using the FAHP method, pairs of relevant data are compared to achieve the research goal [25].	In the hierarchy of barriers, the organizational elements that hinder the supply chain (structure/infrastructure) are on the first place. This has a direct impact on the circular economy. Through the obtained results, measures can be taken regarding the transition of the tourism industry to the circular economy.	4
Cornejo-Ortega, L.J. et al. (2020)	The paper measures the capacity of companies regarding the possibility of implementing circular economy practices in Puerto Vallarta, Mexico. The working tool used was the questionnaire, applied to a number of 64 tourism companies [3].	The results obtained demonstrated that in Mexico companies apply different strategies that can be assimilated to the circular economy: strategies to reduce the consumption of fossil fuels, waste treatment, etc.. Although these strategies have a positive impact on the environment, they cannot be considered to be circular economy strategies. This is due to insufficient knowledge of this concept.	3

Source: own processing based [29].

The current study demonstrates the fact that although the concept of circular economy is one that is more and more frequently encountered in specialized works of recent years due to concerns related to pollution, global warming, resource depletion, being addressed in an important number of researches, in terms of its relationship with tourism, there are still few publications that deal with this subject.

After analyzing the most relevant 15 researches out of the 33 that corresponded to the searches in the Web of Science database, we found that most of the works started from studying the specialized literature with the aim of defining the concept of circular economy and establishing its relationship with the tourism industry . Most of the works present empirical business models that can be multiplied so that they can have an important contribution in the implementation of the circular economy concept in tourism and in complementary fields (leisure, catering, restaurants, etc.). The questionnaires applied to the different categories of actors involved in this industry allowed the identification of strengths, weaknesses, opportunities and threats that it faced when it comes to the application of circularity., but the measures that can be used to achieve both the objectives related to ensuring circularity and the creation of value and profit for tourism investors are identified and ranked.

All the analyzed studies constitute models to follow and useful guides both for practitioners and for decision-makers, so that the objectives proposed at the community and world level for the year 2030, and then for 2050 can be achieved.

CONCLUSIONS

One of the reasons for the analysis of the circular economy-tourism relationship is based on the importance that the tourism and tourism industry has both in the economy of a country and in the world economy. Another reason was represented by the fact that tourism contributes to the registration of large amounts of waste produced both by tourists and by the complementary industries that contribute to ensuring their hospitality. Therefore, the introduction of resources belonging to these branches of the economy in circularity could contribute to the development of a much more sustainable tourism.

The research carried out in the Web of Science database demonstrates the fact that there is still not a very large number of specialized works that address the relationship between tourism and the circular economy. This aspect is in contradiction with the important role that circularity has in the development of today's society.

The application of circular tourism business models is not only necessary, but also mandatory in the context of sustainable development.

In conclusion, we consider that although the number of specialized works has increased in recent years, there is still a need for new research and case studies through which to implement and multiply concrete solutions that can contribute to the development of sustainable tourism, under the conditions in which the new generations are much more concerned with the future of the planet, with the practice of circular tourism. The achievement of these objectives must also be ensured by the implementation of policies and administrative measures that can ensure a global circular strategy in the tourism and hospitality industry.

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STUDY ON THE DEVELOPMENT OF THE BIOFUEL MARKET AND THEIR FUTURE IN SUSTAINABLE PRODUCTION

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Abstract

Considering the current trends regarding the reduction of greenhouse gas emissions, the protection of the environment and the need to ensure food security, as well as the role that biofuels have in achieving these objectives, in this paper we proposed to analyze the evolution of the biofuels market in the period 2010-2022, but also its prospects for the next period. The research methodology assumed both the bibliographic study of the specialized literature, as well as the collection, processing and interpretation of existing statistical data in the internal (INSSE) and international databases (Eurostat, FAO), which were the basis for formulating the conclusions regarding the future evolution of the biofuels market. At the same time, community documents were presented and analyzed that regulate the use or reduction of the consumption of biofuels, in the perspective of achieving some objectives of a neutral continent. Thus, it can be seen that both at the world level and at the community level, in the period 2010-2022 there were increases in both production and consumption of biofuels, with the exception of the period 2020-2021, when due to the Covid-19 pandemic decreases were recorded. Worldwide production increased by 223% in 2022 compared to 2010, and consumption increased by 119%. At the community level, production increased by 125%, and consumption by 117%. These increases in turn influenced price increases. Regarding the estimates for 2027, at the European level, the directives related to environmental protection and the reduction of greenhouse gas emissions will have the effect of reducing production and consumption. At the level of other developing countries, the production and consumption of biofuels will continue to be supported through financial aid.

Key words: *biofuels, production, consumption, sustainability, future*

INTRODUCTION

The crises that the world has gone through in recent years (Covid-19, the war in Ukraine) are a reason to once again discuss the issue of ensuring the necessary energy and fuel at the local and global level, but at the same time respecting the policies and measures to protect the environment, reduce pollution and reduce greenhouse gas emissions and ensure food security [9, 17]. In these conditions, biofuels, together with other alternative sources of energy, represent a solution for a global economy in continuous development.

Biofuels are obtained by processing organic raw material or waste, being one of the renewable sources of energy to which humanity currently has access and which can be used in a mixture with ordinary fuels (gasoline, diesel) [13, 16, 22]. They can be solid, coming from agricultural or forestry plant residues, food plant residues, woody, fibrous, cork residues or other products resulting from agricultural and forestry activities [1, 8, 19]. Liquid and gaseous biofuels are bioethanol, biodiesel, biogas, biomethanol, biohydrogen, synthetic biofuels, etc., they have the advantages of reducing carbon emissions due to the fact that they emit less CO_2 when burned, because they have a low cost due to the sources of origin and are biodegradable, which makes their use much more environmentally friendly [21]. There are other advantages related to the creation of green jobs, increasing profitability, supporting the development of local communities, etc. [15, 18]. Obtaining biofuels, however, requires a large consumption of water, and their caloric capacity is much lower than that of conventional fuels, which represents disadvantages related to their use. However, their use remains a source of reducing pollution, reducing global warming and stopping the consumption of the Planet's resources. Along with the other sources of alternative energy, which just a few years ago humanity didn't even think they could have access to, biofuels represent a solution, at least in the medium term, but they still generate discussions about their use.

Although in the medium term the consumption of biofuels will increase, this will be due primarily to the economic development of developing countries and less to developed countries, where the use of biofuels is limited on the one hand by the decrease in demand for fossil fuels, and on the other on the other hand, the choice of less polluting alternative energy resources [14].

At the level of the European Union, the use of biofuels was regulated in 2009 by a Directive for Renewable Energy which aimed to reduce carbon dioxide emissions from cars with thermal engines. The directive also regulates the use of agricultural resources to obtain biofuels. Later, new directives (RED3 and FQD4) regulated incorporation rates that influence both production and consumption of biofuels [5].

Through new regulations, the European Union proposes that, starting with the year 2035, the sale of cars with diesel and gasoline engines will be prohibited, which will influence the biofuels market. Although the current EU regulation imposed for 2020 a limit of 95 grams of carbon dioxide/km in terms of emissions at the level of a manufacturer's fleet, through a plan called "Fit for 55" it is foreseen that CO2 emissions for cars will be reduced compared to 2021 by 15% by 2025, respectively 37.5% by 2030. The plan also estimates that by 2030, 11% of Europe's car fleet will be made up of electric cars, and by 2050, 54 %, which will lead to the decrease of the biofuels market [4]. To achieve the objective of a neutral continent, from the point of view of CO_2 emissions, the E.U. considers that the car fleet should be made up of electric cars and hybrid cars with emissions of a maximum of 50 grams of CO_2/km, which by 2050 should have a share of between 88% and 99% of the total.

Meanwhile, new challenges have appeared, such as the war in Ukraine which had a direct impact on the supply chain of agricultural products, due to the fact that it is one of the largest agricultural producers in the world, or the drought which in recent years has affected the large countries producing agricultural products, both from the European Union, but also from other parts of the world, which calls into question the ability of agriculture to ensure the food resources of mankind. In these conditions, the use of agricultural potential to obtain biofuels is considered unfair by environmental organizations, and at the level of the European Union, these organizations plead for the abandonment of mandatory quotas for biofuels (8% in the case of gasoline and 6.5% in the case of diesel) [3].

On the other hand, it is considered that the cutting of forests for the production of biofuels has a much greater negative effect than the production of greenhouse gas emissions.

In other regions of the world, however, at the moment there are still attractive policies related to the use of biofuels, especially renewable diesel, (USA) or financial incentives are granted for their production (India, Indonesia and Brazil), which also encourages consumption.

Therefore, the current growth of the biofuels market is still uncertain.

MATERIALS AND METHODS

The research methodology primarily involved the analysis of specialized literature on biofuels and the legislative aspects regarding their use and the reduction of production and consumption of biofuels, with the aim of protecting the environment. In the second part of the research, starting from the information taken from the internal and international databases, processed and analyzed with the help of statistical methods, we were able to establish the conclusions regarding the production and consumption of biofuels, both at the global level and at the level community and national. The growth rates of consumption, production, net trade or prices were analyzed with the help of indices with a fixed base or with a chain base, by using the following indicators:

- The dynamic index with a fixed base was used to determine the value of the increases or decreases recorded in the period 2010-2027:

$I_{t/1} = \frac{yt}{y1} x100$..(1)

- The dynamic index based on the chain was used to determine the value of the increases or decreases recorded from one year to another, in the period 2010-2027:

$I_{t/t-1} = \frac{yt}{yt-1} x100$ ....(2) [2].

RESULTS AND DISCUSSIONS

Statistical data show that after the COVID-19 pandemic in 2020 caused a decrease in global fuel consumption (estimated at 8.5%) and which was due to both the traffic restrictions imposed and the reduction of commercial logistics, in 2021 it increased by 7 %, still being below the pre-pandemic consumption.

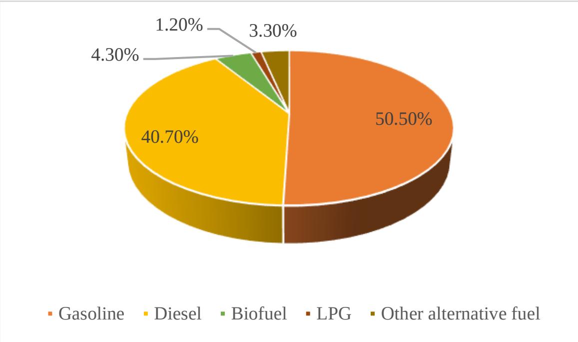

Fig.1. Structure of fuel consumption in 2021
Source: own processing based on [11].

The consumption of biofuels also decreased in 2020, the decrease being approximately 8.7%. In 2021, consumption began to increase, so that the consumption of alternative fuels, that is biofuels, electricity, LPG1, NGV2, was 6% higher than the previous year, representing approximately 8.8% of the total amount of fuels used worldwide [20]. If we refer only to biofuels, in 2021 they represented approximately 4.3% of the total fuels consumed worldwide and 49% of the alternative fuels market (Fig.1), this is due to the increase in demand compared to the hydrotreated vegetable oil (HVO) produced by oil companies. In 2022, the consumption of biofuels increased by 6% compared to the previous year.

The data on the production, consumption and net trade of biofuels (Table 1) reflect the existing situation until 2021, and for the period 2022-2027 the data represent projections, which took into account a moderate forecast. Thus, it can be seen that both worldwide and in Europe, production has continuously increased, with the result that in 2021 the increase compared to 2010 will be 2.23 times higher worldwide and 1.25 times higher in Europe. This increase in production was determined by the increase in demand, which worldwide increased by 119% in 2021 compared to 2010, and at the European level by 16%. What we can note is the fact that in Europe the consumption was permanently higher than the production, which caused the net trade to have negative values in the analyzed period. Supplementing the consumption requirement was achieved on the basis of biofuel imports from large producing countries and areas (China, Brazil, Argentina, USA, etc.). Even at the global level, there were years in which negative net trade values were recorded (2011, 2012, 2015, 2020). As for the projections, they show that starting with 2024, both production and consumption will decrease. If in the case of the production achieved worldwide, the increases from one year to the next were 19% in 2011, 17% in 2018 and 14% in 2016 (the exception being represented by the Covid-19 period which led in 2020 to a decrease of 2% and a return in 2021 of 4%), we note that in the following period a decrease in the production of biofuels determined by the policies of replacing biofuels with other less polluting energy sources is estimated. The same trend can be observed in the case of the production registered and estimated at the European level. Moreover, at the level of consumption in Europe, the forecasts estimate a rate of decrease of 2-3 percent below world consumption, which is due to the European openness to policies to protect the environment and to replace diesel cars with electric cars. On the other hand, many European countries, although they keep the objectives related to the reduction of greenhouse gases, have taken measures, at least temporarily, to freeze the reduction in the use of biofuels. These measures to reduce the consumption of biofuels belong to developed economies, while developing countries will continue to consume fossil fuels and biofuels, considering their development potential.

In Romania, biodiesel production increased by 39% in 2020 compared to 2019, the amount produced being approximately 292 thousand tons, which represents approximately 1.34% of the amount produced at the level of the European Union (Fig. 2). The major producers are Spain, which produces 19% of the total EU, Germany, which produces 17%, and France, which produces 11%. Because at the level of Romania, consumption is higher than production, the difference being imported from Germany, Austria and Hungary. In 2020, imports were approximately 56 tons, and in 2019, 27 tons, worth approximately 122 thousand euros [12].

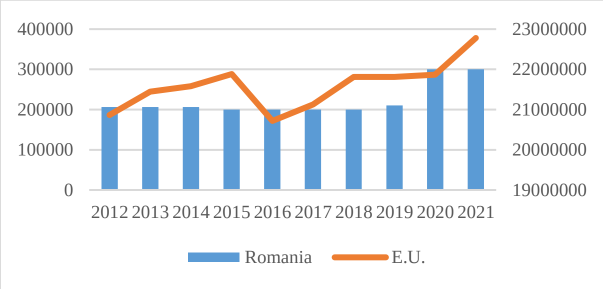

Fig. 2. The evolution of the production capacity of liquid biofuels in Romania and the European Union, in the period 2012-2021
Source: own processing based on [7].

Romania's production capacity was relatively constant during the analyzed period. Compared to the 206,500 tons produced in 2012, the increase was 45% in 2021. At the level of the European Union, production capacity increased by 9% in 2021 compared to 2012. Although the growth rate in 2021 for Romania was high, the share of production capacity was 1.3% compared to that of the European Union.

Table 1. The evolution of production, consumption and net trade, in the period 2010-2027

	Production		Consumption		Net trade	
Year	**World**	**Europe**	**World**	**Europe**	**World**	**Europe**
2010	20,486	11,286	20,674	13,573	-	-
2011	24,435	10,423	24,323	13,888	-388.2	-3,563.3
2012	25,930	10,541	26,225	14,210	-761.2	-3,888.3
2013	28,968	11,112	28,279	13,225	434.4	-1,753.8
2014	32,541	12,918	30,217	13,635	1,081.0	-1,334.3
2015	29,294	12,351	30,095	13,510	-1,127.7	-1,123.1
2016	33,299	12,146	33,100	12,180	-665.0	-252.0
2017	34,726	13,617	34,001	13,456	586.3	-66.8
2018	40,705	14,375	38,149	15,041	1,029.9	-1,926.1
2019	44,910	15,339	43,678	16,803	192.5	-2,502.5
2020	43,808	13,641	45,224	15,712	-2,285.2	-3,556.9
2021	45,712	14,104	44,420	15,648	392.8	-1,555.8
2022	47,429	14,266	46,216	15,859	1,212.9	-1,602.8
2023	50,069	14,152	49,343	15,687	725.5	-1,544.8
2024	52,937	13,965	51,706	15,009	1,230.9	-1,053.2
2025	52,876	13,824	51,372	14,544	1,503.1	-737.1
2026	52,727	13,640	51,094	14,034	1,632.6	-411.8
2027	52,543	13,525	50,980	13,885	-	-378.0

Source: own processing based on [10].

The most important increases in the demand for biofuels in 2022 compared to 2021 were recorded in the USA where the increase was 3.124 million liters/year, in Indonesia where the increase was 1.786 million liters per year and in India where the increase was of 1.786 million liters/year. And in Europe the increase in liters was 1.573 million and in Brazil where it was approximately 794 million liters.

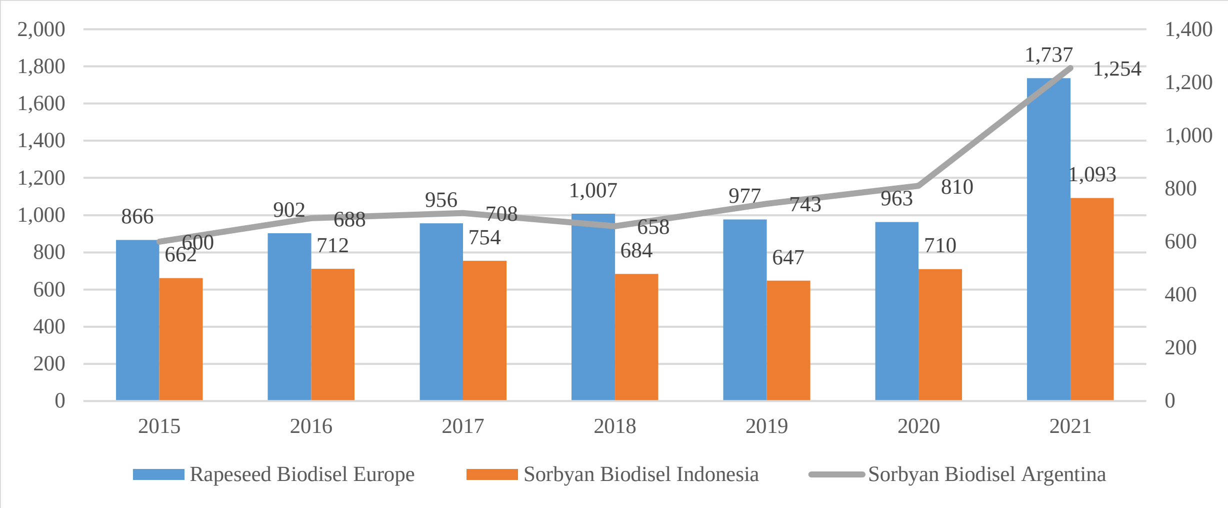

Fig. 3. Price evolution for different categories of biodiesel (US$/metric ton)
Source: own processing based on [10].

As far as prices are concerned, they faced a high volatility that was determined by the crises that the market went through recently (economic crisis, Covid-19 crisis, lack of catalysts, the war in Ukraine). The statistical data show that the biggest price increase, among the 3 variants analyzed, was recorded at Sorbyan Biodisel Argentina where the increase in 2021 was almost 2.1 times, while at Repesees Biodisel Europe it was 2 times higher.

Fig. 4. Evolution of the price of HVO fob ARA in the period 2020-2021 (US$/metric ton)
Source: own processing based on [10].

The price for Sorbyan Biodiesel Indonesia increased 1.65 times in 2021 compared to 2015. The highest rate of price increase was recorded in 2021 compared to 2020, when prices increased by 80.3% for Rapeseed Biodiesel Europe, by 53.9% for Sorbyan Biodiesel Indonesia and with 54.8% for Sorbyan Biodiesel Argentina. These price increases came after the 2019-2020 period in which prices decreased due to the decrease in consumption (Fig. 3).

And the price for the different categories of HVO (hydrotreated vegetable oil) increased in 2021 compared to 2020, this being also determined by the high demand for these oils. It is thus established that in the case of HVO fob ARA range, of generation I, II and III, the increases were 47%, 32%, respectively 29%.

The production and consumption of HVO also contributed to the increase in global investments in biofuels, which worldwide amounted to almost 8 billion dollars (Fig. 4). Although America and Brazil had important contributions (approximately 30%), the European Union also has a high share, despite the adoption of regulations regarding the sustainability of raw materials. Given that the estimated consumption for 2025 is approximately 32 million tons, Europe needs approximately 7 million tons.

Although the environmental directives propose reductions in the use of biofuels for road transport, they will continue to be used in other transport sectors, such as aviation or maritime, where alternative fuel sources cannot yet be used on a large scale. And in the maritime field, there is a European Union proposal called "Fuel EU Maritime" which proposes zero carbon emissions until 2050, which implies the use of fuels with low carbon emissions, which will start to be used from 2025 [6].

CONCLUSIONS

At the moment we are still in an energy crisis accentuated by the war in Ukraine, which means that at the level of the European Union and at the national level there are contrasting measures regarding the future of energy sources and the way in which the energy requirement you can be assured. Inflation, social crises, political conflicts, make the measures taken at the community level aim to reduce the cost of access to energy, which is why the transition to the use of renewable, more sustainable, but more expensive energy sources ends up being slowed down or postponed. In other countries of the world, large producers of biofuels (USA, China, Brazil, Argentina), the use of biofuels is encouraged through financial compensations (for example, replacing the use of diesel with biodiesel). Therefore, the debates related to the use of biofuels and the place occupied by them in the near future in providing energy sources are still open. Moreover, those who reject the possibility of replacing traditional fuels with biofuels, show that in addition to the ethical problem of using agricultural land for the production of biomass to the detriment of securing food resources, another problem is related to the pollution resulting from the production of biofuels.

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STUDY ON THE IMPORTANCE OF USING AGRIVOLTAIC SYSTEMS TO REDUCE THE EFFECTS OF CLIMATE CHANGE

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Abstract

Climate change, global warming are phenomena that have changed the face of the world and that have a direct impact on agricultural production and food security, given that the world's population is growing from one year to the next, without the possibility of growth and natural resources. Another worrying phenomenon is the production of greenhouse gases and their destructive effect on the planet. That's why the technology that is being perfected every day tries to find solutions that simplify both the efforts made to obtain food, but also the possibility of increasing the efficiency of production processes. In this way, in the agricultural field, the idea of developing dual systems appeared, which would protect both agricultural crops, with the aim of increasing productivity, but which would also contribute to obtaining solar energy, necessary not only for own consumption, but also to be included in consumer networks, the proposed concept being that of the AgriVoltaic system. The idea that appeared in 1981 began to be developed, currently reaching the development of a technology that is starting to be adopted in many countries of the world, including Romania. In the current paper, we propose to analyze the opportunity of using AgriVoltaic technology, its advantages and disadvantages, but also the way in which it could contribute to increasing the profitability of agricultural farms. At the same time, increasing the degree of awareness regarding the advantages of introducing agricultural systems and the method of implementing the systems is another objective of the current work. Starting from the analysis of the specialized literature, we outlined the term Agrivoltaic technology and continued the study with an analysis of the possibilities of implementing this technology in Romania, due to the solar energy potential that it benefits from. The research methodology assumed on the one hand the bibliographic analysis, and on the other hand the analysis of the development potential of the system, taking into account the existing agricultural areas and crops suitable for this system. As a result of the research carried out, it turned out that although there are confirmed advantages of using AgriVoltaic technology, it does not yet benefit from sufficient visibility or high accessibility among farmers. Also, the existing legislation at the level of Romania does not yet make possible the development of the dual system. Among the disadvantages of using agrivoltaic systems are the still high costs, but the measures to protect the rural landscape, which occupies an important place in sustainable development, even if the energy produced is renewable.

Key words: *AgriVoltaic, climate change, agriculture, greenhouse gases*

INTRODUCTION

Agrivoltaic systems represent a concept, which has the role of ensuring a better use of agricultural land, on the one hand for the purpose of food production, and on the other hand for the production of energy needed by humanity in ever-increasing quantities. The two objectives can be achieved simultaneously, and those who laid the foundations of this concept, which appeared in 1981, were the German physicists Adolf Goetzberger and Armin Zastrow, and it appeared as a solution to the situation in which humanity began to be increasingly concerned about the effects of warming global and climate effects, it was developed [8]. Another researcher, Akira Nagashima, introduced in 2004 the notion of "solar sharing", as a technology applied to the cultivation of plants located under photovoltaic modules, and which led to results that encouraged the Japanese government in the direction of granting support schemes for farmers, starting with 2012 [30]. The country that has the largest capacity of Agrivoltaic systems is China, which started to develop this system starting in 2014.

In Europe, the first country to start using Agrivoltaic systems was France, which, starting in 2017, implemented the use and support of the use of solar energy for agriculture. At this moment there are many other countries of the world such as America, Canada, India, South Korea, Italy, Germans, etc., which are joined by Romania that have implemented or intend to implement the use of Agrivoltaic systems, as well as some schemes of government support to encourage their use on a wider scale.

In 2021, the capacity of AgriVoltaic systems installed globally amounted to almost 14 GWp. The use of AgriVoltaic energy is possible due to its existing potential in most subtropical and semiarid regions of the world. With all these advantages, the technology has remained largely unknown, but its use appears at this moment as a necessity, considering the measures that must be taken at the global level in the context of climate change that require the adoption of policies to contribute to the reduction their effect. Thus, at the level of the European Union, there have been and continue to be initiatives aimed at achieving climate neutrality. The European climate law, which is part of the European Green Pact, aims to reduce greenhouse gas emissions by 55% by 2030 and achieve neutrality by 2050. In this sense, various measures entitled "Prepare for 55 in 2030" and which interconnects 13 laws and 6 proposed laws that will contribute to achieving this objective [5].

It can even be appreciated that the war in Ukraine and the measures taken against Russia with regard to the ban on the import of fossil fuels, have in turn contributed to speeding up the transition of the European Union states to the Green Transition.

Europe occupies the 3rd place in the world, after China and the United States of America, in terms of the production of greenhouse gases, but India, Japan and Russia occupy the following places. As far as the countries of the European Union are concerned, the largest producers of greenhouse gases are Germany, France, Spain, Italy, Poland, these coming primarily from the energy sector. Industry occupies the 3rd place in this ranking, being overtaken by agriculture.

Statistical data highlight the fact that half of the world's population is actually affected by climate change and are vulnerable due to the fact that they live in risk areas, as a result of heat waves that affect their lives, water shortages or, on the contrary, due to floods . If until 2020, the increase in temperatures compared to the pre-industrialization period had an average growth rate of 1.1 degrees, an increase that would exceed a threshold of 1.5 degrees would have extreme effects, and this can be reduced by trying to reduce by 50% the GHG until 2030.

These risks reduce agricultural production and affect food security, and in addition to measures to reduce greenhouse gases, it is possible to intervene through nature conservation technologies [12].

Another initiative of the European Union was the one from May 2022, when the RePowerEU plan was launched, which aims to achieve an independent infrastructure from an energy point of view, with a role in accelerating the ecological transition, this being achieved both through the efficiency of consumption energy, by diversifying energy suppliers, but also by stimulating the production of alternative sources of green energy. Regarding solar energy, the objective is to reach 320 GW in 2025 and 600 GW in 2030 compared to the 136 GW obtained in 2020 [6].

At the level of the European Union, there are 14 states that have included in the application of the Common Agricultural Policy legislative elements regarding their strategic plans regarding the use of photovoltaic panels.

The use of agrivoltaic systems thus contributes to achieving a synergy between green energy and precision agriculture, elements that belong to the practice of a modern agriculture, adapted to the 21st century, whose purpose is to ensure food security and adapt to climate change,

objectives of the European Union's policies, but also of other countries of the world [21].
In this context, the purpose of the paper is to describe the opportunity of using AgriVoltaic technology, its advantages and disadvantages, how it coudl be utilized in agricultural farms for increasing the profitability.

MATERIALS AND METHODS

The research methodology involved a systematic review of specialized literature aimed at identifying and analyzing research in the field regarding the definition of the concept of agrivoltaic and the possibility of integrating this technology within agricultural farms. In this way, the international experiences regarding the integration of voltaic systems in agricultural activities could be analyzed. At the same time, the existing legislation in Romania regarding the implementation of agrivoltaic systems was analysed, but its limitations were established, which if aligned with the international one, would allow increasing the efficiency of their use.
The calculation of the yield of the use of solar panels simultaneously with agricultural production is determined with the help of the land equivalence ratio (LER), adapted to the concept of agrovoltaic system, it is done starting from the classic model that measures the land required to obtain two crops in comparison with monoculture:

LER = mixed yield_1/pure yield_1 + mixed yield_2/pure yield_2 [19]

In the case of agrovoltaic systems, the LER (Land Equivalent Ratio) is determined as follows:

LER = crop yield in AV/monocrop yield + electricity yield in AV/PV yield [4]

where:
AV - agrovoltaic
PV - photovoltaic

In other words, LER represents the ratio between the surface area of the agrovoltaic installation and the total area required to obtain agricultural production and energy produced by the agrovoltaic systems.
A value greater than 1 for the LER means that the productivity of the land increases under the conditions of the use of agrovoltaic panels and agricultural crops, in relation to their separate use.
Primary factors which have a direct influence on both agrivoltaic production and crop yield are shading, photosynthesis, that's why we also analyzed their importance.

RESULTS AND DISCUSSIONS

As mentioned before, the concept of agrivoltaic system is already one that is gaining more and more applicability worldwide. As shown in a study carried out by Precedence Research, at the level of 2021, the global market was valued at approximately 3 billion USD, and the growth rate until 2030 is estimated to be over 12%, which will make for the market to reach a value of nearly USD 9 billion [25]. The factors that contribute to the growth of the market, in addition to those already mentioned, are related to the increased need for electricity, but also to a decrease in the production costs of the voltaic panels as a result of the innovations in the field and the growing number of producers, among in which the Chinese have an important share.

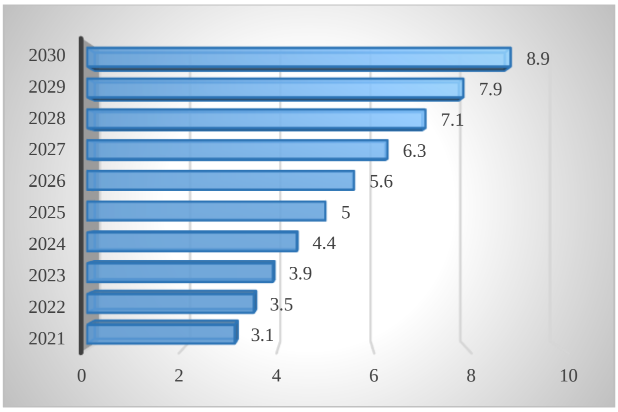

Fig. 1. Evolution of the agrivoltaic systems market
Source: own processing after Precedence Research [25]

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By region, it can be seen that in 2021, the largest market share was held by North America, which is among the first countries to implement this technology (33%), followed by Europe (29%), where among the countries where the system works well include France (which uses the system successfully in viticulture), the Netherlands, Italy, Germany, etc., Asia and the Pacific (24%), where China is the country that has the largest photovoltaic park located in the Gobi Desert and which it has a capacity of 1,000 MV being used in the cultivation of goji fruits, but also Japan where there are over 2,000 implemented projects.

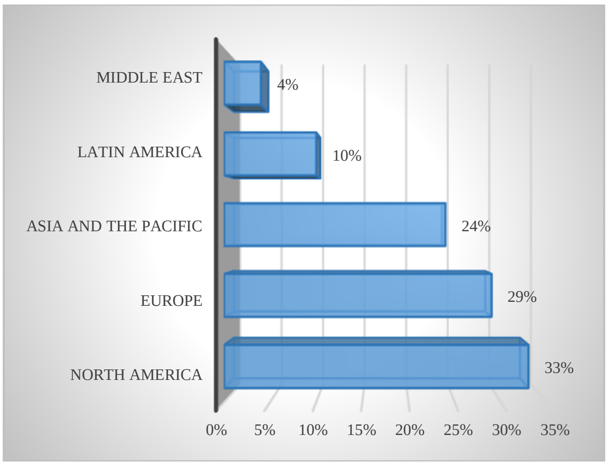


Fig. 2. The situation of the agrivoltaic systems market, by region, in 2021
Source: own processing [25].

If initially the approach to energy production and the use of agricultural land was thought of separately, raising the issue of the cost of decommissioning agricultural land for the purpose of installing photovoltaic panels and producing energy to be used both within the farm, as well as introduced in the centralized system, later Goetzeberg and Zastrow proposed a form of simultaneous use of agricultural land, at this time there were two systems, namely: the raising of fixed panels above the crops to allow either the work to be carried out in the case of vegetable crops, but also to ensure the natural conditions for their development (elevated to 4-5 meters), or to allow the passage of grazing animals under them, for example (elevated to 2 meters); the use of dynamic panels connected with trackers.

The height at which the photovoltaic panels can be mounted can vary depending on the culture, but they can also have a rotation system, depending on the position of the sun, so that both the capture efficiency and the plants' needs are ensured. What is important is that the panels use only the excess solar energy, and not the energy needed for crops.

The main parameters that must be taken into account when choosing agrivoltaic technology are presented in Table 1.

Table 1. The main development parameters of the agrivoltaic system

Indicator	Work	Recommendation
Shade Tolerance	The capacity of the plants regarding shade tolerance is important because this will influence the production obtained. The specialized works highlight the fact that the amount of light is important in the juvenile phase of crop development, and this can be compensated by the dynamic system of photovoltaic panels.	[2, 20, 26]
Water stress and irrigation	Since the shading system has a direct influence on the preservation of humidity, it is expected that the use of agrivoltaic technology will benefit crops that have higher water requirements or that do not have a high resistance to water stress.	[20, 33, 24]
Crop rotation	Crop rotation aims to preserve nutrients in the soil with the aim of increasing fertility, so that the crops can be as profitable as possible. The use of agrivoltaic technology must be done in accordance with crop rotation	[15, 29, 35]
Height	The height at which the photovoltaic panels can be mounted depends both on the culture or category of animals that ensure the symbiosis of the system's functioning, as well as on the applied technology. According to specialized literature, the heights at which photovoltaic panels can be mounted vary between 2-5 meters	[11, 28, 34]
Climate change resilience	Since climate changes are the ones that affect the obtaining of agricultural productions year after year, it follows that agrivoltaic systems can contribute to optimizing productions in the case of crops sensitive to these changes.	[16, 9, 27]
Lifetime	The lifetime of the photovoltaic panels must be adapted to the exploitation period of the crops. There are certain cultures, which have a long lifespan, such as fruit and wine plantations, therefore there must be a concordance between the two elements.	[1, 10, 3]

Source: own processing.

The main crops suitable for the use of agrivoltaic systems, as they resulted from the analysis of specialized works, are: cereals (wheat, corn, barley, oats, etc.), oilseeds (rapeseed, sunflower, etc.), vegetables (tomatoes, cucumbers, carrots, peppers, eggplant, salad, etc.), blackberry, raspberry, blueberry, etc., but also aromatic plants or pastures.

In Romania, the areas occupied by these crops are important. Thus, at the level of 2021, from a total area of 8,263.8 thousand cultivated hectares, the largest share is owned by cereals (65%), considering the specifics of production, but also the climate that favors obtaining high productions, oil plants (20 %) and perennial fodder (8%). There are also areas occupied by vegetables (2%), vines (2%) and leguminous plants (1%), which would make the adaptation of the agrivoltaic system at the level of agricultural farms suitable.

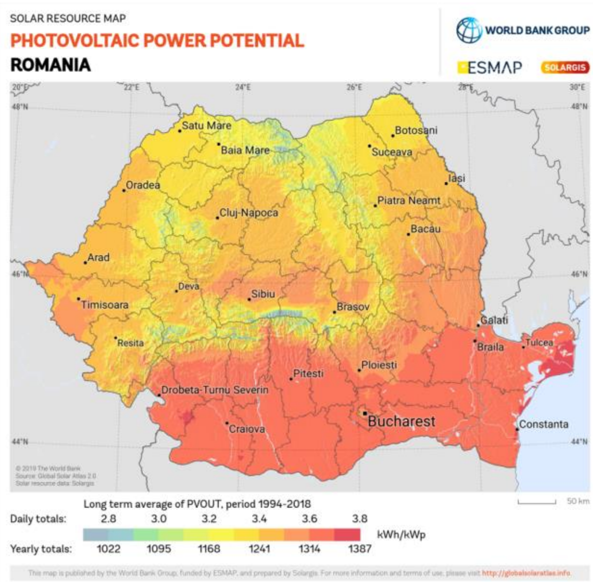
Table 2. Evolution of cultivated areas, which can be adapted to the agrivoltaic system in Romania (Thousand ha)

Culture	2020	2021	2022
Cereals - total	**5,338.1**	**5,351.5**	**5,190.0**
Wheat	2,155.3	2,175.1	2,144.0
Maize	2,537.1	2,549.3	2,472.0
Barley	442.0	449.4	415.0
Oat	101.3	87.0	80.0
Legumes - total	**107.4**	**84.9**	**77.0**
Beans	9.0	8.0	*
Green peas	98.1	76.6	*
Root	130.0	110.4	*
Potatoes	98.5	84.4	75.0
Oil plants - total	**1,678.8**	**1,715.4**	**1,687.0**
Sunflower	1,142.8	1,124.0	1,082.0
Rape	362.9	445.9	467.0
Vegetables - total	**200.5**	**197.7**	**172.0**
Tomato	34.1	34.7	*
Onion	29.2	29.3	*
Garlic	9.5	9.6	*
Cabbage	37.6	38.0	*
Pepper	17.2	18.3	*
Melons	13.8	13.1	*
Perennial fodder	**684.5**	**700.8**	*
Vineyard	**167.3**	**165.6**	**163.0**

Source: own processing [13, 14]
* lack of data

According to Romania's Energy Strategy 2022-2030, with the perspective of 2050, from the point of view of sunshine, it is in the European B zone (1,200-1,600 kWh/m^2 per year), due to the fact that it has approximately 210 sunny days/year, thus having the largest solar potential among the countries located in South-Eastern Europe. The lowest values are recorded at the level of the country in depression areas, and the highest values are recorded in the east of Bărăganu, in Dobrogea and in the south of Oltenia. This means that the solar technical potential registered at the level of Romania is 19.35 GW, i.e. 25.80TWh [23].

The photovoltaic power potential of Romania is presented in Map 1.



Map 1. Photovotaic Power Potential of Romania
Source: [7].

Capitalizing on this potential through the use of photovoltaic panels, with the aim of obtaining electricity, can be achieved by achieving a total capacity of 4,000 MW, which will annually produce energy with a value of 4.8 TWh.

Romanian legislation supported the installation of photovoltaic panels. Thus, Law 220/2008 established the support scheme for the period 2009-2016. On the other hand, there are also certain restrictions that result from the protection of some areas included in Natura 2000, but also from the restriction of the location of photovoltaic parks on agricultural land, these being limited to the location on unproductive or degraded land [17].

According to the data of the Statistical Yearbook, at the level of Romania, in 2022 the number of households that owned uncultivated agricultural land rose to 76,172 ha, which means that these surfaces could have such a destination.

In February 2022, the Land Fund Law no. 18/1991 was amended, adding an amendment whereby agricultural lands of the III, IV and V quality classes, which have the use category of arable land, pasture, vineyards and orchards, but also on those on which land improvement works are planned and which are located outside the village, different categories of production capacity can be located, including those for solar energy production, on the surface of a maximum of 50 ha. However, a building permit and a final removal approval are needed or Also, agricultural land areas located outside the village, with the exception of arable land, can be used in a dual system, being able to obtain both agricultural production and electricity. In these cases, however, removal from the agricultural circuit can be done only for the land surfaces occupied by the solar panels, the rest of the surface being integrated into the agricultural circuit. Therefore, although there is talk about this dual use, in Romania there is still no legal framework for the use of solar panels concomitant with the realization of agricultural production [18].

Under the conditions that, until 2030, from the total of 25,052 MW that Romania must ensure for its energy consumption, a share of 20.17% will come from solar energy sources, increasing compared to 2020 when it represented 7.18% and compared to 2025 when it is estimated that 3,393 MW from solar energy will be reached, i.e. 15.42% of the total, it follows that a development of agrivoltaic technologies is needed.

Table 3. Energy capacity of Romania (MW)

Source	2020	2025	2030
Solar energy	1,362	3,393	5,054
Total	18,968	22,003	25,052

Source: own processing [22].

Even if the legislation does not yet allow the full use of agrivoltaic technology in Romania, solar energy obtained within farms can contribute to providing the energy needed for irrigation systems, heating protected spaces, powering storage and refrigeration spaces, which can contribute to reducing electricity costs and increasing the profitability of agricultural activities

Studies show that according to Dupraz et al. an LER value of 1.7 means that a 100 ha farm with agrovoltaic panels can produce both electricity and agricultural production equivalent to a farm with an area of 170 ha [4].

Another study belonging to Valle highlighted the fact that in the case of the lettuce culture exploited in an agrivoltaic system, the LER index had a value greater than 1.5, which indicates the efficiency of the use of this technology [32]. In the case of the corn study, the LER index approached the value of 2 [2], and a study carried out in 2018 in Germany obtained an LER index with a value of 1.6 for an area of 2 ha cultivated with cereals and covered with photovoltaic panels in -a first variant, and 1.86 in variant 2 in which 1 ha was cultivated in an agrovoltaic system with potatoes [31].

CONCLUSIONS

The solution for the implementation of agrivoltaic systems was also supported by the fact that the land surfaces available to humanity are limited, which necessitated the finding of various combinations of electricity production, concomitant with the use of agricultural land. These systems not only revolutionize agriculture, but also contribute to obtaining non-polluting energy.

Among the disadvantages of photovoltaic systems are: the reduction of production due to the areas occupied by photovoltaic installations, the reduction of the possibilities of ensuring crop rotation, the still insufficient knowledge regarding the implementation of agrivoltaic systems, the costs still high at this moment for the installation of the systems, the lack of adapted legislative support the application of agrivoltaic systems.

The adoption of agrivoltaic systems could contribute to the transformation of agricultural farms from energy consumers to prosumers, thus reducing their expenses and contributing to increasing profits.

Among the advantages of photo-voltaic systems are: the reduction of pressure related to the use of agricultural land in conditions where there is no longer a need for these lands to change their destination, the protection of crops against weather phenomena (hail, heavy rains, frost, erosion, etc.), providing passive income to farmers that can contribute to their financial independence, etc.

In conclusion, agrivoltaic systems are a way of ensuring the synergy between food security, environmental security and energy security in the conditions of population growth and the continuous reduction of planetary resources.

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THE INFLUENCE OF INNOVATIVE TECHNOLOGIES ON THE DYNAMICS OF LAND USE INDICATORS OF UKRAINIAN AGRICULTURAL ENTERPRISES

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Abstract

The article examines the innovative activities of agricultura lenterprises on the territory of Ukraine, in particular the use of unmanned aerial vehicles (DJI Agras T30 multicopter). The policy of the leading Ukrainian company Ukrland farming in the field of balanced land use and effective development of the agro-industrial complex was studied. The criteria used in the development of the plant nutrition system have been formed. Advantages were formed in the performance of works on the application of nutrients and plant protection with the help of the Agras T30 multicopter. Proposals were made to increase the level of resource-saving activities of agro-industrial complexes due to the use of alternative methods of agricultural production, namely organic farming, biointensive mini-farming, biodynamic farming, ecological agriculture, EM technologies, established agriculture with low resource intensity, precision agriculture. The existence of an economic-mathematical model of the influence of the use of innovative technologies, in particular, the use of the DJI Agras T30 multicopter, on the dynamics of indicators of the efficiency of the cultivation of cultivated areas of agricultural enterprises has been formed and substantiated.

Key words**:** *agricultural production, innovative activity, unmanned aerial vehicles, balanced land use*

INTRODUCTION

The agro-industrial complex of Ukraine is one of the most important segments of economic development. That is why the effective functioning of this area should be implemented through the introduction and spread of innovative activities.

Considering that the innovation process goes through a series of stages from the development of an innovative product to its approval and introduction into wide production, currently innovative activity in Ukraine is unbalanced according to the stages of the innovation process, the participants of which are little informed and interested in each other, especially this concerns the production of agricultural products and its consumption.

Ukrainian agricultural products are known in almost 200 countries of the world. It occupies leading positions in global markets in terms of export volumes, namely: sunflower oil - 1st place, corn, oilseeds - 3rd place, barley - 4th place, wheat - 6th place, etc. Further entry into the world economic space, strengthening of processes of globalization and liberalization of trade requires adaptation to constantly changing conditions, and, accordingly, further improvement of agrarian policy [7]. The study of the trends and regularities of the functioning of agricultural enterprises showed that one of the main reasons for the low innovation activity of domestic agricultural enterprises is the lack of mechanisms and tools of interest in introducing innovations into agricultural production. While in the difficult current conditions, agricultural enterprises independently carry out innovative activities, taking into account the limited financial resources for solving scientific and technological problems [8]. Until February 24, 2022, th agro-industrial complex, in particular, the corporate segment, was characterized by a high level of technical progress, an increase in labor productivity, as well as a significant scale of production and export. Starting from January to April 2022, Ukraine exported agricultural products in the amount of 7,420 billion dollars, which exceeded last year's figures by 3% [14].

In the conditions of hostilities, the primary task of the Ukrainian agricultural sector became the reliable supply of agricultural products and food to the population. Farm business and individual peasant farms havep layed a key role in the preservation and development of local markets and food supply chains. Of course, in the coming year, state measures are planned for financial support of the agrarian sector of the economy, taking into account the active implementation of innovative technologies in the context of increasing labor productivity and land use efficiency.

The purpose of the article is to substantiate the essence of theoretical and applied aspects in the process of applying modern technologies on the basis of agricultural enterprises and the formation of a mathematical model that allows determining the dynamics of indicators of the efficiency of cultivation of the cultivated area for a certain period of time [13].

MATERIALS AND METHODS

The basis for theoretical and methodological research was the main economic and macroeconomic laws, the theory of mathematical modeling, as well as the works of Italian, Austrian, Malaysian, and British scientists who work in the field of improving innovative solutions for the purpose of ecologically, economically, ethically, and socially viable production of agricultural products.

Scientific methods of cognition based on a systematic approach to solving the problem were also applied.

The statistical base of the study was made up of the official data base and reports of the State Statistics Service of Ukraine, the agrarian company "Ukrland farming", the official web site about agribusiness LATIFUNDIST.COM. In particular, the data were used to present the main indicators of agricultural land use to calculate the actual economic efficiency as a result of the application of innovative technologies during the sowing campaign.

In the course of scientific research, a complex system was used, including general scientific and special research methods. The conceptual apparatus and the essence of the innovative activity of agricultural enterprises on the territory of Ukraine are theoretically substantiated [12].

With the help of system analysis and synthesis, the principles of the potential development of the field of agro-industrial complex with the use of drones were revealed. Using the method of economic-mathematical modeling, a model of the influence of the use of innovative technologies, in particular, the use of the DJI Agras T30 multicopter, on the dynamics of the efficiency indicators of cultivation of agrarian enterprises was formed and substantiated.

RESULTS AND DISCUSSIONS

A modern tool for the agricultural sector, which is used almost all over the world, and is also gradually penetrating the Ukrainian technology market, is an unmanned aerial vehicle, or in other words, a drone.

Unmanned aerial vehicles are used both to solve everyday needs and to conduct secret military operations, as well as in various types of economic activity (industry, forestry, ecology, space research, inspection of inaccessible or dangerous places, etc.).

One of the most promising areas of application of unmanned aerial vehicles is agriculture itself. According to forecasts of the International Association of Unmanned Systems (AUVSI), they can have the greatest impact precisely in agricultural production, that is, be economically feasible in this area 6 [6].

When using agricultural land, drones can perform various functions, including monitoring and transportation (Table 1).

Table 1 Potential possibilities of agricultural land use when using the main functions of unmanned aerial vehicles

Function monitoring	***Determining the level of nitrogen content in the soil and plant tissues; Monitoring the condition and development of crops; Forecasting yield; Calculation of humidity indices and vegetation indices; Determination of the actual sown area, the area of the land plot and its boundary; Inventory of land plots; Observation of the state of plants at various stages of their development.***
Transport function	*Ensuring the necessary level of plant protection and nutrition; Spraying with special solutions of sown areas; Crop protection and safety in the field; Pollination of plants.*

Source: made by the authors [3].

With the help of drones, agricultural enterprises will be able to receive the necessary information about the condition of productive lands. In addition, such information can be accumulated at such a frequency that the owner needs for further analysis of production processes in dynamics.
The active use of drones by agricultural producers ensures the optimization of production costs due to the reduction of energy costs, the minimization of the use of seeds, fertilizers and water resources [11].
According to the expert data of drone services, the saving of fertilizers and toxic chemicals with the correct use of drone data is up to 30%, and the saving of seed material, depending on the terrain, can reach up to 15%.
Based on the experience of farmers of the French OCEALIA Group, thanks to the use of drones, the yield level increased by an average of 10%. The profit from the use of "drones" in the US agricultural sector is estimated at 75 billion US dollars by 2025 due to the creation of new jobs and optimization of existing processes [4].
The advantages of involving drones in the production process of agricultural activity are that aerial photography from them is more detailed than a space photo.
In addition, drones allow filming even in cloudy weather, which cannot be said about aviation and satellites. The advantage is also that you can get pictures during the flight, which can be adjusted even in real time. The results of aerial photography make it possible to place plots on the cadastral record [5].
The Ukrainian agrarian company "Ukrland farming", which is included in the rating of the TOP-20 most successful investors of Ukraine according to the version of the investment portal InVenture, is gradually implementing programs regarding the use of innovative technologies during the sowing campaign and the direct production of its own agricultural products.
Ukrland farming cooperates with the international organization International Sustainability and Carbon Certification, and complies with the requirements of the ISCS voluntary certification system. Also, the enterprise is characterized by quality indicators of the production of ecologically clean, organic products in compliance with the relevant criteria in relation to suppliers of goods and services [13].
The relevant structural subdivisions of the enterprise organize monitoring and compliance with all environmental safety measures.
The fundamental directions of the company's operation are balanced land use and effective development of the agro-industrial complex.

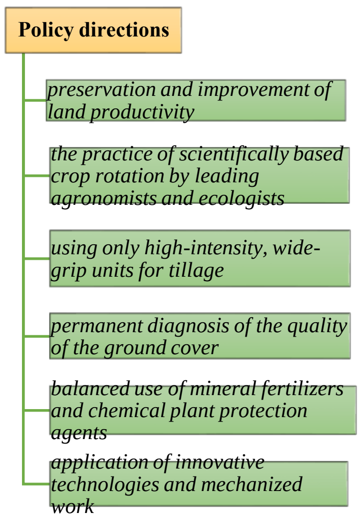

Fig. 1. Policy directions of the company "Ukrlandfarming" in terms of balanced land use and implementation of innovative technologies
Source: made by the authors based on the source [13].

The use of land resources as the main means of production in the implementation of agricultural activities requires an optimized approach to preserving and increasing the level of soil fertility. In particular, the development of plant nutrition systems is influenced by a number of natural factors, in which experts are guided by a number of criteria

It is worth noting that the company's specialists combine various methods of plant protection, in particular: organizational and economic, mechanical, physical, agrotechnical and biological with chemical [2].

Such a rational approach to the chemical method of plant protection allows reducing significantly the negative impact of pesticides on the integrity of the natural environment. Thus, land plots on which agricultural crops are grown are characterized by a high level of safety and a reduction in the number of risks related to environmental pollution by minimizing or reducing to zero emissions of negative substances into the atmosphere.

Lets analyze the functioning of the plant nutrition and protection system with the help of a drone - DJI Agras T30, which is most often used for the needs of agricultural land use and is used by specialists of the agricultural company Ukrlandfarmin.

DJI Agras T30 lifts 30 liters of a special solution into the air, which allows you to process up to 16 hectares of land per hour.

Thanks to the ability to transform the DJI Agras T30, it is suitable for working in orchards and processing hard-to-reach places in tree crowns.

DJI Agras T30 is a transforming agrocopter. It can be used both for spraying plant protection products and for spreading granular fertilizers and seeds [1].

DJI Agras T30 flight features:

1. Unprecedented flight safety under any conditions
2. Agras T30 independently recognizes and flies around unexpected obstacles.
3. Equipped with a spherical radar system for avoiding obstacles, thanks to which the copter is free of blind spots.
4. The RTK module provides centimeter positioning accuracy.
5. T30 Since the dark time of the day is optimal for the operation of the copter; it was equipped with a system of 8 searchlights.

Four of them are frontal, and four more are necessary for the operation of the rear camera, so that the operator can observe the results of the work in real time [1].

Special measures to feed and protect agricultural crops, which are carried out with the help of the DJI Agras T30 multicopter, are characterized by fine-droplet spraying. It should be emphasized that the main difference from traditional methods of tillage is the minimal use of water.

The initial stage of work is the determination of the contour coordinates of an oriented field or fields. After that, it is necessary to agree on an individual plan of the performed works, which necessarily includes such characteristics as: area, location of the object and weather conditions. An important point is the detailed analysis and forecasting of certain meteorological elements, in particular, the speed and direction of the wind, precipitation, etc. [10].

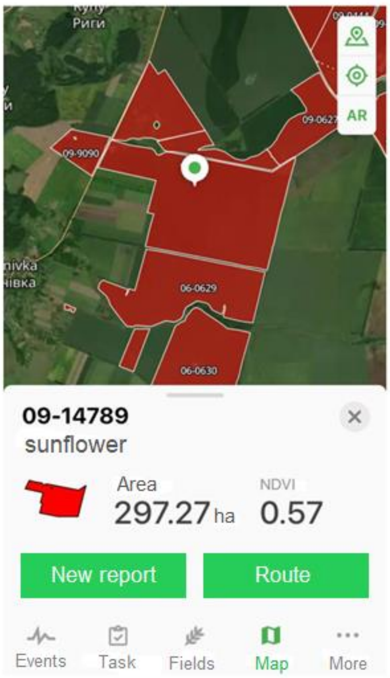

Fig. 2. Map with an individual task with clearly defined identifiers, parameters on the territory of the Poltava region of the Lohvytskyi territorial community
Source: Data from the DJI Agras T30 multicopter control panel.

According to Figure 2, it is possible to analyze a map with an individual task, in particular, an image with a field identifier - 09-14789, an area - 297.27 ha, a vegetation index NDVI - 0.57 and a specifically defined agricultural crop - sunflower.

The next stage is the immediate start of work by a special flight team. Thus, depending on the features of the land plot, it is possible to process from 20 to 100 hectares of the sown area in one work shift (Fig. 3).

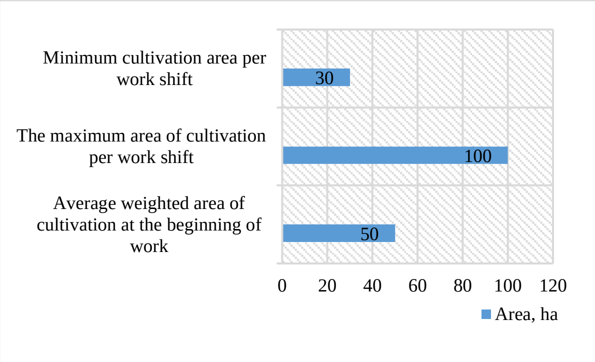

Fig. 3. Analysis of cultivated area for one work shift (ha)

Source: Developed by the authors based on the results of the DJI Agras T30 multicopter during the sowing campaign in the Poltava region.

The average area of the cultivated field at the initial stage of work is about 50 hectares. In the future, depending on the spatial characteristics of the field, for example, if the field is flat without humps and depressions, the cultivation of the sown area can reach up to 100 hectares per work shift, with a maximum speed of the multicopter of 25.2 km/h. If the territory of the field is more relief or has a number of restrictions, for example, power lines, then the cultivation area reaches 30 hectares. Again, on the condition that with this or that field it is necessary to first go around its perimeter, be it 10, 40, 100, 200 hectares of area to clarify the coordinates and only after that start work [9].

Using the apparatus of economic-mathematical modeling, we will express the model of the influence of the use of innovative technologies, in particular, the use of the DJI Agras T30 multicopter, on the dynamics of indicators of the efficiency of the cultivation of cultivated areas of agricultural enterprises.

Let's denote Pz (t) - cultivated area, per shift, hectare.

The change of this value can be expressed by the following formula:

$$Pz(t) = -Pz(t) * kw - Pzr(t) + 0.02 * Pvr\max(t) \quad \text{...(1)}$$

where: kw is the coefficient of influence of weather conditions, which is in the range from 0 to 1 and shows which area may be under-cultivated if the weather conditions are negative.

On average, during the flight, due to unfavorable weather conditions, it is possible to process only a quarter of the planned area.

Pzr(t) is the area actually processed per shift;

0.01-0.05 – a coefficient that shows what proportion of the area is processed per shift (7 hours);

Pzrmax(t) is the maximum possible area that can be processed in 1 flight.

Important attention should also be paid to the calculation of costs for maintenance and repair of the multicopter, which can be determined by the formula:

$$cpr = \begin{cases} \dfrac{Pz(t) * kpqn}{kpq}, if\ t \in [7;10] \\ 0, if\ t \notin [7{,}10] \end{cases} \quad \text{...........................(2)}$$

where: kpq is the coefficient of efficiency of costs for field cultivation, which shows how much area can be provided by a unit of money under the conditions of using a certain amount of spraying material;

$kpqn$ is the depreciation rate, which shows how much of the share wears outdaily, transferring its value into potential yield.

By combining all the above-mentioned equalities, restrictions, and initial conditions, we will obtain a model of the influence of the use of innovative technologies on the dynamics of indicators of the efficiency of cultivation of cultivated areas of agricultural enterprises:

$$Pz(t) = -Pz(t) * kw - Pzr(t) + 0.02 * Pvr\max(t)$$
$$Pzr\ max(t) = \begin{cases} 0, if\ t \notin [100] \\ Pv\ if\ t \in [100] \end{cases}$$
$$cpr = \begin{cases} \dfrac{Pz(t) * kpqn}{kpq}, if\ t \in [7;10] \\ 0, if\ t \notin [7{,}10] \end{cases} Por(t) = \begin{cases} 0\ if\ t \neq 7 \\ Pz(t), if\ t = 7 \end{cases}$$
$$\text{..(3)}$$

With the help of an economic-mathematical model, the indicators of the efficiency of cultivation of cultivated areas with the DJI Agras T30 multicopter were calculated based on spraying operations in three work shifts (Table 2).

Table 2. Values of model parameters

Parameter	*Indicators of work shifts*		
	shift 1	*shift 2*	*shift 3*
Total area for cultivation, ha	*111*	*104*	*26*
Area under cultivation, ha	*31.6*	*51.6*	*23,4*
Factor of influence of weather conditions	*0.000685*	*0.000685*	*0.000685*
The maximum potential area that can be processed by a multicopter	*100*	*100*	*100*
A ratio that shows what proportion of the area is processed per shift	*0.02*	*0.05*	*0.02*
Actual cultivated area for 1 flight lasting 7 hours	***33.5***	***56.6***	***25.3***

Source: Made by the authors based on the results of the DJI Agras T30 multicopter during the sowing campaign in the Poltava region.

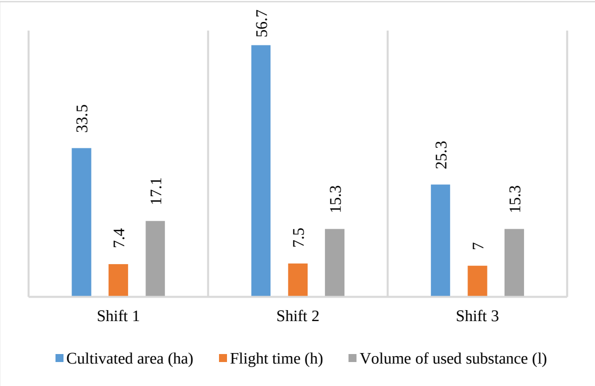

Fig. 4. Comparative analysis of the results of the Agras T30 multicopter and indicators that reflect the level of efficiency of agricultural land cultivation in the Poltava region

Source: Made by the authors based on the results of the DJI Agras T30 multicopter during the sowing campaign in the Poltava region.

On the example of one of the largest Ukrainian agricultural companies, "Ukrlandfarming" activities, a comparative analysis of the results of the Agras T30 multicopter and indicators reflecting the level of efficiency of agricultural land cultivation in the territory of Poltava region with the least ecological and economic losses during the period of 3 different work shifts was carried out.

From the analysis of the multicopter operation data for three work shifts, it follows that the most effective results of cultivation of the planned land area are observed for work shift 2. After all, with the application of 15.3 liters of spraying substance, more than 50 hectares of the cultivated area were processed in 7.5 hours. At the same time, the same amount of material was spent during the 3rd working shift, but 25.3 hectares of the plot were processed, which is more than 30 hectares less compared to the 3rd working shift and 8 hectares less than the 1st working shift.

All final indicators are affected by many factors, starting from the period of the day during which the multicopter flight was carried out, weather conditions, restrictions in the form of artificial or natural objects on the territory of the sown area. In the case considered in the article, the difference in indicators in the result of the drone was influenced by factors related to the different configuration and topography of the cultivated areas. In particular, the work shifts differed by the speeds that were programmed during the operation of the multicopter. After all, fields with hills, valleys and a noticeable difference in the height of plants force you to rely on the clear operation of the radar. In order for the multicopter to work as efficiently as possible, its speed was reduced, which minimized the risk of the copter falling or colliding with plants. On flat fields, you can work at a speed of up to 23 km/h. On fields with difficult terrain, the speed was no more than 10-12 km/h.

However, regardless of a number of factors, there is no need to attract additional material, technical and human resources to perform such types of work, thereby reducing the time and cost, which leads to an increase in the profitability of growing agricultural crops.

CONCLUSIONS

The advantages of using innovative technologies in agricultural land use, in particular, when performing work on the application of nutrients and plant protection with the help of the Agras T30 multicopter, are:

reduction of harmful effects on plants and ground cover;

more efficient and economical use of protective equipment; plants per 1 ha of sown area;

more automated activities without the use of heavy machinery;

high quality of technological operations;

increasing the productivity indicators of cultivation of the sown area.

That's how the use of unmanned aerial vehicles allows to reduce the level of capital costs for technical means of processing. After all, a single multicopter is capable of replacing several ground vehicles at once. Accordingly, operating costs for fuel, water for working solutions, and logistics are reduced.

There is no need to attract additional material, technical and human resources to perform such types of work, thereby reducing the time and cost, which leads to an increase in the profitability of growing agricultural crops.

The formed and substantiated economic-mathematical model of the dynamics of the efficiency indicators of cultivation of the sown area for a certain period of time allows us to establish that the use of innovations, in particular the DJI Agras T30 multicopter, and technical and economic developments in the practice of agricultural enterprises increases the effectiveness of their activities during the sowing campaign.

It is worth to mention that in the future, with the help of intensive technologies of agricultural production, it is possible to increase the production of gross products, improve its quality, reduce resource consumption, which will contribute to increasing the efficiency and profitability of agricultural activity.

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TACKLING LABOUR SHORTAGES AND BOLSTERING PERFORMANCE: A COMPREHENSIVE ANALYSIS OF AGRICULTURAL HIGH SCHOOLS IN ROMANIA

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Abstract

This study explores the challenges facing agricultural high schools in Romania and their impact on their overall performance, looking at how the management of these institutions responds to the dynamic demands of the labour market and combats the current labour shortage. Through a comprehensive survey of all such institutions in the country, we collected and analysed data, then used multiple linear regression to establish connections between different key factors. These factors include material and financial resources, level of teacher commitment and motivation, parental involvement, and collaboration with economic entities and farmers. Our results under-score the importance of updating the technical infrastructure and training teachers in line with modern agricultural technologies. They also highlight the need for more active involvement of parents and closer collaboration with the business environment. It is also crucial to change the public's perception of agriculture by promoting the benefits of this industry to the younger generation. By implementing these strategies, the effectiveness of agricultural high schools can be improved and the labour shortage in Romania can be addressed.

Key words: *agriculture, agricultural secondary schools, labour force, survey, Romania*

INTRODUCTION

In recent decades, the agricultural sector has experienced a number of significant changes, driven by various global and local trends and challenges. These transformations have led to an imperative need for adaptation and innovation within the agricultural industry, as well as in the field of education, which plays a crucial role in training the new generations of professionals in the sector [21].
One of the most important challenge in agriculture is the climate change, which affects natural resources, soil quality, and biodiversity [13]. These impose the need to train specialists in agricultural techniques adapted and resilient to climate change [16]. In this context, agricultural secondary schools need to reconsider their curricula and teaching methods to respond to these challenges.
Another notable trend in the agricultural sector is digitisation and the adoption of new technologies, such as precision agriculture and the use of robotics [2]. This underlines the importance of education in agricultural secondary schools, which need to train students in the use of these technologies and provide them with the necessary skills to be able to cope with the labour market demands for this sector.
The agricultural sector is also under pressure to increase food production in a sustainable way to meet the needs of a growing population [6]. In this sense, agricultural secondary schools have the role to promote sustainable agricultural practices and train professionals who will be able to address

issues related to food security and environmental sustainability.

In recent decades, the educational system and, in particular, agricultural secondary schools have been essential in training future agricultural specialists, both in the European Union and in Romania. These educational institutions have played a crucial role in the development of the agricultural sector, contributing to increasing productivity and promoting sustainable practices in agriculture [12]. However, in recent years, agricultural secondary schools have faced significant challenges, including adapting to climate, technological, and social changes influencing labour market in the agricultural sector. The history and evolution of agricultural secondary schools in Romania is part of a broader context, representing a relevant and interesting topic in European educational and agricultural research [5, 24].

Thus, in the European Union, agricultural and vocational education has proven its value through support programmes for young farmers and by adapting to European requirements and standards for sustainable agricultural practices [11, 24]. In the European Union, the history and evolution of agricultural secondary schools vary according to the traditions and particularities of each member country. However, in general, agricultural educational institutions have played an important role in the development of European agriculture, preparing the workforce needed to face the challenges and changes in the agricultural sector [17, 23]. Over time, agricultural secondary schools in the EU have steadily evolved, integrating new teaching methods and adapting to the demands of the labour market and the needs of the agricultural sector in a globalised and changing context [10].

In Romania, agricultural secondary schools have a long history, having their roots in the interwar period and evolving over the decades according to the political, social and economic context [4, 25]. A common trend in the evolution of agricultural secondary schools in Romania and the European Union has been the continuous adaptation of curricula and teaching methods to the specific needs of the agricultural sector. In this context, the focus has been on the promotion of sustainable agricultural practises, the use of modern technologies in agriculture, and the development of entrepreneurial skills among young people, but the accelerated changes that have occurred in recent years appear to have left be-hind the adaptation of Romanian agricultural secondary schools [7, 8].

A key issue is the migration of young people to other fields of study or to educational institutions abroad. This trend can be attributed to factors such as socioeconomic expectations, perceptions of career opportunities, and access to information on available educational options [22]. Furthermore, climate, technological and social changes are significantly influencing the requirements of the labour market in the agricultural sector. These changes require continuous adaptation of the workforce, infrastructure, and agricultural technologies, as well as a re-calibration of the professional skills and knowledge needed to meet current and future challenges [19]. Given this, a reevaluation of the curriculum and teaching methods in agricultural secondary schools is needed to adapt to the current needs of the agricultural sector. This includes the integration of new technologies and pedagogical approaches into the teaching process, as well as the promotion of interdisciplinary collaboration and project-based learning [9, 26].

One of the main challenges in agricultural education and the labour market is attracting and retaining young people in agriculture. Young people are a key resource to ensure continuity and innovation in the agricultural sector as the workforce ages, making succession issues a concern [20, 27]. Various authors consider that is important to develop career guidance programmes and improve the image of agriculture among young people, secondary lighting the career opportunities and benefits associated with working in the sector. Another challenge is the need to develop cross-cutting competencies and critical thinking skills in graduates to prepare them to respond effectively to the complex and interconnected issues facing the agricultural sector. This also involves a review of the curriculum and teaching methods so that greater emphasis is placed on developing problem solving, communication, teamwork, and adaptability skills [3].

The purpose of the study is to explore the factors that may influence the development of agricultural secondary schools in the context of the challenges facing the agricultural labour market in Romania, based on the opinions of all the principals of agricultural vocational schools at national level.

MATERIALS AND METHODS

We conducted an in-depth investigation to identify the factors that may influence the development of agricultural secondary schools, from the perspective of all the directors of agricultural vocational schools in Romania. Therefore, by applying descriptive and content analysis, we evaluated the factors that can influence the development of the development of these forms of education.

Research methods and instruments

We conducted a questionnaire-based survey as the main research instrument, using the Computer-Assisted Web Interviewing (CAWI) method of data collection that facilitates the filling out the questionnaire online using a computer or other device [14].

The survey includes a total of 59 respondents, consisting of all the principals of agricultural secondary schools in Romania.

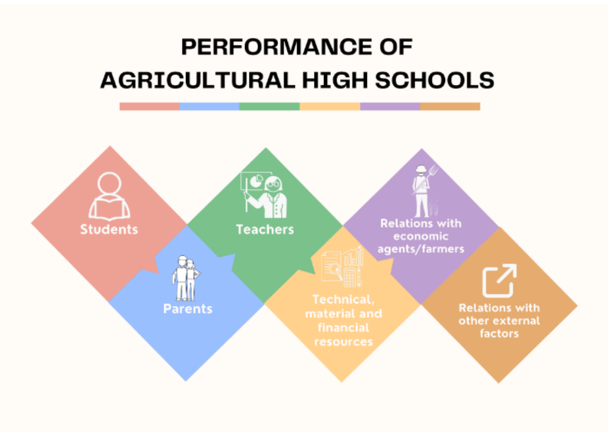

Fig. 1. Structure of the applied questions
Source: own processing.

To this end, all the educational establishments with this profile were identified by administering specific questions to them, taking into account how they evaluate the factors that can influence the performance of a secondary school, targeting: students, parents, teachers, relationship with economic agents/farmers and relationship with other external factors (Figure 1).

Each factor was composed of 3 or more questions, and the Likert scale (1 - strongly disagree to 5 - strongly agree), commonly used in opinion research to measure respondents' attitudes, perceptions or opinions, was used as a psychometric rating method.

Participants in the research and data sources

The structure of the sample analysed is as follows:

Respondent's function: director - 89.5%, deputy director - 10.5%;

Experience in the position of manager for an educational institution: < 5 years - 33.3%, 6-10 years - 35.1%, 10-20 - 22.8%, >20 years - 8.8%;

Secondary school profile: animal field - 5.3%, plant field - 21.1%, mixed field - 52.6%, food field - 8.8%, Other (economic and agricultural, agricultural mechanic, service, veterinary, etc.) - 12.3%.

In addition, the geographical representation of the respondents is shown in the figure below, where Iasi County has the highest number of agricultural high schools (6) (Figure 2).

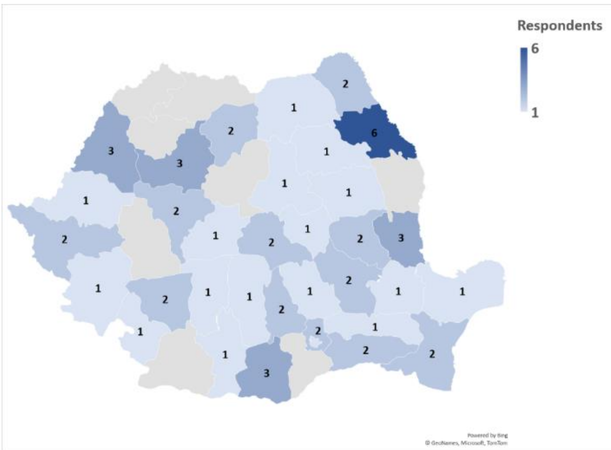

Fig. 2. Representation of respondents at the county level
Source: Questionnaire data processing.

The questionnaire was distributed to respondents between June and July 2022. Subsequently, the collected data were entered, organised, and analysed using SPSS 18. The first stage of data analysis consisted of descriptive data analysis, for which sum, mean, standard deviation, variance, Skewness, and Kurtosis were determined based on the following mathematical formulas [1]:

$$\bar{x} = \frac{x_1+x_2+\cdots+x_n}{n} \text{..................................(1)}$$

$$\bar{x} = \frac{\Sigma f_x}{N}, \text{..(2)}$$

where:

x - the mean value of the set of given data, f - frequency of the individual data, N - sum of frequencies;

$$S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \text{ .... (3)}$$

where: S - Sample standard deviation, x¯ - Arithmetic mean of the observations

$$\text{Skewness} = \frac{\sum_i^N (x_i-\bar{x})^3}{(N-1)\times\sigma^3} \text{ .... (4)}$$

where:

Xi - ith Random Variable, X - Mean of the Distribution, N - Number of Variables in the Distribution, Ơ - Standard Distribution;

$$\text{Kurtosis} = * \frac{\sum_i^n (Y_i-\bar{Y})^4}{\sum_i^n (Y_i-\bar{Y}^2)^2} \text{ .... (5),}$$

where:

Yi - ith Variable of the Distribution, y¯- Mean of the Distribution, n - Number of Variables in the Distribution.

In order to validate the hypotheses, multiple linear regression was used and the following mathematical formula was used [15]:

$$Y = a + bX \text{...................................(6)}$$

where:

Y is the dependent variable (that's the variable that goes on the Y axis), X is the independent variable (i.e. it is plotted on the X axis), b is the slope of the line and a is the y-intercept.

Assumptions underlying the questionnaire:

Hypothesis 1 (H1). *There is a significant relationship between technical and financial resources and the performance of agricultural secondary schools.*

Hypothesis 2 (H2). *There is a significant relationship between teacher and financial motivation and commitment and the performance of agricultural secondary schools.*

Hypothesis 3 (H3). *There is a significant relationship between student quality and agricultural secondary school performance.*

Hypothesis 4 (H4). *There is a significant relationship between parental quality and agricultural secondary school performance.*

Hypothesis 5 (H5). *There is a significant relationship between relationships with economic agents and farmers and the performance of agricultural secondary schools.*

Hypothesis 6 (H6). *There is a significant relationship between relationships with other external factors and the performance of agricultural secondary schools.*

RESULTS AND DISCUSSIONS

Descriptive statistics of the respondents are presented in the table above. This first set of 10 questions asked respondents to rank each answer, assigning it a place (1 most important, 4 least important) according to the importance they attached to it.

It can be seen that for each of the factors considered, the average scores ranged from 2.63 to 3.88, suggesting that principals consider all these factors to have an important influence on school performance.

However, it should be noted that the endowment of secondary schools is the most important factor influencing the performance of agricultural secondary schools, with an average score of 2.63 (Table 1).

Significant variation in scores can also be observed for each of the factors, with standard deviations ranging from 0.375 to 1.395. This variation suggests that principals rank the relative importance of each factor differently in terms of factors that can influence the performance of the schools they represent.

Overall, the results in Table 1 provide a complex picture of the factors that influence the performance of agricultural secondary schools, so that principals consider all of these factors of notable importance, but the weight assigned to each factor varies significantly among respondents. These results may be useful to better understand principals' concerns and to develop strategies to improve the performance of agricultural secondary schools in the context of current labour market challenges in the sector (Table 1).

Table 1. Descriptive statistics of responses on factors that can influence the performance of a secondary school

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Teaching farm/ Material base	155	2.63	1.299	1.686	-.143	.311	-1.728	.613
Motivation and involvement of teachers	186	3.15	1.127	1.269	-.910	.311	-.727	.613
Teacher training	214	3.63	.849	.721	-2.164	.311	3.442	.613
Quality/specialisation of management	225	3.81	.706	.499	-3.665	.311	12.103	.613
Quality of students	166	2.81	1.395	1.947	-.403	.311	-1.782	.613
Quality of parents	213	3.61	.695	.483	-1.525	.311	.873	.613
Relationship with business partners/farmers	202	3.42	.894	.800	-1.408	.311	.925	.613
Relationship with other external factors	229	3.88	.375	.141	-3.374	.311	11.831	.613
Location of the secondary school	228	3.86	.472	.223	-3.499	.311	11.254	.613
Secondary school prestige	202	3.42	.951	.904	-1.457	.311	.854	.613

Source: Questionnaire data processing.

According to the data presented in Table 2, a notable trend is that the majority of respondents believe that students coming to agricultural secondary schools have a poor preparation from the secondary cycle, with a mean of 4.29 and a standard deviation of 1.018.

This suggests that students are having difficulty adapting to the rigors of agricultural education and that secondary schools could benefit from closer collaboration with secondary schools to improve the preparation of these students (Table 2).

Another important finding is that 59% of respondents consider that the level of motivation of students is generally low, with a mean of 3.78 and a standard deviation of 1.161. This may be related to the perception that a significant proportion of students see admission to an agricultural college as a failure rather than a success (mean 3.47, standard deviation 1.223) (Table 2). This negative perception could be addressed through information and career guidance campaigns that emphasise the importance and opportunities offered by agricultural education.

At the same time, the respondents claim that it is necessary to test the skills and competences of pupils as early as secondary school, as the level required by agricultural education is not low, despite the contrary impression (mean 4.05, standard deviation 1.151). In this respect, counselling pupils in their career choice can be decisive in identifying those truly motivated for agricultural education (mean 4.51, standard deviation .858) (Table 2).

According to the results, the respondents state that most of the families where the students come from have a poor financial situation (mean = 4.32; standard deviation = 0.797), suggesting that access to education is quite difficult for these students. Furthermore, they reveal that parents have social problems and dependencies (mean = 3.58; standard deviation = 1.206), which could negatively affect their participation in their children's education (Table 3).

Table 2. Descriptive statistics of respondents' views on student quality

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Students who come to us usually come very poorly prepared from secondary school	253	4.29	1.018	1.036	-1.224	.311	1.077	.613
Students who come to us are often deficient in basic education, behavioral	201	3.41	1.261	1.590	-.129	.311	-1.011	.613
The level of motivation with which they go to secondary school is usually low	223	3.78	1.161	1.347	-.716	.311	.029	.613
A significant proportion of them perceive their assignment to an agricultural college as a failure rather than a success	205	3.47	1.223	1.495	-.408	.311	-.192	.613
It is necessary to test pupils' skills and abilities as early as secondary school. The level demanded by agricultural education is not low, despite the impression to the contrary	239	4.05	1.151	1.325	-.804	.311	.169	.613
Advising secondary school students on their future career path can be decisive in identifying truly motivated children for agricultural education	266	4.51	.858	.737	-1.212	.311	1.173	.613
Some students prefer to pursue less technical majors because they are easier, although they would have more to gain in the long run by doing the opposite	208	3.53	1.209	1.461	-.274	.311	-.247	.613
Some students do not register for the Baccalaureate exam because they are convinced that they cannot pass it	223	3.78	1.260	1.589	-.637	.311	-.214	.613
A significant proportion of students drop out of secondary school to go abroad	160	2.71	1.378	1.898	.379	.311	-.849	.613
After graduation, most students go abroad, avoiding university studies	186	3.15	1.257	1.580	.349	.311	-.522	.613
The labour market insertion rate in the field of graduation is very low	193	3.27	1.201	1.442	.070	.311	-.116	.613
Most of the time, our graduates end up working in fields other than the one they specialised in	206	3.49	1.265	1.599	-.219	.311	-.426	.613

Source: Questionnaire data processing.

Table 3. Descriptive statistics of respondents' views on student quality

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Most of the families our students come from are not concerned about education	221	3.75	1.060	1.124	-.454	.311	-.245	.613
Most of the families our students come from are families with a precarious financial situation	255	4.32	.797	.636	-.866	.311	.957	.613
In many situations, our students' parents have social problems and addictions	211	3.58	1.206	1.455	-.338	.311	-.400	.613
There are situations where parents require children to commute in order to use them for household/agricultural work	220	3.73	1.375	1.891	-.313	.311	-.638	.613
Parents often have a misperception of their children's level and potential, which leads to their children being steered towards academic rather than vocational secondary schools, when this would not be the case.	258	4.37	.945	.893	-.952	.311	.837	.613
Parents could play an important role in guiding their child to the right secondary school and major, but are usually absent from secondary school promotion events.	266	4.51	.751	.565	-.661	.311	1.230	.613
Many of our students' parents are abroad, with grandparents or older siblings looking after their children.	221	3.75	1.183	1.400	-.454	.311	-.600	.613

Source: Questionnaire data processing.

The respondents also reveal that parents could play an important role in guiding their child to the right secondary school and major, but are often absent from secondary school promotion

events (mean = 4.51; standard deviation = 0.751). This result highlights the importance of parents' involvement in their children's career guidance process.
Another important aspect highlighted by the study is that many of the parents work abroad, leaving their children in the care of grandparents or older siblings (mean = 3.75; standard deviation = 1.183). This phenomenon could have negative effects on the emotional and educational support of children (Table 3).

Table 4. Descriptive statistics of respondents' views on teacher motivation and involvement

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
A training programme for our teachers on new technologies used by employers/farmers is needed	234	3.97	1.050	1.102	-1.041	.311	.716	.613
It is necessary to support qualification courses for our teachers on specific topics such as pedagogy, environmental protection, etc.	208	3.53	1.331	1.771	-.511	.311	-.588	.613
There is a deficit of skilled workers, especially for the agricultural mechanic specialisation.	171	2.90	1.494	2.231	.147	.311	-1.405	.613

Source: Questionnaire data processing.

The respondents believe that a teacher training programme on new technologies used by employers and farmers (mean = 3.97; standard deviation = 1.050). This suggests that the implementation of such training programs could help improve the quality of education in agricultural secondary schools and better prepare students for the labor market (Table 4).
Respondents also mentioned the need for teacher training courses on specific topics such as pedagogy, environmental protection, and others (mean = 3.53; standard deviation = 1.331). This finding indicates the importance of continuous development of teachers' professional skills to cope with the changing demands of the agricultural field (Table 4).
With regard to the deficit of skilled workers, especially for the agricultural mechanic specialisation, respondents identified this as a problem (mean = 2.90; standard deviation = 1.494). This suggests that agricultural secondary schools face difficulties in attracting and retaining qualified workers, which could negatively affect the quality of education offered to students and their ability to integrate into the labour market (Table 4).
The equipment used in agricultural secondary schools is usually old (mean = 3.92; standard deviation = 1.317), indicating a need for investment in upgrading. Respondents are of the opinion that the use of outdated equipment is not an appropriate option for the educational process (mean = 4.44; standard deviation = 1.071), highlighting the need to improve the quality of equipment used in agricultural education (Table 5).
Upgrading IT equipment is also considered necessary (mean = 4.29; standard deviation = 1.145), suggesting that investment in information technology could help improve the quality of education in agricultural secondary schools.
Furthermore, respondents support the inclusion of IT solutions for e-learning platforms in the list of future purchases,

especially for the assessment component (mean = 4.12; standard deviation = 1.001) (Table 5).

The existence of own accommodation facilities is considered a strength for agricultural colleges in terms of increasing their attractiveness (mean = 4.61; standard deviation = 1.034).

This suggests that the development and improvement of these facilities could contribute to increasing student interest in agricultural education (Table 5).

At the same time, the respondents believe that it would be appropriate to launch a national equipment programme (mean = 4.69; standard deviation = 0.749), indicating the need for a coordinated national effort to address equipment and infrastructure issues in agricultural secondary schools (Table 5).

Table 5. Descriptive statistics on respondents' views on technical, material and financial resources

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Our equipment is usually old. Most date back to the PHARE programmes, which not all secondary schools had access to.	231	3.92	1.317	1.734	-1.152	.311	.188	.613
Equipping farms with obsolete equipment is not a suitable option for the educational process	262	4.44	1.071	1.147	-1.845	.311	2.855	.613
IT equipment upgrades needed	253	4.29	1.145	1.312	-1.522	.311	2.019	.613
The list of future purchases should also include IT solutions for an e-learning platform, mainly for the evaluation component	243	4.12	1.001	1.003	-.992	.311	.423	.613
The existence of its own accommodation and catering facilities is a strong point for the school in terms of increasing its attractiveness	272	4.61	1.034	1.070	-2.145	.311	4.623	.613
It would be appropriate to launch a national equipment programme	277	4.69	.749	.560	-2.236	.311	5.066	.613

Source: Questionnaire data processing.

The respondents claim that business agents/farmers communicate too little about the expectations they have of agricultural college graduates (mean = 3.88; standard deviation = 0.930). This indicates the need for a closer dialogue between agricultural secondary schools and economic agents/farmers to align the educational offer with labour market requirements (Table 6).

In some cases, economic agents/farmers use students in activities that are not related to their professional practise (mean = 3.36; standard deviation = 1.214), which underscores the importance of monitoring and regulating the relationship between secondary schools and economic agents / farmers that are partners in the internship activities(Table 6).

Table 6. Descriptive statistics of respondents' opinion on the relationship with economic agents/farmers

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Businesses/farmers communicate too little about the expectations they have of agricultural college graduates. This is also visible during institutional meetings	229	3.88	.930	.865	-.822	.311	.651	.613
In some situations, the economic agent/farmer uses the pupils in activities unrelated to their professional practice	198	3.36	1.214	1.475	-.488	.311	-.622	.613
Dual education is the optimal solution for the development of vocational and secondary agricultural education	232	3.93	1.388	1.926	-.476	.311	-.289	.613
Medium and large farmers are more willing to relate to the agricultural college than small farmers	211	3.58	1.404	1.973	-.239	.311	-.935	.613
Overall, the relationship between the agricultural college and the economic agent/farmer-employer is improving from one year to the next	217	3.68	1.008	1.015	-.980	.311	.909	.613

Source: Questionnaire data processing.

Dual education is seen as the optimal solution for the development of vocational and secondary agricultural education (mean = 3.93; standard deviation = 1.388). This suggests that the promotion of the dual education system, which combines theoretical learning with practical training in farms and enterprises, could bring significant benefits in preparing students for the labour market. It is also identified that medium and large farmers collaborate with agricultural secondary schools more than small ones (mean = 3.58; standard deviation = 1.404) (Table 6).

One of the relevant issues is the lack of skilled agricultural labour, which affects businesses and farms (mean = 4.51; standard deviation = 0.817). This underscores the need to improve the quality and attractiveness of agricultural education in order to train more specialists in the field (Table 7).

The respondents identified the need for a legislative framework to provide incentives for economic agents and farmers involved in dual training activities (mean = 4.68; standard deviation = 0.899). Such legislation could stimulate the involvement of these actors in the training of future professionals (Table 7).

Agricultural education is perceived as of poor quality and even is regarded as a denigration (mean = 4.07; standard deviation = 1.081), which could have a negative impact on the attractiveness of this type of education. In this context, efforts are needed to improve the image and quality of agricultural education (Table 7).

Another relevant aspect is the lack of communication between relevant central actors (line ministries), business/employers, and the labour market (mean = 3.97; standard deviation = 0.946). Better communication between these actors could help to identify and address common problems in agricultural education (Table 7). Next, multiple linear regression was used to analyse the relationships between the dependent variables (Table 1) represented by the reasons influencing the good performance of agricultural secondary schools and the causes and solutions identified for each criterion, representing the independent variables.

Table 7. Descriptive statistics of respondents' views on other categories of external factors

	Sum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Businesses / farmers suffer from the lack of skilled agricultural labour	266	4.51	.817	.668	-1.597	.311	4.779	.613
There is a need to create a legislative framework to provide facilities for economic agents/farmers involved in the work experience activities of students in dual agricultural education	276	4.68	.899	.808	-2.695	.311	8.482	.613
Agricultural education is perceived to be of poor quality, even denigrated due to lack of information	240	4.07	1.081	1.168	-1.326	.311	1.488	.613
Part of the planning by specialisation and number of students coming from secondary school level does not find its equivalent in the labour market	205	3.47	1.223	1.495	-.525	.311	-.408	.613
We are expected to continue to see a decline in demographics, which will affect agricultural education enrolment figures	250	4.24	.878	.770	-.649	.311	-.195	.613
The establishment of a state-funded school for agricultural mechanics could be a solution to the problem of a lack of teaching staff with this specialisation.	233	3.95	1.345	1.808	-.786	.311	-.437	.613
Low wages and no subsidies for employers contribute to graduate migration abroad	254	4.31	.836	.698	-1.001	.311	.242	.613
Identifying solutions that allow the association of economic agents for educational purposes would increase the capacity to support scholarships and other facilities for trainees	263	4.46	.953	.908	-2.166	.311	4.830	.613
The abolition of vocational education has damaged the image in the perception of students and parents with which agricultural secondary school principals still struggle today	261	4.42	.855	.731	-1.638	.311	3.087	.613
There is a lack of communication between the relevant central actors (line ministries), business/employers and the labour market	234	3.97	.946	.895	-.816	.311	.521	.613
Migration and an ageing population have created a favourable context for agricultural and vocational secondary schools	187	3.17	1.510	2.281	.106	.311	-1.084	.613

Source: Questionnaire data processing.

Table 8. Influence of technical, material, and financial resources on the performance of agricultural secondary schools

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
				R Square Change	F Change	df1	df2	Sig. F Change	
.887	.773	.755	0.560	.077	35.610	6	52	.001	2.017

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	75.264	6	12.544	35.610	,001
Residual	22.533	52	0.433		
Total	97.797	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.61	3.83	2.63	.361	59
Residual	-1.841	1.607	.000	0.658	59
Std. Predicted Value	-2.803	3.326	.000	1.000	59
Std. Residual	-1.398	1.220	.000	.947	59

Source: Questionnaire data processing.

These results suggest that technical and financial resources are important factors in determining the performance of agricultural secondary schools, and the multiple linear regression model provides a good fit to the data. The multiple correlation coefficient indicates a strong and positive relationship between technical materials and financial resources and the performance of agricultural secondary schools (R=0.887). At the same time, the coefficient of determination shows that almost 77.3% of the variation in the performance of agricultural secondary schools can be explained by the variation in technical and financial resources (R^2=0.773) (Table 8).

The small value of the standard deviation of the estimation error suggests that the models are relatively accurate and that the model estimates are close to the true values (Std. Error of the Estimate = 0.560). The significant statistic F (change F = 35.610) and small p-value suggest that the model is significant ($p<0.005$) and that the independent variables have a significant influence on the dependent variable (Table 8).

Teacher motivation and involvement are important factors in determining the performance of agricultural secondary schools. Specifically, the results show that there is a strong and positive relationship between teacher motivation and participation and financial motivation and participation and agricultural secondary school performance (R=0.824). Approximately 68% of the variation in agricultural secondary school performance can be explained by the variation in teacher and financial motivation and participation, suggesting that these factors are important to improve agricultural secondary school performance (R^2=0.680) (Table 9).

Table 9. Influence of teacher motivation and participation on the performance of agricultural secondary schools

Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
				R Square Change	F Change	df1	df2	Sig. F Change	
,824	.680	.662	0.715	.680	36.890	3	55	.001	2.088

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	50.066	3	16.689	36.890	,001
Residual	23.561	55	0.428		
Total	73.627	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.10	3.66	3.15	.256	59
Residual	-2.235	1.900	.000	0.654	59
Std. Predicted Value	-4.113	1.971	.000	1.000	59
Std. Residual	-1.983	1.686	.000	.974	59

Source: Questionnaire data processing.

ANOVA statistics also indicate that the model is significant and that independent variables (teacher motivation and participation) have a significant influence on the dependent variable (agricultural secondary school performance) (F = 36.890; p<0.005) (Table 9).

These results suggest that student qualities are important factors in determining agricultural secondary school performance, and the multiple linear regression model provides a good fit to the data. The multiple correlation coefficient indicates a strong and positive relationship between student qualities and agricultural secondary school performance (R=0.849). Additionally, the determination coefficient shows that almost 72.0% of the variation in agricultural secondary school performance can be explained by the variation in student qualities (R^2=0.720) (Table 10.).

Table 10. The influence of student quality on agricultural secondary school performance.

Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,849	.720	.705	0.683	.720	18.900	12	46	.001	2.176

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	81.323	12	6.777	18.900	,001
Residual	31.626	46	0.687		
Total	112.949	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.42	4.76	2.81	.684	59
Residual	-2.635	1.982	.000	0.829	59
Std. Predicted Value	-2.033	2.849	.000	1.000	59
Std. Residual	-1.929	1.451	.000	.891	59

Source: Questionnaire data processing;

The small value of the standard deviation of the estimation error suggests that the models are relatively accurate and that the model estimates are close to the true values (Std. Error of the Estimate = 0.683). Significant F statistic (F change = 18.900) and small p-value suggest that the model is significant (p<0.005) and that the independent variables have a significant influence on the dependent variable (Table 10).

The quality of parents is an important factor in determining the performance of agricultural secondary schools. Specifically, the results show that there is a strong and positive relationship between parental quality and agricultural secondary school performance (R=0.794).

Table 11. The influence of parental quality on agricultural secondary school performance

Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,794	.630	.602	.540	.630	12.940	7	51	.001	2.187

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.661	7	2.523	12.940	,001
Residual	10.373	51	.203		
Total	28.034	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.98	4.36	3.61	.302	59
Residual	-1.667	1.017	.000	.450	59
Std. Predicted Value	-2.080	2.482	.000	1.000	59
Std. Residual	-2.496	1.523	.000	.938	59

Source: Questionnaire data processing.

Approximately 63% of the variation in agricultural secondary school performance can be explained by variation in parental quality, suggesting that these factors are

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important in improving agricultural secondary school performance (R^2=0.680) (Table 11).

ANOVA statistics also indicate that the model is significant and that independent variables (parental quality) have a significant influence on the dependent variable (agricultural secondary school performance) (F = 12.940; p<0.005) (Table 11).

Relationships with economic agents and farmers are important factors in determining the performance of agricultural secondary schools. Specifically, the results show that there is a strong and positive relationship between relationships with economic agents and farmers and the performance of agricultural secondary schools (R=0.831).

Approximately 69% of the variation in the performance of agricultural secondary schools can be explained by the variation in relationships with economic agents and farmers, suggesting that these factors are important in improving the performance of agricultural secondary schools (R^2=0.690) (Table 12).

Table 12. Influence of relationships with economic agents and farmers on the performance of agricultural secondary schools

Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,831	.690	.657	.460	.690	11.842	5	53	.001	2.254

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	19.343	5	3.869	11.842	,001
Residual	8.691	53	.164		
Total	28.034	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.19	4.20	3.61	.205	59
Residual	-1.757	.716	.000	.405	59
Std. Predicted Value	-2.068	2.857	.000	1.000	59
Std. Residual	-2.529	1.030	.000	.956	59

Source: Questionnaire data processing.

The ANOVA statistics also indicate that the model is significant and that the independent variables (relationships with economic agents and farmers) have a significant influence on the dependent variable (performance of agricultural secondary schools) (F = 11.842; p<0.005) (Table 12).

Table 13. Influence of relationships with other external factors on the performance of agricultural secondary schools.

Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,807	.650	.610	.290	.650	8.789	11	47	.001	2.079

ANOVA[a]

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.310	11	.483	8.789	,001
Residual	2.859	47	.061		
Total	8.169	58			

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.13	4.34	3.88	.218	59
Residual	-1.372	.529	.000	.246	59
Std. Predicted Value	-3.453	2.117	.000	1.000	59
Std. Residual	-4.042	1.559	.000	.900	59

Source: Questionnaire data processing.

These results suggest that relationships with higher education/scientific research institutions are important factors in determining the performance of agricultural

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secondary schools, and the multiple linear regression model provides a good fit to the data. The multiple correlation coefficient indicates a strong and positive relationship between student qualities and agricultural secondary school performance (R=0.807). In addition, the coefficient of determination shows that almost 65.0% of the variation in agricultural secondary school performance can be explained by variation in relationships with higher education institutions/scientific research institutions (R^2=0.650) (Table 13).

The small value of the standard deviation of the estimation error suggests that the models are relatively accurate and that the model estimates are close to the true values (standard error of the estimate = 0.290). Significant F statistic (F change = 8.789) and small p-value suggest that the model is significant ($p<0.005$) and that the independent variables have a significant influence on the dependent variable (Table 13).

The study aimed to carry out an in-depth investigation to identify the aspects underlying the performance of agricultural secondary schools, from the perspective of agricultural secondary school principals, in order to adapt to the current needs of the labour market and the existing labour shortage in Romania. For this purpose, a survey was carried out using a questionnaire and the data was descriptively analysed. At the same time, to determine in what proportion the dependent variable is explained by the independent ones, multiple linear regression analysis was used.

In recent years, with Romania's accession to the European Union, agriculture has experienced a complex process of modernisation, determined by the possibility of acquiring modern and high-performance technological machinery and equipment, which, on the one hand, has replaced part of the labour force needed on farms and, on the other hand, has led to the need to engage skilled workers to manage this new equipment. Therefore, the results obtained classify material and financial base as a major criterion that could contribute to the good performance of agricultural high schools, the respondents highlighting the existence of a deficient technical and material base and the need to launch national programmes to modernise it, and to adapt to the needs of the agricultural labour market. Access to adequate educational and technological resources is a significant challenge in many agricultural secondary schools, especially in rural and disadvantaged areas. Investments in educational infrastructure and teacher training are essential to ensure quality agricultural education and provide students with the opportunity to acquire the necessary skills in a modern and competitive learning environment [18].

The existing salary level in Romanian education discourages young teachers to enter in this field. Thus, the existing ones need training programs on the new technologies existing in the field of agriculture, and qualification courses for specific topics are needed. According to the results, 68% of the performance of agricultural secondary schools is influenced by factors that contribute to the motivation and participation of teachers.

Most of students in agricultural secondary schools come from rural areas, characterised by a high relative poverty line and a lack of access to various important basic services. This leads to poorly prepared, unmotivated pupils and their admission to an agricultural secondary school is more likely to be a failure. Also, a large number of them migrate to European countries after graduation to work in agriculture, further exacerbating the national labour shortage. A decisive factor in shaping students is their parents, most of whom come from families that are not concerned with education and have a precarious financial situation or various dependencies. Thus, 63% of the factors related to the quality of parents influence the performance of agricultural secondary schools.

While labour shortages have increased, economic agents and farmers do not express their expectations in institutional meetings. However, a solution considered viable both the pre-university and the business environment considers dual education an optimal solution. However, medium-sized and large farms, which feel the effects of the labour shortage most strongly, are more willing to relate to agricultural colleges, and there is a year-on-year improvement in these relationships.

At the moment, legislation does not sufficiently encourage partnerships between vocational schools and economic agents/farmers so that they can take on employees trained on their own activities where they are deficient. However, young people are not tempted to choose and improve a trade in agriculture because of the misperception that such jobs are seen as „dirty” and low paid, without being aware of new trends where these jobs are not dirty at all, and often much better paid than many of the city jobs. Other external factor ais the demographic decline, one characteristic of the Romanian rural environment, caused by the exodus of young people to urban centers or by their migration to other countries following their accession to the EU.

CONCLUSIONS

The present study investigated the issues underlying the performance of agricultural secondary schools in Romania, from the perspective of the principals of these institutions. The main findings highlight the importance of the material and financial base, the motivation and involvement of teachers, the quality of parents and the collaboration with economic agents and farmers.

The results underline the need to modernise the technical and material base and to launch national programmes to meet the needs of the agricultural labour market. It was also found that the level of pay in education discourages young teachers from entering to this field, where that existing teachers need training and qualification programmes in new agricultural technologies.

According to the study, the majority of students come from rural areas characterised by poverty and lack of access to basic services. This leads to poorly prepared and unmotivated students, and graduating from an agricultural secondary school is perceived as a failure. Many of them also migrate to European countries after graduation, exacerbating Romania's labour shortage.

In conclusion, in order to improve the performance of agricultural secondary schools and address the labour shortage in Romania, it is essential to modernise the technical-material base, train teachers, increase the level of salaries, involve parents and work closely with economic agents and farmers. There is also a need to change the public perception of agricultural professions and promote their advantages among young people.

Limitations

The study is based on the perceptions of agricultural secondary school principals, which could be considered a possible gender bias in the results, as their opinions could be influenced by personal experiences and local context. A more diverse sample, including teachers, students and business stakeholders, could provide a more complete picture of the issues underlying the performance of agricultural secondary schools. The study also used a questionnaire to collect data, which may limit an in-depth understanding of these complex issues.

Future research perspectives

Longitudinal studies that monitor the evolution of agricultural secondary school performance and the factors that influence it over time could provide a deeper understanding of the dynamics and causes of these issues. At the same time, future research could specifically examine the influence of external factors, such as government policies, labour market fluctuations and labour migration, on the performance of agricultural secondary schools.

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ANALYSIS OF THE FACTORS AND BARRIERS INFLUENCING THE CONSUMPTION OF ORGANIC PRODUCTS. CASE OF BIHOR COUNTY, ROMANIA

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Abstract

The recent pandemic, as well as sustainability issues have led to changing trends when it comes food purchasing and consumption. Thus, more and more consumers tend to pay more attention to how the food is produced, processed, handled and marketed. Over the past few years, the organic food market has experienced a notable surge in popularity. This study seeks to examine the factors and obstacles shaping the consumption of organic products. Additionally, it aims to explore the socio-demographic traits of consumers in this category and identify the primary types of preferred organic products. The study's convenience sample of 214 customers from Romania's Bihor County served as the basis for data collection, which was done online. The results of our study show that the confidence that a product is organic ranked first among all factors on the consumer's list, followed by a price similar to normal food products and certification by a control body. Organic vegetables, fruits, and eggs were among the most preferred products by the consumers, while processed and canned goods ranked lower on the preferences list for the respondents. Concerning obstacles to organic food consumption, the main concern is related to the additional cost that consumers have to cover relative to other food items. Additionally, half of the respondents who abstain from organic product consumption expressed a lack of belief in organic certification.

Key words**:** *organic food products, food consumption, organic consumption barriers*

INTRODUCTION

In the context in which people are consuming more resources than ever, keep growing the level of waste and pollution, the conventional food system becomes unsustainable from an economic, social, and environmental standpoint [7]. Moreover, the COVID-19 pandemic pointed out the importance of the interrelations between our health, ecosystems and consumption patterns [16].

Organic agriculture as a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity, becomes an important alternative for aware consumers [16]. One driving force that can be identified for organic agriculture is consumer or market-driven organic agriculture.

In these efforts, food consumption is a major sustainability issue, due to the impact on individual and public health, natural resources, social cohesion and economy [18]. Studies regarding consumers' behaviour and their acquisition motives have led to a better understanding of the sustainability attributes of organic food products [38].

Worldwide consumers, given the coronavirus crisis, became more aware about decision making regarding how their food is produced, processed, handled and marketed. In 2020, the organic markets in Europe and the rest of the world rose significantly more than the organically cultivated surface, maintaining the upward trend from previous years [57]. Thus, 14.7 million hectares of land were under organic cultivation in the EU, with the amount of organically grown land rising by 55.6% between 2012 and 2020, from 9.46 million to 15.9 million hectares [15]. In the EU, France occupies the highest place in terms of land organically farmed in 2020 with 2.5 million hectares, closely followed by Spain and Italy with 2.4 and 2.1 million hectares respectively. With 468,887 hectares of organically grown land, Romania comes on the 10 position among the top EU nations. In Romania, the proportion of organically farmed land grew by 62.7% in comparison to 2012 [15].

Moreover, sales of organic products in the USA significantly increased between 2020 and 2021, surpassing $63 billion and increasing by 2% in 2021 compared to the previous year, with the sales of organic goods in the USA also doubling from 2012 to 2021 [31]. Regarding the consume in 2020, the European Union was the second largest market for organic products after the United States, with 44.8 billion euros from organic retail sales. Germany (14.99 billion euros) and France (12.7 billion euros) hold the first places in Europe, while Romania is placed on the 26th place of this European top of organic retail sales, with 41 million euros [43].

Unveiling the primary factors and obstacles shaping consumer behaviour towards organic food products is pivotal for the advancement of the organic food industry, given the heightened awareness and scrutiny consumers now apply to their food choices. Furthermore, the insights derived from this study could offer valuable guidance to key stakeholders in the organic food sector, enhancing their understanding of customer needs and preferences.

In this regard, our study aimed to address the following research queries: What factors influence the adoption of organic products? What socio-demographic traits characterize organic consumers? What are the chief impediments hindering both the consumption of organic products and the growth of the organic market? Lastly, what are the primary categories of organic products that find consumer favour?

Literature review

Factors influencing and affecting organic food consumption

Scholars in the field identified that organic food consumers' profiles may present differences. Consequently, in Brazil, the choice to consume organic foods is influenced by income and ethnic background, whereas in Europe, researchers have discerned preferences shaped by age and gender [18, 58].

Hence, sociodemographic elements such as age, income, educational attainment, and the presence of children in the household appear to impact consumer behavior regarding organic food [12, 27, 47, 55, 56].

Results of some previous studies have confirmed four main factors (health awareness, education level, subjective factors, and price) that influence the consumer's attitude towards organic food products, and an additional one, the availability of clean food [41]. Health and environmental concerns along appear as the main reason for purchasing and consuming organic food [49, 22, 32, 39, 40, 49, 54]. Moreover, a positive impact on the intention to buy organic products is observed with environmental awareness, although variations in the connection between environmental awareness and this inclination exist based on gender [14].

As per a study in Poland, the primary motivations for selecting organic products, in addition to those mentioned earlier, revolve around the superior taste and elements linked to food safety and quality assurance [8].

The findings of extended research carried out in Italy, Denmark, the United Kingdom, Finland, Greece, Spain, Germany, Sweden, and Poland reveal a strong correlation between the consumption of organic products and sociodemographic factors including age, gender, income, education, and environment (urban or rural). These studies' findings suggest that women over 40 with higher-than-average salaries are most interested about buying organic goods [8, 37]. A review on consumers' perceptions and preferences for local food also included emotional and/or ethical dimensions such as personal bounds with the region [38].

Despite numerous favourable reasons for choosing eco-friendly food [50], the share of the organic food products market remains relatively low within the overall organic food market [10]. This indicates the existence of significant barriers for consumers that need thorough analysis to enhance marketing strategies [26]. Notably, the most commonly cited barrier by consumers is the higher cost of purchasing organic food compared to conventional alternatives [1, 2, 6, 23, 24, 25, 26, 28, 32, 36,49, 60, 62].

In 2020, as indicated by FiBL-AMI surveys, global consumption of organic products surpassed 120 billion euros. Leading the way is North America, with a per capita consumption of 147.5 euros, followed by Europe in second place with a per capita consumption of 63.2 euros. [57].

In Romania, the average annual expenditure on organic products is a mere 2 euros [53], in stark contrast to the highest per capita consumption of organic food seen in Switzerland (418 euros), Denmark (384 euros), and Luxembourg (285 euros) [57]. Studies suggest that this discrepancy is attributed to the perception among Romanians that organic products are excessively costly [10].

Low level of awareness regarding organic food benefits is directly related to a low budget allocated for green products [32]. Along with insufficient knowledge [32], availability/accessibility of organic food products is considered an important barrier in consumption as well [9, 46, 51].

Studies carried out in Japan and India have identified and grouped consumption barriers regarding organic products in categories such as usage, value and risk barriers [44,45].

Within the realm of barriers to usage, the predominant issues involve the challenge of obtaining information about organic products and the difficulty in locating retail outlets that offer these items. Additionally, the necessity of establishing a routine for the consumption of organic products, which proves to be a challenging endeavour, falls into this category [44]. Moving on to value barriers, the perceived high cost of organic products is a prominent concern. Lastly, under the category of risk barriers, there's the apprehension of purchasing organic products that may not be authentic, coupled with a lack of trust in the certification process for such products.

In Switzerland, according to a study carried out in 2018, the main barrier to consumption of organic products identified was the high price [21]. Even though Switzerland is a country with a high standard of living, the study highlighted that the cost of living is also high and not all Swiss can afford to buy organic products.

The findings from a study conducted in Poland underscored the primary obstacles to the consumption of organic products. These included the elevated price of the products, inadequate consumer awareness, insufficient availability of organic products, the notably brief shelf life, and an additional challenge pertained to the limited visibility of organic products in stores [8].

In Romania, the reasons that prevent the purchase of organic products, after price, are the perishability of the products and the fact that they are difficult to procure [10].

As shown, among the factors that may affect consumers' willingness to buy is trust in the certification of the product [24]. The fact that consumers are satisfied with the conventional food products might be another explanation regarding the low level of organic food consumption [27].

The primary categories of organic foods being consumed and the locations where they are typically purchased

Recognizing accessibility as a paramount factor in the acquisition of organic food products [52], supermarkets emerge as the primary venue for purchases, despite the preference for procuring directly from producers being highly regarded [17].

In 2020, the EU imported a total of 1.79 million metric tons of organic agri-food products [57]. The main importers were the Netherlands (31%), followed by Germany (18%) and Belgium (11%). In contrast to 2019, organic imports experienced a 1.9% decline in 2020, even as production continued to expand [33].

The largest category of imports, constituting 27.3% of the total, includes tropical fruits (fresh or dried), nuts, and spices, with a total of 885,930 tonnes. Following closely are oilcakes, cereals other than wheat, as well as rice and wheat. Consequently, Ecuador and the Dominican Republic stand out as the leading exporters of organic tropical fruits, nuts, and spices to the EU, while China and Ukraine take the lead in exporting organic oilcakes and cereals [33].

As the national data on the market shares of organic products in many EU countries show, organic dairy products reach the biggest value in the total retail market. It is the case of Denmark (60 %), Austria (50 %), Germany (40 %), France and Switzerland with 37 % [57].

Comparing the European data with studies conducted nationwide, it can be observed that in Romania the purchase for organic fruits (27%) is the most popular. The preference for organic fruits is followed by the one for organic vegetables (26%), the market share for eggs (24 %) and dairy products (21%) registering the 3rd and the 4th place, on Romanians' choices [34]. Regarding the place of acquisition, in many developed countries, supermarkets are the driving force in the market, whereas specialised retailers face more and more competition [5, 42].

Organic eggs represent the second type of organic food consumed by Europeans, reaching values of 37% in France, 30% in Switzerland and Denmark, and more than 20 % in Germany and Austria [34]. Moreover, studies have also shown that in Poland and the Czech Republic the demand for organic products based on cow's milk has increased greatly [6, 19].

Scholars from other European countries (such as Denmark, Austria, Switzerland) show that more than 70% of the marketing channels of organic food, are provided by general retailers. Only a small percent (20%) is represented by special retailers. Moreover, because supermarket chains have partnerships with organic associations and sell their brands, the number of the organic shops even decreased lately (the example of Germany: from 33% in 2014 to 24, 6% in 2020, of organic products sold in organic shops) [57].

In France online distribution and hard discount stores are steadily developing [11].

Studies also show that, especially due to the COVID-19 pandemic, consumers start questioning the global agri-food system and are looking for more sustainable alternatives to the conventional mode of food supply. One of these alternative food networks is known as short food supply chains (SFSCs). According to a study carried out in Poland, during the pandemic, a change was observed regarding the way in which people began to procure their organic products. The Internet has become very important, a large part of consumers preferred to use this purchasing channel [61]. These changes in consumer behaviour are causing companies to change their marketing strategies and adapt to the new demands.

To this extent, many shops had to adapt to consumer preferences for not leaving home and become innovative in selling food. Online sale options, like subscription boxes for organic food or "Click and Collect" forms of contactless shopping, had a significant increase in popularity [11].

MATERIALS AND METHODS

The aim of this research was to determine which are those factors that influence consumers' decision to buy certified products, on one hand, and which the barriers for organic food consumption are, on the other hand.

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The study relied on a convenience sample of 214 consumers from Bihor County, Romania, with data collected through an online questionnaire. Prior to commencing the survey, participants were briefed on the study's objectives and reassured about compliance with the General Data Regulation Protection (GDPR).

A total of 225 questionnaires were distributed, with 214 ultimately validated.

The collected data consisted into 3 main categories:

(i) socio-demographic aspects of the respondents;

(ii) influential factors affecting consumers' choices to purchase certified organic products;

(iii) barriers for not buying organic certified products.

The items regarding the factors that influence consumers' decision to buy certified products were evaluated on a scale from 1 to 5, where 1 means totally disagree, while 5 means totally agree.

For the items related to the barriers for organic food consumption were used dichotomous variables.

The data were analyzed using the descriptive statistics.

The Shapiro-Wilk test was utilized to assess the normality of the data ($p>0.05$). Additionally, the Mann-Whitney U test was employed to compare the two groups.

RESULTS AND DISCUSSIONS

Respondents' socio-demographic profile

A significant majority of the respondents were female (70.1%), indicating an imbalance in the gender distribution within the sample (Table 1).

A total of 23.8% of the participants graduated high school, while 39.7% had a university degree and 36.4% a postgraduate degree. Regarding the age distribution, most of the respondents were over 36 years old.

The proportion of respondents belonging to the 26–35 and 46–55 years groups were similar (22.4% and 22.9%, respectively). Regarding the respondents' income, most of them earned more than RON 5,001 monthly (36%).

Additionally, 60.7% of the respondents reported not having children.

Table 1. Socio-demographic profile of the respondents

Characteristics	Variables	Number of respondents N=214	Percent of respondents (%)
Gender	Female	150	70.01
	Male	64	29.90
Age	18-25	44	20.60
	26-35	48	22.40
	36-45	51	23.80
	46-55	49	22.90
	Over 56	22	10.30
Education Level	High school	51	23.80
	University degree	85	39.70
	Postgraduate degree	78	36.40
Household Monthly Income (RON)	<2,000	16	7.50
	2,001-3,000	46	21.50
	3,001-4,000	42	19.60
	4,001-5,000	33	15.40
	>5,001	77	36.00
Children	YES	84	39.30
	NO	130	60.70

Source: own findings, based on applied survey.

Consumers and non-consumers of organic food products

The Shapiro-Wilk test was employed to assess the normality of statements ($p>0.05$), and the comparison of the two groups based on their family members and attitudes towards reasons for increasing organic product consumption was conducted using the Mann-Whitney U test (Table 2). The results indicate a dominant group of organic food consumers (N=190) in comparison to non-consumers (N=24). Consumers, irrespective of gender, demonstrated a positive inclination and interest in purchasing and incorporating organic products into their daily lives. Notably, the gender distribution reveals a higher percentage of women in both consumer and non-consumer groups, with 71.1% of organic product consumers being women, whereas only 37.5% of non-consumers are men. The respondents were further categorized into various age groups to glean precise insights into the attitudes and purchasing behaviors of organic product consumers. Following the analysis of the collected data, among the surveyed respondents, the largest share is those aged between 26-35 years and 46-55 years (23.7% each). Non-consumers are more prominently represented in the category of young respondents aged 18-25 years old (33.3%). Both consumers and non-consumers of organic food are predominantly individuals with university education (38.4% and 50%, respectively). The group of organic food consumers is characterized by a higher percentage of respondents with elevated incomes (36.3% with a monthly income exceeding 5,001 RON). Moreover, organic consumers tend to have a larger number of family members (40.5%) compared to non-consumers (29.2%).

Table 2. Socio-demographic features of consumers versus non-consumers of organic food

Characteristics	Variables	Consumers (N=190)	Non-consumers (N=24)	p-value
Gender	Female	135 (71.1%)	15 (62.5%)	0.00*
	Male	55 (28.9%)	9 (37.5%)	
Age	18-25	36 (19.9%)	8 (33.3%)	0.00*
	26-35	45 (23.7%)	3 (12.5%)	
	36-45	44 (23.2%)	7 (29.2%)	
	46-55	45 (23.7%)	4 (16.7%)	
	Over 56	20 (10.5%)	2 (8.3%)	
Education Level	High school	48 (25.3%)	3 (12.5%)	0.00*
	University degree	73 (38.4%)	12 (50.0%)	
	Postgraduate degree	69 (36.3%)	9 (37.5%)	
Household Monthly Income (RON)	<2,000	14 (7.4%)	2 (8.3%)	0.00*
	2,001-3,000	38 (20.0%)	8 (33.3%)	
	3,001-4,000	40 (21.1%)	2 (8.3%)	
	4,001-5,000	29 (15.3%)	4 (16.7%)	
	>5,001	69 (36.3%)	8 (33.3%)	
Children	YES	77 (40.5%)	7 (29.2%)	0.00*
	NO	133 (59.5%)	17 (70.8%)	

*p<0.05

Source: own findings, based on applied survey.

Influential factors affecting consumers' choices to purchase certified organic products

Table 3 illustrates the main factors influencing the consumption of organic products, revealing that, for both types of respondents, there are certain elements considered equally important. To this extent, the confidence that a product is organic ranked first among all factors on the consumer list (4.53±1.024 vs 4.00±1.168), followed by price similar to normal food products (4.25±1.021 vs 3.78±1.204) and certification by a control body (4.31±1.045 vs 3.65±1.369). Certification serves as a means to imbue the attribute of organic quality, ensuring sustainable agriculture and promoting a healthy lifestyle. The results show that all factors are ranked as important, especially because the production of organic products does not use pesticides, they can benefit human health, thus contributing less to environmental pollution. However, consumers who reported consuming organic food were more likely to show increased interest in organic food produced environmentally friendly and using organic conditions and technologies (4.14±1.114 vs 3.70±1.460), as well as products certified by a control body (4.31±1.045 vs 3.65 ±1.369).

Table 3 Influential factors affecting consumers' choices to purchase certified organic products

Factors	Consumers		Non-Consumers		P-value
	Mean	SD	Mean	SD	
A price similar to normal food products.	4.25	1.021	3.78	1.204	0.049*
Promotion of a particular type of product.	3.51	1.311	2.91	1.443	0.058
Trust that it is an ecological product.	4.53	1.024	4.00	1.168	0.114
To be certified by a control body.	4.31	1.045	3.65	1.369	0.010*
Let them be cheaper.	3.85	1.177	3.61	1.196	0.320
To be produced under environmentally friendly conditions.	4.14	1.114	3.70	1.460	0.000*

* p<0.05

Source: own findings, based on applied survey.

Main barriers regarding the consumption of organic food products perceived by non-consumers

Table 4 illustrates the primary barriers perceived by non-consumers regarding the consumption of organic food products. Among the respondents who abstain from organic product consumption, 11.20% cited their high prices as the main deterrent. Notably, 79.20% of non-consumers find organic products too expensive, and 58.30% either lack knowledge about them or do not believe in ecological certification. It's noteworthy that two-thirds of these respondents did not consider appearance or the unavailability of products in supermarkets as barriers.

Table 4. Barriers on the consumption of organic products

Barriers	Yes		No	
	Number of Respondents	Percent of Respondents (%)	Number of respondents	Percent of respondents (%)
They are expensive.	19	79.2	5	20.8
I don't know them.	14	58.3	10	41.7
I don't believe in ecological certification.	14	58.3	10	41.7
I don't know where to buy them.	11	45.8	13	54.2
They have an unpleasant appearance.	8	33.3	16	66.7
I can't find them in the supermarket.	8	33.3	16	66.7

Source: own findings, based on applied survey

Main categories of ecologically certified products consumed

Table 5 shows the main categories of ecologically certified products consumed. 88.80% of respondents declared that they consume organic products. The findings indicate that the most commonly consumed certified organic products include fruits (94.2%), vegetables (92.1%), eggs (83.7%), and milk/dairy products (75.3%). On the other hand, fewer than 50% of the respondents reported consuming organic products such as canned vegetables and fruits, sweets, and processed items.

Table 5. Type of consumed certified products.

Certified organic product	Number of respondents	Percentage of respondents (%)
Milk and dairy products.	143	75.3
Meat and meat products.	125	65.8
Vegetables.	175	92.1
Fruits.	179	94.2
Canned vegetables and fruits.	89	46.8
Cereals and cereal products.	109	57.4
Sweets.	83	43.7
Processed products.	79	41.6
Eggs.	159	83.7

Source: own findings, based on applied survey.

Regarding the socio-demographic profile, our study revealed similar results to other studies conducted in Poland, Italy, Denmark, UK, Finland, Greece, Spain, Germany and Sweden [8, 37]. Both men and women have shown interest in the consumption of organic products, but consistently across various studies, the number of women surpasses that of men. The average age of organic product consumers tends to be over 40 years, and their income typically falls into the category above the national average of each respective country. In terms of education, a majority of organic product consumers belong to the highly educated category.

We included gender, education, age, income, and household size as control variables. Research suggests that women may exhibit a greater inclination to purchase environmentally friendly products as they often express more concern for communal goals than men [56]. Additionally, understanding complex environmental issues may be more prevalent among more educated consumers [13, 30]. It is also theorized that consumers with higher incomes might be less affected by the costs of green products and more likely to engage in sustainable behavior, although empirical evidence on this connection remains inconclusive [11, 48].

Finally, household size could have an effect on organic buying behavior as it is positively correlated with price sensitivity [35]. The effects of these sociodemographic data may not be very strong because our model already includes values and attitudes that can mediate their influence.

The outcomes of our study unveiled that the primary factor influencing the consumption of organic products is the trust in their ecological nature. Similar findings were observed in Saudi Arabia [4], where the decision to purchase organic products is most influenced by the quality of these products. Another noteworthy factor influencing organic product purchases in our study is the insistence on certification by a reputable institution. Studies conducted in Bangladesh and Kosovo [3, 29] regarding factors impacting the decision to buy organic products concluded that organic certification takes precedence as the most significant influence on organic product consumption. Additionally, a study in Egypt [63] suggests that eWOM (Electronic Word-of-Mouth) plays a substantial role in the decision-making process when it comes to purchasing agricultural products. It appears that online reviews carry increasing weight in today's context, particularly in the realm of buying organic products.

When it comes to the main factors hindering the consumption of organic products, the fact that they are perceived as an expensive food category is the most important (79.2%), reinforcing the results from previous studies where price is considered a dominant barrier [9, 22, 41, 44, 46, 49, 51]. Related to high prices, organic food is considered a premium category of food and this perception affects the level of consumption a fair one because organic food addresses a niche segment based on low price. [45]. Another aspect that often prevents consumers from buying organic food is the fact that they do not know it (58.3%) and do not believe in organic certification (58.3%). Indeed, other studies have highlighted the perishability of organic foods, particularly in the context of fruits and vegetables, as a barrier to consumption. Interestingly, our study diverges from other related research as it indicates that the perishability of organic food (45.8%) is considered a more significant barrier to consumption compared to the challenge of finding these products. This finding contrasts with studies that commonly rank availability as a second important barrier [9, 10, 26, 44, 46, 51, 62]. The unattractive aspect (33.3%) of organic food and the fact that they cannot be found in the supermarket (33.3%), are mentioned as a barrier by Romanian consumers.

Considering the primary categories of organic products consumed, our study reveals that the top three preferences among Romanian consumers are fruits (94.2%), vegetables (92.1%), and eggs (83.7%). Remarkably, this top three aligns with the preferences observed in other countries, including Poland, Portugal, and Turkey [20, 59], emphasizing the significance of these categories for consumers across diverse regions.

Additionally, the results of our study highlight that another noteworthy category of organic products preferred by Romanian consumers is milk and dairy products, with a consumption rate of 75.3%. Based on the research findings, a series of useful managerial implications were formulated for producers, processors, distributors and traders of ecological agri-food products.

The results of this study revealed that people are searching sustainable solutions in terms of food as well. In this sense, all operators in the ecological agro-food chain should invest time and financial resources in ensuring the highest possible level of knowledge about the environment and in increasing the ecological sensitivity of consumers.

Steps must also be taken to educate the population in order to adopt an "ecological" behavior, reduce pollution and food waste. Actions are needed to raise awareness among the population regarding the benefits of consuming organic products for health and the environment, a fact that will lead to the adoption of a healthier lifestyle.

Moreover, actions are needed to raise the population's awareness of the medium and long-term negative effects of the consumption of food products from the agricultural system that uses pesticides on the human body and the environment. Absolutely, placing emphasis on informing the population about the importance of consuming organic food products and the associated benefits for both the human body and the environment should be a central focus for producers, processors, and distributors of organic food products. Education and awareness play pivotal roles in fostering a greater understanding and appreciation for the positive impact of choosing organic options.

The primary limitations of this study revolve around the relatively modest sample size, preventing the extrapolation of the obtained results to the broader Romanian population.

The data was collected using questionnaires and included mainly respondents from the Northwest region of Romania. Moreover, the organic food market in Romania is an emerging one, much smaller compared to other European countries, although the results of our study are similar to other researches conducted in other countries on the same topic.

CONCLUSIONS

According to the findings of our research, consumers are actively looking for sustainable food options. Thus, all stakeholders in the ecological agro-food chain should devote time and money to ensuring that customers have the greatest possible degree of environmental awareness and ecological sensitivity.

The results of our study show that there are certain elements considered equally important regarding the factors influencing the consumption of organic products among both types of respondents. To this extent, the confidence that a product is organic ranked first among all factors on the consumer list, followed by price similar to normal food products and certification by a control body. Organic vegetables, fruits, and eggs were among the most preferred products by the consumers, while processed and canned goods ranked lower on the preferences list for the respondents.

In terms of obstacles to organic food consumption, the primary challenge is the elevated price compared to other food products. Additionally, half of the respondents who refrain from consuming organic products expressed skepticism or disbelief in organic certification.

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DEVELOPING AN INTEGRATED MODEL ON FOOD WASTE CONSUMER BEHAVIOUR IN ROMANIA

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Abstract

Food waste is one of the most unusual behaviours related to economic systems located on the agrifood chain. In this matter, the study of the food waste and the mechanisms that lead to its development are complex and rooted within several components of the human behaviour and economic system dynamic. In this paper, we propose the development of a model which presents the dynamics of the phenomenon based on several cause-effect relationships between aspects of human behaviour and economic aspects. The model is built using a Systems Dynamic (SD) approach, based on the identification of connections between identified causes and effects and the determination of the ontologic and mathematical nature of the connections.

Key words: *food waste, food behaviour, agrifood chain, human behaviour*

INTRODUCTION

Food waste is a global problem that has a significant negative impact on the environment [1], the economy [7]and human health [9]. Studies developed by the Food and Agriculture Organization of the United Nations (FAO) claim that a third of all the food that is produced every year worldwide is lost or wasted. The quantity related to this proportion equates about 1.3 billions tons of food, which should be a sufficient quantity to feed about 2 billion people [8], [10].
An approach for the phenomenon of food loss and waste must be multidisciplinary in order for this to be solved [8]. The first step of this approach would be the understanding of the causes of food waste and their implementation in practice [5]. In this way, the impact of food loss and waste on the environment, the economy and human health [14] could be reduced. One of the solutions of the reduction of the food loss and waste can be circular economy [3, 4, 13, 15].
The main purpose of this paper is the presentation of the main causes of food loss and waste (FLW) along the agrifood chain, using tools specific to System Dynamics (SD). In this matter, a model based on the agrifood chain is presented. In order to build the model, we have run a bibliographic study in order to establish several terms and topics related to food waste and to determine principal causes for the phenomenon [16].

MATERIALS AND METHODS

The main purpose of the research is to determine the causality of various factors on the food waste phenomenon. In this matter,

for the accomplishment of this purpose, several objectives are established:
O1. The identification of the main factors that influence food waste in Romania
O2. The assessment of the extent to which the identified factors impact food waste
O3. The description of the model framework and structure (parameters and relationships between them)
The research has a methodology which is based on the development of the model framework and structure. This methodology comprises several steps:
S1. The formulation of a bibliographic study related to the food waste factors:
(a)the completion of a search of research papers and studies within a research database;
(b)the mapping of the results from the previous sub-step using a mapping software;
S2. The identification of the factors that cause the food waste and their model-based nature;
S3. The classification of the factors in several groups related to economic and social, collective and individual aspects;
S4. The determination of the quantitative and qualitative relationships between the factors;
S5. The establishment of the model structure and the generation of its results[6].
During the development of the research, several tools will be used. These tools are related to the phase of the research:
-for the bibliographical study, the Dimensions.ai database will be used, alongside VOSViewer software [19]to map the database search result;
-for the identification of the factors, a qualitative research method in form of documentation and analysis will be made;
-for the establishment of the model framework and structure, tools related to System Dynamic method will be used: causal loop diagrams, stock-flow diagrams (in the future research papers) using specific software (Vensim) [17].

RESULTS AND DISCUSSIONS

A bibliographic study

The food waste phenomenon is greatly influenced by a numerous number of factors, one of the most important being related to the economic aspects of food production [16].
The literature shows a great deal of interest in various fields related to food, starting from the biological implications of food waste and including agrifood chain [10], consumer behaviour [11], and policy-based perspectives of the food waste phenomenon[6].
In order to formulate a wider image of the issue, we have formulated a bibliographic study for which we have followed the next steps:
(1)the determination of the study parameters and objectives: for the database, we have used Dimensions.ai academic database (Digital Science, 2018) and we have aimed the attainment of the main concepts used in the research papers, as well as a geographical and institutional distribution of the research initiatives related to food waste; [2].
(2)the determination of the search terms within the database: three terms were established which were determined in relation of inclusion between them:
(a)“food waste”: includes all documents related to food waste;
(b)“food waste AND economy”: this term includes documents related to economic aspects of the food waste;
(c)“food loss”: includes documents focused on consumer behaviour [7], [11].
(3)the mapping process of the obtained search results, using VOSViewer software for the described objectives, with the results in form of concept graphic mapping, term relevance, their number of occurrences and geographic and institutional distribution. The mapping was run for two instances: minimum 10 and minimum 100 number of occurrences of terms within the papers.
The two terms (food loss and food waste) were studied separately because, although they refer to the same process, several subtle differences are established [12].
Food loss is considered to be an unexpected reduction of the quantity and quality of food, both in pre-harvest, post-harvest or production

of food, while food waste is concentrated during the distribution and consumption phases in the agrifood chain. Thus, studying the two terms can offer a broader image of the phenomenon [13].

Firstly, we will present the structure of research types for the three terms. These are presented in Table 1.

Table 1. Research types related to food waste

	Publications	Datasets	Grants	Patents	Clinical trials	Policy documents	Total
food waste	161,684	446	1,870	91,401	26	5,607	
food waste AND economy	78,934	23	195	5,639	1	4,035	
food loss	18,797	50	181	2,607	5	1,971	
Total							

Source: Dimensions.ai [2].

The main domains that were related to the three search terms were connected to Engineering, Agriculture, Biological Sciences, Chemistry, Environmental Sciences, Human Society and Food Sector, as presented in Table 2. Depending on the search term, the amount of research entities (paper, datasets etc.) was different for the given domain and changes in the domain list also were present.

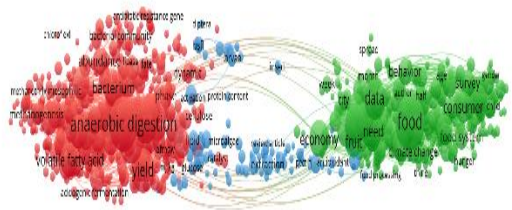
Table 2. Domains related to selected papers

	food waste		food waste AND economy		food loss	
	Domain	Research entities	Domain	Research entities	Domain	Research entities
	Engineering	44,925	Engineering	16,927	Agricultural, Veterinary and Food Sciences	5,329
	Agricultural, Veterinary and Food Sciences	26,488	Environmental Sciences	10,322	Environmental Sciences	2,600
	Biological Sciences	24,749	Agricultural, Veterinary and Food Sciences	9,491	Engineering	2,402
	Chemical Engineering	24,437	Biological Sciences	8,474	Food Sciences	2,307
	Environmental Sciences	20,778	Human Society	8,408	Human Society	2,236
Total						

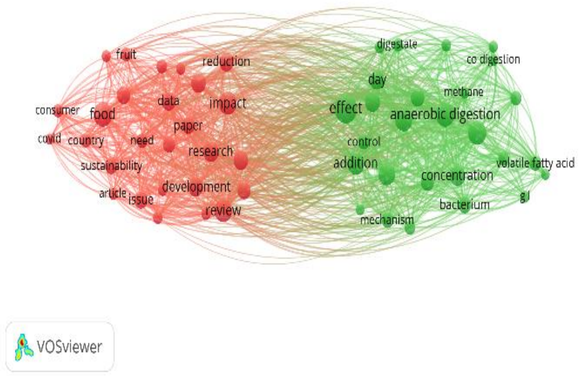
Source: Dimensions.ai[2].

The more generic term „food waste" was related to domains closer to STEM-based domains, which included topics related to the production of food, the chemistry of food and biological and environmental aspects of food waste phenomenon. For the other two, the human factor and agricultural aspects of the issue gained in importance.

We will present the results based on the search term. The results obtained in form of term mapping diagram for the first term are shown in Figure 1.



(a)



(b)

Fig. 1. Graphical mapping of the search results for the term "food waste" with a threshold of minimum (a) 10 occurrences of terms; (b) 100 occurrences of terms
Source: Own determination.

As we can observe, the mapping process of the search results showed the classification of research topics into three (for 10 occurrences) and two (for 100 occurrences) clusters. For the first case, the clusters were determined based on their closeness to specific domains:

-biological domain: anaerobic, digestion, bacterium, fatty acid;

-chemistry-based domain: glucose, lipid, catalyst, pectin, antioxidant;

-agriculture-based domains (agriculture, economy, environment): food, consumer, economy, climate change, hunger, food processing.

For the second case, the clusters were determined based on their closeness to specific domains:

-nature-related domains: anaerobic, digestion, mechanism;

-agriculture-based domains: consumer, development, sustainability.

The terms with the highest number of occurrences for this search term “food waste” is presented in Table 3.

Table 3. The terms with the highest number of occurrences for the search term “food waste”

No.	Term	Occurrences	Relevance
1	effect	740	0.2195
2	food	525	1.7098
3	anaerobic digestion	522	0.8106
4	yield	494	1.1713
5	impact	478	0.3556
6	review	472	0.4951
7	addition	450	0.2390
8	performance	442	0.5071
9	condition	424	0.4106
10	concentration	360	0.9870

Source: Dimensions.ai [2].

The relevance of a term is determined as the specificity of the term. In this matter, using a relevance index separates the usual, more common and frequent terms to terms that are specific to the searched domain. The terms with the highest relevance for the term “food waste” were “covid”, “consumer”, “volatile fatty acid” and “country”.

Next, Table 4 presents the world countries that have the most research entities on the term. The Total link strength attribute indicates the total strength of the co-authorship links of a given researcher with other researchers.

Table 4. The countries with the highest number of research entities for the search term “food waste”

No.	Country	Documents	Citations	Total link strength
1	China	898	13,669	535
2	United States	270	4,139	262
3	India	199	4,245	269
4	Italy	195	2,673	151
5	South Korea	159	3,664	205
6	Spain	138	2,085	133
7	United Kingdom	129	2,129	205
8	Australia	105	1,603	141
9	Malaysia	99	1,990	149
10	Canada	91	1,339	71

Source: Dimensions.ai [2].

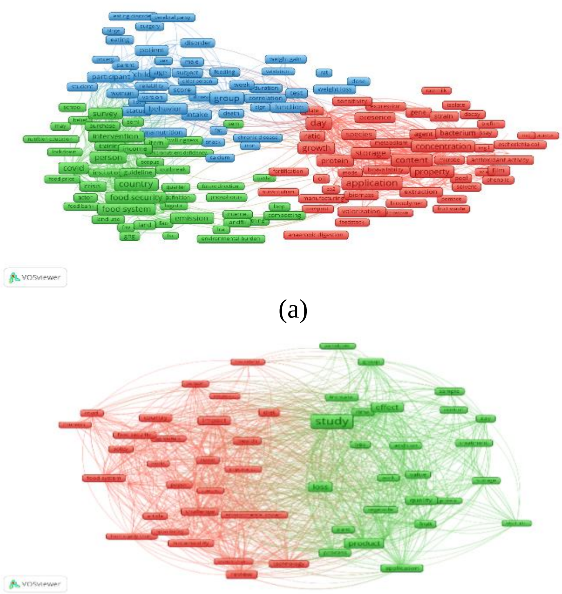
The results obtained in form of term mapping diagram for the second term are shown in Figure 2.

As we can observe, the mapping process of the search results showed the classification of research topics into three (for 10 occurrences) and two (for 100 occurrences) clusters. For the first case, the clusters were determined based on their closeness to specific domains:

-biological and chemistry-based domain: protein, species, concentration, microbe;

-human-based domain: group, correlation, behaviour, reliability, eating;

-agriculture-based domains (agriculture, economy, environment): food security, food system, food price, crisis, emission.



(a)

(b)

Fig. 2. Graphical mapping of the search results for the term “food waste AND economy” with a threshold of minimum (a) 10 occurrences of terms; (b) 100 occurrences of terms

Source: Own determination.

For the second case, the clusters were determined based on their closeness to specific domains:

-human-related domains: study, participant, quality, product;

-agriculture-based domains: food system, food supply chain, sustainability, environmental impact.

The terms with the highest number of occurrences for this search term “food waste AND economy” is presented in Table 5.

The terms with the highest relevance for the term “food wasteabd economy” were “pandemic”, “covid”, “shelf life”, “day” and “food system”.

Next, Table 6 presents the world countries that have the most research entities on the term.

Table 5. The terms with the highest number of occurrences for the search term "food waste AND economy"

No.	Term	Occurrences	Relevance
1	study	1,215	0.3332
2	product	589	0.3655
3	loss	577	0.1046
4	effect	572	0.5190
5	impact	445	0.4129
6	review	380	0.3920
7	quality	369	0.6998
8	time	354	0.3739
9	value	350	0.6766
10	health	336	0.3075

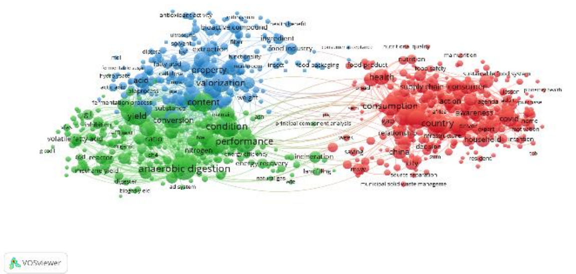
Source: Dimensions.ai [2].

Table 6. The countries with the highest number of research entities for the search term "food waste AND economy"

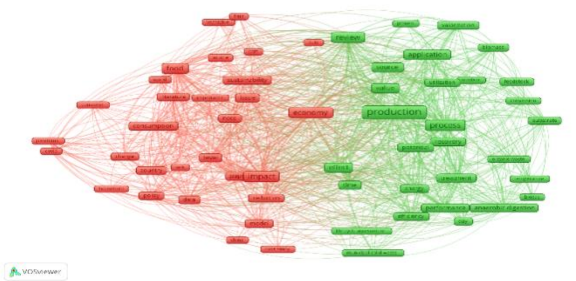
No.	Country	Documents	Citations	Total link strength
1	United States	569	22,903	442
2	China	307	6,564	337
3	Italy	223	7,471	267
4	United Kingdom	193	11,373	334
5	Spain	155	4,763	160
6	India	129	1,586	145
7	Australia	128	5,922	190
8	Germany	109	7,313	197
9	Brazil	99	1,675	100
10	Canada	88	2,441	101

Source: Dimensions.ai [2].

The results obtained in form of term mapping diagram for the third term are shown in Figure 3.



(a)



(b)

Fig. 3. Graphical mapping of the search results for the term "food loss" with a threshold of minimum (a) 10 occurrences of terms; (b) 100 occurrences of terms
Source: Own determination.

As we can observe, the mapping process of the search results showed the classification of research topics into three (for 10 occurrences) and two (for 100 occurrences) clusters. For the first case, the clusters were determined based on their closeness to specific domains:
-biological and chemistry-based domain: acid, bioactive compound, property, fermentable sugar, food industry;
-food industry domain: yield, conversion, condition, ratio, performance;
-economic-based domains: consumption, country, health, supply chain, sustainable food system.
For the second case, the clusters were determined based on their closeness to specific domains:
-economic-based domains: economy, impact, consumption, policy;
-food industry domains: production, process, review, performance, potential.
The terms with the highest number of occurrences for this search term "food loss" is presented in Table 7.

Table 7. The terms with the highest number of occurrences for the search term "food loss"

No.	Term	Occurrences	Relevance
1	production	1,003	0.2997
2	process	714	0.5767
3	impact	669	0.2626
4	review	632	0.1707
5	food	614	0.9258
6	economy	570	0.0292
7	effect	529	0.0789
8	value	504	0.2449
9	application	499	0.5141
10	source	460	0.3155

Source: Dimensions.ai [2].

The terms with the highest relevance for the term "food loss" were "pandemic", "covid", "consumer", "household" and "change".
Next, Table 8 presents the world countries that have the most research entities on the term.
The dedicated term used in the literature for the food waste made during the entire agrifood chain is known as Food Loss and Waste (FLW). In this matter, we can observe that food loss is mainly referred as food that is lost during the entire process and includes biological and health-based aspects of wasting food.

Table 8. The countries with the highest number of research entities for the search term “food loss”

No.	Country	Documents	Citations	Total link strength
1	China	586	13,408	615
2	Italy	321	7,221	225
3	India	268	7,803	428
4	United States	239	6,374	319
5	United Kingdom	223	9,071	351
6	Spain	221	3,817	200
7	South Korea	141	5,442	255
8	Australia	114	3,114	173
9	Germany	101	2,672	182
10	Malaysia	100	2,986	176

Source: Dimensions.ai [2].

Food waste, according to the bibliographic study, mainly refers to agricultural production and human-centered factors, such as behaviour, buying patterns and purchasing power.

The main terms that were determined for all the search terms are related mainly on the production efficiency, the human economic behaviour, the agrifood chain, the economic food system and the impact of the health hazards or dangers on the food industry and consumption. Additionally, we can state that the largest amount of studies in respect to their number is documented in countries such as China, India, United States and Italy, examples of countries where socio-economic conditions lead to significant challenges. Thus, the concern related to food waste research is considered extremely important, due to its effects on national economies and global market.

Factors determination

In order to determine a comprehensive list of the factors that influence the food loss and waste, we will use the results of the bibliographic study and aspects related to literature. Related to the previous research, we can determine several categories of factors, as follows:

-behavioural factors, related to human individual behavioural patterns and reactions;

-demographic factors, related to societal behavioural patterns and trends;

-biological factors, related to the food composition and natural processes;

-policy-based factors, related to rules and regulations, as well as campaigns related to food behaviour;

-economic factors, related to agrifood chain, from food production to food consumption.

Related to the placement of factors within the agrifood chain, classified in the latter category, we can define the next checkpoints:

(a)food production, where several factors related to the agricultural production are considered;

(b)processing, where raw materials obtained in the first phase are transformed by a series of processes in refined food;

(c)packaging [18], where processed food is prepared for sale;

(d)logistics, where the food is handled from the producer to the processer and then to the distributor;

(e)distribution, where food is brought close to the final point, to the consumer;

(f)consuming, where food is consumed [18].

The model will be presented based on the linear structure of these checkpoints, taking into consideration the categories of factors and their major influence on the food loss and waste phenomenon. A list of the factors classified on the taxonomy presented previously is shown in Table 9.

Table 9. The list of factors taken into consideration for the model structure

No.	Category	Factor	
1	Behavioural	Buying patterns Habits Attitudes Subject norms	
2	Demographic	Educational background Age Number of members in household Region	
3	Biological	Food perishability External biological agents (e.g., COVID-19 pandemic, food toxins, bacteria, viruses)	
4	Policy	Social policies related to food waste Economic policies related to income	
5	Economic	Producer	Productivity Management type
		Processing	Number of processing phases Quality standards
		Packaging	Package parameters
		Logistics	Logistic parameters Storage
		Distribution	Promotions Sales volume Low prices
		Consuming	GDP per capita Income

Source: own determination.

For the mentioned parameters in Table 9, we have also added several variables that complete the model and connect several parameters and which will be presented in the next subsection.

Model framework and structure

The present model is created based on the parameters presented in Table 9 and the relationships between these parameters. One of the results is the obtaining of a causal loop diagram, shown in Figure 4, where the parameters were connected in order to establish a causal influence related to food waste. To further detail the model, a stock-and-flow diagram will be projected, in order to determine the quantitative aspects of the food waste phenomenon, based on the agrifood chain phases. The causal loop diagram presented in Figure 4 was created using the Vensim software and presents the most important parameters delimited in Table 9 in respect to the agrifood chain phases. The blue arrows indicate a positive influence, the red ones a negative influence and the green ones indicate a mixed influence, based on the context of the model. In future researches, the green arrows will be detailed and transformed in either positive or negative dependencies.

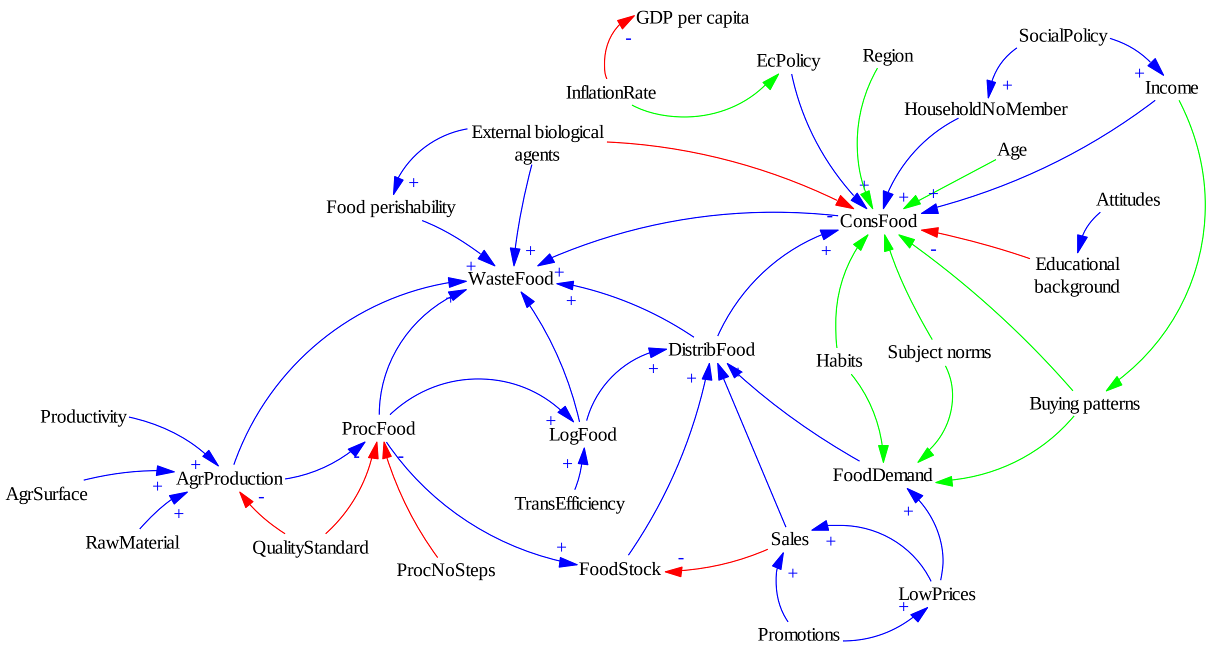


Fig. 4. The causal loop diagram for the considered food waste model
Source: Own determination.

This model illustrates the complex agri-food chain and its interactions related to food waste. The chain starts with agricultural production (AgrProduction) and raw materials and goes through food processing (ProcFood), distribution (LogFood) and retail sales (DistribFood) to consumers (ConsFood). Food waste (WasteFood) is influenced by many factors, including processing and distribution efficiency, food stocks, food demand and consumer behavior. In turn, food waste affects inventory, costs and waste awareness. Farmers, as producers of raw materials, have a significant impact on the entire agri-food chain. The analysis of the feedback and interactions leads to the highlight of the need for effective resource management, a more effective collaboration between the actors and processes on the all levels of the agri-food chain and a consumer educational background which will permit the reduction of food waste amount with socio-economic and environmental benefits.

CONCLUSIONS

Food wastage is a multifaceted issue with substantial social, economic, and environmental consequences. It arises from a variety of interrelated factors that operate across various levels of the agricultural and food supply chain. These include inefficient agricultural production, inadequate production and distribution processes, strict aesthetic standards, consumer behaviour and poor inventory management.

Overall, combating food waste requires a holistic approach that considers the entire agri-food chain and involves the collaboration and commitment of all actors involved, from producers and processors to consumers and policy makers.

Future work is related to the development of the current model, by adding detail levels on the causal loop diagram, and by formulating a stock-and-flow diagram that would quantify the food loss and waste phenomenon in terms of volumes and their influence.

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HUMAN RESOURCES AS A FACTOR FOR THE SUSTAINABILITY IN BULGARIAN AGRICULTURAL HOLDINGS

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Abstract

All strategic documents related to the development of agriculture and its sustainable management in Bulgaria focus on the primary role of the human factor, with priorities aimed at stimulating generational renewal and transferring of experience and skills, leading to the success of agricultural holdings. However, the trend related to the advanced age of most agricultural producers and the lack of sufficiently educated and competent entrepreneurs to use the advantages of technology in agricultural production stands out as a problem. The aim of our research concerns the study and generalisation of main trends in this regard in Bulgarian agricultural holdings, emphasising the importance of several main factors for sustainability and their interrelationship, namely: family - non-family workforce, gender, age and education of farmers. The age and education of people working in agriculture are significant factors in the success and sustainability of the sector. By promoting education and training and bringing the next generation of agricultural entrepreneurs into the agricultural sector, agriculture ensures its continued success and growth. The combination of age and education also contributes to the development of specific skills and knowledge in agribusiness. Research methods used in the study include: general scientific research methods, summary and synthesis, logical method, tabular and graphical presentation of characteristics and trends. The analysis is based on empirical evidence – observation, interview, case studies from the practical activity of agricultural holdings and shared experience from producers. The results of the research can be systematised in several directions: influence of the family – non-family workforce factor on the management process; importance of the gender of the employed in the agricultural sector; age ratio and its benefits; awareness of the need for appropriate education and training of farmers. In conclusion, the summarised studies create an idea of trends in the Bulgarian agricultural sector regarding the importance of human factor and outline future directions for research in the field of human resources in modern agriculture.

Key words: *family and non-family workforce, gender, age, education and training, agricultural producers, agricultural holdings*

INTRODUCTION

In the field of economics, people are the determining factor that makes a business successful [21] and is the main driver for development [16]. Modern agriculture, as well as other significant sectors, create a real opportunity for business development and strengthening the local economy, and their importance for the environment is also key. Analyzing the importance of agricultural employment, as a major factor in agricultural efficiency, and the problem of population aging, as well as the need for technological progress and better management, are addressed in the scientific literature [17, 18].

The achievement of organisational goals depends on human experience, knowledge, skills, competences, level of education, motivation for improvement and sense of decision-making [19]. The management of human factor requires effort and an appropriate approach that focuses on the importance of human resources as the most significant asset determining the success of an agricultural organisation. Key factors for this success are *motivation* [21], which largely depends on whether there is continuity of management in the agricultural holding (family – non-family workforce), the gender of the employees in the sector (emotionality – rationality), the age of the farmers (the young-old relationship, as well as experience-innovation and technology), and last but not least, the level of education (only practice or science and practice).

The choice between family and non-family workforce depends on the specific needs and goals of the agricultural organisation's activity. Both models, a family farm with a predominant family workforce or a farm with a predominance of non-family workforce, have their advantages and disadvantages and it depends on the farmer to determine which approach is best for the specific situation and opportunities.

The importance of gender of persons employed in agriculture also has its advantages, as women's participation in agriculture is critical to achieve sustainable development and promote gender equality globally.

The age distribution of the workforce in agricultural holdings is another factor determining the development with significance for the future of agricultural organisations. As older producers retire, there is a need for younger generations to enter the sector and ensure its sustainability. In addition, older people often bring valuable experience and knowledge and can help and advice younger agricultural entrepreneurs. It is necessary to encourage and support young people to enter the agricultural sector to ensure the continuity and sustainability of modern agriculture.

The development of the human factor also depends on another important point related to the changes and requirements of the contemporary dynamic environment, namely – continuous improvement of knowledge and skills through trainings [20, 21] and further training. Education and specialised training expand the scope of knowledge of agricultural producers, improve skills and competences, create a link between theory and practice, enhance the ability of human resources to apply modern ecological practices and techniques and make adequate and expedient decisions, which improves the management process, the entire cycle of agricultural activities, increases yields, improves efficiency.

(i)*The first factor for sustainability in agricultural holdings*, that we will highlight, *is the importance of a family – non-family workforce* and its impact on the efficiency and success of the agricultural organisation.

(ii)*The second factor for sustainability in agriculture in terms of people,* which we will focus on, is *the ratio of men to women employed in the agricultural sector.*

*(iii)*As *the third factor for sustainability in agricultural holdings,* we will consider *the age of human resources.*

*(iv)*As *the fourth factor for sustainability in agricultural holdings*, we will focus on *the importance of education and training of human resources*.

The combination of these factors creates conditions for implementing good ecological practices [11, 12] adopting innovations and technologies, expanding opportunities for different financing, combining practical experience with scientific achievements in the field of agriculture, balancing between emotional and rational management decisions, confirming generational renewal [20]. All this is important for the environmentally sound and sustainable development of agricultural holdings, which requires that ecological and economic interests are interdependent in the content of the ecological strategy, which is part of environmentally sound management [3].

In this context, the purpose of the research regards to study the human resources as factors for a sustainable development of agricultural holdings in Bulgaria, emphasising the importance of several main factors and their interrelationship, namely: family - non-family workforce, gender, age and education of farmers.

MATERIALS AND METHODS

The research methods used to study the significance of the human factor in achieving sustainability in agriculture include: general scientific research methods, surveys, discussion of case studies with examples from practice through interview, observation, review of scientific literature, summary and

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synthesis of statistical data from official sources, logical method, graphical representation of characteristics and trends.

Surveys collect information on the age ratio and educational level of farmers, case studies examine the experiences of individual farmers and how their age and education have affected their farming practices, observational studies provide information for analysing the behaviour of farmers of different ages and the judgment of action in different climatic conditions. Through interviews with those employed in the agricultural sector, their experiences of farming practices are understood, including how age and education influenced their approach to farming. The literature review provides an opportunity to analyse existing research and new lines of reasoning about the impact of age and education on farming practices.

By combining these methods, researchers can gain a deeper understanding of how age, gender, family and non-family workforce, and education reinforce the influence and give a defining role to the human factor in modern agriculture.

The tasks of the research include highlighting the more important, in our opinion, factors related to the characteristics of human resources, which are a prerequisite for sustainability in agricultural holdings in the conditions of an economy transforming towards sustainability.

To achieve the formulated goal, the factors family and non-family workforce, gender, age, education and training of those employed in the agricultural sector and their role in increasing the efficiency and sustainability of modern agriculture are tracked and analysed.

RESULTS AND DISCUSSIONS

Human resource management is a multifaceted process of formulating goals, making decisions, taking actions. The effectiveness and efficiency of management process depends on a number of factors related to the organisation and its functioning. The main of these factors is undoubtedly human. Therefore, all efforts of the management should be aimed at stimulating motivation, opportunities for development, long-term management decisions, oriented towards constant improvement of the qualifications and competences of employees [21, 22].

The first factor for sustainability in agricultural holdings, that we will highlight in our research on human resources in agriculture, is ***the importance of a family – non-family workforce*** and its impact on the efficiency and success of the agricultural organisation.

Regarding the most important factor in agriculture – the human one, the data indicate an increase in ***the non-family workforce*** and a slight percentage decrease, but a definite preponderance in ***the family labour sector*** [4, 5] in agricultural holdings, namely: in 2020, there are 294,306 persons permanently employed in the agricultural sector, who put in a total of 168,043 annual work units (AWU). 13,841 AWU are invested by temporarily employed and indirectly employed contractors (Figure 1).

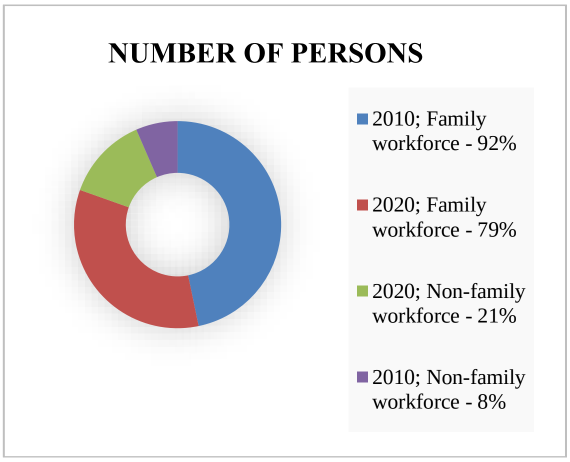

Fig. 1. Number of persons employed in agricultural sector
Source: Author's figure based on data from the Ministry of Agriculture, Agrostatistics [10].

A number of authors [6, 7] highlight the importance of ***the family workforce*** in family farms as a factor for sustainability and growth.

The significance of the labour force in agricultural holdings being family-based is that it creates a sense of belonging and community, commitment, cooperation and shared responsibility. When family members manage and work together, interests and goals are shared, there is a high degree of trust and ethics in relationships, a sense of empathy for problems and pride in successes. In case of crisis situations, need for change or daily routine needs, the family workforce is more flexible and willing to accept new tasks or replace a family member as needed, without negative attitudes or feelings of unfairness. In the case of a preponderance of family workforce in the agricultural organisation, the management process is adaptive, and the decisions are adequate and timely. Family members can react quickly and act successfully when changes occur, replace or protect each other in times of need or emergencies. This quick reaction is especially valuable when unforeseen weather conditions, difficult-to-overcome natural factors related to yield and other external or internal obstacles to the company occur.

Another advantage of having a family workforce in agricultural holding is that the members willingly and eagerly pass on all their knowledge, encourage the development of skills, share experiences and carry on the succession with the younger generations, thus ensuring continuity and sustainability of the family firm over time. The family farming model has been proven to be a successful and sustainable approach to agricultural production.

Regarding the other trend of ***non-family workforce*** in agricultural holding, we can also highlight positive aspects in the management process and farming activities such as bringing: different opinion, different perspective on problem solving, specific skills, diverse perspectives on the production methods. In a generationally closed family business, non-family workers can contribute to success with fresh ideas, techniques and work knowledge and experience not known within the family. In addition, the employment of non-family workers provides opportunities for job creation and economic growth in rural areas.

The non-family workforce allows for seasonal hiring for larger-scale campaigns and agricultural activities. Also, some of the workers, outside the family that runs the agribusiness, may have knowledge in specialised activities or have undergone training in areas such as working with agricultural machinery, new machines and technologies, and bringing their experience to help the farm be more successful and profitable, and the management process – more sustainable.

The organisational environment in a non-family agricultural holding has specifically defined positions and duties, as well as expectations. Relationships are primarily formal, as opposed to informal ones between the members of family firm. This makes the management process more expedient and regulated, and the performance indicators more sustainable. The working environment is mostly professional, communication is tight, responsibilities are clear.

The choice between family and non-family workforce depends on the specific needs and goals of the agricultural organisation's activity. Both models have their advantages and disadvantages and it depends on the farmer to determine which approach is best for the specific situation and opportunities.

The second factor of sustainability in agricultural holding in terms of people, which we will focus on and which is of particular interest, is ***the ratio of men to women employed in the agricultural sector***.

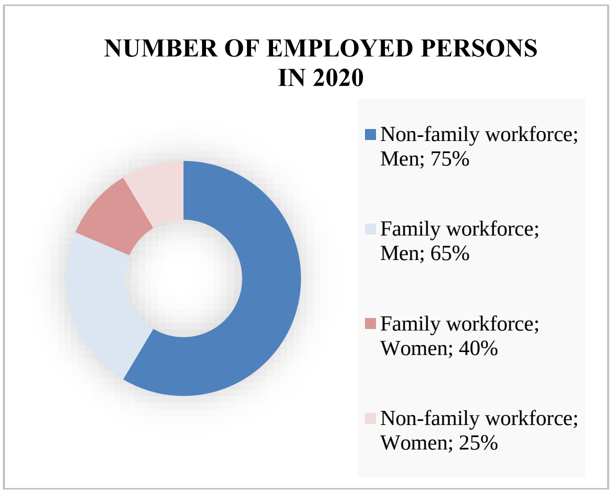

Fig. 2. Data on persons employed in the agricultural sector, 2020
Source: Author's figure based on data from the Ministry of Agriculture, Agrostatistics.

According to statistics disaggregated by ***gender*** of the employed human resources in agriculture, the data are as follows: 60% of those permanently employed as family workforce and 75% of those permanently employed as non-family workforce are men (Figure 2).

Research on the gender of agricultural workers is important because of the observed contemporary trend that, despite the historically entrenched tradition of male dominance in agriculture, today women make up a significant proportion of the agricultural workforce in many countries. This change is related to social and organisational development on a global scale and to the radical change in general in views, values and attitudes towards the place of women in all spheres of life in the world today. In terms of benefits, specifically in farming, the importance of gender and the entry of more and more women into the management and work of farms, this has the following positive aspects and benefits:

-women's participation in agricultural work provides them with income, improves their social status and empowers them to make decisions;

-women have experience and can be responsible for food production, processing and distribution;

-a problem in modern agriculture is the labour shortage and the participation of women can help to deal with this issue;

-elimination of the gender inequality, which prevails in the agrarian sector and can still be found in modern society;

-the participation of women in the work of agricultural holdings can contribute to the promotion of sustainable production practices by adopting more environmentally friendly farming methods, promoting crop diversification and reducing dependence on chemical fertilizers and pesticides.

-the higher degree of emotionality in women, in contrast to the prevailing rationality in men, is sometimes an advantage in making decisions related to the preservation of traditions, the spiritual appearance of rural areas, quick reaction in some crisis situations, changes related to the value system and others.

The importance of gender of the agricultural workforce is significant, as women's involvement in agriculture is crucial to achieve sustainable development and promote gender equality worldwide.

As a ***third factor for sustainability in agricultural holdings***, we will consider ***the age of human resources***. An interesting and indicative trend is the age ratio [9] of human resources in agriculture.24% of the permanently employed are aged 65 and over, 11% are under the age of 35 (Figure 3).

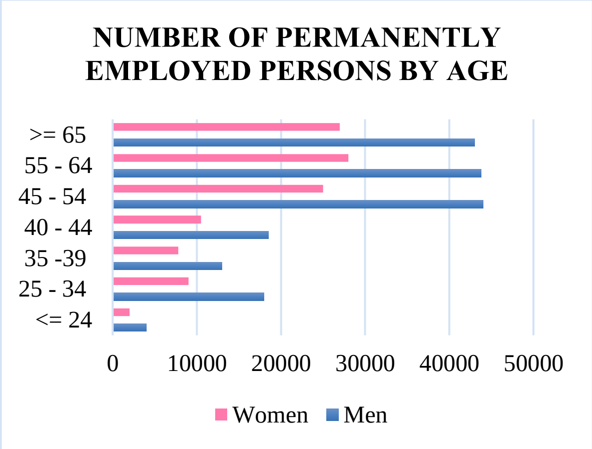

Fig. 3. Number of permanently employed persons in the agricultural sector by age
Source: Author's figure based on data from the Ministry of Agriculture, Agrostatistics [10].

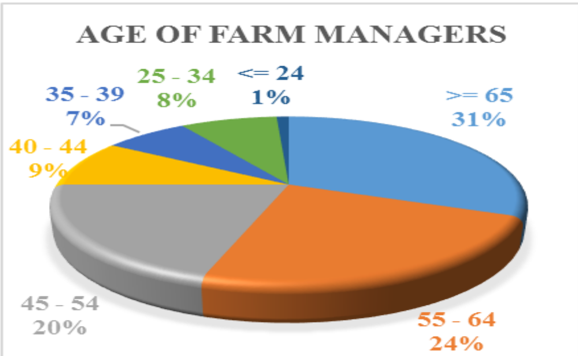

Fig. 4. Age of farm managers
Source: Author's figure based on data from the Ministry of Agriculture, Agrostatistics [10].

The tendency for the preponderance of male managers of agricultural holdings is still preserved – 95,645, although in recent years more and more women have taken risks and succeeded in the agricultural sector, showing managerial skills, leadership, knowledge and preparation. After 2020, more than 28% are women farm managers and they invest 20,223 AWU in agriculture.

The statistics also show another persistent trend regarding the age – 31% of managers are 65 and over, although the entry of younger management personnel is rising slowly but positively (Figure 4).

The age of human resources in agricultural holdings is an important factor in modern agriculture because:

-older producers need to transfer their knowledge, skills and experience to younger ones to ensure ***continuity*** and sustainability of farming operations;

-younger agricultural entrepreneurs are often more willing to adopt ***new technologies and innovative farming methods***, which helps increase productivity, reduce costs and promote sustainability in agriculture. The scientific literature [16] emphasises the importance of technologies in agriculture which young farmers are familiar with.

-the age of farmers also affects ***productivity***, as younger human resources working in the sector have more energy and physical stamina to cope with the requirements of work;

-the age of human resources in agricultural holdings is also important for the ***development of rural areas*** [13, 14, 15], since younger producers with their activity contribute to the economic development of rural areas [2] by creating job opportunities, increasing income and promoting social and cultural activities [8]. The listed main reasons give rise to draw the following conclusion: it is necessary to encourage and support young people to enter the agricultural sector in order to ensure the continuity and sustainability of modern agriculture.

The summarised data from the reasoning and conclusions made are presented in Table 1.

Table 1. Data related to the age of the human factor in agricultural holdings

AGE GROUPS (YEARS)												STATISTICAL REGIONS AND DISTRICTS
<= 24		25 - 34		35 -44		45 - 54		55 -64		>= 65		
Persons	AWU	Persons	AWU	Persons	AWU	Persons	AWU	Persons	AWU	Persons	AWU	
1,599	**931**	**10,945**	**6,307**	**20,636**	**12,950**	**27,296**	**17,088**	**31,948**	**18,833**	**40,918**	**21,140**	**BULGARIA**
218	***131***	***1,211***	***772***	***2,239***	***1,568***	***3,070***	***2,094***	***3,287***	***2,084***	***5,203***	***2,951***	***Severozapaden***
32	17	148	78	354	197	441	244	464	227	1,146	466	Vidin
47	30	304	203	515	381	706	534	688	486	1,037	718	Vratsa
41	24	196	125	339	230	432	291	505	312	881	469	Lovech
49	27	241	157	411	280	632	427	707	460	1,036	627	Montana
49	33	322	209	620	422	859	598	923	600	1,103	672	Pleven
223	***125***	***1,269***	***778***	***2,508***	***1,633***	***3,507***	***2,318***	***3,471***	***2,262***	***3,905***	***2,270***	***Severentsentralen***
47	29	279	174	606	427	757	543	771	525	1,032	525	VelikoTarnovo
22	8	112	57	232	119	222	116	284	157	478	225	Gabrovo
42	27	259	188	517	388	796	602	822	622	799	618	Razgrad
43	24	277	162	513	309	693	438	648	409	771	466	Ruse
69	37	342	197	640	389	1,039	619	946	550	825	435	Silistra
195	***113***	***1,385***	***834***	***2,800***	***1,730***	***3,767***	***2,413***	***3,876***	***2,395***	***4,328***	***2,237***	***Severoiztochen***
43	21	232	131	501	312	688	416	677	390	989	493	Varna
54	28	549	310	1,072	647	1,298	828	1,144	715	1,260	650	Dobrich
47	34	232	161	533	372	760	535	947	627	1,048	648	Targovishte
51	31	372	232	694	398	1,021	634	1,108	664	1,031	447	Shumen
279	***154***	***1,701***	***977***	***3,485***	***2,194***	***3,868***	***2,511***	***4,083***	***2,497***	***4,939***	***2,662***	***Yugoiztochen***
107	64	551	342	1,223	808	1,333	893	1,470	948	1,675	957	Burgas
72	37	443	238	861	504	919	536	944	478	1,233	511	Sliven
64	35	402	235	877	566	956	668	846	588	999	697	Stara Zagora
36	17	305	162	524	316	660	414	823	483	1,032	497	Yambol
276	***175***	***1,938***	***1,285***	***3,662***	***2,368***	***4,921***	***3,130***	***6,055***	***3,762***	***8,334***	***4,826***	***Yugozapaden***

Source: Ministry of Agriculture, Agrostatistics [10].

It can be summarised that the age distribution of the workforce in agricultural holdings has an essential importance for the future of agricultural organisations. As older producers retire, there is a need for younger generations to enter the sector and ensure its sustainability. Furthermore, older people often bring valuable experience and knowledge and can help and advice younger agricultural entrepreneurs.

As ***the fourth factor for sustainability in agricultural holdings from the perspective of the human factor***, we will emphasise on *the importance of* ***education and training*** *of human resources*. Education and passing through specialised training expands the scope of knowledge of agricultural producers,

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improves skills and competences, creates a link between theory and practice, improves the ability of human resources to apply modern ecological practices and techniques and make adequate and expedient decisions, which improves the management process, the entire cycle of agricultural activities, increases yields, improves efficiency. Through appropriate education, producers acquire the necessary knowledge to protect the environment. An important advantage of educated farmers is awareness and use of new technologies and innovations to improve productivity and profitability. In addition, the educated farmer is well informed and familiar with financing opportunities [1] and inclusion in various support programmes.

We can present the summary results related to the trends regarding the practical ***experience, training and education of the human factor*** in management in Tables 2 and 3.

Table 2. Data on the experience, training and education of the human factor in management

Statistical regions and districts	Total	Only practical agricultural experience	Basic agricultural training (a course in agriculture with a minimum of 150 hours)	High-school specialization in agricultural training	University degree in agriculture
Bulgaria	**132,742**	**110,284**	**9,995**	**7,961**	**3,962**
Severozapaden	***15,228***	***12,608***	***1,330***	***868***	***422***
Vidin	2,585	2,174	118	233	60
Vratsa	3,297	2,725	352	161	59
Lovech	2,394	1,992	238	95	69
Montana	3,076	2,667	204	128	77
Pleven	3,876	3,050	418	251	157
Severentsentralen	***14,883***	***10,880***	***1,506***	***1,704***	***793***
VelikoTarnovo	3,492	2,679	349	272	192
Gabrovo	1,350	1,112	132	55	51
Razgrad	3,235	2,480	144	488	123
Ruse	2,945	1,867	473	356	249
Silistra	3,861	2,742	408	533	178
Severoiztochen	***16,351***	***12,819***	***1,193***	***1,600***	***739***
Varna	3,130	2,386	297	340	107
Dobrich	5,377	2,876	482	626	393
Targovishte	3,567	2,958	161	337	111
Shumen	4,277	3,599	233	297	128
Yugoiztochen	***18,335***	***14,273***	***1,833***	***1,435***	***814***
Burgas	6,359	4,750	797	588	224
Sliven	4,472	3,814	307	230	121
Stara Zagora	4,144	3,213	405	248	278
Yambol	3,380	2,496	324	369	191
Yugozapaden	***25,186***	***22,285***	***1,700***	***951***	***250***
Blagoevgrad	13,569	12,416	716	379	58
Kyustendil	4,218	3,576	389	208	45
Pernik	2,000	1,738	127	102	33
Sofia-grad	656	571	55	13	17
Sofia-oblast	4,743	3,984	411	249	97
Yuzhen tsentralen	***42,739***	***37,959***	***2,433***	***1,403***	***944***
Kardzhali	8,705	8,394	228	62	21

Source: Ministry of Agriculture, Agrostatistics [10].

Table 3. Number of persons and average work unit in Bulgaria by region and district

Number of persons and average work unit in Bulgaria by region and district						
Statistical regions and districts	Total		Sex			
			Men		Women	
	Persons	AWU	Persons	AWU	Persons	AWU
Bulgaria	132,742	77,249	95 645	57,026	37,097	20,223
Severozapaden	15,228	9,540	11 423	7,353	3,805	2,187
Vidin	2,585	1,228	1,886	921	699	307

Vratsa	3,297	2,351	2,502	1,834	795	517
Lovech	2,394	1,450	1,780	1,105	614	344
Montana	3,076	1,978	2,303	1,523	773	455
Pleven	3,876	2,533	2,952	1,969	924	564
Severentsentralen	14,883	9,386	11,241	7,230	3,642	2,156
VelikoTarnovo	3,492	2,223	2,669	1,736	823	487
Gabrovo	1,350	681	1,005	519	345	163
Razgrad	3,235	2,445	2,508	1,908	727	538
Ruse	2,945	1,808	2,268	1,424	677	384
Silistra	3,861	2,228	2,791	1,643	1,070	585
Severoiztochen	16,351	9,723	12,001	7,284	4,350	2,439
Varna	3,130	1,762	2,356	1,365	774	397
Dobrich	5,377	3,177	4,081	2,481	1,296	696
Targovishte	3,567	2,377	2,574	1,723	993	654
Shumen	4,277	2,407	2,990	1,715	1,287	692
Yugoiztochen	18,355	10,995	13,092	8,080	5,263	2,915
Burgas	6,359	4,013	4,660	2,997	1,699	1,016
Sliven	4,472	2,304	3,013	1 623	1,459	680
Stara Zagora	4,144	2,789	2,952	2,035	1,192	754
Yambol	3,380	1,889	2,467	1,425	913	464
Yugoiztochen	25,186	15,546	18,161	11,398	7,025	4,148
Blagoevgrad	13,569	8,511	9,867	6,193	3,702	2,318
Kyustendil	4,218	2,235	2,918	1,590	1,300	645
Pernik	2,000	1,322	1,410	972	590	351
Sofia-grad	656	472	481	359	175	113
Sofia-oblast	4,743	3,006	3,485	2,285	1,258	721
Yuzhen tsentralen	42,739	22,058	29,727	15,680	13,012	6,379
Kardzhali	8,705	4,863	5 568	3,073	3,137	1,789
Pazardzhik	8,989	4,402	6,836	3,386	2,153	1,017
Plovdiv	10,897	7,003	9,719	5,261	2,980	1,772
Smolyan	6,204	1,748	4,158	1,173	2,046	575
Haskovo	7,944	4,043	5,248	2,816	2,696	1,226

Source: Ministry of Agriculture, Agrostatistics [10].

The statistics [10] show that the producers from the Pleven District – 3,050 – are the ones with mostly more practical experience, and the same district is the leader in terms of training and education indicators –with basic agricultural training – 418, with secondary vocational agricultural education – 251 and with higher agricultural education – 157. People with higher education are fewer than people with secondary vocational agricultural education, and this trend clearly highlights the need to encourage farmers to increase their competence. In the other regions, the trend is the same: in the North Central (Severen Tsentralen) Region, Ruse District leads with the most higher education graduates – 249, followed by VelikoTarnovo District– 192, and Gabrovo District with the least –51. The Northeast (Severoiztochen) Region and Southeast (Yugoiztochen) Region maintain the tendency for the preponderance of people in the agricultural sector with basic agricultural training and secondary vocational agricultural education, and the data for the Dobrich District, as the most traditional area related to agricultural activity, are as follows: basic agricultural training – 482, secondary vocational agricultural education – 623, higher agricultural education – 393.In the Southwest (Yugozapaden) and South-Central (Yuzhen Tsentralen) Regions, the data clearly indicate the presence of the largest number of farmers with basic agricultural training and secondary vocational agricultural education, with only 97 farmers in the Sofia District, therefore the trend from the other regions is again maintained.

The data in the table [10] related to the education and training of agricultural producers by regions and districts in the Republic of Bulgaria show that people with practical experience, with basic agricultural training or with secondary vocational agricultural education have a significant advantage over people with higher education. Following the statistics by regions and districts, with a higher percentage ratio are agricultural entrepreneurs who do not have a higher education, which has its impact on the success of agricultural science and practice. This finding confirms the need for the thesis advocated by us to emphasise the need for more educated and competent agricultural producers. This factor for the sustainability is clearly linked to the other factor we have considered – age. The preponderance of practical experience over specialised scientific training is tied to the preponderance of older producers over younger agricultural entrepreneurs. This trend and interrelationship between the factors age – education strengthens the direction of development in modern agriculture, namely – stimulation and motivation with all ways and methods for the entry of young trained personnel into the agrarian sector, which will guarantee its sustainability and development towards innovation, digitalisation, ecological management combined with experience and skills passed down through generations.

We can summarise that the training and education of people working in agriculture, as well as the importance of gender and the entry of more and more women into agriculture as the trend of male predominance, according to the indicated statistics, is beginning to change and play an important role in its development and sustainability.

The combination of age and education contributes to the development of specific skills and knowledge in agribusiness by passing on valuable experience of traditional farming practices from the elders, while the younger ones are more familiar with new technologies and innovations, which balances skills and makes farming more efficient and productive.

CONCLUSIONS

Findings from the study on the influence of *age and education on the human factor* in agriculture can provide valuable insight into the practices and behaviour of farmers:

-Older farmers have more experience and traditional knowledge in agriculture and rely more on traditional methods, so they are less likely to adopt new technologies or sustainable farming practices, while younger farmers are more innovative and open to the digitalisation of the transforming to sustainability economy. The analysis carried out by the *age* factor found statistically predominant older producers, but with a definite increase in the tendency for young entrepreneurs to enter the agrarian sector.

-Education and training play an important role in modern agriculture, as agribusiness requires a thorough understanding of the science of agriculture, including soil science, crop and animal production. In addition, education can help farmers keep pace with the latest technologies and practices and make informed decisions about managing their operations.

Entrepreneurs with a higher level of education are more likely to adopt sustainable farming practices, while older farmers are more resistant to change. The study of the *education* factor shows that in Bulgaria there is a tendency for people with basic agricultural training or with secondary vocational agricultural education to prevail over people with higher education, which confirms the need to increase the educational level of agricultural producers.

The influence of age and education on farming practices varies according to the specific context and culture of the farming community under study. Therefore, it is important to interpret the results of each study carefully and take into account the unique characteristics of the Bulgarian farms studied.

The age and education of people working in agriculture are significant factors in the success and sustainability of the sector.

By encouraging the education and training of the next generation of agricultural entrepreneurs to enter the agricultural sector, agriculture ensures its steady success and growth.

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ANALYSIS OF PROFITABILITY OF VEGETABLE PRODUCTION DURING AND AFTER COVID-19 LOCKDOWN IN SOUTHWEST NIGERIA

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Abstract

The study examined the profitability of vegetable farming during and after the Covid-19 lockdown in Southwest Nigeria. It specifically addressed the socioeconomic characteristics of the farmers, the estimated cost, and the returns of vegetable production both during and after the COVID-19 lockdown determined the factors influencing production of vegetables. A Multistage random sampling was employed in the study. The first stage was a random selection of three (3) States from the six (6) States in South West, Nigeria. Three (3) Local Government Areas were randomly chosen from each selected State. Two (2) communities were sampled randomly from each of the Local Government Areas selected and random sampling of fifteen (15) farmers from each community, giving a total of 270 respondents. Descriptive statistics, Budgetary analysis and Ordinary least squares (OLS) Regression Analysis were applied to data collected. The result showed that majority (41.9%) of respondents were in the active age with the mean age of 42 years. Majority (67%) of the respondents were male with household size ranging between 4 and 6 persons. About (64.1%) were married with an average year of farming experience of 31 years. The profitability analysis revealed the net farm income realized during and after COVID-19 was N124,393.9 and N258,587.3 per hectare, respectively. According to the calculation of the gross margin, the value per hectare during and after COVID-19 was N146,219.8 and N270,374.4, respectively. During and after COVID-19, the Benefit Cost Ratio was 2.85 and 4.6 which indicate that for every one naira spent ,₦2.85 and ₦4.6 will be realized as revenue respectively, implying that vegetable production is profitable in the study area. Results of the regression(OLS) analysis showed the basic variables that significantly influenced profit generation during COVID-19 scenario are quantity of vegetable output, gender of the farmer, farmers year experience and cost of labour while variables that influenced profitability after COVID-19 are quantity of vegetable output, gender of the farmer, marital status, household size and access to credit. The study also revealed the major farmers' perception about COVID-19 as it disrupted Supply chain of vegetables, caused harvest losses for vegetable farmers, reduced vegetable farmers' income during the lockdown and income reduction was ranked 1st among various perceptions observed. The study found that as the age of vegetable farmers increases, their profit decreases across all production scenarios, a policy that focuses on ways to attract and encourage young people who are agile and strong to start growing vegetables will help to boost technical efficiency and their income. Education should also be encouraged among vegetable farmers in the study area since the study revealed that education will enable them to adopt new technologies that will make them to have more profit from their production.

Key words: *effects, COVID-19, lockdown, vegetables, production, South-west, Nigeria*

INTRODUCTION

Coronavirus Disease 2019 (COVID – 19) was first surfaced in the Chinese city of Wuhan in December 2019. Dr. Li was the first to identify the virus, and the disease soon spread to a worldwide scale, prompting the World Health Organization (WHO) to designate the disease a pandemic on March 11, 2020 (WHO, 2020) [32]. The disease's rapid expansion has drew the attention of medical professionals, academics, and other researchers all over the world, who are trying to figure out the cause, how it spreads, and what can be done to stop it. COVID - 19 is active and stable at temperatures below 6 degrees Celsius, but loses potency as the temperature rises, according to Madhukalya and Kapoor (2020) [19, 17]. Warmer weather, according to Russman et. al (2020) [26], may impede the spread of this virus however, not everywhere in the globe. The COVID-19 epidemic was caused by the SARS-CoV-2 virus (formerly known as Corona virus). Since World War II and the founding of the United Nations, the COVID-19 pandemic has presented the world with its biggest challenge (UN, 2020) [29]. It is believed to have started in Wuhan, Hubei Province, China, in December 2019. COVID-19 is still spreading over the world. China initially served as the outbreak's focal point, with cases being reported there or among Chinese tourists. On February 27, 2020, the first verified case of the 2019 coronavirus pandemic in Nigeria was disclosed, when an Italian citizen in Lagos tested positive for the virus (NCDC, 2020) [21]. Clearly, the emergency is medical or epidemiological in origin. This outbreak, is assumed to have direct and indirect effects on household food security, livelihoods, and economic activity in Nigeria and the rest of the countries. The effect of the Corona virus outbreak on food security is projected to grow in scope, scale, and severity as the pandemic continues. Furthermore, the pandemic is occurring in areas where food insecurity is already a major issue. The government imposed urgent adaptation of standard physical distancing and lockdown strategies, especially in urban centers, rural settlements, and places affected by active pandemics, to avoid adding a food crisis to the existing health crisis, which would otherwise 2 exacerbate the pandemic's negative effects.

Due to the COVID-19 pandemic's transportation restrictions and lockdown, there was a labor shortage that reduced agricultural output (Ayetoro, 2020) [6]. The impact of the COVID-19 pandemic on agriculture has grown in importance with the pandemic's worldwide spread in the context of contemporary agricultural development. Numerous angles have been used to study how the pandemic has affected agribusiness (Henry 2020; Morton 2020) [13, 20]. Smallholders farmers in Nigeria were taken aback when the government imposed a lockdown at the end of March. Security personnel imposed mobility restrictions indiscriminately over the country, many farmers could not access their fields. Farmers' access to markets was severely hampered as well. Because most small-scale farmers lack storage facilities, they were forced to either let their vegetables rot or sell them for a low price to unscrupulous intermediaries Vegetables are essential for human nutrition because they provide essential vitamins, minerals, and fibre. They are essential anti-oxidant foods that are also extremely beneficial for improving fitness and preventing sickness. They include cherished food components that may be used to successfully accumulate and rejuvenate the body. Vegetables are important for maintaining the body's alkaline reserve. Their high vitamin and mineral content is the key reason for their popularity. Vegetables come in a variety of shapes and sizes. Edible roots, stems, leaves, fruits, and seeds are all possibilities. Each group makes a unique contribution to the diet. Fleshy roots have a high energy content and are high in vitamin B. Carbohydrates and proteins are abundant in seeds. Minerals, vitamins, and water are abundant in leaves, steam, and fruits. Vegetable consumption in Nigeria is increasing year after year, owing to a growing appreciation of their nutritional value (Osalusi, 2019) [25]. Exotic vegetables are a distinct category of vegetables in Nigeria. They're well-known for their distinct flavor, nutritional content, and health advantages. They aid in maintaining the body's fluid equilibrium. Vegetable production as a small-scale enterprise can financially empower the underprivileged, particularly women with little capital, access to land, and labor constraints (Lewis, 1997) [18]. They are well-known for their distinct flavor, nutritional content, and health advantages. They contribute greatly to home food security and enable women achieve some degree of financial freedom within the family budget with the money they offer.

Problem statement

COVID-19 and the associated economic issues, according to many studies, will lead to a global food catastrophe, mainly in Africa, if the food system is unable to adapt (Blanke,

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2020) [7]. According to previous studies, half of Africans are already food insecure, with half of them being seriously food insecure, and the number of hungry people is expected to treble by 2020. According to several research, the African continent is already facing food security issues (Blanke, 2020) [7]. African farmland is already being impacted by locust swarms in the Horn of Africa, local conflict, insecurity, and drought brought on by climate change. These catastrophes cause the loss of crops and incomes for millions of smallholder farmers in Africa (Brookings, 2020) [8]. Aside from that, the COVID-19 pandemic's arrival has weakened and exacerbated current output and distribution capacity, particularly in SSA (Blanke, 2020) [7]. The difficulties facing Africa during and post COVID-19 pandemic are grave, necessitating major actions focused on critical sectors in order to speed the reform of the food system and reduce rising food insecurity and poverty. According to the 2019 Global Food Report, world hunger is on the rise (WFP, 2019) [30]. Poverty and hunger are increasing in practically all African sub-regions, making Africa the region with the highest prevalence of hunger, with an increasing proportion of farming households experiencing food insecurity (GODAN, 2020) [11]. The 2019 edition demonstrates that considerable obstacles remain in the fight against food insecurity and poverty in all forms.. The arrival of COVID-19 has exacerbated the country's food crises and severe poverty levels. This consequence is quite concerning, as it jeopardizes the livelihoods of the world's poorest people, the majority of whom rely on agriculture (GODAN, 2020) [11]. The COVID-19 has already increased the likelihood of acute food insecurity for most farming households (GODAN, 2020) [11]. During times of crisis, the world's poorest people are more likely to run out of food, resulting in hunger and, in extreme cases, going days without eating, putting their health and wellness at risk (FAO, 2019) [9]. The COVID-19 epidemic has had major effect on the production and supply chain of vegetables. Let's take the delivery of vegetables as an example. In Nigeria, the delivery of vegetables from the fields to the consumer includes a number of stages, including production, transportation, wholesale, and retail. Vegetable output has decreased as a consequence of the pandemic's impact on production and the supply chain, which has also caused problems. Furthermore, vegetable production is unappealing due to the time-consuming processes involved, and high production costs are relatively high due to the relative high cost of labor, input costs, and supply chain complications caused by the impact of covid-19, affecting farmers' income and standard of living.

As a result, this study investigates the impact of COVID-19 lockdown on vegetable farmers and their income generation in Southwest, Nigeria. Consequently, this study seeks and hopes to provide answers to the following pertinent research questions such as:

(i)what are the socio-economic characteristics of the vegetable farmers in the study area?

(ii)what are the costs and returns of vegetable production during and after the lockdown?

(iii)what are the factors influencing the profitability of vegetable in the study area?

(iv)What are perceived effects of covid-19 lockdown on production of vegetables in the study area?

Objectives of the Study

The general objective of the study is to investigate the effect of COVID-19 lockdown on vegetable production and farm-income generation in Southwest, Nigeria. Specifically, the research objectives are to:

(i)describe the socio-economic characteristics of the vegetable farmers in the study area;

(ii)estimate the cost and return of vegetable farmers during and after the COVID-19 lockdown;

(iii)determine the factors influencing the profitability of vegetable in the study area;

(iv)ascertain the perceived effect of covid-19 on production of vegetable in the study area.

Justification

The coronavirus (COVID-19) pandemic has had a significant impact on Nigeria's economy, particularly the agricultural industry and farm households. Due to the lockdown, mobility restrictions, reduced availability of labor and other inputs, and reductions in output prices resulting from drops in demand for commodities in specific market segments, farm enterprises have encountered production problems. Farm households may also be harmed by the loss of salaries and benefits from off-farm labor, which they rely on to fund farm production demands, household living expenses, investments, and debt payments. While various studies have looked at how the pandemic might affect global and national economic indicators like global poverty, government spending, GDP growth, budget deficits, and employment (ILO 2020a; ILO 2020b; Nicola et al. 2020; Sumner et al. 2020; UN-Habitat and WFP 2020; World Bank 2020) [15, 16, 22, 27, 28, 31, 33]. There is a scarcity of data on how the epidemic and attendant lockdown restrictions impacted individuals in farm households. As a result, it's difficult to comprehend the repercussions and support mechanisms at the farm household level that can be used to assure income smoothing. Furthermore, given the high degree of unpredictability in the spread of the COVID-19 infection and the severity of the effects at the international level, a comprehensive analysis of the pandemic's impact on socioeconomic characteristics, agriculture, dietary intake, and food security is not yet available as far as we know, owing to the fact that the pandemic is still ongoing globally. As a result, it is critical to comprehend COVID-19's immediate socioeconomic ramifications, as well as how COVID-19 will affect the earnings and standard of living of vegetable farmers. This study, which will contribute to the growing body of literature on the COVID-19 pandemic, looked at the financial effects of the COVID-19 outbreak and the induced lockdown restrictions in South-West Nigeria, as well as the implications on vegetable farmers and their income with their standard of living. Based on the effect of the lockdown on their quality of life, the results will aid researchers in better understanding the urgent needs of farm families in rural areas as well as the variables that affect their ability to generate income. The results will also be used as a supplement to existing knowledge to inform policy talks about farmers' livelihood coping mechanisms during the COVID-19 pandemic and to support decision-making on how to protect the livelihoods of vegetable growers who are the most vulnerable to the pandemic. This study will also act as a roadmap for other academics who want to do more research in this area.

As a result, the purpose of this research is to look at the economic losses caused by the COVID-19 pandemic in terms of agricultural labor loss, income generation, and other accounting expenses like labor cost, as well as to offer potential solutions for addressing the COVID-19 pandemic's effects on farmers in Southwest Nigeria who produce vegetables..

MATERIALS AND METHODS

The Study Area

The research was done in Southwest, Nigeria using a representative selection of 3 states. The zone is made up of six States which are; Ekiti, Ondo, Osun, Ogun, Oyo and Lagos, while the representative states are Lagos, Osun and Ekiti. The area lies between longitude 30°and 7°E and latitude 4°and 9°N with a total land area of 77,818 km^2. National Population Commission, (2007) reported that 27,511,892 people lived (14,049,594 males and 13,462,298 females) in Southwest, Nigeria. It has two distinct seasons which are: rainy season (April-October) and dry season (November-March). The temperature of the zone ranges between 21 and 28 degree centigrade (^{0}C) with high humidity of 77 percent. Hence, crops and livestock production are done with little problems in the area. The major occupation of the people is agriculture. The other occupations include trading, driving, carpentry, etc. The official language is English, while the major informal language for communication in this region is Yoruba, which has different dialects. The choice of the selected states is due to the following:

-*Lagos state*: (i) was reported as the most hit and is the economic hub of the region, (ii)High number of vegetable farmers with several flooded areas useful for the production of vegetable farmers especially during the non-rainy sessions;

-*Osun state* (i) Third most hit state in the regions of the COVID-19 pandemic and one of the economic hubs of the region, (ii) Highest number of vegetable farmers with several flooded areas useful for the production of vegetable farmers especially during the non-rainy sessions.

- *Ekiti State*: (i) this state has been reported as the least hit and relative economic activities hub of the region (ii) Moderate number of vegetable farmers with highest number of irrigated vegetable farming.

Sampling Technique

A multi-stage sampling technique was employed to select respondents for the study. There are six (6) States in South West of Nigeria, namely Ondo, Osun, Ekiti, Ogun, Lagos and Oyo. At the first stage, three (3) States were randomly selected (Osun, Ekiti and Lagos) out of the six (6) States.

In the second stage, three (3) Local Government Areas (regions renowned for their vegetable farming) were randomly chosen from each of the states that had been chosen. A total of two (2) communities from each Local government area were chosen at random for the third stage. During the final stage, a random selection of fifteen (15) farmers in each community. In all, a total of two hundred and seventy (270) respondents were selected for the study.

Data Analysis

Data for analysis were generated primarily using interview scheduled and structured questionnaires administered to two hundred and seventy (270) respondents selected for the study.

Analytical Technique

Using both descriptive and inferential statistics, the study's data were examined. Descriptive statistics like mean, percentages, and frequency distribution were used to evaluate Objectives I and IV. Using budgetary analysis, objective II was examined.

With the help of (OLS) regression, objective III was examined.

Model Specification

The gross margin analysis was used to estimate the profitability of vegetable production across several production scenarios. According to previous research, gross margin is the difference between total revenue (TR) and total variable cost (TVC). According to previous research, the bigger the gross margin, the higher the profit earned by vegetable producers. As a result, the analyses' mathematical notation is shown below:

GM = TR - TVC.....................................(1)

GM stands for gross margin,

TR for total revenue,

and TVC for total variable cost (these are the expenses incurred in production that does not depend on the level of output). These include costs of chemical, fertilizers, labour and seeds.

Pq =Price of the Vegetable per kg,

q Pcm =Market price of variable input.

Also, the Net Revenue (NR) was calculated using the formula as follows:

NI= TR-TC ....(2)

The net income model is expressed as below:

TC= TFC+ TVC ....(3)

NI= TR-TC

Cost Benefit Ratio = TR/TC

where:

NI=Income in Naira/ha

TR=Total Revenue in Naira/ha

TC= Total Cost

TFC = Total Fixed Cost

where: TFC = Total fixed costs.

TVC = Total Variable Cost in Naira/ha

TVC = Gross Margin in Naira/ha.

Ordinary Least Square Regression Model (OLS)

The OLS regression analysis was employed to ascertain factors influencing vegetable production as applied in Fakayode et.al. (2011) [10].

The model is specified as:

$Y = f(\beta X + \mu i)$ … … . . ..(4)

where:
Yi = Total farm output in kilogram
β = parameters to be estimated
X = explanatory variables
Ui = error term
The model is specified as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + + \beta_9 X_9 + \beta_{10} X_{10} + \mu i$ ....(5)

where:
Y= Total farm output in kilogram
The explanatory variables used in the analysis are:

X_1 = Farm size (ha)
X_2 = Farm experience (years)
X_3 = Level of education
X_4= Cost of labour
X_5 = Household size (number of persons in the household)
X_6 = Access to credit (Yes = 1, No = 0)
X_7 = Transportation
X_8 = Output (kg)
X_1 = Gender
$X_{8\ 8}$= Age (years)
X_{98} = Marital Status (Married=1; Otherwise = 0

RESULTS AND DISCUSSIONS

Socio-economic characteristics of the farmers

Table 1 shows that vegetable production is gender dependent given that majority of the farmers were male (67%) and the remaining ones were females, implying that males were more involved in vegetable production enterprise than their female counterparts. The results revealed The result revealed that majority (41.9%) of the famers were between 41 and 50 years of age, out of which male farmers were 35.2% and female vegetable farmers were 6.7%. By implication, the result depicts that vegetable farmers are relatively young, active and have agility to carry out farming activities and the mean age is 42 years, which simply implies that the vegetable farmers in this region were still in an era when they can work. The findings imply that most respondents were in their middle years, falling within the Food and Agriculture Organization's stated age range of 30--50 for agricultural productivity (FAO, 1997; 2005).The results reveal that majority of the respondents (64.1%) were married while single, widowed and divorced respondents are (16.7%), (6.3%) and (12.9%) respectively.

This is an indication that Married people dominated the activities in the study region. The marital status of a farmer may have a substantial impact on production decisions, according to Omolehin et al., 2007[24]. The majority of respondents, it was discovered by the results, were married. They believed that married individuals were most likely to have the best capacity in traditional African society, which would result in higher output/income. The result showed that majority of the farmers were fairly educated with 22.2%, 25.2% and 19.6% having primary, secondary and tertiary education respectively. This means that the farmers had minimum level of education that could enable them to adopt and search for the latest innovation and agricultural technology in vegetable production. This is in agreement with the findings of Akinbile (2003) [3], who reported that educational level of respondents enhances their comprehension of technical information and hence influence their profitability and production.The result further revealed that majority (50%) of the respondent had a farm size between 2.5ha and 4 ha out of which male vegetable farmers were (37.4%) and about (12.3%) were female. About 38.1% of them had a farm size less than 2 ha, while 11% had between 4.5ha and 6ha, with the average mean farm size put at 3 hectares, this implies that production could be improved upon as 3 hectare per average household of 5 persons is on the low side. The result is similar to that of Apata et al. (2011) [5], who posited that subsistence farmers play an important role for food security with an average farm size ranges between 1-3 hectares. Since the majority of respondents have farm holdings of less than 3 hectares, it means that these farmers cannot achieve economies of large-scale production. Small farm size is an impediment to agricultural mechanization because using farm machineries like tractors to control weeds will be difficult. The results revealed that majority (41.9%) of the respondent had been engaged in vegetable production for less than 10 years. Also, about (5.2%) of the respondent had farming experience between 21and 30 years, only (11.5%) had 11 years and above as farming experience, while about (41.5%) of the respondent had engaged in vegetable production for 31 years and above. According to Adebayo (2006) [1], the longer a person stays on a particular job, the better the job performance tends to be. The result further showed that majority (86%) of the vegetable farmers stated they had been refused access to credit facilities for their farming operations in the study region. About 63.6% of vegetable farmers were male, compared to about 23.4% of female farmers without recourse to credit. This suggests that the targeted vegetable producers in the study area have very limited access to credit facilities or that those facilities are most likely not reaching them. This finding is not encouraging because it raises the possibility that the farmers in the study region will produce less and make less money if they have restricted access to credit.

Thus, Okoh et al (2015) [23], found that the major factors responsible for decline of production and profitability are inadequate credit facilities and low capital. Ajah et.al. (2017) [2] stated that limited access to credit perpetuates poverty and low quality of life among farmers who may wish to adopt more profitable innovations.

Table 1. Socio-economic Characteristics of the Respondents

Variables	Male	Percentage	Female	Percentage	Mean
Age(Years)					
01 – 30	15	5.6	28	10.4	
31 – 40	5	1.9	14	5.2	
41 – 50	95	35.2	18	6.7	
51 – 60	38	14.1	15	5.6	
>60	42	15.6	0	0.0	42
Marital status					
Married	149	55.2	24	8.9	
Divorced	22	8.1	13	4.8	
Widowed	17	6.3	0	0.0	
Single	7	2.6	38	14.1	
Level of Education					
No formal	68	25.2	21	7.8	
Primary	60	22.2	0	0.0	
Secondary	28	10.4	40	14.8	
Tertiary	39	14.4	14	5.2	
Farm size(ha)					
<2	76	28.1	27	10	
2.5 – 4	101	37.4	34	12.6	
4.5 – 6	18	6.7	14	5.2	
Farming Experience					
<10	78	28.9	35	13	
11 – 21	72	26.7	40	14.8	
21 – 31	14	5.2	0	0.0	
>31	31	11.5	0	0.0	
Access to credit					
No	169	62.6	63	23.4	
Yes	26	9.6	12	4.4	

Source: Field survey, 2021.

Estimated Costs and Returns on vegetable production during and after covid-19 in the study area

According to the findings of the profitability analysis (Table 2), the study area's Total Variable Cost (TVC) per hectare for vegetable output before and after COVID-19 was N51,239.45 and N58,486.7, respectively. The majority of the costs incurred during vegetable production in the study region are comprised of the expenditure used in the production of vegetable in the study area. Among the variable costs recorded by the vegetable producers, land clearing recorded the highest cost during covid-19 as ₦12,514.25 representing 17% per hectare of the overall cost of production. Additionally, after COVID-19, plowing expenses accounted for the highest variable cost paid in the production of vegetables, totaling 29.3%.

From the results, , the net farm income realized by a farmer during and after covid-19 accounted for ₦124,393.9 and ₦258,587.3 per hectare respectively. The gross margin analysis revealed a value of ₦146,219.8 and ₦270,374.4 per hectare during and after covid-19 respectively. The positive values obtained during and after Covid-19 indicated that In the study region, growing vegetables is a successful business. The revenue generated by the cultivation of vegetables in the study region is not significantly different from the revenue generated by the cultivation of a different exotic vegetable (watermelon) in the states of Ekiti and Borno, respectively. In Ekiti State, according to Ajewole (2015) [4], the gross margin for vegetable production was N138,044.22 per hectare, while in Borno State, according to Ibrahim (2011) [14], the gross margin for vegetable production was N105,002.95 per hectare. It was discovered that the yield on invested naira was 1.70 and 3.68 during and after COVID-19, respectively. This means that during COVID-19, a farmer in the study area earned N1.70K in profit for every N1 invested in vegetable produce, while the area also saw a return of N3.68K after COVID-19.The Benefit-to-Cost Ratio of ₦2.85 and ₦4.6 during and after covid-19 also indicate that for every one naira spent ,₦2.85 and ₦4.6 will be realized as revenue respectively and so farmers in the region can go on with production of vegetable.

Gross Margin (GM) = TR –TVC (During Covid-19)
= ₦197,459.20 -₦51,239.45 = ₦146,219.80.
Gross Margin (GM) = TR – TVC (After Covid-19)
= ₦328,861.10 – ₦58,486.70 = ₦270,374.40
Therefore,
Benefit Cost Ratio(BCR) =Benefit/Cost (During Covid-19)
= ₦146,219.80/ ₦51,239.45 = ₦2.85.
Benefit Cost Ratio(BCR) =Benefit/Cost (After Covid-19)
=₦270374.40/₦58,486.70 =₦4.6.
Return on Investment = Net Return/Total Cost (Before Covid-19)
= ₦124,393.90/₦73065.29 =₦1.70.
Return on Investment = Net Return/Total Cost (After Covid-19)
=₦258,587.30/₦70273.78 =₦3.68

Table 2. Estimated Cost and Return of Vegetable Production During and After Covid-19

Description	During Covid-19 Lockdown	% of Total Cost	After Covid-19 Lockdown	% of Total Cost
Variable Cost				
Land Clearing	₦12,514.25	17.1	₦15,354	21.8
Ploughing	₦15,800	21.6	₦20,580.5	29.3
Chemical Application	₦2400	3.3	₦3,000	4.3
Fertilizer	₦5,000	6.8	₦4,500	6.4
Herbicides	₦7600	10.4	₦8,402.05	12
Transportation	₦5,625.2	7.7	₦4,800	6.8
Seed	₦2,300	3.1	₦1,850.2	2.6
Total Variable Cost	**₦51,239.45**	70.1	₦58,486.7	83.2
Fixed Cost				
Cutlass	₦3,800	5.2	₦1,200	1.7
Hoe	₦3,250.5	4.4	₦890.5	1.3
Depreciation on Knapsack Sprayer	₦4,850	6.6	₦6,200	8.8
Depreciation on Wheelbarrow	₦8,000.15	10.9	₦1,098.5	1.6
Depreciation on Watering Can	₦1,925.19	2.6	₦23,98.08	3.4
Total Fixed Cost	**₦21,825.84**	29.9	₦11,787.1	16.8
Total Cost	₦73,065.29	100	₦70,273.8	100
Total Revenue	₦197,459.2		₦328,861	
Net Return	₦124,393.9		₦258,587	
Gross Margin	₦146,219.8		₦270,374	
Return to Investment	1.7		3.68	

Source: Field survey, 2021.

Factors Influencing Profitability of Vegetable during COVID-19 Lockdown in the study Area

Table 3 displays the results of the regression estimates for the variables influencing vegetable output in the study area during COVID-19 lockdown**.** The criteria used in the selection of the lead equation are economic, statistical and econometric criteria, which specifically considered t-ratio, F-value, R^2, Adjusted R a priori expectations and significance of the estimated coefficients. The R^2 value of 0.61 implies that 61.0% of the total variation in the quantity generated of vegetable produced. The regression estimates revealed that output (X_8), gender of the farmer (X_9), farmers year experience (X_7), level of education (X_3), cost of labour (X_4) had a significant influence on the profitability of vegetables in the study region during COVID-19 Lockdown. The amount of output generated had a positive significant impact on vegetable farming profit and was statistically significant at 1%, meaning an increase in output of 1 kg would result in a 0.61 increase in profit. The likelihood of being a male vegetable farmer will result in an increase in profit by a coefficient of 47,168.43. Gender of vegetable farmers had a positive association with vegetable output. The 7,059.89 coefficient will result in a rise in profit. Farmers' years of experience in vegetable production had a positive association with profitability.

Also, Education is significant at 1percent, which implies that a unit increase in years spent in formal education will bring about the coefficient of 299,66.43 increase in profit from vegetable farming. Cost of labour had a positive significant on profit from vegetable farming. This implies that a naira increase in cost of labour will give rise to an increase in profit on vegetable production by the coefficient of 212,661.70, the result showed that increase in cost of transporting vegetable from production point to the point of sale will bring about more than the respective increase in sale price which in turn generate a higher profit.

Table 3. Factors Influencing Profitability of Vegetable Production during COVID-19 Lockdown

Variables	Coefficient	Standard error	P-value
Constant	-429,212.1	0.22	0.005
Farm size(X_1)	8,155.88	10,575.89	0.000
Farming Experience(X_2)	7,059.89**	7,526.46	0.659
Level of Education(X_3)	29,966.43**	89,153.09	0.367
Cost of Labour(X_4)	212,661.70*	21,523.37	0.302
Household size(X_5)	22,213.53	10,430.65	0.782
Credit access(X_6)	-41,022.19	1,182.56	0.000
Transportation(X_7)	-146.56	11,660.09	0.010
Output(X_8)	0.61**	70,870.27	0.563
Gender(X_9)	47,168.43**	94,221.55	0.024
Age(X_{10})	3,318.64	98.71	0.138
Marital status(X_{11})	-80,358.28	0.02	0.014
R^2	0.61		

Prob > chi2 =0.000
Dependent variable: Profitability
Significant: ** represent 1% significant level, * represent 5% significant level.
Source: Field survey, 2021.

Factors Influencing Profitability of Vegetable after COVID-19 Lockdown in the study Area

Table 4 shows that X_8, X_9, X_{11}, X_5 X_6 are significant variables that significantly influenced the profitability of vegetables after the COVID 19 Lockdown in the research area: quantity of output, farmer gender, marital status, family size, and access to credit. All of the postulated explanatory variables explained the variation in the respondents, according to the estimated adjusted R^2 of 0.92. The quantity of vegetable produce (output) is statistically significant at 1 percent level of probability, implying that a unit increase in kg of vegetable produce will increase the profit by the coefficient of 0.92. The result also showed that the coefficient of farmers age has an inverse relationship on vegetable net return and it is significant at 1% level.

According to this, the impact of respondent age on the profit of vegetables in the study region is lessened as respondent age increases. The result also indicated that if the farmer age is increased by 1 year, there will be a decrease of 38,199.47 coefficient in his or her profit.

Marital status is significant at 5 percent and positively correlated with the profit of vegetable farmers. The likelihood of being a married vegetable farmer increases the profit by a coefficient of 8595.20. Household size had a positive impact on vegetables profit, with a statistical significance level of 1%. The profit of vegetable farmers will rise by 95,180.05 coefficient as family size rises. At a 5% level of probability, farmers' access to credit is significant and positively correlated with their profitability. This suggests that having access to credit will allow farmers to grow vegetables on a big scale, thereby increasing their profits.

Table 4. Factors Influencing Profitability of Vegetable Production after COVID-19 Lockdown

Variables	**Coefficient**	**Standard error**	**P-value**
Constant	165,092.6	132,387.9	0.212
Farm size	51,381.073	33,084.7	1.553
Farming Experience	-452.84	1,409.88	0.748
Level of Education	9,428.46	10,154.54	0.353
Cost of Labour	-0.01	0.09	0.942
Household size	5,110.45**	898.15	0.000
Credit access	9,518.05*	3,792.05	0.011
Transportation	-1,024.726	1,090.03	0.94
Output	0.92**	0.15	0.000
Gender	-231.65	1,757.78	0.895
Age	-38,199.47*	17,647.9	0.031
Marital status	-8,595.20*	3,508.25	0.014
R^2	0.92		

Dependent variable: Profitability
Significant: ** represent 1% significant level, * represent 5% significant level.
Source: Field survey, 2021.

Table 5. Distribution of the Respondents based on their perceptions in the Region

Perceptions	**Strongly Disagree**		**Disagree**		**Agree**		**Strongly Agree**		**Mean**	**Rank**
	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.		
Covid-19 reduces vegetable farmers' income because of lockdown	38	14.07	38	14.07	109	40.4	85	31.5	8.7	1st
Covid-19 affects farming activities negatively because of lockdown	22	8.15	39	14.4	153	56.7	55	20.4	8.7	2nd
Covid-19 disrupts Supply chain of vegetables because of lockdown	50	18.52	62	22.96	65	24.1	93	34.4	8.6	3rd
Covid-19 will affect availability of labor for land preparation	43	15.93	22	8.15	188	69.6	17	6.3	8.2	4th
Covid-19 causes harvest losses for vegetable farmers because of lockdown	35	12.96	53	19.63	95	35.2	87	32.2	8.4	5th
Covid-19 reduces vegetable farmers yields in the upcoming harvest	38	14.07	32	11.85	145	53.7	55	20.4	8	6th
Covid-19 causes lack of trust on the government because of lockdown	71	26.3	51	18.9	107	39.6	41	15.2	2.8	7th
Covid-19 affect the quality of vegetables for sales	64	23.7	41	15.2	101	37.8	64	23.7	7.5	8th
Covid-19 reduces ability to plant vegetables in the next planting season	44	16.3	137	50.74	60	22.2	29	10.7	6.8	9th
Covid-19 affects sales of farm inputs	168	62.2	58	21.5	30	11.1	14	5.2	4.8	10th

Source: Field Survey, 2021.

Farmers' Perceived Effect of COVID-19 on Vegetable Production in the Region

Table 5 reveals that the perceived effect of covid-19 on vegetable farmers in the study area. The result revealed that reduction in income was ranked as the 1st major perceived effect of covid-19 by the farmers ($\bar{x}$ = 8.70). During the pandemic, it is obvious that vegetable producers' revenue fell. In light of this, farmers' annual incomes were significantly impacted by the pandemic's drop in farm income. Reduction in farmers yield was ranked the 2nd perceived effect of covid-19 by the respondents by ($\bar{x}$ = 8.60), Due to the lockdown, the vegetable producers were unable to cultivate their crops efficiently during the growing season, which had an impact on their crop yield for the following season. Farmers of vegetables felt that the main effects of COVID-19 were post-harvest losses and supply chain disruption due to the shutdown.

This agrees with the findings of Hai-ying et al. (2021) [12] who reported that reduction in farmers income was the major effect of pandemic on vegetable farmers.

CONCLUSIONS

The study reveals that in Nigeria's southwest, vegetable production is profitable. It shows that the profitability of vegetables during the COVID-19 Lockdown was significantly influenced by the quantity of vegetables produced, the farmer's gender, his or her years of experience, and the cost of labor, while the profitability of vegetables after the COVID-19 Lockdown was significantly influenced by the farmer's gender, marital status, household size, and access to credit. The research also showed that the farmers in the study area ranked the loss of income due to lockdown as the first major effect they observed. The study's mean value for this effect was (= 8.70)) while the least ranked perceived effect was unavailability of farm inputs with mean value ($\bar{x}$ = 4.8) during COVID-19 lockdown.

The preceding analysis has brought some findings that have implications for this research work. Based on these findings, the following recommendations were made to increase the profit from the production of vegetable by the farmers in the study area:

(i) Because the study found that as vegetable farmers' age increases, their profit decreases across all production scenarios, a policy that focuses on ways to attract and encourage young people who are agile and strong to start growing vegetables will help to reduce unemployment since the production of vegetable in the study area is profitable.

(ii) Age, education, marital status, labour costs, household size, farm size, and access to credit facilities are just a few of the socioeconomic factors that greatly influence vegetable production and profit generation in the study region. It is important to give all of these serious consideration.

(iii)Given that this situation was seen in the study region, the government should support and provide women with the tools they need to produce vegetables in order to address gender disparities.

(iv)Farmers' perceptions of the COVID-19 lockdown across the research area should also be taken into account in order to avoid any reduction in vegetable output in the event of a future pandemic.

(v)Availability and allocation of large farm size should be encouraged among farmers so as to enhance their participation in vegetable production activities for higher profit since majority of them still engage in small farm size in the study area.

(vi)Education should also be encouraged among vegetable farmers in the study area since the study revealed that education will enable them to adopt new technologies that will make them to have more profit from their production.

(vii)In order to secure enough production and profit generation, the government should always permit free movement of vegetable producers from their farms to the market in the event of future occurrences.

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DETERMINANTS OF CASSAVA FARMERS PRODUCTIVITY IN OYO STATE, NIGERIA

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Abstract

Using primary data, the study analyzes the factors that affect cassava farmers' production in Oyo state, Nigeria, using cross-sectional data obtained from 330 cassava farmers through a multistage sample and a well-structured questionnaire. Data collected was analyzed using inferential statistics (Cobb Douglas production model analysis) using software for statistical analysis (STATA). The empirical results of the analysis revealed that farming experience was positively significant at (β= 0.220, $p<0.01$), farm size (β= 0.504, $p<0.01$), age of respondents (β= 0.188, $p<0.01$), credit (β = 0.182, $p<0.01$), mode of cultivation (β = 0.05, $p<0.01$), cassava stem used (β = 0.069, $p<0.01$) respectively, except land used duration which was negatively signed and significant (β = -0.164, $p<0.01$) to cassava productivity. The F Statistics was 71.420 and R^2 of 0.781 obtained indicated that the explanatory variables explained 78% level of variation in cassava output. The study therefore confirmed that all the significant variables were the major determinant of cassava farmers' productivity in the study area.

Key words*: *cassava, Cobb Douglas, determinants, productivity, Nigeria

INTRODUCTION

Agriculture has always been an important sector of Nigerian economy which depends largely on small scale farmers using traditional farming methods. In order to secure and maintain food security, agricultural systems need to be transformed to increase the productive capacity and stability of these smallholder agricultural productions [6].

In Nigeria, the sector is almost entirely dominated by small scale resource poor farmers living in the rural areas, with farm holdings of 1-2 hectares, which are usually scattered over a wide area [15]. The size-distribution of these holdings has been defined by previous studies and evidenced in literature as small-scale farms which range from 0.10 to 4.99 hectares, medium scale farms, from 5.0-9.99 hectares and large scale from 10 hectares and upward [18];[23];[10].

[9] defined land as an important factor of production in agricultural sector on the whole. Land serve as a social security function to most Nigerians because after all else have failed they could still return to their villages to stake a claim on a portion of the family land and raise crops on this for subsistence. It also determines the level of productivity in agricultural production. Available information shows that in southern Nigeria for example, there was consistent decline in yield per hectare of major food crops between 1995 and 2000 [2].

Cassava is important not only as a food crop but even more so as a major source of income for rural households [3]. The world production of cassava root was estimated to be 184 million tonnes in 2002. The majority of production is in Africa where 99.1 million tons were grown; 51.5 million tonnes were grown in Asia and 33.2 million tonnes in Latin America and the Caribbean [7]. As at 2018 the Food and Agriculture Organization Statistics database recorded that Nigeria is the largest producer of cassava in the world, with about 59 million metric tonnes annually from a cultivated area of about 3.7 million hectares.

Cassava annual cultivation was 45,721,000; 43,410,000; 44,582,000; 36,822,300; 42,533,200, 52,403,500, 47406770, 56,328,480, 57,643,271 and 57,134,478 million tonnes in 2006, 2007, 2008, 2009, 2010, 2011, 2013, 2014, 2015 and 2016 respectively while Land area harvested was 3,481,900, 4,120,166, 6,401,996, 6,741,300 and 7,102,300, 6,216,434 and 6,261,047 hectares in 2010, 2011, 2012, 2013, 2014, 2015 and 2016 respectively [8]. More than 60% of the cassava produced is consumed by farmer's household, cassava industries and breweries locally while the remaining 40% are exported to other countries such as China [16].

Since then, the demand for Cassava products globally has increased, making the cultivation to increase but not enough to meet up with demand. It's due to this that the research work is analyzing the determinants of cassava farmer's productivity in the study area.

Hypotheses testing

The Hypothesis was reported in null form hypotheses (Ho): that farmer's socio-economic characteristics and farm specific factors does not determine the cassava farmers' level of productivity in the study.

MATERIALS AND METHODS

This research was conducted in Oyo State, Nigeria. The State is situated in the country's southwest with thirty-three (33) Local Government Areas make up Oyo State, which is divided into four (4) agricultural zones: Saki, Ibadan-Ibarapa, Ogbomoso and Oyo, Zones. The State total land area was about 27,249,000 square kilometers with a total population of about 5.6 million. It is situated between Latitude 7°N and 19°N and Longitude 2.5°E and 5°E of the meridian. It is bordered by Ogun State in the southern part, by Kwara State in the north, partly bordered by Ogun State and Republic of Benin in the western part and Osun state in the east.

Sampling technique

The study sample comprises of the registered Cassava farmers across four agricultural zones in Oyo State.

Two-stage sampling method was used to select the respondents; a total number of three hundred and thirty (330) respondents were selected.

Data collection and analysis

The study used data mainly from primary source. The data (primary source) were obtained from the farmers' with the use of structured questionnaire and interview schedule.

The data collected was analyzed using inferential statistics; Cobb Douglas production model, with a four functional model which were fitted for the analysis of the data using STATA analytical tool.

Model specification

The model used for the estimation was given as:

$Y = b_0 + b_1X_1 + b_2 X_2 + b_3X_3 + b_4X_4 + b_5X_5 \ldots\ldots\ldots + b_{12}X_{12} + \mu \ldots\ldots\ldots\ldots$ (1)

$Yi = f(Xij, \alpha j) \ldots$ (implicit form) $\ldots\ldots\ldots\ldots\ldots\ldots$ (2)

$Y = f(Xs) \ldots\ldots\ldots\ldots\ldots\ldots$ (3)

$Y = (X_1, X_2, X_3 \ldots Xn) \ldots\ldots\ldots\ldots\ldots\ldots$ (4)

Explicitly:

Linear

$Y=a+b_1X_1+b_2X_2+b3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_{12}X_{12}+e \ldots\ldots\ldots\ldots$ (5)

Double log

$LnY = a+ b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5ln X_5 + b_6ln X_6 \ldots + b_{12}ln X_{12}+e \ldots$ (6)

Semi-log

$Y = a+ b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5ln X_5 + b_6ln X_6 \ldots + b_{12}ln X_{12}+e \ldots$ (7)

Exponential

$LnY=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6 \ldots + b_{12}X_{12}+e \ldots\ldots\ldots\ldots$ (8)

where:

Y = Cassava yield (kg/ha)

X_1 = Farming experience (years)

X_2 = Farm size (ha)

X_3 = Educational level (dummy)

X_4= Types of Land ownerships (dummy)

X_5 = Land use duration (years)

X_6 = Age of respondent (years)

X_7 = Credit (Naira)

X_8 = Labour use (man days)

X_9 = Mode of cultivation (dummy: local/manual = 0, mechanized = 1)

X_{10} = Fertilizer used (quantity)

X_{11}= Stem used (bundles)

X_{12} = Sustainable Land Management Indices (discreet and continuous)
e = error term
b = Parameter estimated
a = Constant

RESULTS AND DISCUSSIONS

Table 1 discussed the determinants of the farm-specific and socio-economic factors in crop output. Different functional forms were fitted for the determination of crop output among the farmer. The functional forms of linear, semi log, exponential and double log were fitted, but the double log was chosen as the lead equation due to its conformity with *a priori* expectation in terms of signs and magnitude of the coefficient, the number of significant variables and the coefficient of multiple determinations (R^2) [21]; [17].

The regression results in linear form revealed that years of farming experience was positively significant ($p<0.01$) and it is similar to the findings of [11]; [1] that farmers had the capability to apply or not apply sustainable practices on their farm, especially when taking into account the farmers' ages and years of experience, which were similarly significant ($p<0.01$) which is in line with the expectations that the older the farmers the higher their experience and the better they become. This is also at variance with the finding of [13] and [14]. Farm size cultivated, credit used, Stem use and mode of cultivation by the farmer were positive and significant ($p< 0.01$).

Table 1. Determinants of farm-specific and socio-economic factors in cassava output

Variables	Linear	Double log	Exponential	Semi-log
a = Constant	4.968	-0.125	1.046	-85.052
X_1 = Farming experience	0.633***	0.220***	0.007***	19.323***
	(6.537)	(6.616)	(6.002)	(6.301)
X_2 = Farm size	3.083***	0.504***	0.035***	40.373***
	(4.928)	(10.534)	(4.703)	(9.164)
X_3 = Educational level	-0.641	-0.041	-0.008	-1.735
	(-0.706)	(-0.925)	(-0.773)	(-0.423)
X_4= Types of Land ownerships	0.839	0.059	0.007	7.858*
	(0.999)	(1.195)	(0.660)	(1.730)
X_5 = Land use duration	-0.245**	-0.164***	-0.003***	-13.125***
	(-1.800)	(-4.625)	(-2.284)	(-4.017)
X_6 = Age of respondents	0.093	0.188***	0.002***	7.408
	(1.182)	(2.153)	(2.507)	(0.924)
X_7 = Credit	0.000***	0.182***	0.000***	15.456***
	(5.430)	(3.401)	(5.357)	(3.131)
X_8 =Labour use	-0.527	0.012	0.025	-1.672
	(-0.201)	(0.434)	(0.803)	(-0.680)
X_9 = Mode of cultivation	5.696***	0.051***	0.067***	4.411***
	(3.246)	(2.856)	(3-184)	(2.692)
X_{10}= Fertilizer used	-1.497	-0.022	-0.032	-0.899
	(-0.648)	(-0.944)	(-1.174)	(0.417)
X_{11}= Stem used	0.001***	0.069***	0.000***	0.005***
	(4.110)	(3.042)	(3.723)	(3.002)
X_{12} = SLM Index	1.162	0.029	0.047	-4.721
	(0.174)	(0.426)	(0.594)	(-0.756)
R^2	0.604	0.781	0.599	0.666
F Statistics	43.849	71.420	43.144	54.932

(*)=p<0.01; (**) =p<0.05; (***) =p<0.10. Note: Values in parenthesis are t-values.
Source: Authors Data Analysis, 2019.

These implies that a unit increment the combination of any of the positive significant variables will probably increase cassava output [22], [4] and this is similar to [11] result and supported by the work of [19] that the existence of significant relationship between the farm size and cassava output can be attributed to economy of scale, since large hectare would translate to increased production area and access to credit and good variety of cassava stem use will bring a better output, except land use duration which had a negative relationship with the crop output and significant (p<0.01).

This could bring about a reduction in the level of output which may be due to the continuous use of the same portion of land over a long period of time (i.e. more than 14 years) by the farmers.

This also conforms to the work of [20]. However, land fallow periods long enough can restore farm productivity [5].

The R^2 of 0.781 obtained shows that 78.1% value can be explained by the model specified but the unexplained 21.9% can be captured by the error term. Since farming experience, farm size, land use duration, credit, age of respondents, cassava stem use and mode of cultivation significantly affect cassava output. Therefore we do not reject the hypothesis (H_A).

CONCLUSIONS

The study clearly concluded that cassava farm size cultivated by the farmers, farming experience in years, age of farmers, credit, cassava stem use and mode of cultivation by the farmer were positively significant (p<0.01) except land use duration which was negatively signed but significant (p<0.01) to the crop outputs.

R^2 was 78.1% which explain the level of variation in the crop outputs per hectare due to the explanatory factors, it is implied that an increase in productivity will equate to a unit increase in the combination of inputs utilised.

Its however, recommended that good combination of these variable inputs may enhance productivity and sustainable agricultural production, continuous use of the same portion of land over a long period of time (i.e. more than 10 years) by the farmers may have negative effect on productivity, therefore land fallow periods long enough and better land use practices and managements can reclaimed the land viability and enhance farm productivity in the study area.

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CONSUMER ATTITUDES, PERCEPTIONS AND MOTIVATIONS TOWARDS BUYING OPEN MILK IN TURKEY

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Abstract

Open milk is subject to adulteration and threatens public health. Despite the health experts' warnings, many consumers in Turkey still prefer milk sold by street vendors. This study investigated families' open milk (street milk) and packaged milk consumption habits and the reasons for consuming open or packaged milk in Bursa, Turkey. The data were obtained through a face-to-face survey of 478 families. Research revealed that 34.6% of adults and 66% of children regularly consume milk. Participants who consumed milk consumed it for bone development (38.1%) and a rich protein source (22.7%). Half of those (45%) who did not drink milk were not accustomed to drinking milk. %13.8 did not like the taste, and %13.5 is allergic to dairy products. People primarily bought milk from markets (41.1%) and street vendors (21.1%). They preferred whole milk (29.7%) and semi-skimmed milk (29.%). Reasons for purchasing open milk were freshness (31.1%) and no additives (24.0%). Reasons for not buying open milk were unhygienic (40.7%) and not being subject to quality control (41.7%). Although its sales are decreasing, open milk purchases continue. Open milk sales should be restricted, and packaged milk options offered to consumers should be increased.

Key words: *consumer choice, milk drinking habits. open milk, packaged milk, street milk, street vendors*

INTRODUCTION

Milk is an essential food item that humans should consume for a healthy life. Milk is the primary protein, vitamin, and mineral source; it is precious and indispensable for babies, children, and individuals. Recent clinical and biochemical studies have shown that milk consumption, especially low-fat milk, effectively reduces hypertension, dental diseases, colon cancer and heart diseases [8, 45]. According to the FAO, the consumption of dairy products differs significantly from region to region and between countries in the same region, depending on dietary habits, available milk processing technologies, market demand and social and cultural development. The per capita consumption of milk and dairy products is higher in developed countries, and demand for milk and dairy products in developing countries is experiencing an increase due to increased income, population growth and urbanisation. This upward trend is evident in East and Southeast Asia, China, Indonesia and Vietnam. The most consumed dairy product in the world is raw milk. In Europe and North America, the total per capita demand for fresh dairy products is declining. However, the demand composition has shifted towards low-fat cow's milk over the past few years [36].

Turkey's milk and dairy product consumption has shown an unwelcome change in recent years, which is pretty low compared to European and other developed countries. Milk consumption in Turkey is mainly concentrated on cheese and yoghurt. The per capita consumption of drinking milk is over 100L in Northern European countries; it is 92.7L in the European Union, 79L in Canada and 74.7L in the USA, 132.0L in Russia and 23.9L in China [36]. This rate is estimated to be 40.7L in Turkey [26].

Reliable data on the amount and value of milk and dairy products supplied by marketing methods other than industrial products in Turkey is unavailable. However, it is estimated that in the calculations made using the amount of milk received and processed by the milk industry, approximately 20% of the milk produced is not recorded. The raw milk distribution figures reveal that most milk is not processed technologically. About 25% of the raw milk produced is consumed in the production unit, 10% is breastfed to animals, and 5% is wasted, so only 60% of the total milk is available for marketing purposes. Approximately 40% of this available milk is delivered to the consumer as raw milk (street milk/open milk). The rate of milk processed in modern enterprises is approximately 20%, and the rate of milk processed in dairy farms with low hygienic conditions is another 40%. In developed countries, the milk consumed, breastfed or lost in the enterprise is 2-3%, and the rate of raw milk marketed is 97-98%. The portion of this 97-98% reaches the consumer unprocessed is 5-6%. In Denmark, Holland, and Ireland, the milk processed in modern enterprises is 99.5% [1].

Numerous consumer research also determined that up to 80% of families in Turkey use open milk (street/raw milk). However, it is known by many consumers that water and other additives that threaten human health are mixed into street milk. Turkey's per capita processed and packaged milk consumption is also far behind other European countries. For example, while packaged milk consumed per capita is approximately 6L per year in Turkey, this amount is 139L in Finland, 108L in Spain, 100L in England and 65L in Greece [1].

Many consumers throughout Turkey consider packaged long-life milk dead milk due to the heat treatment applied. Again, some consumers believe that antibiotics and antiseptic substances are added to the packaged, long-lasting milk to provide durability during processing and that the packaging materials used are carcinogenic [4]. On the other hand, street milk is seen as the "purest", "most natural", and "freshest milk" by the vast majority of consumers. Despite the prohibition of street milk, the most important reasons it is still consumed are economic factors such as consumer habits, price and income [44]. However, another study emphasised that the consumption of both open milk and packaged milk is very closely related to the prejudices and thoughts of consumers and that consumer prejudices are more effective in milk consumption than socio-economic and demographic factors [1].

The COVID-19 outbreak has increased demand for milk and dairy products in Turkey, as in the rest of the world. The demand for dairy products, especially UHT (Ultra High Temperature) milk and cheddar cheese, has increased. In this process, the importance of packaged food was indisputably understood, and there was a significant increase in the demand for packaged dairy products [36].

Despite the importance of milk, studies examining the milk consumption habits of consumers have been scarce. A limited number of studies have only revealed per capita milk consumption amounts and the consumed open and packaged milk rates. However, current studies have not addressed why consumers prefer or avoid open milk or packaged milk.

This study was designed to determine the milk consumption patterns of households in Bursa, the largest city in the Southern Marmara Region, and the reasons for using open and packaged milk. Regarding population size, economic development and immigration potential, Bursa is one of the major cities in Turkey. The result of the research will provide valuable insight into determining the factors that shape the preference for open and packaged milk and products and information on consumer awareness. The study will also benefit dairy enterprises and their marketers operating in the sector, making significant contributions to sectoral stakeholders.

MATERIALS AND METHODS

The primary data in the study consists of face-to-face surveys with households living in the Bursa province of Turkey. Bursa is the fourth most populous city in Turkey, with 3,147,818. The population comprises 35% young, 51% middle-aged and 14% older adults. The average household size in Turkey is 3.30 people, and the total number of households is 25,329,833. The average household size of a Bursa is 3.24 people, and the total number of households is 966,765 [40]. The survey was conducted with the person responsible for food shopping in the family. If the person who does the shopping in the family does not consume milk, the family members were asked to answer the questionnaire considering the people who consume poultry. Semi-structured questionnaires were used in the study. The 2021 population of Bursa province and the number of households were taken into account to determine the sample size. A probabilistic simple sampling method was used in sampling. Interviews were conducted with 480 people. The participants' consent was obtained before implementing the survey, and they were ensured that the information provided would only be used for academic purposes. Two questionnaires were disabled due to missing data, and 478 questionnaires were processed. The survey consists of 22 questions. The first ten questions in the survey are aimed at determining the demographic characteristics of the participants. Twelve questions are about determining the milk consumption of the participants. The data were analysed using the SPSS 23.0 Package Program.

RESULTS AND DISCUSSIONS

Demographic results

The research aimed to interview people who did more than half of household essential food shopping. Half of the participants were women (50.9%), and half (49.1%) were men. Contrary to small settlements, food shopping in metropolises is not left to women but is also done by men. A quarter of the participants (26.2%) were families of two people, while half (52.6%) were families of 3 or 4. This meant families had 1 or 2 children. In short, a significant portion of the participants (78.8%) had a nuclear family. In the study by Erdal and Tokgöz [12], which examined the factors affecting the consumption preferences of packaged and open milk, 77% of the participants were nuclear families. A significant part of the participants (68.8%) was married. Ages were fairly proportionally distributed among the groups studied. While the participants under the age of 40 are 43.9%, the participants over 40 are 56.1%. About half (46.8%) of the people interviewed in the study are university graduates. In the present study, a small portion of the participants were housewives (11.9%) and retired (16.6). Most participants work for the state or private sector or own businesses (13.6%). 32.1% of the participants earn 6,000TL or more. Demographic findings of the families examined are given in Table 1.

Table 1. Sociodemographic profile of the participants.

Variable		N	%
Gender	Male	234	49.0
	Female	43	50.8
Marital Status	Single	149	31.2
	Married	329	68.8
Age	20-30	110	23.0
	31-40	100	20.9
	41-50	93	19.5
	51-60	89	18.6
	61≥	86	18.0
Income*	>2 ,825 TL	108	22.6
	2,826 -4,000	48	10.0
	4,001-6,000	168	35.1
	6,001-8,000	52	10.9
	8,001+	102	21.2
Education level	Literate	13	2.7
	Primary	164	34.3
	Secondary	115	24.1
	University	224	46.9
Household Size	1	46	9.6
	2	125	26.2
	3	120	25.1
	4	132	27.6
	5+	55	11.5
Professional activity	Housewife	57	11.9
	Retired	79	16.5
	State worker	118	24.7
	Blue collar	75	15.7
	Self-employed	65	13.6
	Student	12	2.5
	Unemployed	31	6.5
	Other	41	8,6

Turkey's minimum Legal Basic Salary was Gross 2,943 Turkish Lira (TL) and Net 2 324 TL in 2020. N=478
Source: Author's calculation.

Milk consumption

Every member of the family should consume milk. However, studies conducted in Turkey and health experts often emphasise that individuals do not consume enough milk. Consumers buy milk for both individual and family consumption. Many factors, such as the presence of a child in the family, elderly individuals in the family and health problems, can affect milk consumption. For this reason, the participants were asked whether they or their family members drank milk regularly. The findings are given in Table 2.

Alarmingly, only 34.6% of the participants regularly consume milk. 34.7% of the participants stated that their spouses consume milk. 37% of other family members, such as elderly parents, consume milk. Studies conducted in Turkey show that milk consumption as drinking milk is deficient. In the survey conducted by Şimsek et al. [34] with 1,000 people in Istanbul, 33% of the participants consumed milk. Onurlubaş and Çakırlar's [29] research revealed that 47.3% of women and 52.7% of men did not consume milk in the three largest cities of Turkey (Istanbul, Ankara, Izmir). Whereas in Chile, 84% of respondents consume milk [43].

Table 2. Regular milk consumption in a family

Do you consume milk regularly?				
	Yourself	Your spouse/partner	Children	Other family member
Yes	165	130	179	68
No	313	216	103	130
No children	-	-	196	-
No spouse	-	132	-	-
No other family member	-	-	-	279
Weekly milk consumption	0.78	0,69	1.18	0.44
Total	478	478	478	478

Source: Author's calculation.

Milk and milk products play an essential role in the healthy development of bones and teeth, especially in children and adolescents, in the prevention of cardiovascular diseases, stroke, high blood pressure, Type 2 diabetes, osteoporosis, colon cancer, and in the management of body weight in adults, due to having calcium content [18]. Turkish Nutrition Guide [38], prepared by the Ministry of Health, recommends taking three servings of milk and dairy products daily. (1 serving of milk: 240 mL, one serving of yoghurt: 200 mL, one serving of feta cheese: 60 g). However, 66% of the participants who had children in our study consumed milk regularly. Nahcivan's [25] study also confirmed that 45.2% of children aged 6-14 drank a glass of milk daily, and 31.8% drank milk occasionally. Toptaş Bıyıklı and Akman's [37] study also reported low-level milk drinking by children: the rate of primary school students aged between 10-15 who consume milk every day was 55.7%. In the current study, child milk consumption rates are higher than in other studies in Turkey, but they are far behind developed countries. A study conducted on individuals aged 60 and over in the USA reported that 30.8% of adolescents (12-19 years) consumed three glasses of milk or more per day [10].

Milk consumption levels

Average monthly milk consumption *per capita* is around 3.1L *per month* and around 37.2L per year. *Households* in Bursa consume 3L of milk *per week*, 12L *per month* and 156L *per year*. Although these figures are meagre, they align with the TurkStat data. According to TurkStat [40] data, Turkey's average annual milk consumption *per capita* was 39.5±7L.

Existing studies have reported similar results. In a recent Engindeniz et al. [11] survey, annual milk consumption *per capita* was 37.43L. Karakaya and Akbay [19] calculated that the average consumption of drinking milk *in the families* studied was 12.19L, and *per capita* consumption was 36.75L. This study and other available research findings also confirm the low milk-drinking rates in Turkey [1, 7, 9,12,14].

In recent years, the mass media has encountered contradictory statements in Turkey about milk consumption. Many health experts claim that consuming milk in adulthood is neither beneficial nor harmful. Besides the studies confirming the health benefits of milk, Michaëlsson et al. [24] showed that hip fractures were 60% more common in those who drank more than three cups of milk a day compared to those who drank less than a glass of milk a day and in their research in Sweden. The same study also revealed that cow's milk increased the risk of dying from a heart attack by 15% and cancer by 7% in women. According to this study, those who drank more than three glasses of milk a day had a 93% greater risk of dying from cancer than those who drank less than one glass. Several available studies argue that the risk of prostate cancer in men [23, 35] and ovarian cancer in women [16, 22] who drink plenty of milk is significantly increased compared to the non-drinking group. According to Campbell and Campbell [4], milk is one of the most harmful foods. In their research, Campbell and Campbell [4] emphasised that *casein*, the primary protein substance of milk, is a severe carcinogen. The substance called *casomorphin* is released from the breakdown of casein and affects the brain. This is a kind of "morphine" derivative and increases the dependence on milk and dairy products. In addition to all these, it is reported that milk intolerance causes skin problems such as acne, rash and redness or irritation.

These and similar studies adversely affect the already low milk consumption, adding to expert opinions.

In the current study, adult participants and their spouses consume around 0.6-0.7L of milk per week, while children's milk consumption is 1.2L. Older parents consumed less than 0.5L of milk per week. According to the Ministry of Health Turkey Health and Nutrition Survey [39], milk consumption per capita is 34.5 mL per day and 12.5L per year for people over 15 in Turkey. Current research findings coincide with the upper limits for adults and the lower limits for the elderly.

Frequency of milk consumption

Children pattern themselves on their parents in nutrition and milk-drinking habits. Research has shown that only 12% of family adults regularly drink milk daily.

Children whose parents did not have the habit of drinking milk did not drink milk either. 32% of the children of the participants drank milk every day.

One-third of adult participants drank milk several times a week, while 20-25% drank milk several times a month. 15.6% of individuals of older ages did not drink milk at all, whereas the necessity of milk for bone health is often emphasised (Table 3).

Current research shows that individuals in Bursa province drank less milk than stated in the literature. Participants generally consumed milk once every 2-3 days (33.6%) and once a week (33.4%) in Karakaya and Kızıloğlu's [20] research. The rate of those who consumed daily was 19.9. Niyaz and İnan [27] found that 16.3% of the consumers drank milk daily, 28.3% several times a week, 11.4% every two weeks, 21% once a month and 22.9% rarely consumed milk.

However, 44% of the individuals interviewed in Chile drank milk daily, while 30% drank milk three times a week and 19% once a week [43].

Table 3. Frequency of drinking milk

	Yourself		Spouse		Children		Elderly	
	N	%	N	%	N	%	N	%
Several times a day	17	3.6	6	1.7	32	11.3	4	2.0
Once a day	58	12.1	35	10.1	90	31.9	20	10.1
Several times a week	160	33.5	108	31.2	75	26.6	60	30.3
Several times a month	115	24.1	74	21.4	35	12.4	40	20.2
Seldom	102	21.3	84	24.3	22	7.8	43	21.7
Do not drink milk	26	5.4	39	11.3	28	9.9	31	15.7
No spouse			132	28.2				
No kids					196	41.0		
No elderly							280	58.6
Total	478		478	478		478	478	

Source: Author’s calculation.

Reasons for consuming and not consuming milk

Individuals drink milk because they believe it is healthy, giving it to their children. A significant portion of the 273 participants who have the habit of consuming milk consumes it because they believe that milk is beneficial for bone development (38.1%) and health and is a rich source of protein (22.7%) (Table 4).

Table 4. The reason for consuming milk regularly.

	N	%
A rich source of protein	62	22.7
Necessary for bone health	104	38.1
Necessary for child development	47	17.2
No particular reason, just habit.	44	16,1
Other	12	4.4
Health	2	0.7
Helps with weight loss	2	0.7
Total	273	100%

Source: Author’s calculation.

Demircan et al. [9] stated that 65.3% of consumers drink milk because it is healthy. About half of the participating families in the current research did not have children. For this reason, the rate of those who said they consumed milk because it was essential for child development remained at 17.2%. It is evident in the research that habits affect consumption. Very few of the participants (16.1%) consume milk by habit. Consumers in Australia [4] and Chile [43] give more importance to sensory characteristics such as taste, odour and colour in milk consumption, while consumers in Turkey give more importance to its health benefits [3].

The most important reason for *not* consuming milk was not having the habit of drinking milk. About half (45%) of those who did not drink milk regularly did not have the habit of it. Experts emphasise that parents should encourage their children to get into the milk-drinking habit for healthy development. When asked individuals who did not consume milk the reason for not drinking it, 51.5% of consumers stated that they were not in the habit of drinking it, 31.8% said they did not like it, and 10.6% for health problems.

Milk has a unique taste and distinct smell. Some people find this taste and smell particularly appealing, while others dislike it. In the study, those who did not like the smell of milk were relatively few (7.6%), but it is noteworthy that those who were allergic to milk and felt stomach discomfort after drinking milk made up a quarter of all participants (25.1%) (Table 5). Milk consumption in Turkey is still deficient, so children develop lactose intolerance and digestion problems early. Studies show that a quarter of children between the ages of 5 and 11 refuse to drink milk.

Table 5. The reason for not consuming milk regularly.

	N	%
Don't like the taste	45	13,8
Don't like the smell	25	7,6
Upsets my stomach	38	11,6
I am allergic to dairy products	44	13,5
It is expensive	16	4,9
No particular reason, it's just not in my habits	147	45,0
Can't find fresh milk	1	0,3
Other	11	3,4
Total	327	100.00

Source: Author's calculation.

Open milk vs packaged milk

The debate on open milk and packaged milk consumption in Turkey has been ongoing for many years. Some health experts state that processed milk loses its nutritional value; therefore, unprocessed (open milk) should be consumed. Another group states that open milk is ideal for bacteria growth and cheating, and processed milk should be consumed. Resultantly, consumers, especially those with children, are exceedingly confused about how to consume milk. Families with children prefer street milk to provide their children with milk without additives, while those with allergic children prefer processed/packaged milk. Many consumers have chosen to purchase open milk, believing that all vitamin values are lost when pasteurised milk undergoes heat treatment. Packaged milk contains preservatives and is less healthy. They even believed their elders were fed with open milk and lived healthier than they were.

Individuals in the high-income group prefer to buy milk packaged from markets and supermarkets. In contrast, low- and middle-income individuals get their milk primarily raw from milkmen [31]. In a study conducted in Kenya and Tanzania, where household incomes were low, consumers only bought packaged milk without raw milk [13]. Van Rossum et al. [42] also stated that high-income individuals prefer low-fat milk and dairy products sold in packages. Another study expressed that high-income families especially found it costly to cook and store open milk in their homes, so packaged milk is more economical for them [12].

The rate of consumption of raw milk (i.e. buying from street vendors) starts from 40% in Turkey. It can go up to 70%, especially in the eastern and central Anatolian regions [1, 12, 30]. Cities are smaller in these regions. Many family farms produce and sell open milk in the region, or consumers have acquaintances who live in the village and can order milk directly. Chain markets in these cities are yet widespread. Dairies, corner shops and bakeries also sell open milk.

Consumers in metropolitan areas use more processed packaged milk [18, 28, 33]. Processed milk is usually sold in small (1L, 0.5L) packages. Families being smaller in big cities, having more markets around, and having fewer milk producers in the neighbourhood increase the consumption of packaged milk compared to rural areas.

In addition to the frequency and quantities of open or processed milk consumed, ease of shopping, getting all needs from one place, cheapness, promotion, delivery, social facilities, and so on may affect where we purchase the milk [30]. While open milk is generally obtained from the street seller (milkman), dairy and bazaars, processed (pasteurised and sterilised) milk is obtained from local and national markets and corner shops [2]. Street selling is a significant problem in Turkey's dairy sector and holds a non-negligible place in the current research. 21.1% of the participants buy their milk from street vendors, and 6.3% from a local dairy. In other words, one-third of the participants consume unprocessed milk (34.3%). About half of the participants bought processed milk (41.4%) from national markets. Those who bought from local markets and corner shops made up one-third (31.2%) of the participants (Table 6).

Table 6. Where do you buy milk the most?

	N	%
Street vendor	101	21.1
Grocery /corner shop	63	13.2
Local dairy	30	6.3
Local market	86	18.0
National market	198	41.4
Total	478	100.0

Source: Author's calculation.

Small cities and towns commonly have local dairy. From here, consumers can buy milk and essential dairy products (yoghurt, cheese and curd) daily. However, finding such dairy in big cities is getting harder because these small businesses cannot compete with chain stores [32]. Today's consumers mostly use chain stores for food shopping. Milk consumed daily and regularly should be purchased frequently from local markets and grocery stores. Consumers in Turkey generally shop for vegetables and fruits at the local markets, while they do their durable food and other shopping at national markets once a week. Consumers typically consume milk in processed form and buying approximately half of it from national markets confirms the low frequency of milk purchases [20, 29].

Parallel to the findings in Table 6, only 22.2% of the participants consumed open milk. Half bought the milk in a carton box (UHT) (50.4%). Consumers who prefer pasteurised milk can buy it in glass bottles or plastic bags. Consumers were more sensitive about the use of plastic and preferred daily (4.4%) or processed milk (3.8%) relatively less in plastic packaging. The rate of consumers who preferred packaged products is around 75% (Table 7). SETBIR (Turkish Dairy, Meat and Food Industrialists and Producers Association) confirms that consumers prefer packaged products, which they rightly think are cleaner and hygienic, due to the coronavirus epidemic in 2020 and beyond.

Studies conducted in Turkey, both in metropolitan and rural areas, stated that open milk purchased from street vendors is still widely sold and preferred. This study confirmed that open milk consumption in Bursa province was much lower than in the current studies [34].

Table 7. What is the main type of milk you usually buy?

	N	%
Raw milk (milkman/dairy)	106	22.2
Semi-skimmed milk	142	29.7
Whole milk	141	29.5
Skimmed milk	15	3.1
Lactose-free milk	21	4.4
Raw + semi-skimmed	14	2.9
Raw + whole milk	13	2.7
semi-skimmed + Whole milk	14	2.9
semi-skimmed + lactose-free	6	1.3
Other buying combinations	6	1.3
Total	478	100

Source: Author's calculation.

Because access to open milk is more difficult in metropolitan areas, participants had higher educational levels, and fewer children led to this outcome. However, pasteurised milk consumption was also lower than in the current research. Participants generally preferred long-lasting UHT milk. This finding is consistent with existing studies [18, 19]. Consumers take the milk raw in the open, use it for drinking, making yoghurt and food, or prefer it as a long-lasting product in a cardboard box. It is seen that the use of pasteurised milk has not become widespread in Turkey yet.

The fat ratio in milk is a decisive factor in choosing low-fat milk types [16, 43]. Vargas-Bello-Pérez [43] states that 75% of consumers in Chile prefer low-fat milk. In a study examining the consumption of dairy products by adults in Switzerland, 53% of the participants prefer low-fat products to reduce their daily fat and calorie intake [6]. Another dairy consumption study by Cashel et al. [5] showed that older women prefer to skim or low-fat milk more than younger women. Bus and Worsley [4] and Johansen et al. [17] stated that women's full-fat milk consumption rate is lower than men's and emphasised that women attach more importance to fat ratios and weight control than men. Hammarlund [15] showed that most dairy consumers prefer skimmed milk. Then they prefer 2% fat milk, 1% fat milk, and finally whole milk. A study examining the consumption of milk and dairy products by participants over the age of 60 in the USA reported that the majority of the elderly pay great attention to their fat intake and cholesterol-rich foods, and most of the elderly prefer 2% fat milk consumption [10].

However, the opposite is the case in Turkey. Open milk is full-fat. One-third of the consumers who preferred packaged milk chose whole milk, and half of the participants consumed whole milk. While the other third preferred semi-skimmed milk, skimmed milk consumption was deficient (3.1%). This finding was confirmed by Engindeniz et al. [11] study that households consumed whole milk (44.3%) more. Twentify [41] reports that the rate of those who prefer lactose-free milk in milk consumption besides open and packaged milk preferences is 17%, but the use of lactose-free milk in this study remained at 4.4%. Lactose-free milk is a type with a sweeter taste produced for people who do not like milk and cannot drink it. Dieters also prefer lactose-free milk. The high use of whole milk and the low use of lactose-free and diet milk indicate that consumers in Turkey did not count calories in milk.

Reasons for consuming open milk

Even though expert warnings and widespread concerns regarding open milk use, consumers do not give up on open milk. Open milk sales are more common in small cities close to rural areas; they gradually decrease in big cities. Nevertheless, sales continue. Freshness (31.3%) and unprocessed, having no additives (24%) were among the most prominent public preferences for buying open milk (Table 8).

Street vendors usually live in nearby villages and typically sell their milk. Alternatively, they buy the milk directly from the farm and sell it.

Table 8. If you are using loose milk, what is the reason?

	N	%
Freshness	82	31.3
No additives	63	24.0
Taste	46	17.6
Low price	32	12.2
Home delivery	18	6.9
Ease of payment	16	6.1
Weighed by the buyer	5	1.9
Total	262	100

Source: Author's calculation.

Thus, the buyer knows which farmer produced milk on which farm. There are concerns about bacterial reproduction in milk in countries with hot climates, such as Turkey. However, there are also concerns about enterprises' processing, storage, and packaging conditions. Negative news in the media on those matters prevents people from switching from open milk to packaged milk. Open milk is cheaper than packaged processed milk, but one of its most substantial advantages is being bought in desired quantities. The milk comes to the door and is poured and weighed in front of the consumer. In the current research, participants belonged to the relatively high-income group, generally working people. So above mentioned convenience that open milk offers were irrelevant to them.

The most important reasons consumers prefer street milk are habits and misleading and incomplete information about packaged milk. In addition, the majority of consumers see street milk as "the purest", "most natural", and "freshest milk". On the contrary, many consumers consider packaged long-life milk dead milk due to the heat treatment. Consumers commonly believe that antibiotic and antiseptic substances are added to the packaged, long-lasting milk to ensure longevity and that the packaging materials used are carcinogenic [13]. Remarkably, families give priority to the factors of being healthy and reliable when they prefer both open and packaged milk.

In the study, the most critical factor that led consumers to buy open milk was the freshness of the milk (31.3%). As emphasised in the literature, the absence of additives is the second most important reason for consumption (24%).

Milk sold in the open may not be completely additive-free, and there may be some adulteration. The most common of these are extracting fat from the milk, adding water, and adding neutralising agents to prevent the development of acidity or to mask the developing acidity. It is forbidden to add preservatives to milk to make it last longer. Nevertheless, hydrogen peroxide, potassium dichromate, formaldehyde, sodium carbonate, salicylic acid, and boric acid are the leading preservatives that are widely used. Despite all these possibilities, literature findings confirm that milk sold in the open is perceived as healthier, additive-free and reliable by consumers [2, 20]. Twentify [41] conducted a study with 1,010 participants, and 60% of consumers think that open milk is more natural and has higher nutritional value than packaged milk. On the other hand, 44% of the participants perceived that their milk was natural and additive-free. Although the literature often emphasises that open milk is preferred over packaged milk because of its lower price, the price was less important in this study and similar studies [2]. As stated before, there is a possibility of adulteration of open milk. Further, its rapid spoilage and bacteria-producing properties, and therefore the possibility of causing disease, are among the reasons that hinder the preference for open milk. In addition, it is not possible to control the milk content sold open and the conditions of sale and distribution. Mass media often broadcast major adulterants added to open milk. Moreover, the summer season in Turkey is generally hot and long, which further accelerates the deterioration of milk in the distribution process. For these reasons, being unhygienic (40.7%) and not being able to carry out health inspections of the milk sold (41.7) were the main reasons for not using open milk (Table 9). Kibar et al. [21] stated that participants prefer packaged milk more. In this preference, the ease of access and labelling of the products, especially hygiene, emerged as important reasons for preference.

Table 9. If you are NOT using open/street milk, what is the reason?

	N	%
Can't access fresh milk	32	14.8
Not hygienic	88	40.7
No quality/health control	90	41.7
Don't like the taste	2	.9
Loose milk is expensive	4	1.9
Total	216	100.0

Source: Author's calculation.

Reasons for not using packaged milk

Milk is packaged by going through a series of processes in enterprises. Consumers believe that there are chemicals in processed milk and therefore avoid using processed milk. In the current study, the presence of additives in milk (28%) is the most critical factor preventing the use of packaged milk. Although daily milk is sold in glass bottles and plastic packaging, the belief that packaged milk (especially cardboard and plastic boxes) is not fresh is quite common (19.7%). Yoghurt is more common than milk, and families in Turkey can make their yoghurt. Research findings also showed that not being able to make yoghurt is an inherent factor in not buying packaged milk. Similarly, Gözener and Sayılı [14] found that 53.14% of the families surveyed did not prefer packaged milk because they found the price high (59.03%), and no one in the family liked it (42.36%) (Table 10).

Table 10. If you are NOT using packaged milk, what is the reason?

	N	%
Contains additives	61	28.0
More expensive	23	10.6
Not natural	29	13.3
Not fresh/daily	43	19.7
Unable to purchase as much as needed	11	5.0
Not good for children	12	5.5
Cannot make yoghurt	39	17.9
Total	218	100.0

Source: Author's calculation.

CONCLUSIONS

Milk and dairy products are indispensable in human development for their nutritional values. Milk consumption has many benefits and Turkey is an agricultural country with a high milk production amount. Still, when the per capita milk consumption statistics are examined, Turkey is far behind the developed countries. It is necessary to undertake studies to increase milk consumption and raise society's awareness of this issue. The research aimed to determine the factors affecting the consumption of milk and dairy products by consumers living in Bursa, one of the largest provinces of Turkey.

The research region's milk and milk processing industry is more developed than in other provinces. The milk consumption in the Southern Marmara Region, where the province is located, remains above the country average. Despite this, the level of milk consumption in the research area has not reached the developed countries' consumption levels. Consumers who regularly drank milk every day were only 16%. Most consumers, including children, did not have milk-drinking habits. The school milk program is a good instrument that helps children to gain this habit. This programme has been successfully implemented in many countries, especially European Union countries. It was also implemented by the Ministry of Health in Turkey between 2011 and 2018. However, this programme was quietly abandoned in 2018 and needs to be implemented again with the cooperation of dairy enterprises and pupils' families. In this way, starting from a young age, all segments of society can gradually gain the habit of drinking milk-drinking habit.

Some experts' conflicting statements about whether to buy raw or packaged milk, whether or not to consume milk in adulthood and consume milk as a dairy product (buttermilk, kefir, yoghurt) instead of drinking milk lead to confusion. Therefore, health professionals and those who publish such news should be more prudent.

It is vital to carry out studies in Bursa province on the dairy industry's development and closely follow the technological developments because there is a developed food processing industry. At the same time, agriculture and animal husbandry are intensively carried out on the city's fertile plains. However, local and central governments must support the dairy industry to control the sale of unregistered street milk. The advantages of selling unregistered street milk must be eliminated. In addition, it is necessary to undertake an inspection mechanism to ensure the hygienic milk supply. Many companies have entered the packaged milk market under various brands. The presence of brands brings in competition, but it is evident that consumers do not have enough information about both these brands and packaged milk options on offer. Firms with a high or low market share should offer a price advantage and a wider variety of packaging options to satisfy consumers' preferences.

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KEY DRIVERS IN SECURING THE LONG-TERM SUSTAINABILITY OF A PAN-EUROPEAN DISTRIBUTED RESEARCH INFRASTRUCTURE

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Abstract

This article aims to provide insights on how to create a sound financial model to secure the financial sustainability of a pan-European distributed research infrastructure (RI). The financial sustainability is a key challenge for any Research Infrastructure (RI) sustained by the European Strategy Forum on Research Infrastructures (ESFRI) along its construction and implementation process (nearly 10 years) due to its large-scale size and complexity. Therefore, the Horizon 2020 (H2020) and Horizon Europe call dedicated to the different phases of ESFRI RIs requested/request thorough financial calculations, pushing the RIs' members to pay special attention to the financial aspects in order to overcome any financial shortcomings and make sure that these RIs will survive on a long-term with the aim of fulfilling their mission and objectives. In this regard, the article presents the approach applied in showing the long-term financial sustainability of METROFOOD-RI, a future distributed-RI operating in the ESFRI domain of Health & Food. METROFOOD-RI was included in ESFRI Roadmap in 2018 as an Active Project and in May 2022 completed its preparatory phase financed under the H2020 METROFOOD-PP project. It focuses on moving forward to METROFOOD-ERIC and becoming an ESFRI Landmark. National R&D Institute for Food Bioresources – IBA Bucharest is an active member of this RI and it was fully involved in preparing its financial plan, cost book and business plan. The document describes the steps taken in showing the financial sustainability of METROFOOD-ERIC, financial options, costs and revenues.

Key words: *research infrastructure, agri-food, financial sustainability, costs*

INTRODUCTION

The European Commission defines, evaluates and implements strategies and tools to provide Europe with world-class sustainable Research Infrastructures. RIs are notable research facilities providing resources and services, specifically designed to address global complex challenges in various key domains that the European Strategy Forum on Research Infrastructures (ESFRI) set as top priority for action [7].
ESFRI elaborates a long-term European strategic planning for the development of RIs and facilitates multilateral initiatives leading to the better use and development of RIs, at EU and international level. It identifies and financially supports new pan-European RIs or major upgrades to existing ones included in a document dedicated to such RIs entitled ESFRI Roadmap [1].
ESFRI Roadmap includes an assessment of the research landscape and presents the list of RIs according to key domain, typology and phase. The document is updated on a regular basis, based on the needs of the European scientific community. Once an RI is included in the ESFRI Roadmap, it has the opportunity to access funds under the European Commission funding programmes, i.e., Horizon Europe, by applying to specific calls dedicated to sustain such RIs in each phase of its lifecycle (e.g., design, preparation, construction phase) [2].
Most of the ESFRI RIs are distributed [3] with the aim of enhancing collaboration and integration among various research institutions/ organisations, fostering innovation, sustaining co-creation, and

making thus, a wider impact, not only at the European level, but also worldwide.

A distributed RI (Fig. 1), as defined by ESFRI, represents a research facility that is geographically dispersed. It is composed of a Central Hub and an interconnected network of National Nodes, the facilities being located in different locations (e.g., ACTRIS, DANUBIUS-RI, ELI, METROFOOD-RI) [11].

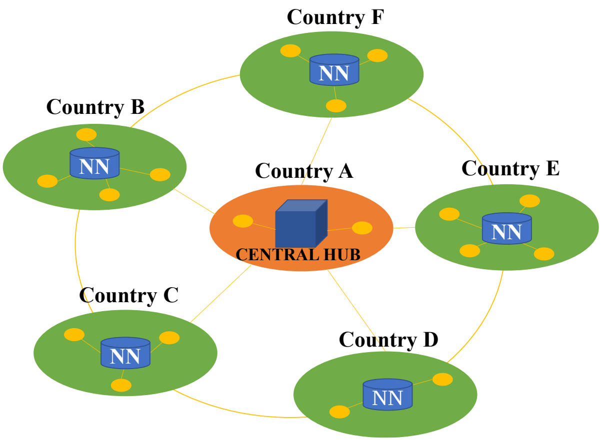

Fig. 1. Distributed RIs
Source: adapted after European Commission - Supporting the Transformative Impact of Research Infrastructures on European Research.

METROFOOD-RI "Infrastructure for Promoting Metrology in Food and Nutrition" was created as a distributed RI aimed to promote scientific excellence in the field of food quality and safety. It provides metrology services in food and nutrition across various highly interdisciplinary, interconnected fields along the food value chain, such as agri-food, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health [9].

METROFOOD-RI is perfectly aligned with European policy objectives and strategies, specifically the European Green Deal [4] with its main component strategy Farm to Fork. The main initiatives of this strategy are: sustainable food production; food security; sustainable food processing; sustainable food consumption and the shift to healthier & sustainable diets; food loss and waste and food fraud [5].

Metrology is the foundation of any measurement system and provides the tools to make the measurement results reliable and comparable. To have a Metrological RI able to allow trade, demonstrate the quality of products and services and strengthen the knowledge base for decision-making in the environmental, health and forensic sectors is an essential factor [8].

The development of METROFOOD-RI enables the realization of a global measurement system, that makes uniform every aspect of a measurement (unit of measurement, reference materials and reference methods, procedures for the assessment of competence, procedures for quantifying measurement uncertainty, etc.), increasingly improving the quality of measurements, especially in terms of reliability and comparability of the results.

At present, 48 partners from 18 countries (Italy, Belgium, Switzerland, Czech Republic, Germany, Spain, Finland, France, Greece, Hungary, Moldova, Republic of North Macedonia, Netherlands, Norway, Portugal, Romania, Republic of Slovenia and Turkey) are involved in the creation of METROFOOD-RI [12][10].

MATERIALS AND METHODS

The financial model was built considering the set-up of a European Research Infrastructure Consortium (ERIC) which is a specific legal form that facilitates the establishment and operation of RIs with European interest [6].

The methodology consisted in estimating all costs and potential revenue streams for the Central Hub and the National Nodes.

Consequently, a cash flow was prepared for the Central Hub and a separate one for the National Nodes. Costs and revenues were well-founded, based on reasonable judgement, using a prudent approach. Costs were estimated based on the personnel costs of the participating country, actual costs and quotations per (similar) equipment/ consumables/ maintenance services.

Diagrams were created to visually represent the key aspects related to METROFOOD-RI.

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RESULTS AND DISCUSSIONS

RI's structure

METROFOOD-RI will be built on a Hub and Node model, composed of a Central Hub in Italy and a network of National Nodes (NN), one NN created per each country involved. Some NNs entail more partners such as Italy, Romania, the Republic of Macedonia, and Slovenia, which will be in turn organized in a network of Centres.

METROFOOD-ERIC will be set as a legal entity to take advantage of the benefits provided by the ERIC status such as more flexibility and exemptions from VAT and excise duty. In fact, it will represent the Central Hub acting as an "umbrella" of all NNs, in charge of the coordination/ management of the RI, while the NNs, will be totally independent units, bearing the responsibility of ensuring their self-sustainability. Consequently, the Central Hub represents the coordinating/ management office of the ERIC, while the NNs will carry out the R&D activities and be involved in the service provision. Having that said, the financial plan was prepared separately, on one side for the Central Hub and on the other side for the NNs. In this way, ERIC will focus mainly on covering the Central Hub costs which facilitate its operation, accounting and management systems, whereas each NN will make sure it has sufficient funds for supporting investments in assets or upgrades, as well as costs related to day-to-day operation.

The ERIC will be composed of Members and Observers who will be entitled to perform research activities according to their research facilities and capabilities following their rights stipulated in the ERIC's Statute.

This way of structuring METROFOOD-RI is aimed to facilitate different aspects in terms of finances, economics, logistics, procurement, accounting and so on.

Financial model

Bearing in mind that METROFOOD-ERIC depends on the activities performed by the NNs and other external institutions (if the case), the financial model was designed to integrate all parts, meaning the Central Hub and the NNs, as a whole, because the viability and feasibility of a distributed-RI depend on both ERIC and NNs' financial sustainability (Fig. 2).

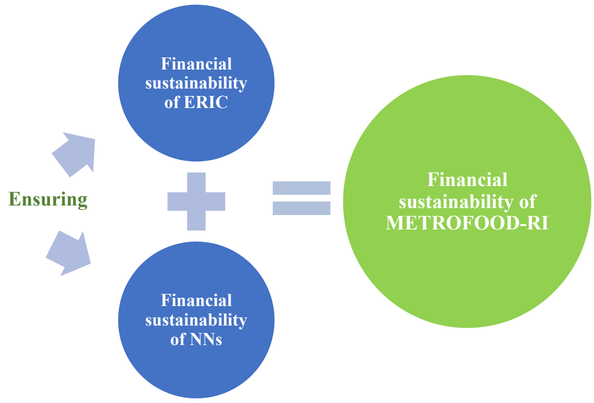

Fig. 2. Approach related to the financial sustainability of a distributed RI
Source: Own results.

Therefore, starting from the RI's structure, the financial model was developed gradually, step by step, having in mind the global picture of the RI.

Step 1 - Cost book

This step consisted in estimating the costs for setting and running the whole RI, meaning the costs for the ERIC (the Central Hub) and the costs at NNs level, as shown in Fig. 3.

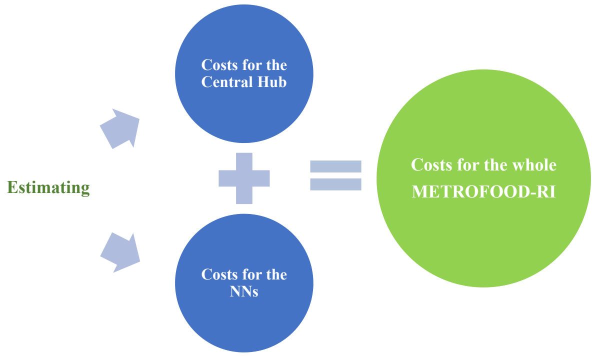

Fig. 3. Approach related to costs estimated for a distributed RI
Source: Own results.

The Central Hub costs were calculated in detail for the different cost items in order to reach a higher confidence level of the estimated costs for setting and running the Central Hub, the total cost being further used in defining the financial contribution for being

Member or Observer of the METROFOOD-ERIC.

The Central Hub costs include personnel costs, start-up costs/ registration taxes, and building and operation-related costs.

The personnel costs were estimated based on the salary level in the hosting country, in our case Italy, taking into account the professional profiles, responsibilities, seniority level, and full-time equivalent.

The costs at the NNs level were calculated starting by preparing a cost-breakdown per each institute, then aggregated by each NN and finally, calculated in total NNs. For example, in the case of METROFOOD-RI, the cost-breakdown was performed by each of the 48 organizations, then grouped by each country (to form the NN) and afterwards, making the sum of all NNs in order to have the whole picture with the contribution of each NN and the magnitude of the RI.

Only in this way, by knowing all types of costs, each Node will be able to figure out both income and financing sources necessary to cover the costs incurred for being part of this large RI, with the aim of being sustainable in the long run.

In order to do so, each institute have decided the pre-existing facilities, both physical and electronic, and the new equipment needed to be purchased and shared with METROFOOD-RI for the operation and specific service provision.

It is worth mentioning that METROFOOD-RI relies on pre-existing facilities, therefore a list of the current assets that each partner puts at the disposal of the ERIC has been provided in the cost book to showcase their great capacities.

For each Node, the following items have been calculated: costs for new equipment and % dedicated to METROFOOD-RI; costs for new e-resources (non-physical assets) and % dedicated to METROFOOD-RI; personnel costs and FTE dedicated to METROFOOD-RI (for different professional profiles: management, researchers, lab technicians, temporary staff, administration and IT staff); consumables; maintenance; other costs (e.g., training, travels, dissemination, upgrades, accreditation); indirect costs.

The full approach is displayed below in Fig.4.

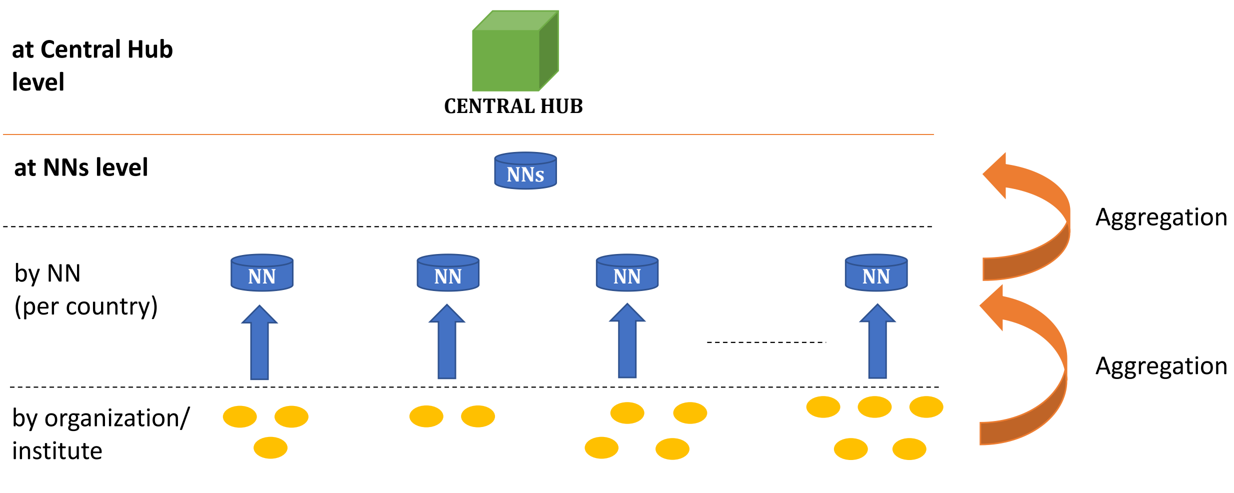

Fig. 4. Methodology used in calculating the costs for METROFOOD-RI
Source: Own results.

Step 2 - Revenues

Similar to costs, revenues were estimated on one hand for the Central Hub and on the other hand at the NNs level.

The potential revenues (cash inflows) of the ERIC mainly consist of:

– Host Country contribution (Italy);
– Membership Contribution from ERIC Members and Observers;
– Commercial/ economic activities from chargeable services;
– EU grants or other calls dedicated to the ERIC.

The funding model was built so that the sum of all contributions from Members and Observers is equal to the annual financial needs of METROFOOD-ERIC. This means that the funds needed to cover ERIC's costs are secured in full.

Different alternative criteria have been taken into consideration for calculating the financial contribution that ERIC members have to provide annually in order to support the costs that ERIC:

– Gross Domestic Product (GDP) per country
– GDP per capita
– Combination between GDP per country and GDP per capita
– GDP exact values per Country

In the end, the partners proposed to go with the combination of GDP per country and GDP per capita.

The scheme of the financial contribution is presented in Fig.5.

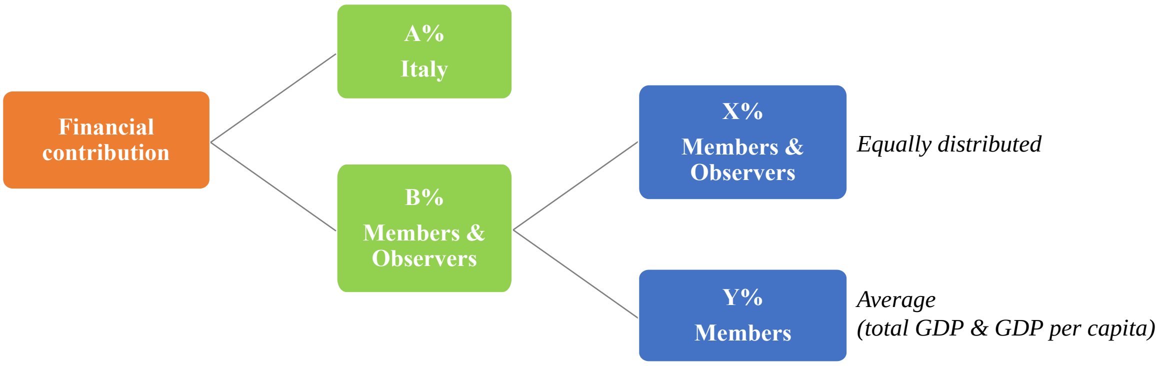

Fig. 5. Example of a mathematical formula for calculating the financial contribution of partners
Source: Own results.

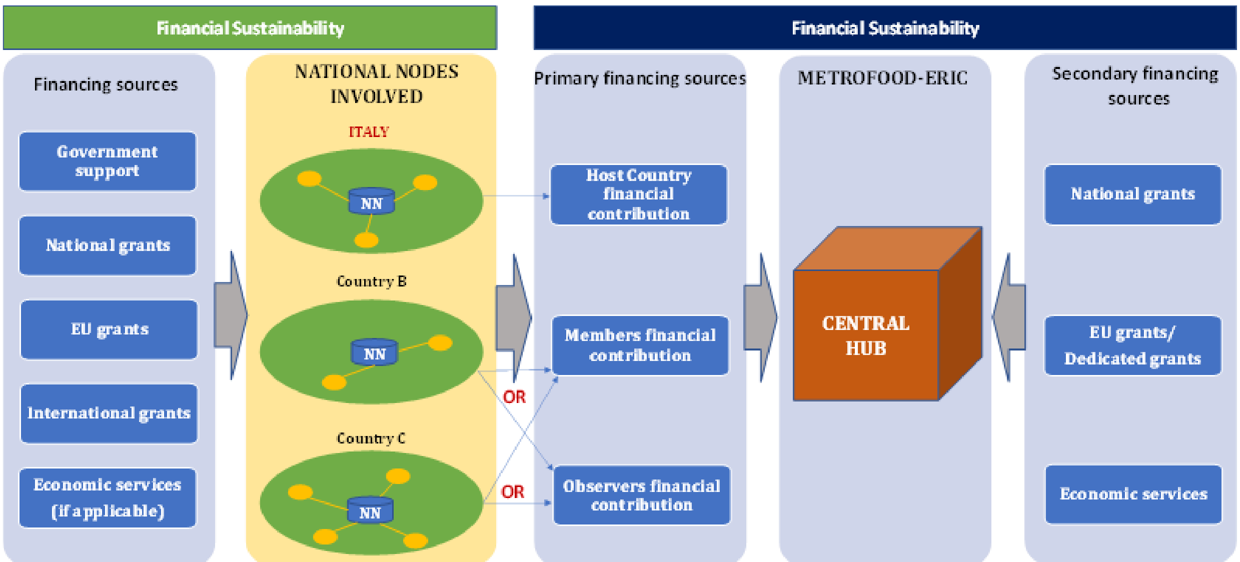

Fig. 6. Potential financing sources for the National Nodes and the Central Hub
Source: Own results.

The financial contribution was calculated for a 5-year period, according to the period set for it; afterwards, being subject to recalculations.

Different projections on the fees were prepared taking into consideration: the whole cost calculated for the Central Hub, the Countries potentially entering as Members and Observers and the proposed criteria.

Each National Node must ensure its self-sustainability. This means that Members and Observers are responsible for covering their own operating costs. In general, the expenses incurred for setting up a National Node are covered by a dedicated national grant.

Subsequently, each NN should identify additional funds such as:

- Grants from the national Ministry;
- Cash from METROFOOD-ERIC depending on the services provided under its brand;
- In-kind contribution from each member of the NN.

Various financing sources for both ERIC and NNs (Fig.6) were considered in view of ensuring financial sustainability.

Step 3 - Financial plan (cash-flow)

The costs of the ERIC will be fully covered by the financial contribution paid by the NNs included as Members or Observers. Furthermore, each NN, either Member or Observer, will have to cover its operating costs concerning METROFOOD-RI and the investments and upgrades necessary to perform the R&D activities for the ERIC. In this way, there will be no problems in ensuring the financial sustainability of the ERIC, whereas the National Nodes will make investments depending on its financing sources available.

The cash-flow has been forecasted since the beginning of the project (PRO-METROFOOD) and throughout a 25-year timeline to reveal the amount of costs incurred along the design, preparation, construction and operation of METROFOOD-RI.

CONCLUSIONS

Preparing a rigorous financial model for such complex RIs, as in the case of METROFOOD-RI with 48 organizations from 18 countries, requires a great effort, a lot of financial calculations, solid knowledge and experience in accounting, finance, economic-financial analysis, project management, so that the assumptions, the financial estimates and projections be as accurate as possible.

It is a great challenge in deciding the mathematical formula for calculating the financial contribution of each country joining the ERIC as a Member or Observer. Each financial option based on the above criteria could lead to the significant difference in the financial contribution of a country, therefore, a combination between a fixed amount and a variable one would be more appropriate and acceptable to partners. This is a complex process, which entails long discussions and negotiations among partners. Nevertheless, the financial commitments from the ministries of each country involved are essential in securing the funds necessary for large-scale RIs.

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STRATEGIC TOOLS IN ASSESSING THE BUSINESS ENVIRONMENT OF A PAN-EUROPEAN DISTRIBUTED RESEARCH INFRASTRUCTURE

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Abstract

The purpose of this article is to showcase the strategic tools used in examining the business environment of a pan-European distributed research infrastructure (RI) with the aim of identifying the key factors that may influence its activity, identifying the emerging risks, better defining its strategy and objectives, better-addressing stakeholders' concerns. PESTLE analysis, SWOT analysis and Mendelow's stakeholder matrix are effective tools for strategic planning and decision-making. In this regard, the article conveys these tools in the case study of METROFOOD-RI, a future distributed RI operating in the ESFRI domain of Health & Food. It indicates the key factors at the macro-economic level, the main pros and cons of METROFOOD-RI, market opportunities and menaces and the relationships that should be built with various stakeholders. A clear understanding of the impact of these elements is essential in planning the creation of such large-scale RI.

Key words: *research infrastructure, agri-food, PESTLE, SWOT, analysis, stakeholders*

INTRODUCTION

Food continues to be the main concern of all global societies. There is a high pressure on modern agriculture and food production to withstand a fast-rising global population which requires access to safe and reliable sources of nutrition [5].
The OECD‑FAO Agricultural Outlook 2023‑2032 states that the world population is expected to grow from an average of 7.9 billion people in 2022 to 8.6 billion people in 2032 [9].
The EU's Common Agricultural Policy (CAP) underlines the strategic importance of the agri-food sector, representing about 36% of the overall budget of the EU [7]. It has also become an industrial sector competing on the global level.
The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), which fosters competitive and sustainable farming and forestry [1] and the European Institute of Innovation and Technology for Food (EIT Food), a large European food innovation initiative, working to make the food system more sustainable, healthy and trusted [2], emphasize the central position of the agri-food sector in Europe's industrial and innovation strategy.
The complexity of the agri-food system requires a systemic approach, promoted by Food 2030 EU initiative, to connect, scale up, and boost EU R&I and investments for providing solutions to four overarching priorities: i) nutrition for sustainable and healthy diets; ii) climate-smart and environmentally sustainable food systems; iii) circular and resource-efficient food systems; iv) food systems innovation and empowerment of communities [6]. Among them, the most related priority to food safety is "nutrition for sustainable and healthy diets". In addition to supporting the new Farm to Fork strategy, this priority also aims to contribute to further development and implementation of EU food regulation and food safety policies, the Steering Group on Health Promotion, Disease Prevention and Management of Non-Communicable

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Diseases, and the relevant targets of the 17 Sustainable Development Goals: 1-Less poverty, 2-Zero hunger, 3-Good health and well-being, 8-Decent work and economic growth, 10-Reduced inequalities and 12-Responsible consumption and production [13].

Food quality and safety, authenticity and health benefits have become a focus for public concern and consumer requirements all over the world. However, there is still a significant fragmentation with regard to food control, analysis, data and research in Europe and worldwide.

ESFRI Roadmap 2018 clearly states that new infrastructure efforts are needed at the EU level in the field of food, nutrition and processing. There is a need to connect RIs across the EU and globally, and across the entire food chain [3].

In this context, the creation of METROFOOD-RI, as a pan-European distributed research infrastructure [3][4], fulfils the needs identified by ESFRI in the Health & Food domain by conducting top-level research activities in this domain through its mission to enhance quality and reliability of measurement results and make available and share data, information, and metrological tools [8][10]. The scientific offer is addressed to a broad set of users, such as researchers/academics; food business operators; policymakers, food inspection and control agencies; consumers/citizens [8].

According to the ESFRI classification of scientific domains, METROFOOD-RI belongs to "Health & Food" [11]. Nevertheless, given its wide impact, it is also connected to other ESFRI domains (Fig.1) [3], especially to the "Environment" domain.

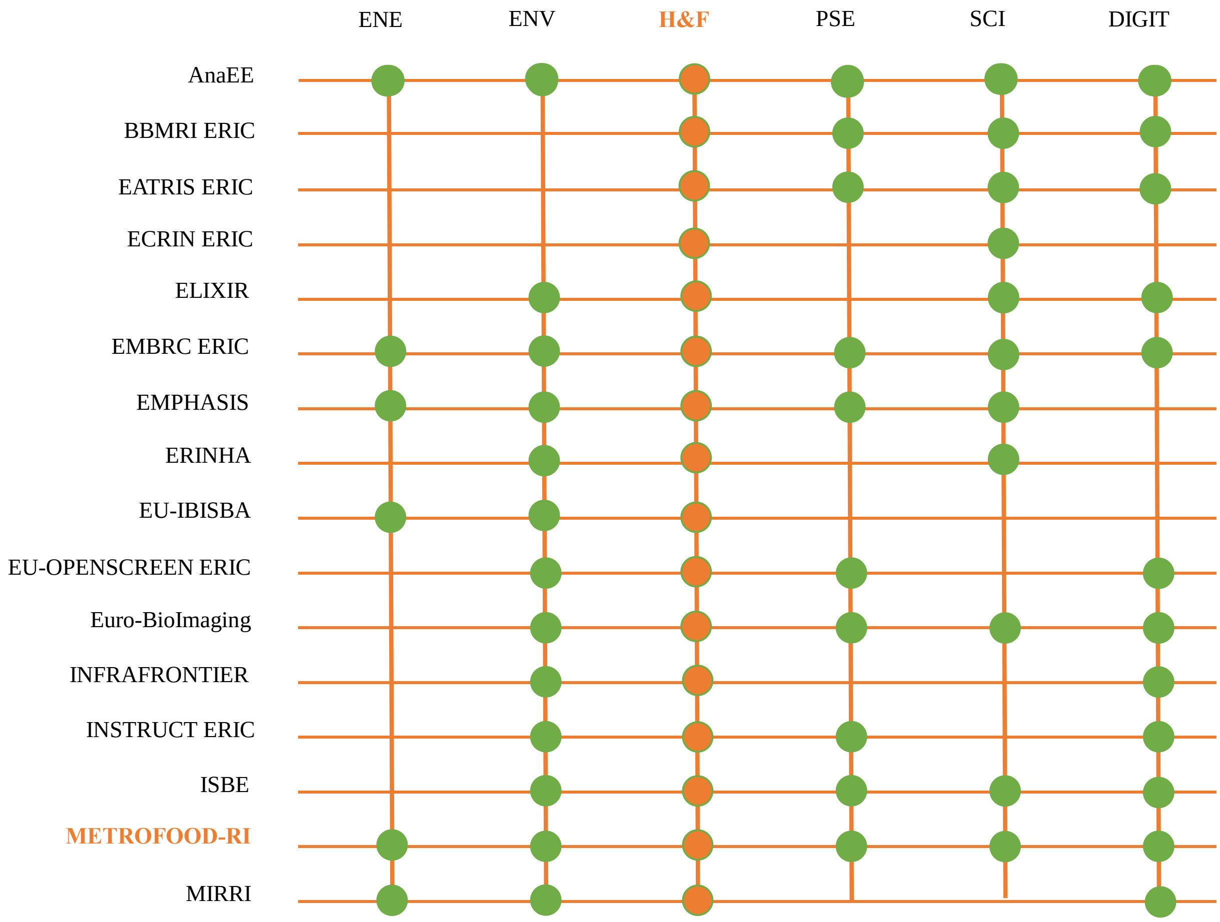

Fig.1. Interconnections between ESFRI RIs from Health & Food domain and the other scientific domains
Source: ESFRI Strategy Report on Research Infrastructures Roadmap 2018.

METROFOOD-RI completed its preparatory phase in May 2022, financed under the H2020 METROFOOD-PP project. At present, it has just received approval for additional financing under the call HORIZON-INFRA-2023-DEV-01-02 — Early phase implementation of ESFRI Projects which entered the ESFRI Roadmap in 2018 which represents a step forward in reaching its goal of becoming a legal entity METROFOOD-ERIC.

MATERIALS AND METHODS

The PESTLE analysis was used in order to have a thorough understanding of the external factors that could influence the activity of METROFOOD-ERIC.

The SWOT analysis was performed to analyse its strengths, weaknesses, external threats and possible future developments. It was developed based on the entries from METROFOOD-RI partners via brainstorming.

The Mendelow's stakeholder matrix was prepared to assess RI's stakeholders' attitudes and expectations and their potential impact on business decisions.

Most diagrams were created in Miro platform.

RESULTS AND DISCUSSIONS

Environmental analysis

Before taking any decision regarding the implementation of METROFOOD-RI and ERIC set up, an in-depth analysis of both RI's internal and external environment was carried out in order to properly plan the implementation and operation of a large and complex RI.

The **PESTLE Analysis** was developed as METROFOOD-RI is subject to various macro-environmental factors (political, economic, social, technological, legal and environmental) that could impact its overall performance. Its business framework is broken down into the 6 key external factors posted in Fig.2.

The political environment is characterised by government, EU and ESFRI actions which by setting policies, strategies, regulations can directly and/or indirectly influence the activity of METROFOOD-ERIC or its targeted areas such as agri-food sector, food security, food quality, etc.

Moreover, it has a significant influence on METROFOOD-ERIC financial sustainability as the national governments are actively involved in this research infrastructure by offering political and/ or financial support which is paramount for its long-term existence. In addition, the EU offers major funding opportunities for the construction of such RIs [12].

Economic factors include inflation rates, salary level, market trends, national budget deficit which have a great influence on the market demand, services prices, employment conditions, and overall users' consumption. Considering particularly these tough times, the most of the EU countries face high inflation rates, increased budget deficit, a slowing down of the overall economy.

Social factors refer especially to demographic trends, population age and mobility, lifestyle, customers' tastes, education and population health. These factors can influence on one hand, for example, the mobility of researchers, their expertise, and on the other hand, the range of services offered by METROFOOD-ERIC which will be changed in line with users' needs.

Technological factors influence both physical and electronic infrastructures of METROFOOD-RI. National Nodes have to constantly invest in upgrading and/ or new research equipment, as well as to keep up the pace with aspects related to digitalisation, analytics, clouding, platforms and applications. In this way, it will ensure the provision of high-quality services and users' satisfaction.

Legal factors are also important and include the regulations specific to the ERICs, food quality and safety regulations, copyright and patent laws, data protection laws, etc.

Environmental factors do not have a direct impact on METROFOOD-RI but have a significant influence on the agri-food sector, with consequences on the Health & Food domain to which METROFOOD-RI belongs.

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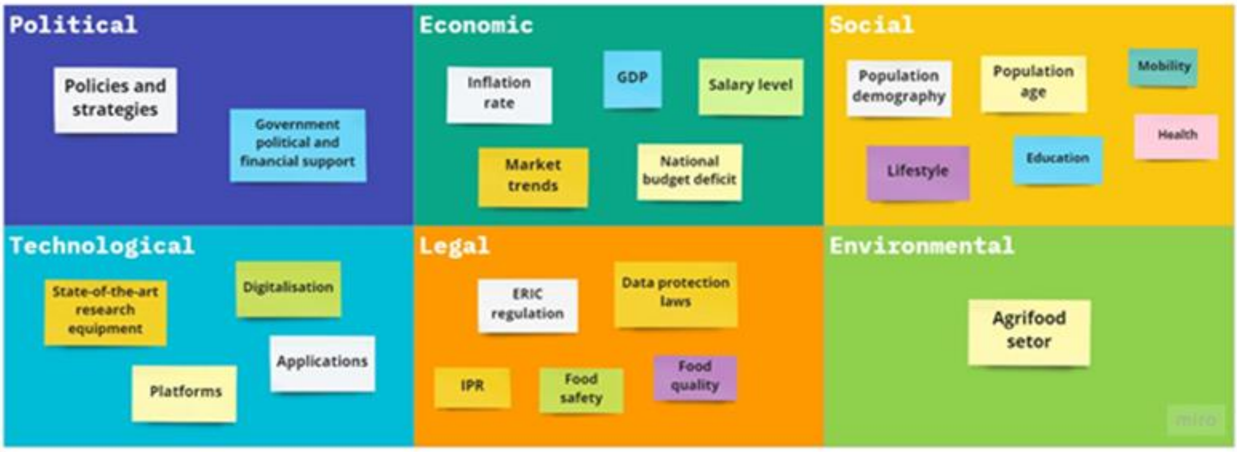

Fig.2. PESTLE Analysis
Source: Own results.

The **SWOT Analysis** (Fig.8) was performed in order to better capture METROFOOD-RI's role. The strengths, weaknesses, possible future developments and external threats have been identified and analysed.

It aimed to examine the RI's business environment for supporting the METROFOOD-RI partners in identifying the most appropriate strategies to reduce weaknesses and threats, as well as to mitigate any potential risks that may impede the smooth implementation and operation of METROFOOD-RI and the future ERIC.

Strengths and weaknesses refer to the pros and cons of METROFOOD-RI.

The main pros of METROFOOD-RI include ERIC's structure, state-of-the-art facilities, high expertise, high-qualified staff involved, multiple and integrated services provided and multiple challenges that it addresses.

The cons consist mainly of some scientific topics or areas insufficiently covered and few countries with political and economic commitments.

Opportunities and threats refer to the external features that METROFOOD-ERIC should leverage or take action. It helps in shaping current and future operations and setting strategic goals.

The opportunities refer to social opportunities given by education and professional training for new jobs that RI can offer. This will lead to an increase in overall competence. Cooperation between partners and also between European research groups with other RIs will increase the visibility of organisations at the European/global level. The measurement methods and standards developed by METROFOOD-RI partners will help to identify contaminants that affect human health and also to identify bioactive compounds necessary for a healthy diet. This is an opportunity to strengthen consumer protection and improve quality of life. Policy improvement is envisaged. METROFOOD-RI, as rapid information and dissemination and transfer of knowledge and technology tool, can improve innovation-related activities and interaction with users, becoming a major driver for innovation in food safety.

Threats arise from insufficient resources: human (brain drains) and reduced finances (poor investment in research in the last period in almost all partner countries, low-level financial support granted by public authorities). COVID-19 (or other pandemics) situation and Fake news related to food is affecting the food market from a quantitative and qualitative point of view. Incoherent national policy related to METROFOOD-RI and poor dialogue between different levels of participants on the food system and METROFOOD-RI could also be an important threat.

The key internal and external factors of METROFOOD-RI that can influence its strategy and activity are outlined in the below board.

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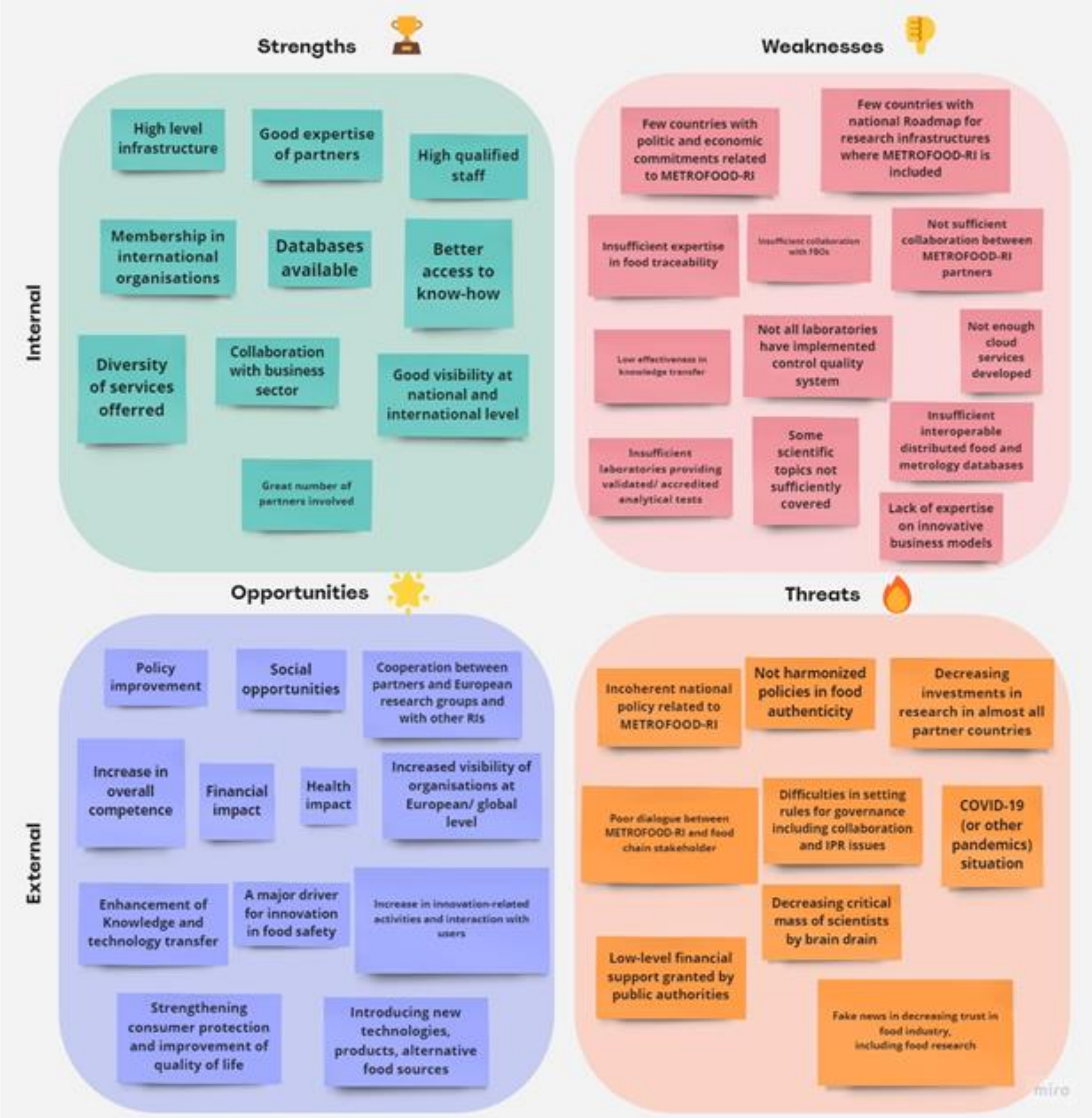

Fig. 3. SWOT analysis
Source: Adapted after METROFOOD-RI results.

Mendelow's Stakeholder Analysis of all the interested parties/ actors, whether internally or externally, that could have an interest or power in the construction and operation of METROFOOD-RI, was carried out in order to be able to take the right actions and decisions in relation to this new RI.

The analysis revealed the following aspects of stakeholders:

-The ERIC's members and observers have the highest interest and power in METROFOOD-RI, relying on the political and financial support granted by their governments. These stakeholders represent the key players as the whole infrastructure depends on their decisions.

-Users and customers of METROFOOD-RI's services should be kept satisfied and continuously monitored in order to anticipate their needs and be able to provide the right services that fit their expectations. This segment includes food business operators, policymakers, academic entities, researchers and consumers.

-EU, ESFRI, other international bodies, as well as METROFOOD-RI staff should always

be kept informed on the activities, services, changes, new perspectives of development, results and so on, depending on their area of interest in METROFOOD-RI.
-Citizens, Media, and NGOs represent the category of actors to whom, a minimal effort should be made by METROFOOD-ERIC as they can contribute to increasing METROFOOD-RI's visibility, reputation and brand.

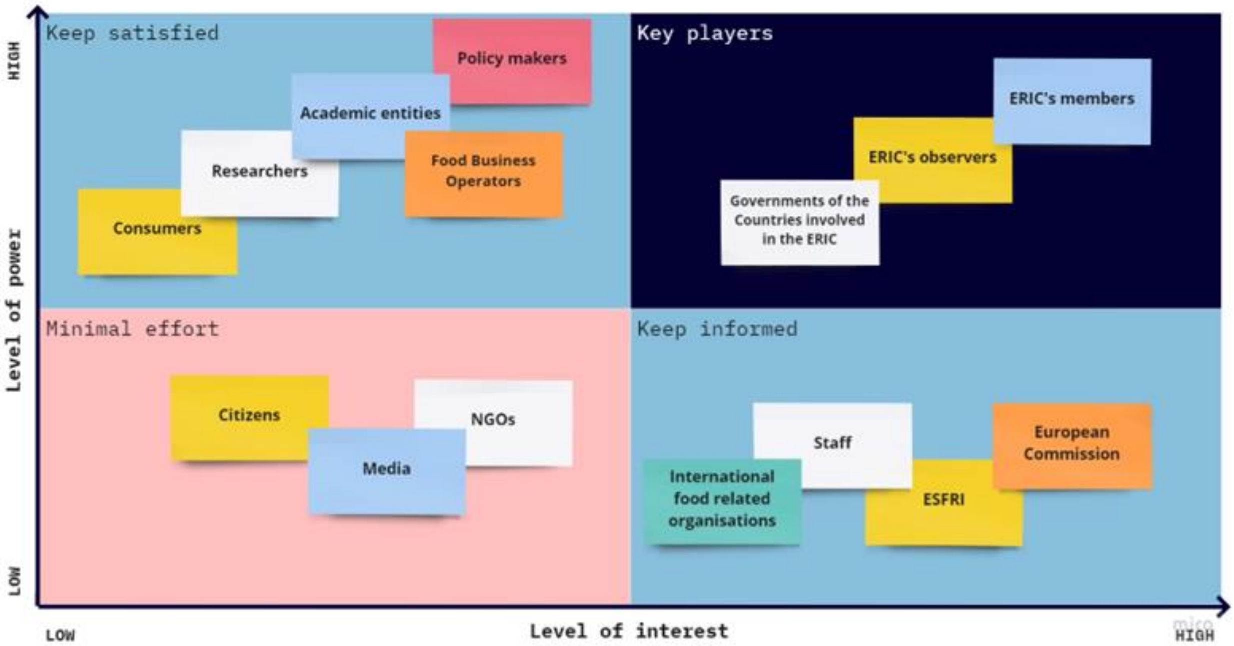

Fig.4. Mendelow's matrix
Source: Own results.

CONCLUSIONS

Besides a high increase in food production, there is also a need for more food controls and testing to pass strict regulations on food safety as new food products, new processing techniques and new environmental conditions emerge.
METROFOOD-RI, through its research activities and services, plays a key role in addressing the global challenges in respect of the food system and human health.
Based on the environmental analysis, the strategy was better defined, the risk management analysis was carried out and TOWS strategies were developed. As such, METROFOOD-RI relies on the following key factors for keeping its sustainability in the long run:
-Investing in new facilities and/or upgrading the Physical-RI and e-RI, if necessary, to keep providing high-quality services
-Strengthening the relationships and involvement of Members and Observers
-Widening the number of Members and Observers with a focus on attracting more partners as Members
-Enhancing networking with various RIs, Associations, Clusters, industry, etc.
-Enhancing the visibility of METROFOOD-RI at European and International levels by promoting its activities, services and benefits
-Maintaining high-quality standards in providing the services
-Maintaining highly-skilled staff by pursuing a continuous professional development
-Tailoring the range of services according to the users' requests
-Strengthening the wide range of expertise, tools and capacities
-Ensuring an ongoing mutual communication with stakeholders in order to keep them informed and satisfied

-Ensuring the sustainability of the RI in terms of infrastructure (P-RI and e-RI), human resources and finances.
-Rigorous cost control at the National Nodes level
-Accessing various financing opportunities in order to ensure financial sustainability in the long run
-Monitoring and assessing the impact and the KPIs.

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COMPARATIVE ANALYSIS OF THE GDP OF EUROPEAN COUNTRIES IN THE PERIOD 2017-2022

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Abstract

The present paper presents a statistical analysis of the Gross Domestic Product/person, at the national level, in relation to the member countries of the European Union, using statistical data published by Eurostat, Naational Institute of Statistics (INSSE), FAOSTAT and the World Bank. Based on the data centralization, calculations were made to determine some absolute and relative statistical indicators, such as the absolute change, the dynamic index or the dynamic rate. The purpose of this paper is to analyze and observe GDP per inhabitant evolution, in the period 2017 - 2022, as well as the hierarchy of European member countries, according to this macroeconomic indicator. Going through the work, it can be observed that the order of each member state in different hierarchies based on the GDP level, nominal or real, differs, depending on the perspective from which the data is analyzed. Not always a country with a high level of GDP is characterized by a higher level of well-being of the population. Also, a country that has not yet reached economic maturity in terms of GDP level, may have advantages over the already mature European economic markets over a longer period of time.

Key words: *statistical indicators, GDP, European Union, economic efficiency, population well-being*

INTRODUCTION

GDP (gross domestic product) value, a reference macroeconomic indicator, at the level of a country's economy reflects the sum of all goods and services market value intended for final consumption, produced in all branches of the country’s economy, in a certain period of time, usually 1 year. Depending on the geographical area on which the economic analysis is made, the GDP indicator can be calculated at the country, region or locality level. A GDP’s country’s higher value, compared to the level of this indicator registered in another country, reflects economic power. Due to each state particularities (area, population), GDP per person reflects the living standard for a country. Mathematically, we can calculate the GDP value using 3 methods: the income method, the expenditure method and the added value method [1].

In 2022, at the European level, the countries with the greatest contribution to the formation of the GDP recorded at the level of the European Union were: ***Germany*** (29.57%), ***France*** (16.71%), ***Italy*** (12.08%), ***Spain*** (10.16%). Moreover, according to the Eurostat database, this hierarchy is preserved in all the years, between 2017 – 2022. ***Romania*** had a 1.43% contribution EU’s GDP total value, a smaller value comparative to 2021 (1.63%), this value places Romania ahead countries like Portugal, Bulgaria, Greece, Hungary [4].

According to the statistical data, in 2022, ***Romania's GDP*** recorded approximately 286 billion euros, which represents a 19% increase compared to the same indicator value recorded in 2020, respectively, 240 billion euros [4]. Compared to 149.8 Billion Euro in 2014, in 2022, GDP was by 90% higher [9]. Moreover, according to the World Bank data, regarding Romania's GDP, it can be observed a constant annual increase, in 2017 – 2022 period, with the 2020 exception, when GDP’s value decreases, compared to 2019, in the Covid-19 pandemic context [12].

GDP per person is a measuring indicator, obtained by reporting the total production value produced within a country, at the number of country’s inhabitants. The average value of GDP per person, at European level, in 2017-2022, was 31,396 euros/inhabitant. The trend for this parameter was increasing, excepting the 2020-2019 period, when, within the background of the Covid-19 pandemic, economic losses were recorded in all European countries [6]. In this context, the purpose of the paper is to comparatively study GDP in the EU, 2017-2022.

MATERIALS AND METHODS

In order to analyze the GDP per person level, both at national and European level, official reports of the World Bank data [12], the National Institute of Statistics [10], Eurostat [4, 5, 6], and Faostat [7], were used. Also, specialized national and international publications was studied in order to counter some possible causes that influence the evolution of the GDP per inhabitant, national and European level.
Last but not least, chronological series statistical indicators have been calculated using the formulas presented in Table 1.

Table 1. Statistical reference indicators

No.	***Indicator type***	***Formula***	***Explanation***
I	**Absolute indicators**		
	Absolute modification ($\Delta^y_{t/t'}$)	$y_t - y_{t'}$	t' = the base period (the first interval, the first moment of the series) or t' = t - 1 the previous period
a.	Fixed Base Absolute Change ($\Delta^y_{t/1}$)	$y_t - y_1$	shows how many units has changed the level of a phenomenon in the current period compared to the recorded level of the phenomenon in the first series.
b.	Absolute chain-based modification ($\Delta^y_{t/t-1}$)	$y_t - y_{t-1}$	shows how much a phenomenon level has changed, in the current period compared to previous period.
II	**Relative indicators**		
	Dynamics index($I^y_{t/t'}$)	$(y_t/y_{t'}) * 100$	shows how many times has changed a phenomenon's level, in the current period compared to previous period level, considered a reference base
a.	Fixed base dynamic index ($I^y_{t/1}$)	$(y_t/y_1) * 100$	calculated as a percentage ratio between the level reached by a phenomenon in the current period and the registered level in the first series period
b.	Chain-baseddynamics index ($I^y_{t/t-1}$)	$(y_t/y_{t-1}) * 100$	calculated as a percentage ratio between the level of the phenomenon in the current period and the levelrecorded in the previous period
	Dinamic rythm($R^y_{t/t'}$)	$I^y_{t/t'}$ % - 100%	shows by how many percentages the level of the phenomenon has changed in the current period compared to the level recorded in a previous reference base period
a.	Fixed base dynamics rhythm ($R^y_{t/1}$)	$I^y_{t/1}$ % - 100%	shows by how many percentages the level of the phenomenon has changed in the current period compared last year recorded value, period considered as a reference base
b.	The dynamic chainbased rhythm ($R^y_{t/t-1}$)	$I^y_{t}/_{t-1}$ % - 100%	calculated as a percentage ratio between the absolute change with a chain base corresponding to a period and the level of the phenomenon recorded in the previous period

Source: Turdean M.S. et al, 2010 [13].

RESULTS AND DISCUSSIONS

GDP at the main components level (output, expenditure and income)

Between 2017 and 2022, the GDP's evolution was positive, at the level of all European countries, as can be seen in Figure 1.

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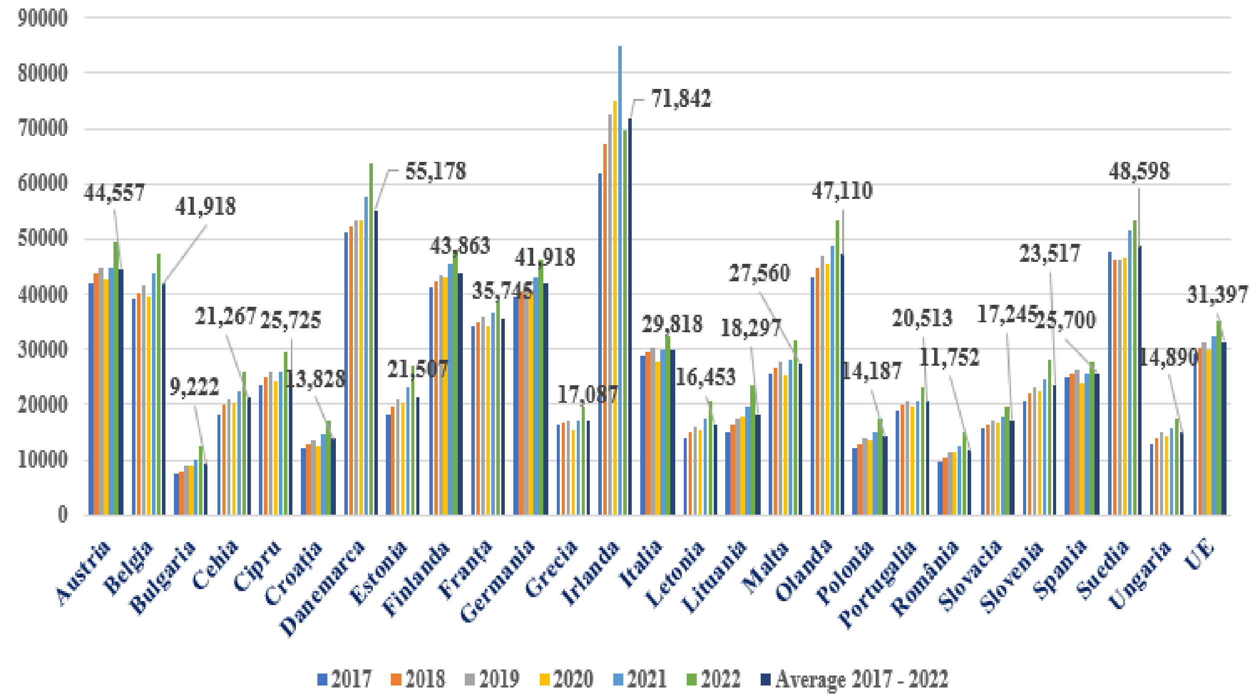

Fig. 1. GDP values (mil.euro), in EU., 2017 – 2022
Source: own processing based on Eurostat Data [4].

Thus, based on Figures 1 and 2, we can observe each country's contribution in EU's GDP's total. It worth to note that, in the analysed interval, the largest share is brought by ***Germany*** (24.67%), ***France*** (17.28%), ***Italy*** (12.27%), ***Spain*** (8.33%) and ***Netherlands*** (5.92%). In 2021, Romania contributed with 1.66% to EU's GDP registered level, thus placing itself ahead of countries such as *Portugal (1.46%), Bulgaria (0.47%), Greece (1.26%), Hungary (1.06%)*. It is also noted that the 2019 and 2020 transition, over the pandemic context, brought losses in all countries, with the Ireland exception. In Ireland, GDP followed an upward trend throughout 2019-2020, increasing by 5.9% compared to the 2019 value.

This can be explained by the presence of a large number of multinational companies, companies that hold property rights [2]. Production contracts associated with these property rights generate income for companies, increasing the level of gross domestic product.

In the same reference period, regarding this macroeconomic indicator, notable losses were recorded in ***Spain*** (-10.8%), ***Greece*** (-9%), ***Italy*** (-8.9%), ***Portugal*** (- 8.4%), ***Malta*** (8.2%), ***Croatia*** (-8.1%) and ***France*** (-7.9%). As shown in

Figure 2, the most significant contribution to the GDP's formation at the European level was given by countries such as ***Germany*** (24.46%), ***France*** (16.72%), ***Italy*** (12.08%) and ***Spain*** (8.41%). At the opposite pole, there are countries like ***Malta***, ***Estonia***, ***Cyprus***, ***Croatia***, ***Bulgaria*** (0.53%).***Romania*** registered a 1.81% contribution EU's GDP recorded value.

At the country level, ***GDP*** reflects its economic performance, while ***GDP per person*** reflects the living standard in a certain country or the labor force productivity [7].

Of course, interpreting the country's inhabitant's wellbeing by using the GDP per person indicator only has several limits. For example, the GDP per person indicator does not yet take into account the technology influence on the worker's output.

Although, if at a given time point, the GDP per worker values reaches the same level in two different countries, with the same share of labour in GDP, from a mathematical point of view, it could be stated that in both countries is a certain living standard.

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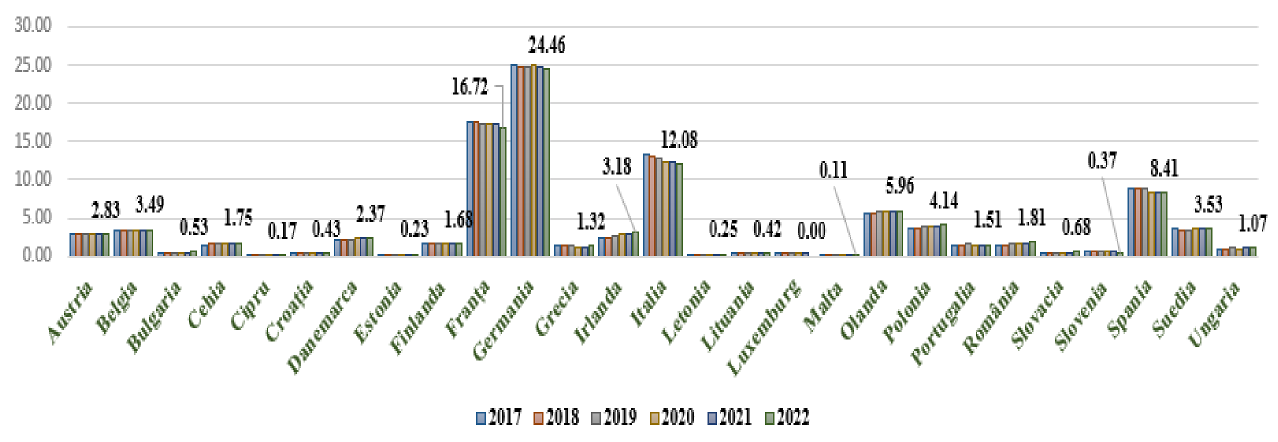

Fig. 2. EU country’s contribution to GDP (%), 2007-2022
Source: own calculations based on the data from [4].

However, analysing the GDP from the efficiency’s perspective, taking into account the volume of worked hours, it could also be stated that the population’s well-being is higher in the country with a lower number of worked hours, because the inhabitants of that country enjoy more free time [8].

GDP value/person in Europe

Figure 3 presents the existing statistical data regarding the recorded level of GDP per person, according to market prices, in the period 2017 – 2022, in the member countries of the European Union. Thus, it can be observed that, in the period 2017 - 2022, the leading position is occupied by ***Ireland*** (with 130% above the average recorded at European level), followed by ***Denmark*** (with 76% above the average recorded at European level) and ***Sweden*** (with 55% above the European average). At the opposite pole, the countries with the lowest GDP per person compared to the European Union average are ***Bulgaria*** (with 71% below the European average), ***Romania*** (with 67.38% below the European average), ***Croatia*** (with 57.88% below the average European) and ***Poland*** (with 57.73% below the European average) [6]. In 2021, ***Luxembourg*** holds the leading position in terms of GDP per person in the European Union, (with 235.34% above the average recorded at the level of the European Union, in the same reference period), thus exceeding 2 and a half times average recorded at European level. A possible explanation for this derives from the fact that a large number of foreign residents are employed in ***Luxembourg*** and therefore contribute to its GDP, but they are not included in the resident population. As for the year 2022, the economic statistical data regarding Luxembourg were not published yet [3].

In 2022, from provisional statistical data, regarding the first 3 quarters of 2022, the GDP per inhabitant values reached the highest value in ***Austria*** (38,382 euro), ***Luxembourg*** (29,453 euro), ***Norway*** (25,757 euro), ***Ireland*** (24,370 euro) or ***Switzerland*** (17,193 euro), thus exceeding the European average. In ***Romania***, in 2022 first 3 quarters, GDP/person recorded value is below the European average (9,937 euro, with 65% less compared to the European level). In this ranking, ***Romania*** occupies the penultimate place, ahead ***Bulgaria*** (with GDP/person estimated at 7,718 euro) [6].

Regarding the 2017-2022 absolute change at GDP/person indicator level (with fixed and mobile base), we can state that significant increases were recorded in ***Netherlands, Ireland, Luxembourg, Denmark and Belgium*** (Figure 4)**.** At the opposite pole we can mention countries like ***Spain, Greece and Italy***. Regarding the GDP/person evolution, it can be state that in most countries case, signs of progressive economic growth appear. However, the negative economic effects brought by the Covid-19 pandemic are visible in 2020, when most countries recorded a lower GDP level comparative to 2019, with several exceptions: ***Bulgaria, Denmark, Lithuania, Luxembourg and Sweden***. Also, we can observe that the most affected EU’s

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countries are Spain, Malta, Italy, Belgium and Austria. Moreover, a direct relationship can be observed between the countries with the highest level of incidence rates of the Covid-19 virus and the economic repercussions in the reference time period.

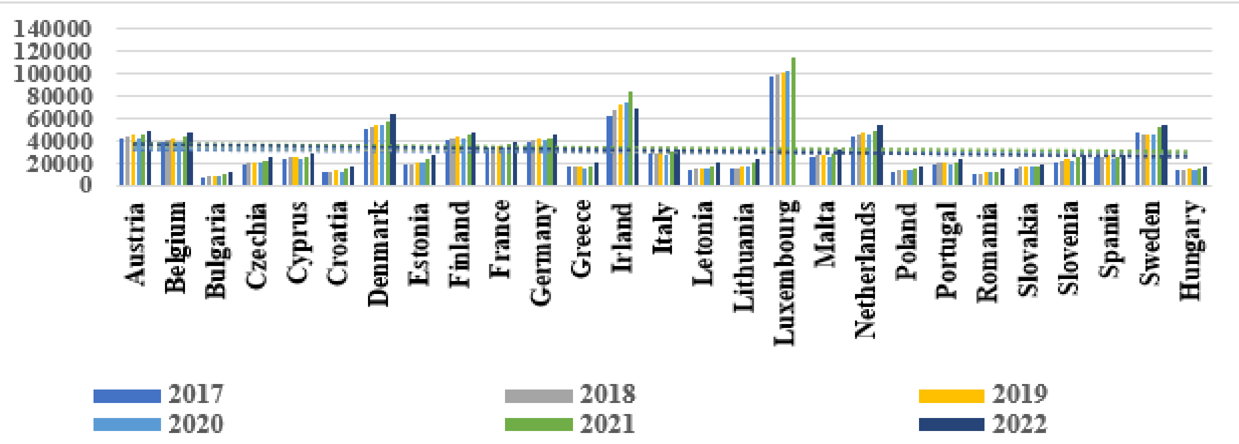

Fig. 3. GDP/person values (euro), in EU, 2017 – 2022
Source: own processing based on Eurostat Data [6] .

Regarding Romania's situation, GDP registered a constantly increasing trend between 2017-2022, but with an exception for the 2019-2020 transition period.

Figure 4 shows the dynamic rhythm level, obtained by using the calculation formula described in the "Materials and methods" section.

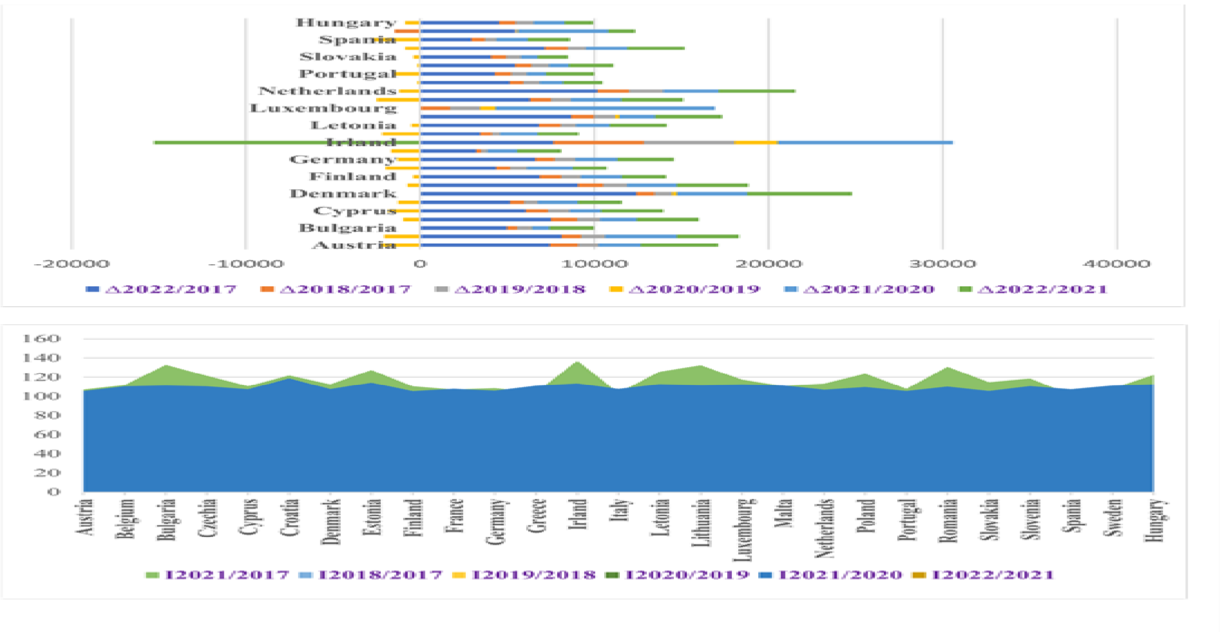

Fig. 4. Statistical indicators for GDP / person (euro, %) evolution
Source: own calculation.

Thus, it can be seen that, in terms of the dynamics recorded at the GDP/person level, regarding 2021 compared to 2017 evolution, countries such as ***Bulgaria (67.12%); Romania (56.99%), Lithuania (57.99%)*** can be mentioned. The weakest dynamics were recorded in countries such as Sweden (11.38%), Spain (11.77%), Italy (11.92%) and France (12.34%). The agriculture's sector contribution to GDP's formation, at the European countries level, is presented in Figure 5 [5].

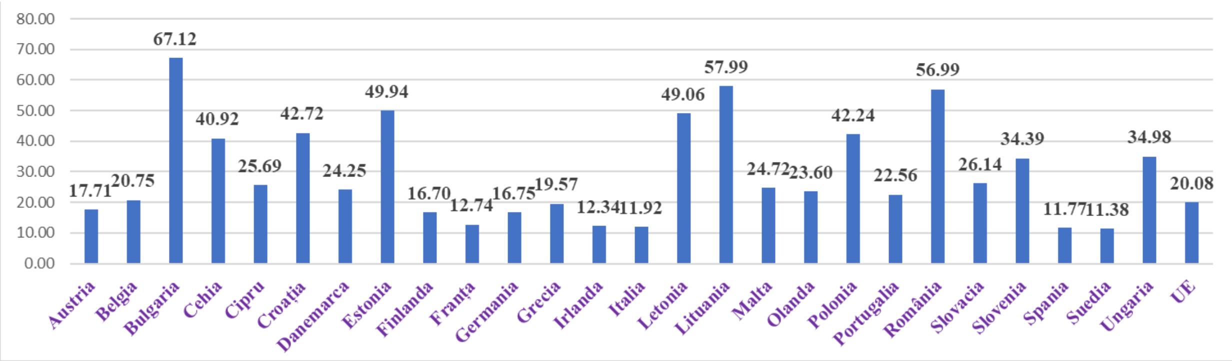

Fig. 5. Growth rate of GDP/person (%), 2022/2017, in the EU
Source: [5].

Agriculture sector contribution's to the EU GDP

It can be observed that, at the European level, Romania is the country with the largest agriculture sector share, in achieving the GDP (3.76%), along with Greece (3.55%) and Bulgaria (3.43%). Thus, within the Balkan countries, agriculture is a basic economic activity, due to the favourable climatic characteristics, traditions and specific are customs. However, the values presented in Figure 6 refers to each individual state GDP, but without showing the state economic power or the sector's efficiency. For example, although agriculture practiced in ***France*** registers a weight of only 1.40%, the value of agriculture's sector was estimated in 2022 at 43,511.18 mil. euro, the highest Europe's recorded value. Secondly, follows Italy, with an agricultural activity estimated at 38,360 mil. euro in the same reference year. In ***Germany***, the same reference sector reached the threshold of 30,943.39 mil. euro. We also mention several registers competitive values, in ***Spain*** (28,529.39 mil. euro), ***Poland*** (12,103.63 mil. euro), ***Netherlands*** (11,863.39 mil. euro), ***Romania*** (10,767.57 mil. euro). Therefore, in terms of European economic powers, Romania occupies the ***7th place***, ahead to Greece, Austria, Denmark. From the same perspective, the lowest values of the agriculture's sector were recorded in Malta, Ireland and Luxembourg.

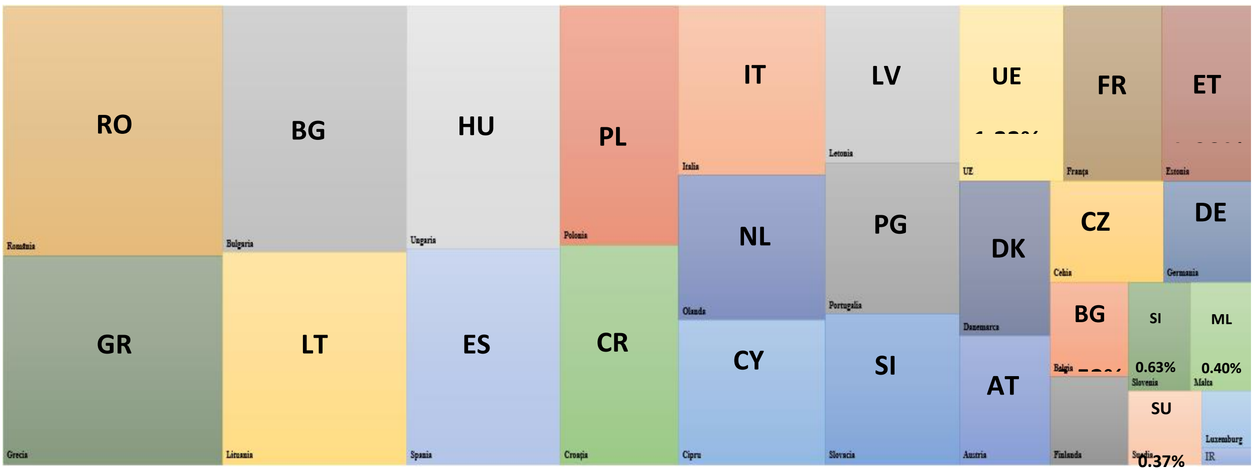

Fig. 6. Agriculture's contribution to GDP (%), between 2017-2022, by country
Source: author's processing based on Eurostat Data [5].

CONCLUSIONS

Following the present research, it can be noticed a surprising ranking of the EU's states members, especially regarding GDP per person indicator, but also regarding the dynamic of this macroeconomic parameter. From the EU's GDP's share contribution perspective, it can be stated that the highest threshold of economic efficiency is registered in countries like ***Germany*** (29.57%), ***France*** (16.71%), ***Italy*** (12.08%), ***Spain*** (10.16%). Thus, these countries are characterized by high economic power and an already matures markets in terms of their development degree, with a main actor's role, in international trade relations. In this hierarchy, Romania occupies the 15thplace, with a share contribution of 1.81% in the EU's achieved GDP, close to the Czech Republic. Romania's place is ahead of countries like Portugal, Bulgaria, Croatia, Greece.

In terms of GDP per person, in market prices, we can observe a surprising ranking. Thus, the greatest economic powers in Europe (***Germany, France, Italy, Spain***) give up the leading places, in Luxembourg, Ireland and Sweden favour. A possible explanation for this situation derives from the fact that a large number of foreign residents are employed in Luxembourg and therefore they contribute to country's GDP, but they are not included in the resident population. Regarding the Ireland top position in Covid-19 pandemic context, many multinational companies have their headquarters on its territory, companies that holds property rights. Production contracts associated with these property rights generate incomes for companies, increasing the level of GDP. In ***Romania***, the 2017-2022 time period GDP/person level was 37% of the EU's level recorded average, in front of Bulgaria. GDP/inhabitant's level is an indicator whose reflects the population's living standard. The Covid-19 pandemic affected the level of 2020 registered GDP's value, compared to the values recorded in 2019, in the case of most European states, even in the case of the strongest. However, countries such as Luxembourg, Ireland, Denmark, Sweden or Bulgaria made an exception to this phenomenon.

In the second part of this paper, different statistical indicators were calculated (absolute change, dynamic index, dynamic rate), in order to obtained a detailed analysis of the GDP/person dynamic evolution, between 2017 and 2022. Thus, the most dynamic economic markets in Europe were showed in countries such as Bulgaria or Romania, and the least dynamic economic markets are represented by economic powers, such as Germany or France. Thus, there is a chance that in the future, using the right strategies and policies and by keeping the same market dynamics, that Romania could approach a highest contribution share or value, in terms of GDP, considering that for Romania, GDP growth rate is almost 5 times higher than the same parameter registered, for example, in France. Regarding the agriculture's sector and the economic efficiency, it can be stated that in countries like ***Romania, Bulgaria, Greece or Lithuania***, the share of agriculture in achieving the GDP is higher, at the European level. However, from the agriculture's perspective, at European level, countries such as France, Italy, Germany, Spain, Poland and the Netherlands have still the most competitive markets. In this sense, Romania ranks the 7th place.

Of course, the GDP's single approach, in order to describe the well-being level for a certain nation, in all its expression, has several limitations. Over time, this topic generated multiple controversies, even among international famous economic specialists [11]. GDP's amount does not take into account other particular importance aspects, in a complex, modern society, for the population's living standard characterization, such as: the number of worked hours, the share of free time, social inequality, the environment status, the country's available natural resources, the performance of the banking credit system, the natural disaster impact, as well as others.

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COMPARATIVE ADVANTAGE IN HONEY TRADE AMONG THE TOP EXPORTING COUNTRIES IN THE WORLD

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Abstract

The paper aimed to analyze the competitiveness of top 16 honey exporting countries in the world in the period 2018-2021 using World Bank data, based on the specific indicators Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), Comparative Export Performance Index (CEP) and Trade Balance Index (TBI). The results showed that in 2021, New Zealand, Argentina, Ukraine, Greece, Hungary, Romania, Brazil, India, Spain, Vietnam, Poland and Mexico had a comparative advantage, while EU, China and Germany have a comparative disadvantage in the international honey market. A strong comparative advantage belongs to New Zealand, Argentina, Ukraine, Hungary and Romania, and partially to Greece, a moderate comparative advantage belongs to Brazil, India, Spain, Mexico, Vietnam and Greece in specific years, a weak comparative advantage belongs to Poland, Vietnam, China and Spain in specific years, and finally, China, EU and Germany are disadvantaged. The highest RSCA is characteristic to New Zealand, Argentina, Ukraine, Greece, Hungary, Romania and Brazil. New Zealand has the highest CEP against EU, China, Germany, and the smallest CEP versus Brazil, Romania, Hungary, Greece and mainly Ukraine. New Zealand, Argentina, Brazil, Ukraine, Hungary, Mexico, followed by India and Vietnam have a high TBI being net exporting countries. EU, Germany, Poland had a negative TBI, reflecting that they are net importers and also Greece in 2018. As any country desires to be more competitive, exports and imports have to be kept under control, larger amounts to be available to be sold at the best price and the geographic area of influence to be extended looking for new trade partners.

Key words: *comparative advantage, honey, top 15 exporting countries, RCA, RSCA, CEP, TBI, world*

INTRODUCTION

Bees play a very important role on the Earth from an economic, social and environment point of view [48].
They are vital for our planet as the history of civilization proved for thousands years.
Picking up the nectar from agricultural and forage crops and also from the wild flora, bees assure the pollination which allows reproduction of numerous plant species [17, 36, 37, 43]. According to FAO, bees contribution to food security at the global level is about 30% [9].
Beekeeping is an important subsector of agro-economy assuring jobs for an important number of farmers, additional income for farmers and bee lovers, a higher living standard and contribute to the growth of agricultural production value, to the support of agriculture to GDP and economic prosperity in the world [39].
Honey, pollen, royal jelly, propolis, bee wax, venom etc are the most important bee products for human nutrition and health [34, 35].
By their existence, bee colonies assure environment protection, biodiversity preservation and the perennial beauty of the landscapes.
Despite this important role in maintaining life, nowadays, bee colonies are facing obstacles in their development like: decrease of their habitat, intensive agricultural technologies

based on high consumption of chemical substances (fertilizers, herbicides, pesticides), parasites and diseases, invasive species, climate change. All these factors affect bees life and work, pickings and honey yield and led to the decline of bee population at the global level, which is an "alarm bell" for the their existence and of mankind as well [40, 41, 52].

To sustain bee colonies and beekeeping development, United Nations issued an "Environment Programme destined to support biodiversity, to preserve the habitat and management, to mitigate the effects of climate change [47].

In the year 2021, the statistical data showed that the world honey production reached 1.77 million metric tons, meaning by 41% more than in the year 2000 (1.25 million MT) and by 5.4% less than the peak reached in 2017 (1.87 million MT) [44].

The leaders in honey production in the year 2021, in the decreasing order, were: China, Turkiye, Iran, Argentina, Ukraine, India, Russia, Mexico, United States, Brazil, Canada, Spain, Tanzania, Romania, Rep. Korea, which all together carried out 1,260,537 MT, representing 71.13% of the global honey output [10] (Fig. 1).

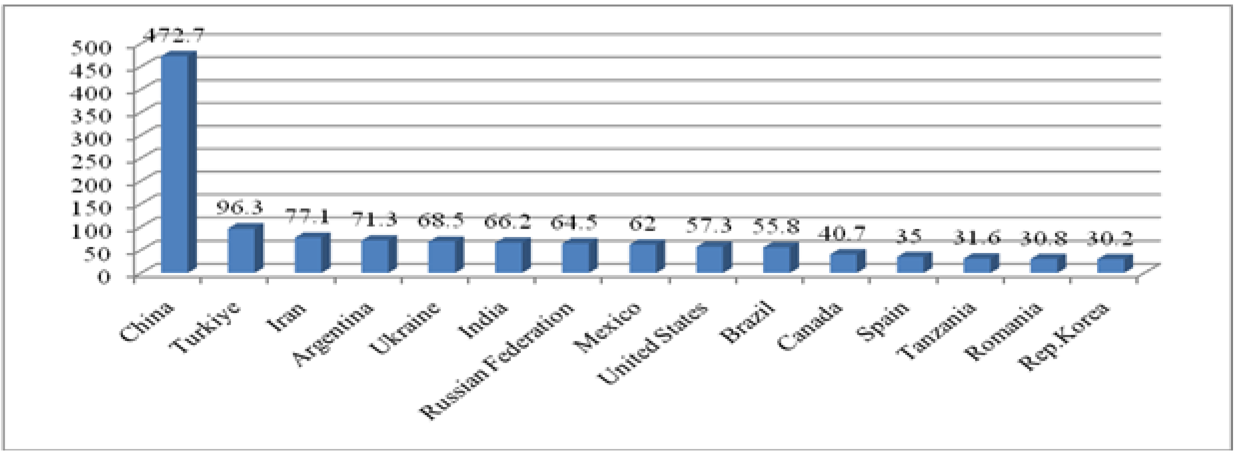

Fig.1. Honey production in the top 15 producing countries worldwide in 2021 (Million tons)
Source: Own design based on the data from [49].

In 2021, the value of global export of honey accounted for USD 2,824.84 Million, and the value of import was USD 3,157.56 Million [50]. In 2021, the top 15 honey exporting countries in the world were: New Zealand, China, Argentina, European Union, Brazil, Germany, Ukraine, India, Spain, Hungary, Mexico, Vietnam, Poland, Greece and Romania (Fig.2).

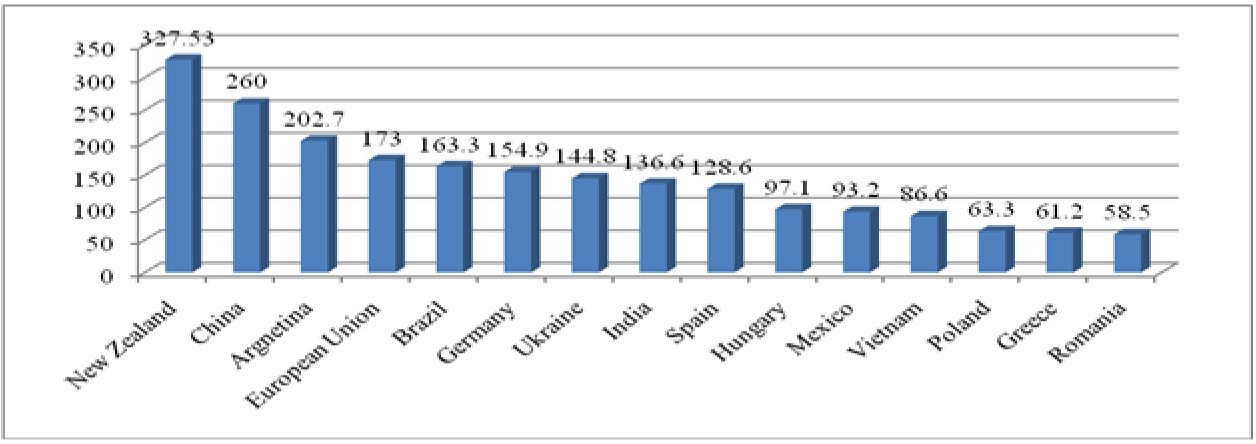

Fig. 2. Honey export value in the top 15 exporting countries worldwide in 2021 (USD Million)
Source: Own design based on the data from [49].

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In the same year, the top 15 importing countries were; Unites States, European Union, Germany, Japan, United Kingdom, France, Italy, China, Poland, Saudi Arabia, Spain, Netherlands, Belgium, Switzerland, Canada (Fig. 3).

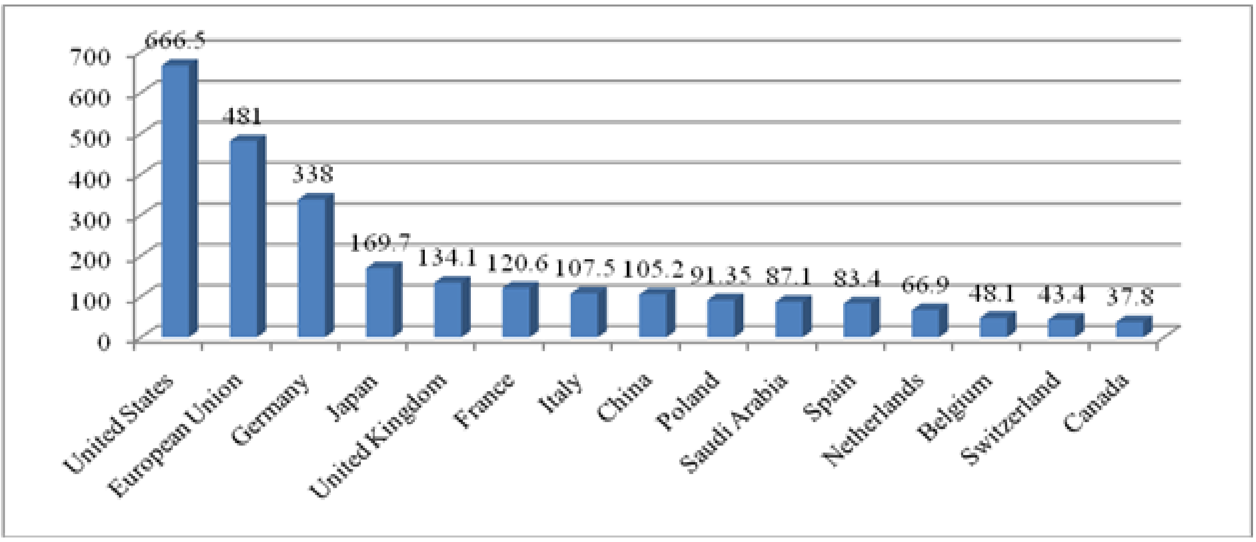

Fig. 3. Honey import value in the top 15 importing countries worldwide in 2021 (USD Million)
Source: Own design based on the data from [49].

Honey market was studied from various points of view: the number of bee hives, bee families [51, 18], number of apiarists, honey yield per family, honey production [4, 15, 34, 38, 39, 42], gross margin in honey production [15], optimization of apiary size [3, 17, 23, 25, 26, 29], beekeepers income [1, 31, 32], honey price volatility [33], demand and offer, main producing, exporting and importing countries, produced, exported and imported honey quantities, export, import and trade balance, geographical trade partners, efficiency in honey trade etc. [11, 22, 24, 27, 28, 35, 46].

The development of honey trade has led to a higher and higher competition among producers, exporters and importers, an aspect of high interest for each country which has to know its competitors and their power, and more than this to quantify in what measure a country could have a comparative advantage or disadvantage in the international market.

In this respect, from a methodological point of view, researchers have at their disposal specific indices developed to measure the comparative advantage [29].

The revealed comparative advantage index, RCA, was established by Balassa (1965) to compare the export share of a country for a certain product in the total export of that country with the weight of the product world export in the global export of all goods [6].

A more detailed interpretation of Balassa index was given by Hinloopen and Marrewijk (2001) [12].

RCA was adjusted by Laursen (1998) who set up the Revealed symmetric comparative advantage, RSCA [20].

Lafay (1992) developed Trade Balance Index, TBI, in order to find out if a country is a net exporter or importer of a certain product [19].

Starting from Balassa index, Donges (1992) developed Comparative Export Performance Index, CEP, which measures the competitiveness of a country's export versus a competitor country for a special product [8].

These indices and other alternatives of indices have been used by various researchers to analyze the comparative advantage of a country or a group of countries for a product or group of products or sectors.

However, the literature offers just a few examples regarding the competitiveness of honey in the international market.

Ma Lunjiao (2009) found that China, Argentina and Mexico are among the major honey exporters in teh world and have a RCA

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higher than 1, reflecting their comparative advantage [21].

Ignjatijević et al.(2015) used RCA, RXA, RTA, lnRXA, RC and RSCA to measure the comparative advantage of Serbian honey export in the global market [13].

De Paula et al. (2017) studied the comparative advantage index of the Brazilian honey and affirmed that its honey is high competitive in the international market [7].

Terin et al. (2018) calculated RCA and TBI and found out that Turkiye is a net exporter of honey with a weak comparative advantage in relation to the Balkan countries (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Moldova, Montenegro, Macedonia, Romania, Serbia and Slovenia) [45].

Avila et al. (2019) analyzed the comparative advantage of Mexican honey [5].

Pippinato et al. (2019) analyzed the EU honey market emphasizing the Italian market using TXA, RMA, RTA, finding out that Italy is not so competitive in honey export, being more oriented to export [23].

Illés et al. (2021) used RCA for analyzing the competitiveness of honey production between the four Visegrad country group and also mentioned that Hungary has a comparative advantage [14].

Kalita et al. (2021), studied the export pattern of India in the world [16].

In 2022, Akdeniz and Kantar analyzed honey export potential and competitiveness in Turkiye using RCA, RSCA AND TBI and affirmed that Turkiye is a net honey exporter and with a high comparative advantage [2].

In this context, the purpose of the paper was to analyze the comparative advantage of honey among the top 15 honey exporters in the world in the period 2018-2021 using RCA, RSCA, CEP and TBI in order to identify for which countries the comparative advantage is revealed or not, and which countries are net exporters and have a high export performance.

MATERIALS AND METHODS

The empirical data needed to setup this research were picked up from the following official information sources; WITS World Bank and FAOStat for the period 2018-2021.

The main indices used for measuring the comparative advantage in the global honey market in the top exporting countries were: Revealed Comparative Advantage -RCA, Revealed Symmetric Comparative Advantage-RSCA, Comparative Export Performance Index- CEP and Trade Balance Index-TBI.

These indices were calculated for the following countries: New Zealand, China, Argentina, European Union, Brazil, Germany, Ukraine, India, Spain, Hungary, Mexico, Vietnam, Poland, Greece and Romania.

the formulas used for the determination of these indices are given below:

(a) Revealed Comparative Advantage RCA_{it}^{j}:

$$RCA_{it}^{j} = \frac{(X_{it}^{j})}{(X_{t}^{j})} / \frac{(X_{it}^{w})}{(X_{t}^{w})} \text{..........................(1)}$$

where:

$RCA_{it}^{j} =$ comparative advantage index for commodity i (honey) of the country j (the world top 15 exporting countries of this commodity) in the year t (2018 2019, 2020, 2021).

$(X_{it}^{j}) =$ export of commodity i (honey) of the country j in the year t;

$\left(X_{t}^{j}\right)$ = country j's export of all goods in the year t;

(X_{it}^{w})= world export of the commodity i in the year t;

$(X_{t}^{w}) =$ world export of all goods in the year t.

The interpretation of RCA value according to Balassa's classification (1965) [6] is the following one:

- If RCA_{it}^{j} has a value higher than 1, the country j has a comparative advantage in honey in the year t. Therefore, honey is more important for that country's export than the exports of the reference countries. This value results because the weight of honey export in the total export of the country j is higher than the share of the global honey export in the global export.

-If RCA_{it}^{j} has a value smaller than 1, the country j has a comparative disadvantage in honey in the year t. In this case, the share of honey export in the total export of the country j is smaller than the weight of global honey export in the global export.

- If RCA_{it}^{j} is equal to 1, for the country j, the comparative advantage is revealed.

According to Hinloopen and Marrewijk's classification (2001) [12], RCA values are interpreted as follow:

- "No" comparative advantage when 0 < RCA ≤ 1;
- "Weak" comparative advantage when 1 < RCA ≤ 2;
-"Moderate" comparative advantage when 2 < RCA < 4;
-"Strong" comparative advantage when RCA > 4.

(b) Revealed Symmetric Comparative Advantage-$RCSA_{it}$

$$RSCA_{it}^{j} = \frac{(RCA_{it}^{j} - 1)}{(RCA_{it}^{j} + 1} \text{ ....(2)}$$

This index could take values between 1 and -1.

If RSCA has a positive value, 0 < RSCA < 1;honey has a comparative advantage , and if RSCA has a negative value, -1 ≤ RSCA < 0, this product has a comparative disadvantage for the country j in the year t.

(c)Comparative Export Performance Index-CEP_{it}

$$CEP_{it}^{j} = \frac{(X_{it}^{j}/X_{it}^{r})}{(X_{t}^{j}/X_{t}^{r})} \text{ ....(3)}$$

where:

(X_{it}^{j}) = export of commodity i (honey) of the country j in the year t;

(X_{t}^{j}) = country j's export of all goods in the year t;

(X_{it}^{r})= export of commodity i (honey) of the competitor country r in the year t;

(X_{t}^{r}) = export of all goods of the competitor country r in the year t.

(d)Trade Balance Index-TBI_{it}^{j}

$$TBI_{it}^{j} = \frac{(X_{it}^{j} - M_{it}^{j})}{(X_{it}^{j} + M_{it}^{j})} \text{.................................(4)}$$

where:

(X_{it}^{j}) = export of commodity i (honey) of the country j in the year t;

(M_{it}^{j}) = import of commodity i (honey) of the country j in the year t;

The interpretation of TBI values is the following one:

-If TBI has a positive value, 0 < TBI < 1, the country is a net exporter of that commodity (honey); this means that honey export is more important for that country.

- If TBI has a negative value, - 1 ≤ TBI < 0, the country is a net importer of that commodity. In this case, this means that honey import is more important for that country or the country is disadvantaged.

If TBI = 0, the export value is equal to import value.

RESULTS AND DISCUSSIONS

Revealed Comparative Advantage-RCA

RCA registered different values from a year to another and also from a country to another.

From all the group of countries, New Zealand recorded the highest performance in all the years. In 2021, its RCA was 58.41, lower than in 2020, when it had a peak of 66.48.

On the 2nd position is Argentina which recorded RCA 20.56 in the year 2021, the lowest value, compared to 25.15 achieved in the year 2018.

Then, Ukraine is ranked the 3rd for an RCA equal to 17.38 in the year 2021, a little smaller than in the year 2020 when the country carried out 22.32, the top value.

Greece comes on the 4th position having an RCA value of 10.24, the highest in the analyzed period.

Other countries like Hungary and Romania has a relatively similar RCA, 5.44 and, respectively 5.23 in the year 2021, being followed by Brazil with 4.59.

India, Spain and Vietnam carried out RCA Values between 2 and 3 (2.73, 2.59 and 2.04), while Poland and Mexico recorded values between 1 and 2 (1.57 and, respectively 1.49).

In the remaining countries China, EU and Germany, are on the last position for their RCA smaller than 1 (Table 1).

Table 1. Revealed Comparative Advantage for the top 15 honey exporting countries in the world in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.New Zealand	56.16	58.09	66.48	58.41	104.02
2.China	0.91	1.12	0.77	0.62	68.13
3.Argentina	25.15	21.77	23.65	20.56	81.74
4.European Union	0.55	0.58	0.67	0.53	96.36
5.Brazil	3.75	3.08	3.72	4.54	121.06
6.Germany	0.85	0.93	0.89	0.74	87.05
7.Ukraine	18.88	20.15	22.32	17.38	92.05
8.India	2.88	3.11	2.39	2.73	94.79
9.Spain	2.78	2.62	2.85	2.59	93.16
10.Hungary	6.67	6.93	6.32	5.44	81.55
11.Mexico	2.22	1.37	1.19	1.49	67.11
12.Vietnam	2.46	1.99	1.98	2.04	82.92
13.Poland	1.50	1.71	1.93	1.57	104.66
14.Greece	4.23	0.95	3.64	10.24	242.08
15.Romania	5.62	5.66	5.48	5.23	93.06

Source: Own calculations based on the official data from [49].

In 2021, RCA was higher than in 2018 in Greece (+141.08%), Brazil (+21.06%), Poland (+4.66%) and New Zealand (+4.02%), while in the other countries was noticed a decline.

The comparative interpretation on RCA values taking into account the two classification systems is shown in Table 2.

Table 2. Comparative RCA interpretation based on Balassa's classification and Hinloopen and Marrewijk's classification

Country	RCA interpretation based on Balassa's classification	RCA interpretation based on Hinloopen and Marrewijk's classification
1.New Zealand	Comparative advantage	"Strong" comparative advantage
2.China	Comparative disadvantage	"No" comparative advantage in 2018, 2020 and 2021, and "Weak" RCA in 2019
3.Argentina	Comparative advantage	"Strong" comparative advantage
4.European Union	Comparative disadvantage	"No" comparative advantage in all the years
5.Brazil	Comparative advantage	"Moderate" comparative advantage
6.Germany	Comparative disadvantage	"No" comparative advantage in all the years
7.Ukraine	Comparative advantage	"Strong" comparative advantage
8.India	Comparative advantage	"Moderate" comparative advantage
9.Spain	Comparative advantage	"Moderate" comparative advantage in 2018, and "Weak" RCS in 2019, 2020 and 2021
10.Hungary	Comparative advantage	"Strong" comparative advantage
11.Mexico	Comparative advantage	"Moderate" comparative advantage in 2018 and "Weak" RCS in 2019, 2020 and 2021
12.Vietnam	Comparative advantage	"Moderate" comparative advantage in 2018 and 2021 and "Weak" RCS in 2019 and 2020
13.Poland	Comparative advantage	"Weak" comparative advantage
14.Greece	Comparative advantage	"No" comparative advantage in in 2019, "Moderate" comparative advantage in 2020 and " Strong" RCA in 2018 and 2021
15.Romania	Comparative advantage	"Strong" comparative advantage

Source: Own calculations based on the official data from [49].

The hierarchy of the top honey exporting countries based on RCA in 2021 is shown in Figure 4.

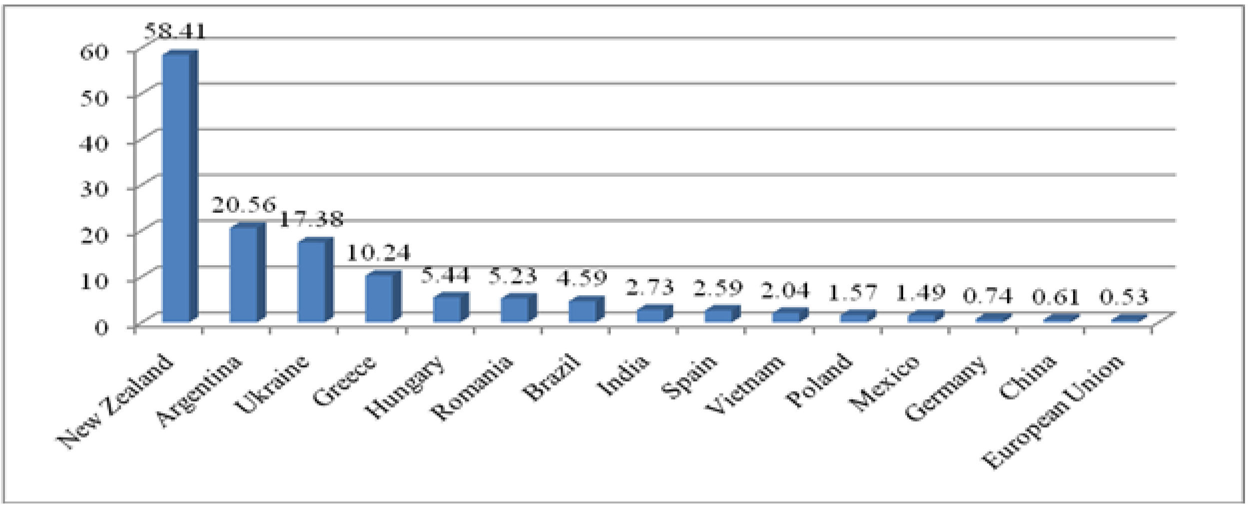

Fig. 4. The hierarchy of the top honey exporting countries based on RCA in 2021
Source: Own design based on own results.

Revealed Symmetric Comparative Advantage-RSCA

The countries with a positive RSCA: New Zealand, Argentina, Brazil, Ukraine, India, Spain, Hungary, Mexico, Vietnam, Poland, Romania have a comparative advantage in all the years, except Greece which has a symmetric comparative advantage only in the years 2018, 2020 and 2021.

The countries with the highest RSCA, in the decreasing order, are New Zealand, Argentina, Ukraine, Greece, Hungary, Romania and Brazil.

The countries which registered a negative RSCA: China, European Union, Germany in all the studied years and Greece in 2019 have a comparative disadvantage for honey.

In 2021 versus 2018, China registered an increase of the negative RSCA by 380 %, while the European Union by 6.89%. In case of Greece, it was found an increase by 34.42% and in Poland by 10% for RSCA value.

In all the other countries, RSCA value recorded a decline in various proportions ranging between 48.65% in Mexico and 2.18% in Argentina.

In New Zealand and Ukraine, in 2021 it was achieved the same RSCA (Table 3).

Table 3. Revealed Symmetric Comparative Advantage for the top 15 honey exporting countries in the world in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.New Zealand	0.96	0.96	0.97	0.96	100.0
2.China	-0.05	0.05	-0.13	-0.24	480.0
3.Argentina	0.92	0.91	0.92	0.90	97.82
4.European Union	-0.29	-0.26	-0.19	-0.31	106.89
5.Brazil	0.67	9.51	0.57	0.64	95.52
6.Germany	-0.08	-0.07	-0.05	-0.14	175.0
7.Ukraine	0.89	0.90	0.91	0.89	100.0
8.India	0.48	0.51	0.41	0.46	95.83
9.Spain	0.47	0.44	0.48	0.44	93.61
10.Hungary	0.73	0.74	0.72	0.68	93.15
11.Mexico	0.37	0.15	0.08	0.19	51.35
12.Vietnam	0.42	0.33	0.32	0.34	80.95
13.Poland	0.20	0.26	0.31	0.22	110.0
14.Greece	0.61	-0.02	0.56	0.82	134.42
15.Romania	0.69	0.70	0.69	0.67	97.10

Source: Own calculations based on the official data from [49].

The hierarchy of the top honey exporting countries based on RSCA in 2021 is presented in Figure 5.

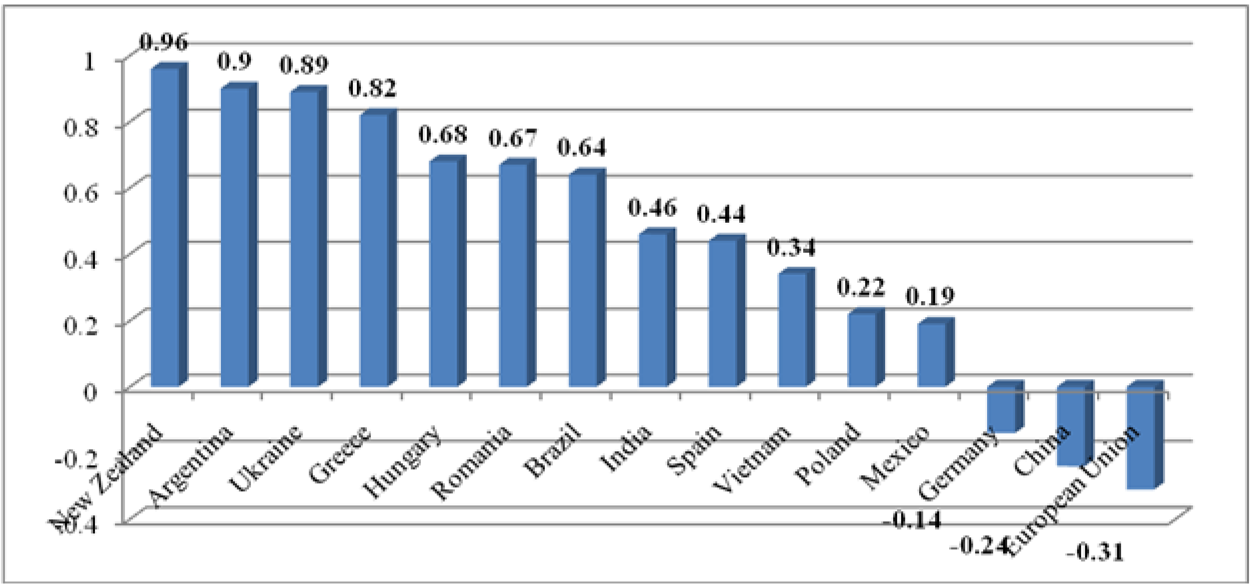

Fig. 5. The hierarchy of the top honey exporting countries based on RSCA in 2021
Source: Own design based on own results.

Comparative Export Performance Index-CEP

This index was calculated only for New Zealand, ranked the 1st honey exporter and for Romania, which is placed on the last 15th position among the top exporting countries in the world.

In case of New Zealand against the other exporting countries, CEP values have registered a general decreasing trend in all the countries from the year 2018 to the year 2021. In 2021, CEP index has the highest value in New Zealand versus its level performed in the European Union, China and Germany, but New Zealand registered a lower CEP value against Mexico, Poland, Vietnam, Spain and India. Also, the lowest values were carried out against Brazil, Romania, Hungary, Greece and mainly versus Ukraine (Table 4).

Table 4. Comparative Export Performance CEP for Argentina against the other 14 honey exporting countries in the world in the period 2018-2021

Country	**2018**	**2019**	**2020**	**2021**	**2021/2018 %**
2.China	61.43	65.26	84.73	48.42	78.82
3.Argentina	2.23	2.66	2.81	1.42	63.67
4.European Union	103.11	101.52	99.49	55.64	53.96
5.Brazil	15.02	21.57	17.91	6.34	42.21
6.Germany	66.84	72.13	74.67	39.12	58.52
7.Ukraine	2.97	3.30	3.01	1.67	56.22
8.India	19.60	21.51	27.78	10.64	54.28
9.Spain	20.18	25.50	23.42	11.21	55.55
10.Hungary	8.43	9.62	10.50	5.36	63.68
11.Mexico	25.37	4.85	55.87	19.60	77.25
12.Vietnam	22.87	33.43	33.50	14.31	62.57
13.Poland	37.57	33.93	34.71	18.53	49.32
14.Greece	13.27	11.69	13.64	2.88	21.70
15.Romania	10.00	11.78	12.12	5.56	55.60

Source: Own calculations based on the official data from [49].

Comparative Export Performance of New Zealand against the other 14 honey exporting countries in 2021 is shown in Figure 6.

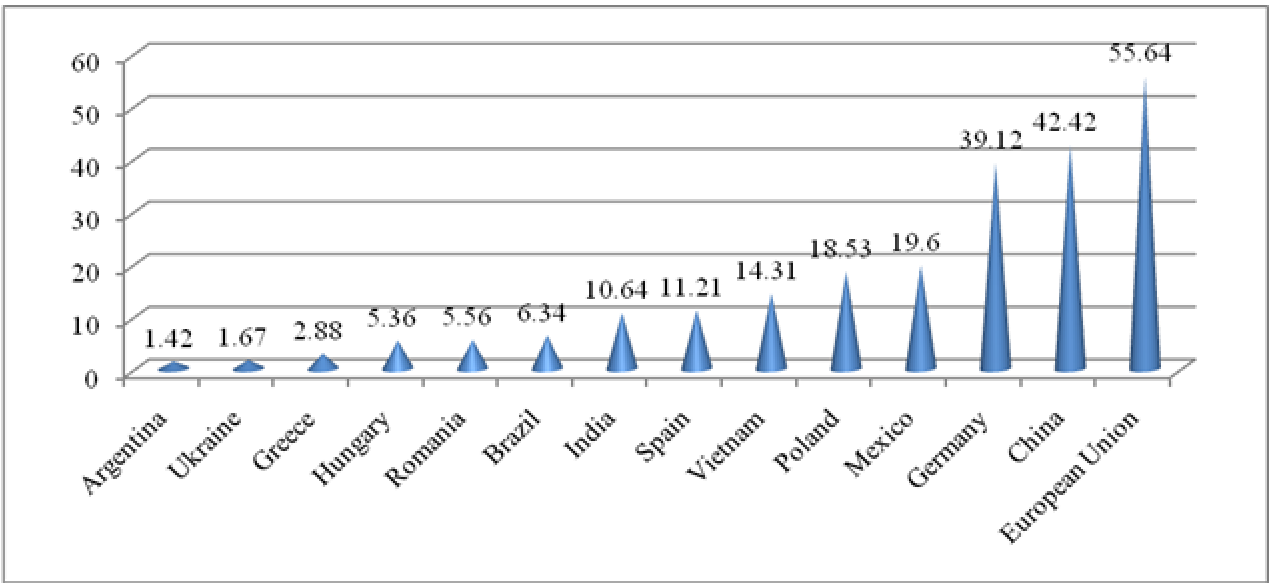

Fig. 6. Comparative Export Performance of New Zealand against the other 14 honey exporting countries in 2021
Source: Own design based on own results.

In case of Romania against the other exporting countries, in 2021, CEP index had the highest values versus European Union, China, Germany, followed by Mexico, Poland and Spain. The lowest index value was noticed against New Zealand 0.08, Argentina 0.25, Ukraine 0.30, Greece 0.53 and Hungary 0.96. In 2021, CEP values for Romania increased in general in relation to almost all the other exporting countries, except New Zealand, European Union, Brazil, India, Spain, Poland and Greece (Table 5).

Table 5. Comparative Export Performance CEP for Romania against the other 14 honey exporting countries in the world in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.New Zealand	0.10	0.09	0.08	0.08	80.00
2.China	6.15	6.20	7.14	8.54	138.86
3.Argentina	0.22	0.26	0.23	0.25	113.63
4.European Union	10.35	9.93	8.34	9.91	95.74
5.Brazil	1.49	1.83	1.47	1.14	76.51
6.Germany	6.58	6.17	6.17	6.98	106.07
7.Ukraine	0.29	0.28	0.24	0.30	103.44
8.India	1.95	1.81	2.29	1.91	97.94
9.Spain	2.02	2.16	1.92	2.01	99.50
10.Hungary	0.84	0.81	0.86	0.96	114.28
11.Mexico	2.53	4.14	4.60	3.51	138.73
12.Vietnam	2.28	2.83	2.76	2.56	112.28
13.Poland	3.76	3.31	2.84	3.32	88.29
14.Greece	1.32	0.99	1.12	0.53	40.15

Source: Own calculations based on the official data from [49].

The comparative Export performance of Romania versus the other top 14 competitors in honey export in the international market in presented in Figure 7.

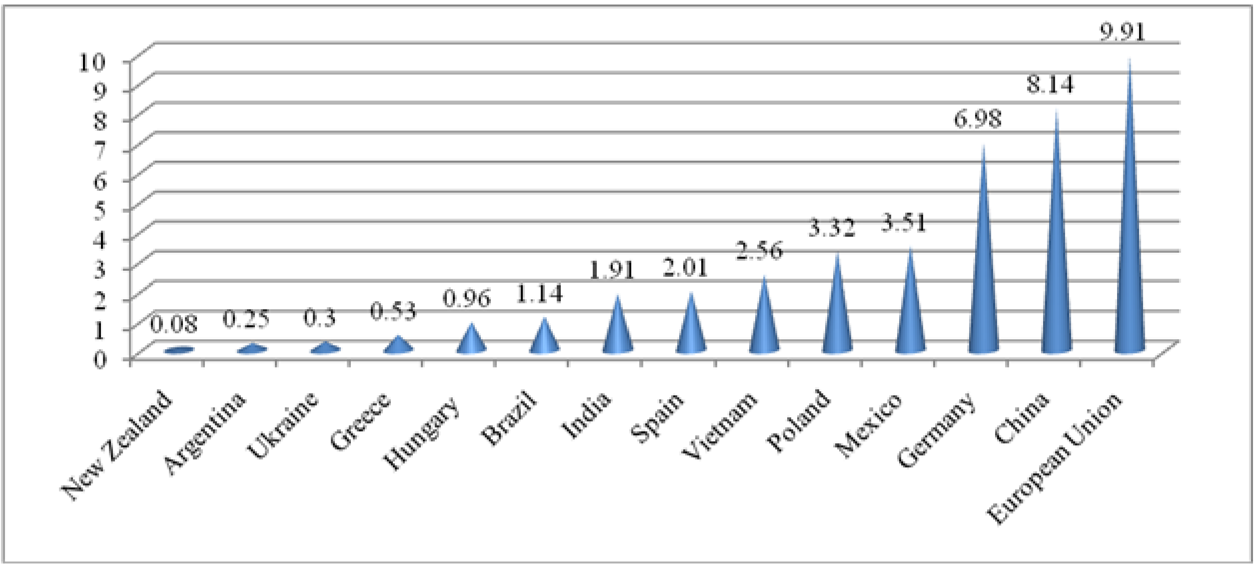

Fig. 7. Comparative Export Performance of Romania against the other 14 honey exporting countries in 2021
Source: Own design based on own results.

Trade Balance Index- TBI

TBI index values are different from a country to another depending on each country's honey export and import value. Most of the countries situated in the top at the global level do not import too much honey and have in general low import value, a fact which led to a TBI =0.99 in case of New Zealand, Argentina, Brazil, Ukraine, Hungary and Mexico, but, in case of India 0.92 and Vietnam 0.98. The countries with a smaller import value compared to export value, like: China, Spain and Romania, have registered a TBI positive with variations between:

- 0.42-0.56 in case of China, and decreasing values to the year 2021;
- 0.26-0.21 in case of Spain, with a tendency to grow to the year 2021;

-0.62 in 2018, the highest TBI, and 0.57 in 2021 in case of Romania, with the smallest TBI, accounting for 0.44 in 2019.

The countries with a negative TBI like: EU, Germany and Poland have higher imports than exports.

Greece registered a positive TBI, but small in the period 2019-2021, but, in 2018, it recorded a negative value.

Table 6. TBI values registered by the top 15 exporting countries in the world in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.New Zealand	0.99	0.98	0.99	0.99	100.00
2.China	0.56	0.46	0.48	0.42	75.00
3.Argentina	0.99	0.99	0.99	0.99	100.00
4.European Union	-0.58	-0.55	-0.37	-0.47	81.03
5.Brazil	0.99	0.99	0.99	0.99	100.00
6.Germany	-0.33	-0.37	-0.29	-0.37	112.12
7.Ukraine	0.99	0.98	0.99	0.99	100.00
8.India	0.92	0.96	0.96	0.96	104.34
9.Spain	0.21	0.21	0.25	0.26	123.80
10.Hungary	0.99	0.99	0.99	0.80	80.80
11.Mexico	0.99	0.99	0.99	0.99	100.00
12.Vietnam	0.98	0.98	0.98	0.98	100.00
13.Poland	-0.18	-0.17	-0.12	-0.18	100.00
14.Greece	-0.02	0.09	0.14	0.27	1,350.00
15.Romania	0.62	0.44	0.49	0.57	91.93

Source: Own calculations based on the official data from [49].

Therefore, the countries having a positive TBI are net honey exporters, for them honey export is more important than import and they are more competitive than the other competitors. The countries with a negative TBI are net importers and have a comparative disadvantage in honey international market.
In 2021 versus 2018, it was noticed a similar TBI for the most countries and even higher like in case of Germany, India and Spain, while in China EU, Hungary and Romania, it was noticed a decrease, reflecting a reduction of exports versus imports.
Greece passed from a honey trade importer in 2018 to honey exporter in 2021 (Table 6).
Trade Balance Index in the top 15 exporting countries in 2021 is reflected in Figure 8.

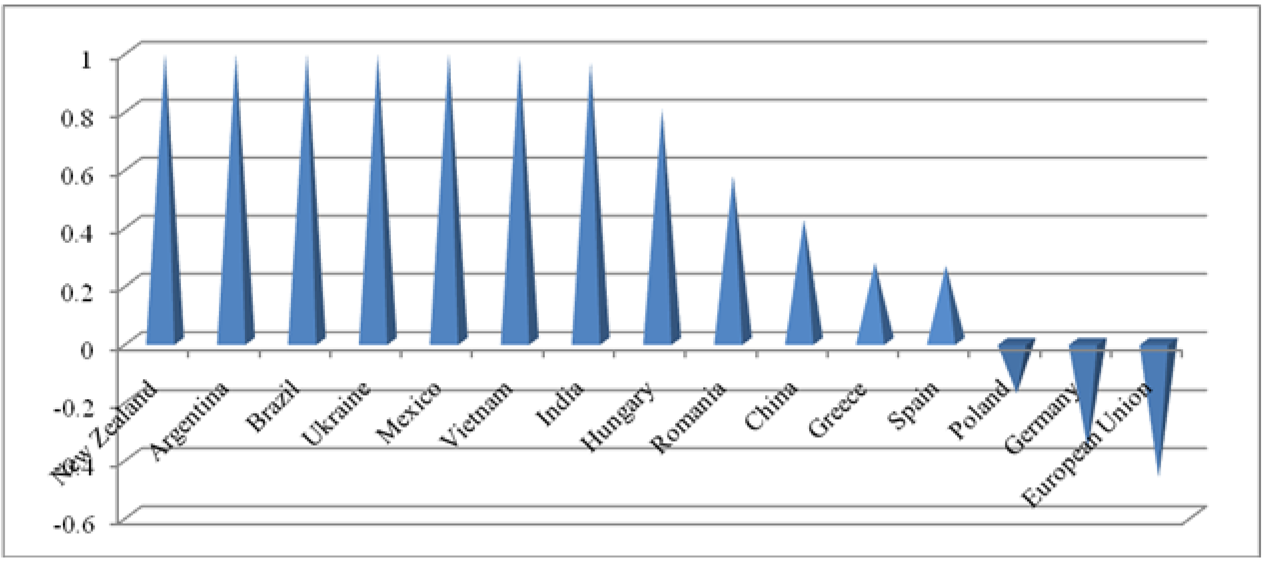

Fig. 8. Trade Balance Index in the top 15 exporting countries in 2021
Source: Own design based on own results.

CONCLUSIONS

The analysis for comparative advantage for honey in case of the top exporting countries at the global level led to the following conclusions:
A number of 12 top exporting countries of honey have a comparative advantage, as shown by RCA index, in the decreasing order in the year 2021 being: New Zealand, Argentina, Ukraine, Greece, Hungary, Romania, Brazil, India, Spain, Vietnam, Poland and Mexico.
The EU, China and Germany have a comparative disadvantage in the international honey market as they are mainly importing countries.
Based on Hinloopen-Marrewijk classification, it resulted that:
- A strong comparative advantage in all the studied years belongs to New Zealand, Argentina, Ukraine, Hungary and Romania, whose RCA was higher than 4 and to Greece in the years 2018 and 2021.
-A weak comparative advantage belongs to Poland, as its RCA ranged between 1 and 2 in all the years, and also a "weak" advantage in case of Vietnam in the years 2019 and 2020, and also China in 2019, Spain in 2019, 2020 and 2021, and Mexico in 2018 and 2021.
-A moderate comparative advantage was registered by Brazil for a RCA between 2 and 4, India, Spain in 2018, Mexico in 2018, Vietnam in 2018 and 2021, and Greece in 2020.
-No comparative advantage (RCA between 0 and 1) was found in China in 2018, 2020, 2021, the EU, Germany, Hungary, Romania in other analyzed years and Greece in 2018 and 2021.
Based on RSCA value, the countries with the highest comparative advantage in honey market are New Zealand, Argentina, Ukraine, Greece, Hungary, Romania and Brazil.

In the opposite side, there are China, the EU, Germany which have a comparative disadvantage in all the years and also Greece in 2019.

Regarding the competitiveness in export performance, reflected by CEP values, it was noticed that New Zealand has the highest export performance against the EU, China, Germany, and a lower CEP level against Mexico, Poland, Vietnam, Spain and India. The smallest CEP is versus Brazil, Romania, Hungary, Greece and mainly Ukraine.

According to TBI value, New Zealand, Argentina, Brazil, Ukraine, Hungary, Mexico, followed by India and Vietnam have a higher export value versus import value, and in consequence they are net exporting countries of honey.

China, Spain and Romania have also a positive TBI, but with a smaller value. They are also net exporting countries of honey in the world market.

The countries with the negative TBI are the EU, Germany, Poland as they are net importing countries and also Greece in 2018.

As a final conclusion, comparative advantage system of indicators reflects the level of competitiveness of a country in the international market.

Any country desires to have a high competitiveness, and this means permanent efforts to keep under control export and imports from a quantitative point of view, and value in relations to price volatility which depends on demand/offer ration in the international market and opportunities to extend the geographic area of influence looking for new trade partners.

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COMPARATIVE ADVANTAGE IN HONEY TRADE AMONG THE EUROPEAN UNION'S TOP EXPORTING COUNTRIES

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Abstract

The goal of this study is the analysis of the competitiveness of the EU top 10 honey exporting countries. Based on World Bank data for the period 2018-2021, Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), Trade Balance Index (TBI), Production Mapping (PM) and Comparative Export Performance Index (CEP have been determined. RCA results proved that the comparative advantage is "strong" for Bulgaria, Hungary, Romania and Greece, "moderate" for Spain, "weak" for Poland and Belgium, while Germany, Italy and France have "no" advantage. The RSCA positive values showed that Spain, Hungary, Poland, Greece, Romania and Bulgaria are advantaged in honey trade, while Germany, Italy and France are disadvantaged. According to TBI results, Spain, Hungary, Romania, Greece and Bulgaria are net exporting countries, while Germany, Poland, Belgium, Italy and France are net importing member states. Romania has a high comparative export performance against France, Italy, Germany and Belgium (CEP>5), a moderate performance against Poland and Spain (2 <CEP <4), and a low performance against Bulgaria, Hungary and Greece (CEP <1.5). As honey demand is higher and higher on the EU market and the competitiveness as well, the exporting countries must intensify their production and quality to better satisfy the needs of the importing member states. Also, they need to maintain a comparative advantage against the imported honey on the EU market.

Key words: *comparative advantage, honey, EU, top 10 exporting countries, RCA, RSCA, TBI, PM, CEP*

INTRODUCTION

Bees are essential for mankind survival as they are a part of biodiversity [45].
From an economic point of view, besides other insects and animals, bee colonies contribute to the development of agriculture, assuring pollination of the agricultural crops and wild plants [16, 34, 35], in a word their reproduction, biodiversity preservation and environment conservation.
From a social point of view, bees assure jobs and pleasant work in fresh air for beekeepers, income for many rural livelihoods [1, 29, 30], contributing to the development of the rural areas.
According to FAO, about 30% of global food production depends on bees, showing how important are these insects to food security [11, 41].
Honey, pollen, royal jelly, propolis, bee venom and beeswax are the main products coming from beekeeping and by their high nutritional quality help people to maintain health and life.
Beekeeping is practiced in all the EU countries in a large diversity of geographical conditions regarding climate, flora type and structure, which result to various yields and honey quality.
In 2021, the global honey production reached 1,772 thousand tons, to which China contributed by 486 thousand tons (27%) and the EU by 215 thousand tons (12%) [9, 43].
Despite that beekeeping is practiced in all the EU countries, the main producing countries

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are Spain, Romania, Hungary, Greece, Poland, Germany, Italy and France [8, 37].

In 2021, in the EU there were 20,058 thousand bee hives, by 6% more than in 2020 and by 18.22% more than in 2016. The most numerous beehives are in Spain, Romania, Poland, France, Italy, Hungary, Germany, Bulgaria and Portugal [9, 25, 26].

The number of apiaries differs from an EU member state to another, and the apiary size in terms of the number of bee families as well. Important efforts are made to increase apiary size to ensure a higher productivity and profitability [23, 24, 32]. The higher the apiary size, the higher profitability in beekeeping [3, 12, 17, 28].

In the EU, the highest honey production is achieved by Spain, Romania, Poland, Greece, Germany, France, Hungary and Italy [33, 36].

Also, the EU is the 2nd importer of honey after USA, because the EU is only 60% self-sufficient in honey. In 2021, it imported 173,511 tons honey whose value accounted for Euro 406,800 thousand, representing 28.3% of the world import value. From the EU honey imports, 31% come from Ukraine and 28% from China. At present, the EU average imports are about 175,000 tons honey [9].

The EU is also a honey exporter in the world. In 2021, the global honey export accounted for 751,070 tons, equivalent to Euro 1,863,875 thousand [44].

In 2021, the EU exported 25,025 tons honey, which ranked the EU the 8th after China, India, Argentina, Ukraine, Brazil, Vietnam and Mexico.

But, for the equivalent in Euro 152,040 thousands, representing 8.2% of the global honey export value, the EU came on the 2nd position after China (11.9%) [44].

The extra-EU honey export value accounted for Euro 146,442 thousand [10].

In 2021, the average price for honey export was Euro 2.34, while the average price for honey import accounted for Euro 5.76 per kg. Its volatility is determined by demand and offer amount and quality [10, 31].

As beekeeping is facing the decline of the bee population and honey yield caused by many factors like: reduction of bee colonies habitat, high consumption of chemical substances (fertilizers, herbicides, pesticides) to sustain intensive agricultural technologies, parasites attack and diseases occurrence, invasive species, and climate change [38, 39, 40, 49]. to sustain beekeeping, the EU offers financial support for the Apiculture Programme 2020-2022, approved by Commission Implementing Decision EU 2019/974 in all the EU member states. The funds are destined to eight specific measures concerning: (a) technical assistance (beekeepers training on breeding, disease prevention, honey extraction, storage and packaging); (b) combating beehive invaders and diseases, especially varroa; (c) transhumance improvement; (d) analysis of bee products quality; (e) applied research; (f) restocking of beehives; (g) bee products marketing; (h)improvement of bee product quality to better compete on the intra and extra-EU market [8].

Also, United Nations established "Environment Programme to support biodiversity, preserve the habitat and management, and mitigate the effects of climate change on beekeeping development [45].

Taking into account the high demand of honey on the international market, the competition among producers, exporters and importers, has become more enhanced.

Scientific research provides a large range of econometrical analysis tools destined to study the competitiveness of products and countries [27].

In this field, the most relevant studies mentioned by literature regard specific indices developed to measure the comparative advantage like: The Revealed Comparative Advantage index, RCA, [5], Balassa's RCA more detailed interpretation established [13], the Revealed Symmetric Comparative Advantage, RSCA [19], Trade Balance Index, TBI [18], Comparative Export Performance Index, CEP [7], Products Mapping, PM and other econometric tools [46, 47].

Despite the existence of these econometric methods and procedures to study

competitiveness on honey market, the literature provides just a few examples as mentioned below.
-Comparative Advantage applied in China, Argentina and Mexico [20]; in Serbia [14]; in Brazil [6]; RCA and TBI in Turkye [42] and also RCA, RSCA and TBI in Turkye [2]; in Mexico [4]; in the EU and Italy using TXA, RMA, RTA [21, 22]; in Visegrad four countries group using RCA [15].
In this context, the objective of the paper was to analyze the comparative advantage of honey among the EU top 10 honey exporters in the period 2018-2021 using RCA, RSCA, TBI, PM and CEP in order to established the status of each member state regarding the comparative advantage or disadvantage on honey market, which countries are net exporters and which countries have a high export performance.

MATERIALS AND METHODS

Data collection
To set up this research study**,** the empirical data for the period 2018-2021 have been picked up from the data bases belonging to World Bank World Integrated Trade Solutions.
The EU selected countries
The EU countries for which the comparative advantage for honey was analyzed have been Germany, Spain, Hungary, Poland, Greece, Romania, Bulgaria, Belgium, Italy and France, which in 2021 were the top exporters of honey.
The main indices reflecting the comparative advantage used in this study were the following ones:
(i)Revealed Comparative Advantage $RCA\,^{j}_{it}$ [5]:

$$RCA\,^{j}_{it} = \frac{(X^{j}_{it})}{(X^{j}_{t})} \,/\, \frac{(X^{w}_{it})}{(X^{w}_{t})} \text{......................(1)}$$

where:
$RCA\,^{j}_{it} =$ comparative advantage index for commodity i of the country j in the year t.
(X^{j}_{it}) = export of commodity i of the country j in the year t;
(X^{j}_{t}) = export of all commodities of the country j in the year t;
(X^{w}_{it})= world export of the commodity i in the year t;
(X^{w}_{t}) = world export of all goods in the year t.
The RCA results were interpreted using Balassa's classification (1965) [5], according to which:
- $RCA\,^{j}_{it}$ > 1, the country j has a comparative advantage; $RCA\,^{j}_{it}$ < 1, the country j has a comparative disadvantage; $RCA\,^{j}_{it}$ = 1, the comparative advantage is revealed for the country j.
Also, RCA values were appreciated using Hinloopen and Marrewijk's classification (2001) [13], according to which when 0 < RCA ≤ 1, the country j has " no" comparative advantage, when 1 < RCA ≤ 2, the country j has a "weak" comparative advantage, when 2 < RCA < 4, the country j has a "moderate" comparative advantage, and when RCA > 4, the country j has a "strong" comparative advantage.
(ii)Revealed Symmetric Comparative Advantage-$RCSA_{it}$ (Laursen, 1998) [19],

$$RSCA\,^{j}_{it} = \frac{(RCA\,^{j}_{it} - 1)}{(RCA\,^{j}_{it} + 1} \text{ ....(2)}$$

When RSCA has a positive value, 0 < RSCA < 1, the country j has a comparative advantage , and when f RSCA has a negative value, -1 ≤ RSCA < 0, the country j has a comparative disadvantage.
(iii)Trade Balance Index- TBI^{j}_{it} (Lafay, 1992)[18]

$$TBI\,^{j}_{it} = \frac{(X^{j}_{it} - M^{j}_{it})}{(X^{j}_{it} + M^{j}_{it})} \text{................(4)}$$

where:
(X^{j}_{it}) = export of commodity i of the country j in the year t;
(M^{j}_{it}) = import of commodity i of the country j in the year t.
When TBI has a positive value, 0 < TBI < 1, the country is a net exporter of the commodity i, when TBI has a negative value, - 1 ≤ TBI < 0, the country is a net importer of the

commodity i and when TBI = 0, the export value is equal to import value.

(iv)Production Mapping (PM) allows a classification of the countries j in four groups of comparative advantage based on a mix between the RSCA and TBI values as follows (Widodo, 2008, 2009) [46, 47]:

Group A: RSCA > 0 and TBI > 0, the country j has a comparative advantage and is a net exporter;

Group B: RSCA > 0 and TBI < 0, the country j has a comparative advantage and is a net importer;

Group C: RSCA < 0 and TBI > 0, the country j has a comparative disadvantage and is a net exporter;

Group D: RSCA < 0 and TBI < 0, the country j has a comparative disadvantage and is a net importer.

(v)Comparative Export Performance Index- CEP_{it}

$$CEP_{it}^{j} = \frac{(X_{it}^{j}/X_{it}^{r})}{(X_{t}^{j}/X_{t}^{r})} \quad \text{....................(5)}$$

where:

(X_{it}^{j}) = export of commodity i of the country j in the year t;

(X_{t}^{j}) = export of all goods of the country j in the year t;

(X_{it}^{r}) = export of commodity i of the competitor country r in the year t;

(X_{t}^{r}) = export of all goods of the competitor country r in the year t.

RESULTS AND DISCUSSIONS

Honey production in the EU

The EU is an important honey producing area, in the year 2021, achieving 228,837 tons. In the last years, honey production remained relatively constant compared to the world honey output, which registered a decline by 1.68% in the interval 2019-2021. In 2021, the EU contributed by 13.35% to the global honey production of 1,713,785 tons, which means by +0.26 percentage points more than in 2019.

In the decreasing order of the production performance, the top 10 member states producing honey are: Spain, Romania, Poland, Greece, Germany, France, Hungary, Italy, Bulgaria and Portugal, which together, in 2021, produced 190,056 tons, representing 83.05% of the EU honey output and 11.68% of the world honey production (Figure 1, Table 1).

Table 1. Honey production in the EU in 2021 and growth rate compared to 2019=100 (Tons)

Country	2021 (Tons)	Growth rate (%) 2019=100
Austria	3,830	-4.25
Belgium	5,000	ND
Bulgaria	11,638	+1.04
Croatia	8,630	+3.06
Cyprus	520	-21.22
Czechia	6,086	-26.32
Denmark	ND	-
Estonia	1,343	+4.27
Finland	3,100	-6.07
France	14,382	-8.72
Germany	19,600	-18.68
Greece	21,400	-5.27
Hungary	12,794	-28.07
Ireland	ND	ND
Italy	12,450	-17.00
Latvia	2,135	-0.21
Lithuania	7,894	+49.39
Luxembourg	48	-68.22
Malta	ND	ND
Netherlands	ND	ND
Poland	21,520	+13.07
Portugal	10,441	+3.33
Romania	30,831	+22.00
Slovakia	ND	ND
Slovenia	195	-71.14
Spain	35,000	+12.31
Sweden	ND	ND
EU-TOTAL	228,837	+0.3

Source: Own results based on the data from [48].
ND- No data.

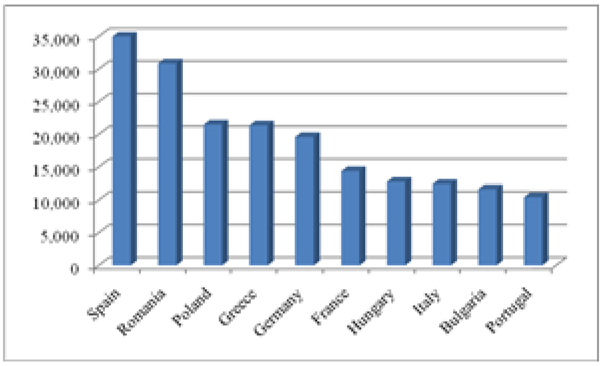

Fig. 1. Honey production in the EU top 10 producing countries in the year 2021 (Tons)
Source: Own design based on the data from [48].

The tendency of production varied from a country to another. Compared to 2019, in 2021, important growth rates were noticed in Lithuania, Romania, Poland, Spain, Portugal, Croatia. But, the majority of the member states registered decreases: Slovenia, Luxembourg, Hungary, Italy, Germany, France, Finland, Greece (Table 1).

Honey export value in the EU top exporting countries

In the EU, honey export value increased from USD 628.53 million in 2019 to USD 860.32 million in 2021, meaning by 36.87%. This was determined by the high growth of honey export in the top 10 exporting countries: Germany, Spain, Hungary, Poland, Greece, Romania, Bulgaria, Belgium, Italy and France, which in 2021 reached USD 751.79 million, by 37.43% more than in 2019. The top 10 member states contribute by 89.59% to the EU honey export value. In general, almost all the top honey exporters registered a higher growth rate, except Belgium (Table 2, Figure 2).

Table 2. Honey export value in the EU top exporting countries of honey in 2021 (USD million), and growth rate, 2019 = 100

	Honey export value (USD million)	Growth rate (%), 2019=100
Germany	154.97	+13.90
Spain	128.64	+45.42
Hungary	97.12	+14.50
Poland	63.32	+46.53
Greece	61.20	+315.7
Romania	58.49	+33.50
Bulgaria	47.87	+18.4
Belgium	37.26	-0.80
Italy	36.82	+21.03
France	34.42	+14.77

Source: Own results based on the data from [48].

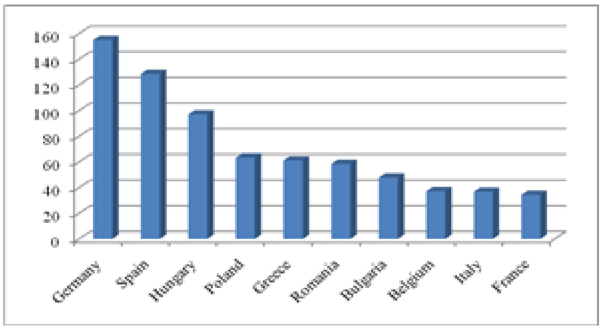

Fig. 2. Honey export value in the EU top 10 exporting countries of honey in the year 2021 (USD million)
Source: Own design based on the data from [48].

Honey import value in the EU top importing countries

The higher demand than production requires honey imports to cover the needs in the EU. For this reason, not only the amounts of honey coming from various suppliers increased. In 2021, honey import value accounted for USD 1,097.32 million compared to USD 815.35 million, therefore, being by 34.58% higher.

The main member states importing honey are: Germany, France, Italy, Poland, Spain, Netherlands, Belgium, Greece, Austria, Denmark, followed by Portugal, Czechia, Sweden, Romania, Ireland and Bulgaria. All these 16 countries summed a honey import value of USD 1,052.23 million in the year 2021, representing 95.96% of the EU import.

Compared to 2019, in 2021, most of these countries recorded high growth rates: Bulgaria, Czechia, Greece, Romania, Denmark, Germany, Spain etc and only Sweden and Ireland registered a negative rate (Table 3, Figure 3).

Table 3. Honey import value in the EU top importing countries of honey in 2021 (USD million), and growth rate, 2019 = 100

	Honey import value (USD million)	Growth rate (%), 2019=100
Germany	338.23	+45.70
France	120.66	+1.70
Italy	107.50	+34.60
Poland	91.35	+15.50
Spain	83.42	+45.20
Netherlands	66.95	+28.00
Belgium	48.11	+10.47
Greece	35.05	+94.90
Austria	28.72	+12.89
Denmark	25.94	+52.49
Portugal	21.49	+39.96
Czechia	20.17	+99.90
Sweden	20.07	-14.67
Romania	16.05	+84.40
Ireland	15.54	-14.80
Bulgaria	12.91	+231.00

Source: Own results based on the data from [48].

As we may notice, in 2021, Romania was ranked the 2nd for honey production, the 6th for export value and the 14th for the import value.

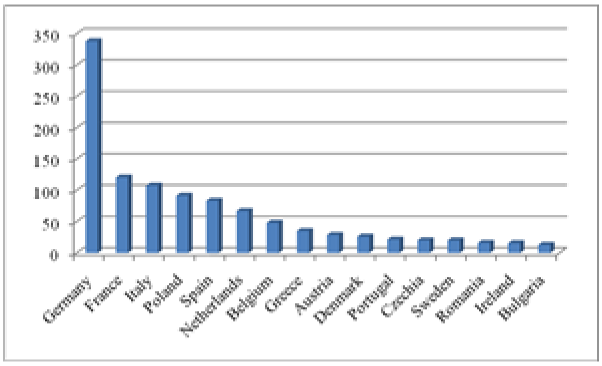

Fig. 3. Honey import value in the EU top 16 importing countries of honey in the year 2021 (USD million)
Source: Own design based on the data from [48].

The competitiveness of the EU top 10 exporting countries of honey

(i)Revealed Comparative Advantage-RCA registered different values from a country to another.

Germany, Italy and France in all the years and Belgium in 2021 recorded A RCA smaller than 1, reflecting that they have a comparative disadvantage, while the other countries: Bulgaria, Greece, Hungary, Romania, Spain, Poland in all the years of the period 2018-2021 and Belgium in the years 2018, 2019 proved to have a comparative advantage as RCA was higher than 1.

Bulgaria looks to be on the top position for its RCA which has the highest values, ranging between 12.06 in the year 2019 and 11.37 in the year 2018.

The lowest RCA was found in case of France. The small RCA values are determined by the low share of the honey export value in the export of all the commodities in the countries mentioned above (Table 4).

Table 4. Revealed Comparative Advantage for the EU top 10 honey exporting countries in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.Germany	0.85	0.93	0.89	0.74	87.05
2.Spain	2.78	2.62	2.85	2.59	93.16
3.Hungary	6.67	6.93	6.32	5.44	81.55
4.Poland	1.50	1.71	1.93	1.57	104.66
5.Greece	4.23	3.87	4.87	10.24	242.08
6.Romania	5.62	5.66	5.48	5.23	93.06
7.Bulgaria	11.37	12.06	9.86	9.22	81.09
8.Belgium	1.19	1.20	1.02	0.54	45.37
9.Italy	0.52	0.56	0.40	0.47	90.38
10.France	0.49	0.53	0.46	0.46	93.87

Source: Own calculations based on the official data from [48].

Looking at the dynamics of RCA values, we may easily notice a general decreasing trend from 2018 to 2021 for almost all the EU top exporting countries, except Greece and Poland were RCA increased. Table 5 presents a more detailed classification of the EU top exporting countries of honey based on the method developed by [13].

Table 5. The classification of the EU top 10 exporting countries based on RCA values, 2019-2021

	"Strong" comparative advantage RCA > 4	**"Moderate" comparative advantage" 2 < RCA ≤ 4**	**"Weak" comparative advantage 1 < RCA ≤ 2**	**"No" comparative advantage RCA 0 ≤ 1**
1.Germany	-	-	-	In all the years
2.Spain	-	In all the years	-	-
3.Hungary	In all the years	-	-	-
4.Poland	-	-	In all the years	-
5.Greece	In all the years	-	-	-
6.Romania	In all the years	-	-	-
7.Bulgaria	In all the years	-	-	-
8.Belgium	-	-	In 2018, 2019, 2020	In 2021
9.Italy	-	-	-	In all the years
10.France	-	-	-	In all the years

Source: Own classification based on [13].

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The hierarchy of the EU top exporting countries according to RCA values in 2021 is shown in Figure 4.

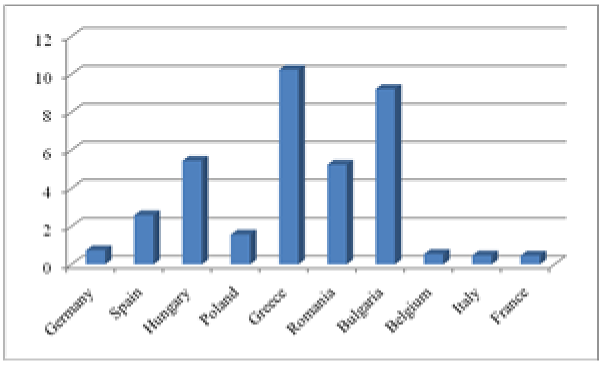

Fig. 4. The hierarchy of the EU top 10 exporting countries of honey based on RCA in 2021
Source: Own design based on own results.

(ii)Revealed Symmetric Comparative Advantage-RSCA registered both positive values and also negative values, depending on the EU member state and year, and of course, of RCA values which are included in the calculation formula.

The countries which registered a positive RSCA like: Spain, Hungary, Poland, Greece, Romania and Bulgaria have a symmetric comparative advantage for honey, while Italy and France in all the years and Belgium in 2021 have a symmetric comparative disadvantage as RSCA recorded negative values (Table 6).

Table 6. Revealed Symmetric Comparative Advantage for the EU top 10 honey exporting countries in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.Germany	-0.08	-0.03	-0.05	-0.14	57.14
2.Spain	0.47	0.44	0.48	0.44	93.61
3.Hungary	0.73	0.74	0.72	0.68	93.15
4.Poland	0.20	0.26	0.31	0.22	110.00
5.Greece	0.61	0.58	0.65	0.82	134.42
6.Romania	0.69	0.69	0.69	0.67	97.10
7.Bulgaria	0.83	0.84	0.81	0.80	96.38
8.Belgium	0.08	0.09	0.009	-0.29	-362.50
9.Italy	-0.31	-0.28	-0.42	-0.36	116.12
10.France	-0.34	-0.65	-0.36	-0.36	105.88

Source: Own calculations based on the official data from [48].

The hierarchy of the EU top exporting countries according to RSCA values in 2021 is shown in Figure 5.

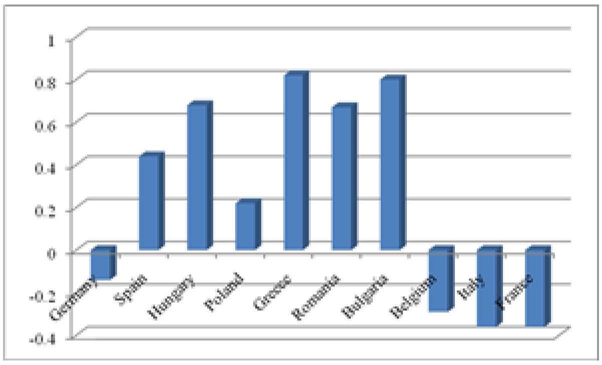

Fig. 5. The hierarchy of the EU top 10 exporting countries of honey based on RSCA in 2021
Source: Own design based on own results.

(iii)Trade Balance Index- TBI carried out different values from a member state to another, either with positive and negative values depending on the export and import values and the formula of calculation.

A negative TBI was achieved by Germany, Poland, Belgium, Italy and France in all the studied years and Greece and Bulgaria in 2018, reflecting that these countries were net importers of honey.

On the other pole, there are Spain, Hungary and Romania in all the years, Greece and Bulgaria in 2021, 2020 and 2019, which carried out positive TBI values, reflecting that they are net exporting countries (Table 7).

The hierarchy of the EU top exporting countries according to TBI values in 2021 is shown in Figure 6.

Table 7. Trade Balance Index TBI for the EU top 10 honey exporting countries in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.Germany	-0.33	-0.37	-0.29	-0.37	112.12
2.Spain	0.21	0.21	0.25	0.26	123.80
3.Hungary	0.99	0.99	0.99	0.80	80.80
4.Poland	-0.18	-0.17	-0.12	-0.18	100.00
5.Greece	-0.02	0.09	0.14	0.27	1,350.00
6.Romania	0.62	0.44	0.49	0.57	91.93
7.Bulgaria	-0.85	0.82	0.84	0.05	5.88
8.Belgium	-0.008	-0.07	-0.03	-0.12	1,500.00
9.Italy	-0.52	-0.44	-0.51	-0.41	78.84
10.France	-0.60	-0.59	-0.63	-0.60	109.09

Source: Own calculations based on the official data from [48].

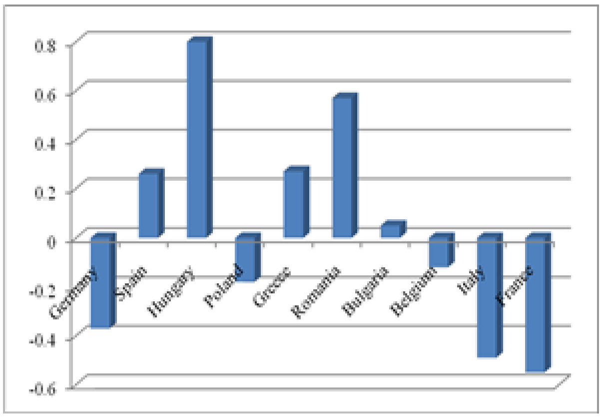

Fig. 6. The hierarchy of the EU top 10 exporting countries of honey based on TBI values in 2021
Source: Own design based on own results.

(iv)Production Mapping-PM reflected the situation of each EU member state concerning the comparative advantage or disadvantage and its position as trader- net exporter or net importer of honey. The EU countries belonging to Group A, having a comparative advantage and being net exporters of honey are: Spain, Hungary, Romania in all the analyzed years, Greece and Bulgaria in 2019, 2020 and 2021. Poland in all the years and Belgium in 2018, 2019, 2020 belong to Group B, having a comparative advantage, but a negative honey trade balance. None of the top 10 honey exporting countries belonged to Group C. But, there are member states belonging to Group D, reflecting that they have a comparative disadvantage for honey and that they are net importing countries. It is about Germany, France and Italy in all the studied years and Belgium in the year 2021 (Table 8).

Table 8. Production Mapping for honey in the EU top 10 exporting countries, 2019-2021

	2018	2019	2020	2021
1.Germany	D	D	D	D
2.Spain	A	A	A	A
3.Hungary	A	A	A	A
4.Poland	B	B	B	B
5.Greece	B	A	A	A
6.Romania	A	A	A	A
7.Bulgaria	B	V		
8.Belgium	B	B	B	D
9.Italy	D	D	D	D
10.France	D	D	D	D

Source: Own results.

(v) Comparative Export Performance Index-CEP was calculated only for Romania to show its position in connection to the other top nine competitors in the EU honey market.

CEP values obtained by Romania reflect that the country has a high comparative export performance against France, Italy, Germany and Belgium (CEP > 5), a moderate export performance against Poland and Spain (2 < CEP < 4) and a low comparative export performance against Bulgaria, Hungary and Greece (CEP < 1.5) as shown in Table 9.

Compared to 2018, in 2021, CEP value for Romania registered a decline against Greece, Poland and Spain, and an increase against Germany, Hungary, Bulgaria, Belgium, Italy and France.

Comparative Export Performance - CEP of Romania against the other EU top nine honey exporting countries in the year 2021 is shown in Figure 7.

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Table 9. Comparative Export Performance - CEP of Romania against the other EU top nine honey exporting countries in the period 2018-2021

Country	2018	2019	2020	2021	2021/2018 %
1.Germany	6.58	6.17	6.17	6.98	106.07
2.Spain	2.02	2.16	1.92	2.01	99.50
3.Hungary	0.84	0.81	0.86	0.96	114.28
4.Poland	3.76	3.31	2.84	3.32	88.29
5.Greece	1.32	1.45	1.12	0.53	40.15
7.Bulgaria	0.49	0.46	0.55	0.56	114.28
8.Belgium	4.69	4.72	5.04	9.66	205.97
9.Italy	10.73	10.06	12.69	11.02	102.70
10.France	11.02	10.57	11.14	11.25	102.08

Source: Own calculations based on the official data from [48].

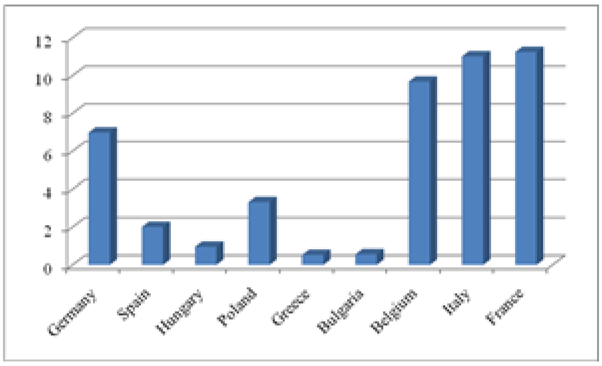

Fig. 7. Comparative Export Performance - CEP of Romania against the other EU top nine honey exporting countries in the year 2021
Source: Own design based on own results.

In this study, CEP index was calculated for each EU exporting country in order to evaluate its export performance against the other nine member states with which it is in competition on the honey market. The results are shown in Table 10.

Germany had a small CEP index against the other nine competitor countries. Its values varied between 0.07 against Greece and 1.60 against France, reflecting a low export performance in general.

Spain registered CEP values ranging between 0.25 against Greece and 5.58 against France. Spain is a weak competitor for Greece, Bulgaria, Hungary and Romania, but with a higher export performance against Italy, France and Spain.

Hungary carried out CEP values ranging between 0.53 against Greece and 11.70 against France. It looks to be a strong competitor for France, Italy, Belgium and Germany, but a weak one against Greece, Bulgaria and Romania.

Poland obtained CEP values varying between 0.15 against Greece and 3.38 against France, reflecting a weak position as competitor on the EU honey market.

Greece obtained the highest CEP values ranging between 1.88 against Hungary and 22.22 against France. It could be considered the strongest competitor country against France, Italy, Belgium, Germany and also against Poland and Spain, but a weak competitor against Bulgaria, Hungary and Romania.

Bulgaria also looks to be an important competitor because its CEP values varied between 0.90 against Greece and 19.85 against France, the highest value. It is a strong competitor against France, Italy, Belgium and Germany, but a weak competitor against Greece, Hungary and Romania.

Belgium recorded low CEP levels, most of them being below 1 against almost all the other EU countries, except Italy and France. It proved to be a weak competitor on the honey market.

Italy also achieved small CEP values ranging between 0.04 against Greece and 1.02 against France. It is one of the weakest competitor against the other EU exporting countries of honey.

France also proved to be a weak rival against the other nine top exporting countries, as its CEP levels were smaller than 1, ranging between 0.04 against Greece and 0.97 against Italy.

Romania**,** as mentioned before, plays an important role on the EU honey market both as producer and exporter. In 2021, it registered three CEP values below 1, 0.53

being the smallest one against Greece and six values higher than 2, the highest value accounting for 11.25 against France. Therefore, Romania is strong competitor for France, Italy, Belgium and Germany, but a weak rival against Greece, Bulgaria and Hungary (Table 10).

Table 10. The matrix of CEP values for each top EU exporting country against the other nine in the year 2021

Country against	Germany	Spain	Hungary	Poland	Greece	Bulgaria	Belgium	Italy	France	Romania
Germany	-	0.28	0.13	0.47	0.07	0.08	1.38	1.57	1.60	0.14
Spain	3.47	-	0.47	1.64	0.25	0.28	4.54	5.44	5.58	0.49
Hungary	7.27	2.09	-	3.45	0.53	0.58	10.09	11.41	11.70	1.04
Poland	2.10	0.60	0.28	-	0.15	0.17	2.91	3.30	3.38	0.30
Greece	14.07	3.95	1.88	6.52	-	1.11	19.09	21.58	22.22	1.95
Bulgaria	12.32	3.57	1.69	5.86	0.90	-	17.12	19.40	19.85	1.76
Belgium	0.72	0.20	0.09	0.30	0.05	0.05	-	1.13	1.16	0.10
Italy	0.63	0.18	0.08	0.30	0.04	0.05	0.88	-	1.02	0.09
France	0.62	0.17	0.08	0.29	0.04	0.05	0.86	0.97	-	0.08
Romania	6.98	2.01	0.96	3.32	0.53	0.56	9.68	11.02	11.25	-

Source: Own results.

CONCLUSIONS

The analysis for the comparative advantage for honey in case of the EU top 10 exporting countries in the period 2018-2021 was analyzed using the following specific indicators Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), Trade Balance Index (TBI), Production Mapping (PM) and Comparative Export Performance Index (CEP).

RCA results proved that Bulgaria, Hungary, Romania and Greece have a "strong" comparative advantage, while Spain has a "moderate" advantage, Poland and Belgium have a " weak" advantage and Germany, Italy and France have "no" advantage, in other words, their disadvantage on honey market was revealed.

The RSCA positive values reflected Spain, Hungary, Poland, Greece, Romania and Bulgaria are advantaged in honey trade, while Germany, Italy and France are disadvantaged because they carried out negative values for this symmetric index.

The results obtained for TBI showed that Spain, Hungary, Romania, Greece and Bulgaria are net exporting countries, while Germany, Poland, Belgium, Italy and France are net importing member states. Therefore, for the first group of countries, export is more important, while for the last group, import is required to cover the internal market needs.

Concerning the compared export performance, CEP values reflected that Greece is the strongest competitor country against France, Italy, Belgium, Germany and also against Poland and Spain, but a weak competitor against Bulgaria, Hungary and Romania.

Also, Bulgaria is a strong competitor against France, Italy, Belgium and Germany, but a weak competitor against Greece, Hungary and Romania.

Hungary is a strong rival for France, Italy, Belgium and Germany, but a weak one against Greece, Bulgaria and Romania.

Romania has a high comparative export performance against France, Italy, Germany and Belgium (CEP>5), a moderate performance against Poland and Spain (2 <CEP <4), and a low performance against Bulgaria, Hungary and Greece (CEP <1.5).

The EU honey market is in a continuous extend as honey demand is higher and higher. For this reason, the competitiveness between producers and exporters has increased.

The financial support given to the EU members will strengthen production and honey quality to better satisfy the needs of the population and also the competition will become stronger for a higher export performance.

Honey imports are needed to cover 40% difference to reach self-sufficiency, but they must not affect the EU beekeepers chance to valorise honey production at a convenient price to cover their costs and assure income and profitability of the beekeeping sector.

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OVERTOURISM IN THE MOST VISITED EUROPEAN CITY AND VILLAGE DESTINATIONS

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Abstract

The goal of this study is to analyze overtourism in a selection of the top visited European countries, in the most visited cities and villages, based on a specific indicator "density per inhabitant" and also on "density per square km" in the cities in the years 2022 versus 2019. The results proved that overtourism is present because the density of tourists per inhabitant is very high and per square km is a few times higher than the number of the local population. In 2022, the highest tourist charge per inhabitant was found in all the selected cities, but especially in: Venice, Dubrovnik, Vienna, Paris, Florence, Amsterdam, Milan and Barcelona. Per square km, the overcrowded cities by tourists are: Venice, Barcelona, Nice, Florence, Paris, Amsterdam, Prague, Madrid and Vienna. There were also highlighted the villages which are suffocated by tourists taking into consideration the local population: Cinque Terre, Capri-Anacapri, Alberobello, Hallstadt, Giethoorn, Oia, Tibermory, Ciocanesti, Viscri, Bran, Marginimea Sibiului, and Sapanta. Finally, the study emphasizes the measures taken by the authorities in each city and village, depending on the local situation, as well as UNWTO strategies recommended to be implemented for diminishing the negative effects of overtourism.

Key words: *overtourism, features, causes, cities and villages affected destinations, Europe, UNWTO strategy*

INTRODUCTION

Tourism was without any doubt the most dynamic branch of the global economy till 2019 when it reached the highest performance of 1,460 million tourist arrivals and USD 1,481 billion receipts as mentioned by UNWTO International Tourism Highlights, 2020 [43].

The growth of the values of these two indicators was noticed in almost all the regions and countries with slight variations depending on their attractiveness regarding diversity and quality of tourism and travels activities, facilities and hospitality [42, 48, 57]. The competitiveness among the EU countries which are among the top destinations of world has increased year by year fighting to maintain their position [52] by a more balance demand/offer ratio [45, 44], knowing that an increased number of arrivals will have a beneficial impact on receipts [47, 53].

The statistics showed a high seasonality in tourism highlighting the peak in summer season especially in July and August when most of the people plan their holidays [55].

In the EU, these trends are available in all member states both in the old and new ones [50].

The Covid-19 pandemic paralyzed the whole economic activity and deeply affected tourism because of the restrictions imposed by each country [30, 31, 54] and also at the global level [60, 61]. The worst year was 2020.

The year 2021 brought a hope that in the longer periods of relaxed measures tourism was able to recover, but not at the 2019 level.

Human resource in tourism and travel is essential both concerning the number of employed people in the sector and also regarding its quality in terms of training level [9, 46]. The pandemic brought a serious loss of workforce in tourism and as demand for tourism increases it had to be renewed.

However the period pandemic was a crucial moment when the stakeholders were obliged to adopt a new strategy.

Tourists have changed their preferences to safer places, in smaller accommodation establishments and less crowded destinations avoiding the large cities. In some countries it was visible a preference to travel and spend holidays and week-ends in the middle of nature, giving a chance to rural tourism and agri-tourism to show that it could be a good alternative for accommodation, food and leisure, and more activities outdoors [49, 59].

The year 2022 was a much better year for tourism, the number of arrivals being higher than in the two previous years, but not yet at the level of 2019.

Unfortunately, the statistics of the last decades showed that the number of tourists has become higher and higher in the most visited destinations where the local population had the feeling of being frustrated from its normal life.

This phenomenon which is named "overtourism" has appeared in the last years in various historical, cultural heritage and short-break destinations where it has had a strong negative influence on the residents' life and quality of the tourists' experiences [77].

It was identified mainly in the urban areas but also in a few very popular communes and villages of high attraction. This happens especially in the summer season when most of people plan the holiday, like the months of July and August, or in week-ends or on various occasions like Christmas markets, festivals, football matches and other events when a huge number of visitors invade the desired destination over its capacity to receive them, disturbing and deteriorating daily life, traffic, infrastructure, environment and creating an anti-tourism feeling from the local population [33].

Overtourism has emerged because some special factors which have favoured its appearance.

The high tech products and new communication technologies used by social media (Facebook, Twitter, Instagram, Pininterest, Tumbir, Flickr etc) and also the digital platforms have allowed access to valuable information and opinions, photos, videos influencing and encouraging people to change their preferences and adopt a peculiar travel behaviour [20].

The extent of internet access and intensification of online services for booking (accommodation, transport, tickets etc) and the creation and popularization of Airbnb home-sharing platform have also stimulated tourism all over the world [15].

The air ticket fare facilities offered by the low cost companies have created an incentive to people to travel saving some money. Also, the development of airline industry has provided aircrafts of high passenger capacity, while the cruise ship travels have more and more offers and could leave more than 9,000-12,000 tourists in a port.

The travel planning in similar periods of the year linked to vacation, week-end, events and other occasions has led to overcrowded destinations.

In addition, looking for a higher turnover in tourism business, the control of overtourists' bookings has been ignored .

In consequence, overtourism increased the tourist density per inhabitant creating a high pressure and stressful life, leading to overcrowded traffic, shops, markets, cultural objectives (museums, art galleries, cathedrals, palaces and castles, archeological sites, streets, restaurants, bars, shops etc), high pollution (dusty air, more carbon emissions, wastes). The presence of a high number of tourists has led to a higher consumption of resources such as: water, food, fuel, workforce and to a higher risk to get health problems [2].

In addition, in the overcrowded destinations, tourists themselves had a feeling of discomfort losing their precious time waiting in the queues at the entrances in tourist attractions or in the visiting rooms, airports, ports, restaurants, or walking in the streets etc. [27, 82].

During the Covid-19 pandemic when tourism suffered in the period of restrictions, it was noticed a recover of the wild life in the absence of the tourists, which proves a negative impact of overtourism on ecosystems, an aspect to be taken into account in the next tourism strategies.

Overtourism has led to conflicts between the residents and tourists, to demonstrations and requests to the local authorities to take measures.

More than this, the presence of so many tourists has a negative impact on the local culture, civilization and traditions, the overcrowded destinations facing "touristification" and "losing their identity".

Europe was the world most visited continent in 2022 and, according to various information sources, the most overloaded destinations are: Dubrovnik, Venice, Brugge, Rhodes, Reykjavik, Florence, Heraklion, Amsterdam, Dublin, Tallinn, Paris, Porto, Prague, Athens, Nice, Edinburg, Lisbon, Copenhagen, Barcelona, Capri-Anacapri, Cinque Terre, Mallorca, Madrid, Alicante etc. [23, 74].

Also, there are tourist objectives which have millions of visitors per year like: Louvre Museum (7.72), Versailles Palace (6.9), The Eiffel Tower (5.85), Vatican Museum (5.08), Natural History Museum - London (4.65), The British Museum (4.09), Tate Modern (3.88), Musee d'Orsay (3.3), Centre Pompidou (3), the National Gallery-London (2.72), Prado Museum (2.45), Victoria and Albert Museum- London (2.37), Galleria degli Uffizzi-Florence (2.22).

In almost all these cultural attractions, there were taken measures to protect the exhibits limiting the number of visitors per day by practicing on line reservation, pre-booked tickets, increased ticket price, monitoring the number of visitors in the museum rooms [81].

In this context, the study aim was to analyze overtourism in a few selected European countries with top overcrowded destinations based on number of visitors, tourism density in terms of number of visitors per inhabitant and per square kilometer in the year 2022 compared to the year 2019, when it was recorded the highest tourist arrivals.

Also, there were identified not only the most crowded cities, but also a few villages and communes from Europe, Romania being included, despite that the country is not one of the top visited ones on the continent.

Finally, the study tries to highlight the good measures taken by various destinations in order to reduce the negative impact of overtourism.

MATERIALS AND METHODS

Data collection

The data were collected from official sites like: UNWTO, Euromonitor, World Population Review, Wordometer, Macrotrends, World Bank, and Wikipedia.

The European countries

The European selected countries in this study are France, Spain, Italy, United Kingdom, Germany, Netherlands, Austria, Croatia and Romania.

The selected cities are among the most affected by overtourism: Paris, London, Amsterdam, Barcelona, Madrid, Berlin, Milan, Venice, Munchen, Rome, Prague, Florence, Vienna, Dubrovnik.

The main index reflecting overtourism considered in this study is ***"tourism density***", TD expressed in terms of "number of tourist arrivals/number of inhabitants", (TD_P), and "number of tourist arrivals/km ^{2} ", (TD_A), [36, 42, 43], calculated according to the formulas:

$TD_P = TA/ P$ ....(1)

where:
TA = Tourist arrivals
P = population

$TD_A = TA/ A$ ....(2)

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where:
A = surface of the tourist destination.
The calculations were made for the year 2022 and 2019. The index level in the year 2019 was the term of reference for making the comparison.
The applied methodology consists of :
-Collecting the data concerning the number of tourist arrivals in the main visited countries in Europe, as selected and mentioned above.
-Establishing the main cities with high number of tourists in the years 2019, the pre-Covid-19 pandemic year when tourism registered the highest performance and 2022, the year which could be considered better for tourism recovery.
-Collecting the data regarding the population of the selected cities in 2019 and 2022.
-Collecting the data concerning the area of the selected cities in 2019 and 2022.
-Calculating tourism density.
-Comparing tourism density among the selected cities, and establishing the differences in 2022 versus 2019 and their hierarchy.
Also, the study provided information about a few villages which are over-crowded by tourists in the selected countries.

RESULTS AND DISCUSSIONS

Dynamics of the world inbound tourism, 2010-2022

The year 2019 was the best in the world tourism, because it was recorded the highest number of international tourist arrivals accounting for 1,465.16 million (Figure 1).

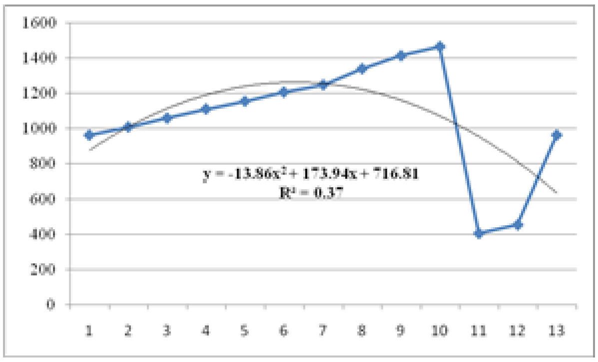

Fig. 1. Dynamics of international tourist arrivals at the world level, 2010-2023 (Million)
Source: Own design based on the data from [78].

In the period of the Covid-19 pandemic, 2020 and 2021, tourism was the most affected branch of the world economy. Only in the period of diminished or cancelled restrictions, people could travel. In 2020, there were just 406.89 million international tourist arrivals and in 2021 a little more accounting for 455.77 million. These figures represented 72.23% and, respectively, 68.9% less arrivals than in 2019 (Figure 1).
Since 2022, tourism started to recover much better, and the arrivals became more than double, reaching 962.80 million, representing 65.17% of the 2019 pre-pandemic level. Also, this figure is almost similar with the tourist arrivals in 2010 (Figure 1).

Dynamics of the inbound tourism in Europe and the most visited countries

In 2022, Europe received 594.5 million international tourist arrivals, representing 61.7% of the global figure, 962.80 million arrivals.
Also, the 2022 level accounts for 80% of the peak of arrivals carried out in 2019. For this reason, in 2022, Europe was the top visited region in the world.
If at the world level, in 2022, the tourists arrivals were by 37% smaller than in 2019, Europe registered 745 million arrivals, accounting for only 20% less than in 2019 [79].
It is expecting that by the end of 2023, tourist arrivals to represent 95% of the 2019 level at the global level.
The most visited countries in Europe, selected in this study, registered the following situation of tourist arrivals in 2022: France 82.6 million, Spain 75.6 million, Italy 52.4 million, United Kingdom 35.8 million, Austria 26.2 million, Germany 35.6 million, Croatia 18.9 million, Czechia 19.5 million, Netherlands 16 million. These figures are smaller compared to the number of arrivals achieved in the year 2019 (Figure 2).
The growth rate in 2022 versus 2019 accounted for 91.77% for France, 90.32% for Spain, 80.86% for Italy, 87.53% for United Kingdom, 89.98% for Germany, 79.48% for Netherlands, 81.87% for Austria, 90% for Croatia and 52.41% for Czechia.

In the graphic, the USA was also included as a comparison term, because the country came on the 2nd position in the world for 75.6 million arrivals in 2022 after France and representing 95.69% of the 2019 level.

Dynamics of the inbound tourism in the most visited cities of Europe

In 2022, the most visited city in the world was Paris which received 44 million international tourist arrivals, by 15.78% more than in 2019. London came on the 2nd for 16.1 million tourists.

Most of the cities registered a lower number of tourists arrivals in 2022 versus 2019, except Paris, Amsterdam, Barcelona, Venice and Florence which were facing a higher tourist arrivals in the year 2022 (Table 1).

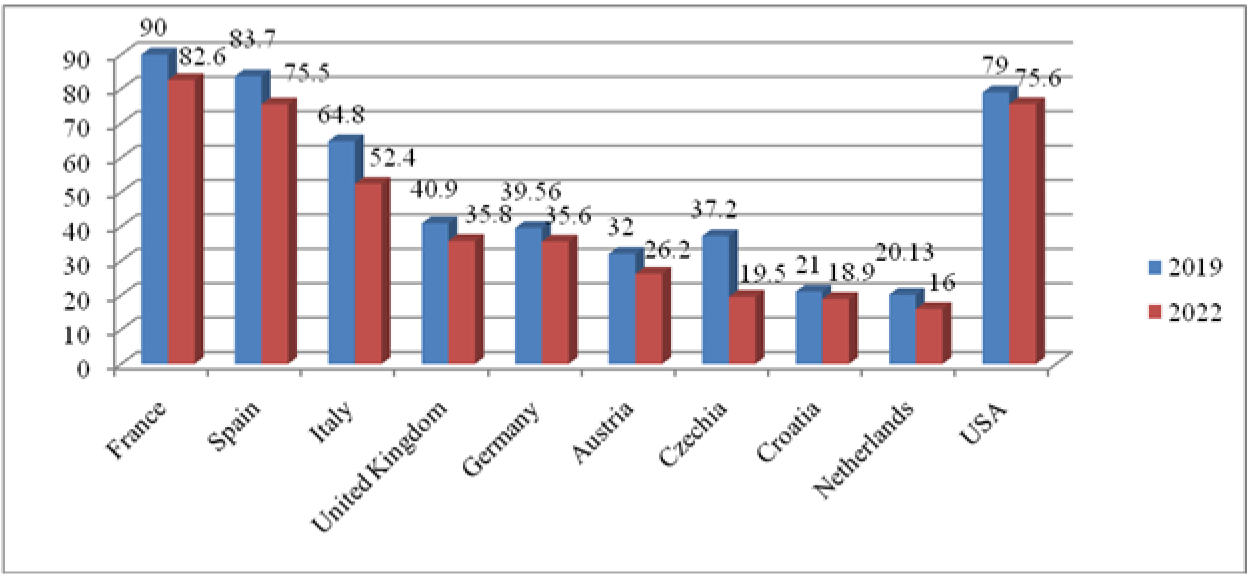

Fig. 2. Dynamics of international tourist arrivals in the most visited European countries and USA in 2022 versus 2019 (Million)
Source: Own design based on the data from [78, 80].

Table 1. Number of tourist arrivals in the selected cities of Europe in 2022 versus 2019 (Million)

	2019	2022	2022/2019 %
1.Paris	38	44	115.78
2.London	21	16.1	76.66
3.Amsterdam	5.34	6.6	123.50
4. Barcelona	8.52	9.9	116.19
5.Madrid	10.41	9.1	87.33
6.Berlin	14	10	71.42
7.Milan	10.86	10	92.08
8.Venice	4.8	8.9	185.41
9.Munchen	8.8	6.94	78.86
10.Rome	10.32	5.82	56.40
11.Prague	6.78	5.97	88.05
12.Florence	5.00	5.60	112.00
13.Vienna	7.90	5.60	70.88
14.Dubrovnik*	1.44	1.04	72.22
15.Nice	5.00	5.00	100.00

Source: Own calculation based on the data from [17, 75].

Tourism density in the most visited and selected cities in Europe in 2022 versus 2019

The results for tourism density vary from a city to another depending on the number of tourists arrivals and the local population. In a few cases, the calculation was made taking into consideration both the number of city residents and also the number of inhabitants in the metropolitan area.

Paris is a very crowded because is a top destination in the world. It has a rich treasure of tourists attractions like: Louvre Museum, Notre Dame Cathedral, the Eiffel Tower, the Pantheon, Musee d'Orsay, Centre Pompidou, Montmartre district etc, and Versailles Palace and gardens and Disney land in the proximity. [42, pp. 92-94].

In 2022, tourism density accounted for 19.73 arrivals per inhabitant, being by 12.16% higher versus 17.59% in 2019, reflecting a high pressure of overtourism especially on the tourism sites and more or less on the local population. After the local population claimed problems caused by overtourism, the local authorities decided to monitor the number of tourists in the tourism sites based on online reservation. For example, Louvre Museum limited the access of tourists to 30,000 a day [16].

London is a beautiful city full of attractions like: the Buckingham Palace, Westminster Abbey, The Parliament House, London Eye, the Wax Museum, The White Tower, London Bridge, Saint Paul Cathedral, Tate modern, Hyde Park etc. [42, pp. 149-150-43].

In 2022, it recorded 1.68 tourism density versus 2.28 tourists per inhabitant in 2019. The figures do not look to be so high, as local authorities applied a balanced tourism management in connection to tourist flows. The authorities do not discuss yet about over tourism, but they suggest visitors to visit London outside of the peak months and also to explore more of the city. Also, it could be a problem with the visitors who visit the city and who spend just a few money. They affect the infrastructure and environment, raise properties prices and rents. Recommendation for tourists to what to do to diminish overtourism are already made [24].

Amsterdam is one of the pearl cities from the Western Europe which offer tourist many attractions like: The Royal Palace in Dam Square, Rijksmuseum, Van Gogh Museum, Anne Frank's house, Rembrand's House etc. [42, pp.157-158].

The city registered a tourism density of 5.64 tourist arrivals per inhabitant in 2022 compared to 4.68 in the year 2019. It is obviously a pressure on the residents, and also a negative impact on the cultural heritage, the historical buildings along the canals, bridges and on the environment in the city parks and green spaces. The tourism authorities decided to focus more on tourism management than in advertising, and in this respect the visitor groups have a limited access to accommodation and entertainment services in order to spread visitors to other parts of the destination.

Also, there are established interdictions to build new hotels and souvenir shops and private rentals are limited. The public drunkeness is punished with hefty penalties. The canabis consumption in public is punished by paying a fine and the grass is sold only to the residents. Also, the red light district will be not included in the visit tours and will be moved to suburb of the city by the end of the year 2023. There were also imposed fines to get rid of party tourists [38, 62].

Barcelona, one of the most beautiful cities situated on the coast of the Mediterranean Sea, offers many tourist attractions like: the masterpiecess created by the architect Antonio Gaudi: La Sagrada Familia, Casa Mila, Casa Batlo, Park Guell, Picasso Museum, Park of Montjuic and the Magic Fountain, Las Ramblas, Palau de la Musica Catalana, The Gothic district, Mercat de la Boqueria, Port Vell etc. [42, p. 198].

The city recorded 6 tourists per inhabitant in 2022 versus 7.27 in 2019. But, in summer season Barcelona is overcrowded by tourists, a fact which in 2018 started the demonstration of the locals against tourists who were invited "to go home". Barcelona is recognized as the most polluting city due to the cruise ships, planes, cars. Despite that tourism has a beneficial economic effect, it also determined the houses and rental price increase obliging a part of the residents to leave homes because they could not live in a place beyond their budget. In addition, many basic utilities for the residents were transformed in facilities for tourists: restaurants, shops, attractions, accommodation units etc., extent of the airport and port etc. For this reason, since 2019, there were imposed restrictions regarding the number of visitors in Barcelona and the number of short-term rentals. In the last decade, the short-term rental boom (the Airbnb model) has appeared as many people used to rent accommodation in old and new tourist locations. But the authorities decided that tourists must stay only in legal accommodation units. Also, it was recommended to come in off-season, to avoid the popular attractions and respect the life style and traditions in the city. To keep under control the number of tourists in the most important attractions, online reservation was generalized, the number of cruise ships to dock was limited per day and the airport will remain at the same dimension not to increase the number of air flights and visitors [25, 26].

Madrid, the capital of Spain invites tourist to visit: The Royal Palace, the Almudena Cathedral, Prado Museum, Plaza Mayor, Park Buen Retiro, National Museum La Reina Sophia, Thyssen-Bornemisza Museum etc. [42, p. 198].

The city registered 2.75 tourism density in 2022 compared to 3.15 arrivals per inhabitant in 2019. It is also a crowded city in summer season. To diminish overtourism, the authorities imposed severe measures regarding the rental accommodation and also tourist flows in the area of the historical attractions [22].

Berlin is well known for its interesting buildings starting with the Dome, the Parliament Building, Bradenburg Gate, the Museums Island, Pergamon Museum, Bode Museum, Berlin Wall Memorial, Unter den Linden Boulevard, Alexander Platz and Television Tower, Chralottenburg Castle etc. [42, pp. 103-104].

The city recorded 2.80 tourism density in 2022 compared to 3.94 tourists per resident in 2019. To manage overtourism, it was established the Citizens' Advisory Service which is called to be involved in the city tourism strategy, suggesting "what groups to target for marketing and how to present the city’s neighborhoods" [66].

Milan is well known as a city of fashion, but it has architectural buildings of an exceptional value like: The Dome, Vittorio Emanuele II Gallery, Sforza Castle, Santa Maria delle Grazie Church, Brera Pinacoteque, La Scala Opera House [42, p. 125].

In 2022, Milan achieved 7.14 tourist density per inhabitant compared to 7.75 in 2019, if we take into consideration only the city.

Milan is not mentioned in literature as being a destination facing overtourism, but tourist density figures reflect a high number of visitors per inhabitant which is for sure embarasing and discomforting the local population. However, the Italian government established measures for tourists visiting Milan. It is about "a cap on the number of tourists allowed in the city each day and a ban on Airbnb rentals" [76].

Venice is a beloved city, small, but very attractive for its attractions: Ca' d'Oro Palace, Correr de la Ca' Grande, St. Mark Basilica and square, Ponte Rialto, the Palace of the Doges, Piazza dei Signori, Teatro Fenice, Campanila San Marco, Basilica Santa Maria della Salute, and the islands in the lagoon: Murano, Burano and Torcello [42, p. 124].

For this reason, overtourism is very common and deeply affect the city, besides the benefits from an economic point of view. In 2022, the tourist density in the historical city was 148 per inhabitant compared to 80 in the year 2019. These figures are very high, and show the degree on negative influence of the residents in the historical city who account for only 55,000 and if we take into consideration the metropolitan area they were 258,051 in 2022. However, in full season, Venice receive over 10 million tourists and this means 181 tourists per inhabitant which is too much, in this period not only the residents have a feeling of frustration regarding their rights, but also the visitors in the overcrowded places. The interest for tourism business has led to a concentration of almost all the population to work in tourism, in the detriment of other activities important for the locals. Traditional economic branches are disappearing advantaging tourism. The increased value in real estate led to a sharp decline of the number of residents. The cruise ships have deteriorated the environment quality in the lagoon and contributed to overtourism in the city bringing too many visitors daily. All these have reduced the purchasing power of Venice's inhabitants who are obliged to leave the city.

In 2019, the residents protested against out of control tourism, against the lack or not enough education, health, transport and other social services, and against the "artificialization" and "touristification" of Venice which lost its genuineness.

The local authorities imposed measures to diminish overtourism and its negative effects like: tourist city tax, monitoring the boats traffic in the canals, regulations regarding tourists behavior in St. Mark Square and the violation of these rules could oblige the tourists to pay fines, tips. Also, there were made recommendations for visitors how to respect the city of Venice individuality, its historical buildings, landscape and environment. Also, the access of the visitors was regulated in the city.

The tourist staying longer than one day in the city hotels are obliged to book and pay in advance a lodging tax. Also, the day-trippers who do not book and pay ahead for their visit in Venice are obliged to pay a fine of up to Euro 300.

Also, the tourists coming by cruise ships are obliged to pay a special fee, except the one paid for the cruise company. Children and people with disabilities are exempted from paying this tax [1, 13, 14].

During the carnival in February 2022, Venice received 198,000 tourists and, in 2019, 337,000 tourists, which means a tourist density of 3.88 and, respectively, 6.60 [72].

To prevent overtourism in the future, Italian government established a system of measures in most popular destinations like Venice, Sardinia and Amalfi Coast. If tourists have no accommodation during the night, they have to pay a tax both for adults and children in order to contribute to the funds for maintaining the infrastructure and preserving environment quality. In Venice, tourist must also pay a fine if they want to sit on the bridges and sidewalks. In addition, it is prohibited to swim in the canals [76].

Munchen is an attractive city with its historical background, cultural events and beautiful surroundings of the Bayern region. The Old Town Hall, the Marry Square, the Allianz Arena, BMW World, October Beer Fest, the Nymphenburg Palace, and also the Bayern castles in the proximity are among the most important attractions for tourists [42, p. 104].

In 2022, the tourist density accounted for 4.42 per inhabitant compared to 5.98 in 2019, and these figures confirm that Munich is a city facing overtourism.

But, besides London, Vienna and Berlin, Munich cope very well with overtourism, paying attention to a harmonized relationship between urban planning and tourism sustainable development. From this point of view, a special accent is put on infrastructure, environment and smart city offerings. Also, the guests' routes are oriented more to other attractions than in the historical center and the luxury tourism becomes more promoted in relation to tourist service quality. Limiting the number of hotel beds and regulating apartment rentals are also welcome measures to avoid overtourism [4, 35].

Rome recorded in 2022 a tourist density of 1.35 per resident and in 2019 a higher level 2.43. Apparently the figures are not too high, but knowing the attractions of high interest like: Colosseum, Trevi Fountain, the Pantheon, Saint Peter's Basilica in Vatican City, Spain Square, Venice Square, Navona Square, Roman Forum etc, [42, pp. 123-124]. they are overcrowded by visitors. In October 2018, the residents' associations protested and claimed that "Rome has fallen in a state o decay". The local council issued new regulations like: "bans on eating and drinking in the most tourist-heavy areas of the city, fines to pay for the people who sit on the Spanish steps recently restored, the sale and consumption of alcohol in open public spaces is illegal from 10pm to 7am. Bathing and dipping your feet in the Trevi Fountain, eating and climbing the monument are prohibited. Due to illegal rentals, house and rental prices went up affecting the local population [29].

Prague, the Golden City of Czech Republic and Europe has important places to visit: Charles' Bridge, the Old Town Square, the Astronomic Clock, Charles' Castle, St. Vit Caathedral, the Municipal House, the National Museum of Prague, Vysehrad, St. Nicholas Church in Mala Strana, St.George Church, Lobkowicz Palace [42, p.62].

Prague is also facing overtourism. In 2022, tourist density was 3.49 per resident compared to 5.17 in 2019. Prague is among the top visited cities in Europe, tourism contributing substantially to its receipts. But, Prague is also facing overtourism, due to the accommodation offering via Airbnb, low cost air travel tickets, and social media boom.

The historical center, the narrow streets of the city, the Royal route have become overcrowded in summer season, and also at Christmas market and Easter. The real estate price increased, the airport requires to be extended, infrastructure needs to be restored. The locals have nothing against tourists, but they are unsatisfied by the mismanagement of the local authorities. In consequences, there were taken measures to reorient tourists to other attractions and routes in the city. The city card with an application on the mobile phones offer discounts to tourists and also monitor their movement and behavior. The use of 3D technology could reduce overtourism by advertising less known attractions [8].

In the surroundings of Prague there are many places to visit in the rural areas. Therefore, Rural tourism could be an alternative to diminish overtourism in the cities [5].

Florence, the ex-capital of Italy, a smaller city than Rome, but charming and full of wonderful attractions, among the most important being: The Dome Santa Maria del Fiore, Piazza del Duomo, Baptiserium, Campanila di Giotto, Santa Croce Basilica, Piazza della Signoria, Palazzo Vecchio, Uffizzi Gallery, Piazza della Repubblica, Pitti Palace, Boboli Gardens, Galleria dell Academica, Bargello Museum, Ponte Vechio, Piazzale Michelangelo, Basilica San Miniato etc. [42, p.123].

The city is visited by more and more tourists every year and this creates a high pressure on the about 367,000 inhabitants. As a result, tourist density increased reaching 15.25 visitors per inhabitant in 2022 compared to 13.61 in 2019. However, the huge number of tourists who walk in the street, stay in the long queues at the entrance in the museums, eat on the street and leave wastes, etc. cause damages to the city and affect the life of the residents. The increased rental price has obliged a part of the residents to leave their homes situated in the historical center of Florence and to move in other areas of the city.

The local authorities passed to measures destined to diminish the overcrowding recommending new tourist routes, online bookings, prohibition to consume food in the streets during the day and the violation of these measures involves to pay a huge fine [2, 10, 73].

Vienna, the well known city of the music, is also of a high attractiveness for its historical buildings and cultural places like: Schonbrunn Palace and gardens, The city Hall, the Parliament House, Hofburg Palace, The Art Museum, the Natural History Museum, Albertina Museum, St. Stephen Cathedral, the Opera House, Belvedere Palace, St. Charles Church, Prater, etc. Also, of a high attraction are the Christmas markets, the opera performances, the concerts in the Musikverein, especially the New Year's Concert [42, pp. 40-43].

In 2022, Vienna recorded 2.85 tourists per inhabitant, while in 2019, tourist density accounted for 4.17, which reflects that it is a crowded destination.

To regulate the tourist flow, the Austrian government established new rules because the citizens complained about the overcrowded buses and cruise ships along the Danube River. Tourist are encouraged to visit districts outside of the city center, museums area and St. Stephen cathedral. More than this, mass tourism and day tourism are not encouraged [18, 65].

Dubrovnik, Croatia, is nicknamed "The Queen of the Adriatic Sea" as it has attractions of high interest like: Fort Lovrijenac, the old cathedral, the Rectors' Palace, Sponza Palace, the Franciscan Monastery, Dominican Monastery, Pile Gate, the city walls, Stradun, the Cable Car [42, p.72]. For this reason it is visited by many tourists.

In 2022, it recorded 23.76 tourists per inhabitant compared to 35.12 in the year 2019. For a small population of only 41,000 inhabitants, the city is overcrowded. And in the summer season, it is difficult to accept so many people in the city. Being an UNESCO World Heritage, Dubrovnik authorities were warned by this organization that in the old town not to receive more than 8,000 people a day. The local authorities installed video cameras which count the tourists to limit their number and also for the cruise ships there are imposed a number of hours to stay in Dubrovnik. Also, the number of cruise ships to dock in the harbor was limited and new restaurants are not allowed to be open in the city [11].

Nice, the 2nd important city in France after Paris, registered 14.28 tourist density as usual, if we take into consideration an inbound tourism of 5 million and the small local population of 350,000 inhabitants. The beautiful position on the Cote d'Azur, next to Monaco and Monte Carlo, with its known Promenade des Anglais, lovely beach, luxury hotels, St Nicholas Cathedral, St. Reparate Cathedral, Marc Chagal National Museum, Villa Massena Museum, etc, Nice is a dream destination. Tourists have to pay a city tax and other taxes according to the rules imposed by the authorities.

Tourist density in terms of number of tourists per inhabitant in 2022 versus 2019 is shown in Table 2.

Table 2. Tourist density in the selected European cities facing overtourism in 2022 versus 2019 (Tourist number per inhabitant)

	2019	2022	2022-2019
1.Paris	17.58	19.73	+2.15
2.London	2.28	1.68	-0.6
3.Amsterdam	15.78	12.52	-3.26
4.Barcelona	7.27	6.00	-1.27
5.Madrid	3.47	2.02	-1.45
6.Berlin	3.93	2.80	-1.13
7.Milan	7.75	7.25	-0.50
8.Venice	25.45	27.20	+1.75
9.Munchen	5.97	4.43	-1.54
10.Rome	2.43	1.35	-1.08
11.Prague	5.18	3.47	-1.71
12.Florence	13.62	15.25	+1,63
13.Vienna	16.81	20.30	+3.49
14.Dubrovnik	35.12	23.76	-11.36

Source: Own calculations based on the existing data regarding tourist arrivals and local population.

Of course, these figures reflect the average number of tourists per inhabitant which has an indicative importance. In reality, in the months with a peak of tourists, the density is much higher, being unpleasant both for the resident population and tourists themselves.

Table 3. Tourism density per surface unit in the selected cities compared to local population density in the year 2022 (number of persons/ km^2)

	Population density (No. of inhabitants/ km^2)	Tourist density (No. of tourists/ km^2)
1.Paris	21,157	41,746
2.London	6,069	10,242
3.Amsterdam	5,197	30,093
4.Barcelona	16,272	97,633
5.Madrid	5,460	15,085
6.Berlin	4,005	11,220
7.Milan	7,702	55,018
8.Venice	11,538	1,711,538
9.Munchen	28,322	22,207
10.Rome	3,346	4,529
11.Prague	5,738	20,033
12.Florence	3,588	54,730
13.Vienna	4,724	13,497
14.Dubrovnik	293	6,963
15.Nice	4,867	68,522

Source: Own calculations based on the existing data regarding tourist arrivals, area and population of each city.

Note: For Venice, it was taking into consideration only the area of 5.2 km^2 of the historical center, not for 157 km^2 for the city and suburbs.

The results obtained after making the calculations for tourism density, in terms of number of tourists per km^2, are presented in Table 3, compared to the density of the local population per the same area if each city in the year 2022.

Making the comparison between the two figures, we may easily notice that the number of tourists per square kilometer is much higher against the population density in all these selected cities.

The worst situation is in case of Venice where the tourist density is 148 times higher than the local population. Also, in Dubrovnik, where tourist density is 23.76 times higher than population density. In Nice, the tourist density is 14.28 times higher than the one of the residents per surface unit.

Barcelona has a tourist density of 6 times higher than the one of the residents per square meter. In Amsterdam, tourist density is 5.79 times higher than the population density.

And these are average density figures which do not reflect what happens during the summer season when most of tourists plan their vacations.

European villages and communes facing overtourism

Despite that rural tourism has a small share in total tourism regarding the number of tourist arrivals, there are rural communities of a high attractions where the number of tourists is very high.

There is not an available statistics which to confirm this, except at the local council of each community and the accommodation establishments tourist who are interested to stay more than one day, but using social media tools we may easy identify these beautiful villages and communes on the Europe map.

The examples given below are not exhaustive and there are certainly many others that deserve to be promoted because rural tourism could be an opportunity and good alternative to reduce overtourism in the cities, but not to exaggerate in the rural destinations as well.

In this way, the local residents could promote their history and traditions, local products and obtain an additional income, while tourists to know much better the local culture and customs and enjoy the landscapes, hospitality and unforgetable moments from their excursion.

Cinque Terre, Italy, is the well know area including 5 villages of a rare beauty: Riomaggiore, Manarola, Corniglia, Vernazza and Monterosso, situated in the costal Liguria region of Italy. All villages together have only 4,000 inhabitants, and each locality has his own history and personality, but they have also common features such as the marvelous landscapes, charming beaches, colourful houses, vineyards terraces, traditional gastronomy and wines and hiking opportunities as the villages are surrounded by hills which belong to Cinque Terra National Park, an UNESCO Heritage site. [42, p. 124]. They are visited annually by about 2.5-3 million tourists which reflect that overtourism is a phenomenon even in this small part of Italy. For this reason, the local authorities apply on line ticket reservation and limited the number of tourists to 1.5 million a year. Also, it was introduced a trekking card combined with a train card, as the access in the area is by train. Hikers are distributed on less crowded trails.

Capri-Anacapri, Italy are two small communes situated on Capri island, a high attraction of Italy in the Thyrrhenian Sea, close to Sorrento. Having only 12,300 inhabitants, of which Capri 7,200, they receive annually about 2.3 million tourists. This means a density of 178 tourist per inhabitant, a high figure reflecting overtourism.

Tourists are interested to visit the island, the Belvedere of Tragara, waking through the small lanes, admiring the villas, Augustus Garden, tasting seafood, buying souvenirs, visiting the Villa San Michele, making a cruise from Marina Grande around the island to admire the rocks named "Faraglioni" and to visit the Blue Grotto and Marina Piccola, and to admire the beautiful scenery of the sea. [42, p.125].

However, many of these day-tourists visit the island in 4-5 hours without spending any money, but they deteriorate infrastructure and environment leaving wastes. For this reason, a tax is welcome per tourist a day and also the number of tourists admitted on the island to be monitorized.

Alberobello, Italy, close to Bari, is well known for the so called "Trulli" houses in line, painted in white and with a similar architecture and characterized by the conic and sculpted roofs which has a mystic significance. The tourists visit Sant' Antonio Church, the old Aia Picola, and Rione Monti, the most touristic part of the small village-city, with shops and restaurants. The locality has 10,237 inhabitants, but it is frequently visited by a higher number tourists [19, 42. p.123].

Hallstadt, Austria, also an UNESCO World Heritage, well known for the old salt mines, iron age artifacts, and beautiful mountain scenery. It has a small population of only 780 inhabitants and receive between 10,000 and 30,000 tourists per day. The locality was the 1st example of overtourism in Austria and after long discussions between the local population and authorities, it was decided to limit the number of tour buses per day to 54, meaning by 50% less than before. Also, tourists are allowed to take quickly some pictures and to move more rapidly [19].

Albarracin, Spain is a small village of 1,075 inhabitants and situated in a mountain area, in Aragon province. It is well known for its history and medieval architecture, narrow streets, walls and rocks, which attract the hiking lovers. It is overcrowded by tourists which affect the population life [19].

Giethoorn, Netherlands, is a nice and fairytale village at about one hour drive from Amsterdam. It is nicknamed "The Venice of Netherlands" as it has only canals, no roads. The small islands of the village are connected by 176 bridges and the travel by boat along the canals could offer a beautiful landscape of the old houses with thatched roofs and gardens. About one million tourists visit this charming village a year and for a population of about 2,795 inhabitants means a tourist density of 357 tourists [19].

Oia, Greece, is a small village on Santorini island and has 1,541 inhabitants,. It is characterized by volcanic cliffs, nice white houses, small churches with the roof in blue, windmills, narrow streets, breathtaking views of the blue sea, Amoudi Bay, Londsa Castle, Katharos beach, Naval museum, shops with souvenirs which attract over 2 million tourists per year, which means overtourism and a density of 1,297 tourists per resident. The local authorities limited the number of tourists from 18,000 to 8,000 per day [19].

Tobermory, Scotland, United Kingdom, is a small fishing village, situated on the Ilsa of Mull, a wonderful port, through which tourists could come by a ferry and fishermen go to work. In the village, tourists could visit the archeological sites, admire the painted houses in bright colours, visit the Mull museum, whisky distilleries, brewery, aquarium, the clock tower, and a small theatre, restaurants and shops. The village has only 1,000 inhabitants, but is visited by about 600,000 tourist annually, which means a density of 600 visitors per inhabitant [19].

Ciocanesti, Bucovina, Romania is a commune consisting of two villages Botos and Ciocanesti. Since 2017, the commune is included in the top most colourful European destinations, being ranked the 6th and in 2014 was considered the cultural village of Romania. It has a long history for centuries, the landscapes are marvelous, and due to the beautiful painted and decorated houses with traditional motives is well known in Romania and also abroad. About 600 households are transformed in heritage houses and also it is an ethnographic museum. In the commune, it is a national museum of painted eggs, and there three festivals are organized annually: the Painted eggs, Folk Traditions and Trout festival. The commune is surrounded by beautiful landscapes, where wildlife is at home, and also tourist routes for the hiking lovers [41].

The 1,384 inhabitants are happy to present their village, its achievements, culture and traditions to tourists. Annually more and more tourists visit this nice commune.

Viscri, Brasov, Romania, the well known village from Transilvania, with picturesque sceneries, quiet and charming atmosphere, a real open air museum with nice traditional houses and customs well preserved, with its medieval fortified church and history behind, bed and breakfast peasant hospitality. This is a place beloved by King Charles, who found its origins in Transilvania and like to live for a certain time almost every year in an old peasant house that he bought here in 1996. His Foundation developed programmes to support the locals to restore their houses and the school, to improve the roads and transport and make life more comfortable preserving the old architecture, furniture, decorations, in a word without losing its identity [28].

His population is only 422 inhabitants, but the number of Romanian and foreign tourists who visited it increased year by year being 100 times higher than the number of its residents.

Bran, Brasov, Romania is a village of 1,492 inhabitants, but with a high tourist flow determined by the presence of Bran Castel, dating from the 13th century and which is well known for the fact that Vlad the Impaler, whose nickname was Dracula, lived here for a period of time. Also, because here it was carried out "Dracula" movie by Bram Stocker. Tourists could visit also the Chapel of the Queen Mary of Romania which hosts her heart, take part to local events related to Milk measurement and Sheep slaughter and could practice biking and hiking on the routes which start from Bran to the mountain and hilly surroundings. Local food products and handicrafts could be bought from the local producers. In 2022, the number of tourists who visited Bran village accounted for 720,000, which means a density of 482 tourists per inhabitant [6].

Brasov County is a well know region in tourism and agro-tourism, and here, Sirnea village was the first tourist village in Romania since the '60s.

Many communes and villages have good conditions for accommodation, offer traditional food and local products, the marvelous landscapes absorb a high number of tourists a few times more than the local population [21, 39].

Marginimea Sibiului, ***Sibiu, Romania*** is a complex of 18 small villages situated in the South of Sibiu county and which represent a socio-historical and ethno-cultural space covering about 200 square kilometers and having about 38,517 inhabitants. These villages are: Boita, Tabnacel, Sadu, Raul Sadului, Rasinari, Poplaca, Orlat, Gura Raului, Saliste city with its villages Cacova (Fantanele), Sibiel, Sacel, Vale, Gales, then come Tilisca and Rod village, Poiana Sibiului and Jina [37].

People deals with sheep breeding, and traditions are beloved and well preserved in the local Romanian architecture with German influences, folk suits, dances, music, handicrafts and fests. Among the most important attractions we could mention the Orthodox Church, the Roman United Church, The Romanian Church from Saliste, the wood churches in Poiana Sibiului, Fantanele, Talmaceu, as well as the village museums like in Rasinari and Saliste, the museum of the icons painted on glass in Sibiel and the ethnographic and monachal art museum in Fantanele. Many writers and scientists were born in this area where tourists could visit their memorial houses: the poet Octavian Goga, the philosopher Emil Cioran, the bishop Inocentiu Micu-Klein, historians like Andrei Otetea and Dumitru Rosca and others.

In Marginimea Sibiului there are farms and farmers' markets where visitors could buy local organic products, grace to the local Association of Producers of traditional and organic products which supports the initiative [7]. They could also enjoy various events like: “Culinary traditions in Mărginimea Sibiului”, “Cheese and plum brandy festival”, "Harvest Day" in Rășinari [50, 56, 68].

Also, in the area there are many guesthouses and agro-tourism guest houses where tourist could be accommodated and served with traditional meals [68].

The landscapes are wonderful and invite tourists to ecotourism: hiking, biking, admiring the flora and fauna, and benefiting of movement in fresh air and nature [67, 69] and this was the reason why in 2018, the area was recognized as a destination of "digital detoxification" [6, 12].

This area is frequently both by the local residents of Sibiu city and also from other localities on the occasion of the local traditional fests and markets, and also by foreign tourists, their number increasing year by year and accounting for several ten thousands.

Rasinari, belonging to Marginimea Sibiului, Romania, received in 2022 the title 'Best Tourism Village" offered By UNWTO [32].

Săpânta, Romania, is a commune in the North of Transilvania, in Maramures County. It has 2,903 inhabitants, but is visited by thousands of tourists. In 2022, tourists number accounted for more than 8 times the number of the residents.

This is because is it well known for its attractions: The Merry Cemetery hosting 800 monuments of folk art, with the graved and painted crosses where some lyrics describe the life of the deceased by the master Stan Pătras. Also, in the area there is the Natural Reservation "The Swamp The glade of fir-trees", the Peri-Săpânta Orthodox Monastery, the wood churches of a rare beauty, The Whirpools of Săpânta - constructions made of logs, where the captured river water is used for washing the carpets. From Săpânta, tourists could visit interesting objectives such as: Barsana Monastery, the city of Sighetu-Marmatiei, Borsa mountain resort well-known for its ski slopes and winter sports, Moisei Monument, Bogdan Voda locality, Rohia Monastery and also could enjoy a journey by the Mocanita train on the Vaser Valley and other rural unique experiences, benefiting of the hospitality of the friendly residents who are wonderful artisans and wood sculptors. Local gastronomy consists of delicious meals [3, 63, 64].

In Romania, there are many villages which preserved their identity and traditions, the population is kind, friendly and full of hospitality like in Brasov County [21], Marginimea Sibiului, Sibiu County [7, 34, 70, 71], Transilvania [40], Maramures County [58] and Bucovina region [41].

Ecotourism is also an alternative promoting a healthy form of tourism in the middle of nature and also contributing to the reduction of overtourism in the cities [67, 69].

CONCLUSIONS

This analysis reflected that the main tourist country, city and village destinations are affected more or less by overtourism which besides its positive impact regarding the receipts from tourism which contribute to the development of this sector and also to the GDP and economic growth, has a negative social and environmental impact and also deteriorate life of the local residents.

The causes are complex and to assure a balance between tourist flows and the capacity of the hosts to offer high quality services and hospitality to tourists satisfaction without affecting the local population is a real challenge to which authorities in any country and communities are looking for the best solutions.

The results proved that the density of tourists per inhabitant is very high. Also, in terms of tourists per surface unit, it was a few times number of tourists higher than the number of the residents.

In 2022, the highest charge of tourists per inhabitant was found in all the selected cities, but mainly in: Venice, Dubrovnik, Vienna, Paris, Florence, Amsterdam, Milan and Barcelona.

The overcrowded cities by tourists per square km are: Venice, Barcelona, Nice, Florence, Paris, Amsterdam, Prague, Madrid and Vienna.

The selected villages suffocated by tourists in Europe are: Cinque Terre, Capri-Anacapri, Alberobello, Hallstadt, Giethoorn, Oia, Tibermory, Ciocanesti, Viscri, Bran, Marginimea Sibiului, and Sapanta.

This situation imposes a close cooperation between the destination stakeholders and policy makers serving to the same goal - to diminish the negative effects of over tourism or to reduce tourist flows in some limits in the main tourist attractions and to reorient them to other destinations.

In this context, UNWTO set up a Report on the state of overtourism and established 11 strategies to manage tourism in the local context as follows:

"-Tourists' dispersion among various attractions in the same destination;

-Temporal tourists' dispersion by encouraging off-season travel and visits;

-Intensify the promotion of other tourist attractions and routes;

-Regulations regarding tourism to be effectively respected and applied, and also updated depending on the situation;

-Enlarge the types of activities to better satisfy all the segments of the tourism market;

-Assure balanced benefits from tourism both for the local communities and tourists;

-Diversify tourism activities by developing new beneficial experiences both for tourists and local population;

-Develop infrastructure;

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-Call residents to be involved in solving overtourism problems by taking part to policymaking;
-Make tourists to become more conscious on the impact of tourism on their chosen destination;
-Create and permanently update a data base synthesizing the problems linked to over tourism" [77].

A synthesis of the most applied measures practiced by the local authorities in the destinations selected and studied in this research is given below:
-On line booking for air tickets, accommodation, entry tickets to main attractions;
-Managing the air, road and sea traffic;
- Developing infrastructure and establishing new tourist routs;
-Involving residents in the development of the strategy destined to mitigate the effects of overtourism;
- Implementing a tax system for protecting environment, improving transport services and tourism infrastructure;
-Developing a fine system for the tourists who do not respect the tourism regulation at their destination;
-Extending the alternatives for which all the categories of tourists could apply for being better satisfied.

Overtourism is not a problem only for the local residents and authorities, but it is also a problem for tourists who have to become conscious that tourism requires a special civilized behavior and feeling of admiration and respect for the local hosts, their culture and life.

Tourists are the first who have to become more responsible and pay attention to the following aspects:
- To plan their travels in extra-season, avoiding the months of tourism peaks like July and August;
-To choose sustainable destinations which could bring them full satisfactions from a cultural, health, wellbeing and leisure point of view, being aware that they must help local business and environment;
-To choose less travelled destinations, itineraries or alternatives (regions, routes, localities) where to better enjoy new experiences and save time;
-To collect information in advance about the chosen destination;
-To travel alone or in a small group, and avoid mass tourism, for diminishing the number of tourists per day in a destination;
-To appreciate and respect the local culture and traditions and also to proceed according to the rules imposed by each destination.

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TECHNICAL EXAMINATION AND FUTURE OF APRICOT PRODUCTION IN ISPARTA, TURKIYE

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Abstract

The aim of this study was to examine the technical applications and future expectations of the apricot growing enterprises in Isparta within the framework of their socio-demographic characteristics. The main material of the research was the data obtained by the survey method from 138 apricot farms located in the villages where apricot cultivation is intense in Yalvaç and Senirkent districts in Isparta province. The data obtained belonged to the production season of 2021. The farms used 1.97 hours of machine power, 27.57 hours of family labour and 27.00 hours of foreign labour per decare in apricot production. They applied 8.86 kg nitrogen, 12.92 kg phosphorus and 4.33 kg potassium as pure substance per decare in apricot orchards. There is a tendency for farms to continue apricot cultivation in the research region. In the region, land fragmentation was high and small-scale enterprises were dominant. Therefore, the awareness that natural resources are not unlimited should be increased and measures should be taken to protect soil and water. In addition, producer organization culture should be developed and encouraged. In order to prevent unconscious/wrong choices and practices of the producers, it is considered important to increase and expand the consultancy services provided by the institutions and organizations related to the agricultural sector.

Key words: *apricot, input, problems, future, Isparta*

INTRODUCTION

In terms of production and exports of apricots, Turkey has a significant position. In terms of production and export, it comes in first place worldwide [1][10].

Various economic studies have been carried out on apricot in Turkey. For example, Demirtaş [5] made an economic analysis of apricot in Mersin. Demirtaş and Gül [6] examined the socio-economic characteristics of apricot farms in Mersin province. Dellal and Koç [4] estimated an apricot supply model and a dried apricot export demand model for Turkey to provide unitless measurement coefficients for better supply and marketing management. They calculated the long-run supply, price-yield and export elasticities of dried apricot as 0.72, 0.54 and -0.87, respectively. They calculated the export demand price elasticity of dried apricot as -0.71. Gündoğmuş [12] examined 10 conventional and organic apricot farms in Turkey for production, profitability, producer-defined limitations and objectives, and research interests. Three of the organic farms claimed to have produced as much as or more than their conventional counterparts, but overall, the three-year average output of organic farms was 9% lower. The average variable expenses and net revenue for both groups, when organic certification fees were excluded, were comparable because the farmers' organic price premiums made up for the reduced yields. Olgun and Adanacıoğlu [15] examined the production and marketing of organic dried apricots in Turkey. They also talked about the outcomes of a poll of Malatya's apricot growers. Production of dried apricots in organic form was not common on the farms they examined. The majority of the producers had learned about the manufacture of dried apricots that were produced organically via friends, neighbours, and control and certification organisations. Çukur et al. [3] evaluated the views of apricot producers on risk transfer and the new agricultural insurance law in Malatya

Doğanşehir Polatdere Village. In order to determine the causes of cost inefficiency, Gündüz et al. [13] analyzed the efficiency metrics of dried apricot farms in Turkey's Malatya area. To gauge efficiency, Data Envelopment Analysis (DEA) was performed. The sample farms in the first group had average technical, allocation, and cost efficiencies of, respectively, 0.738, 0.760, and 0.558. These numbers were 0.905, 0.762, and 0.697 in the second group. They found that the level of education of the farm owner and non-agricultural income had a negative effect on cost inefficiency, while tractor ownership, the ratio of apricot land size to farm size, the number of apricot trees and marketing cost variables had a positive effect on cost inefficiency. Uçar and Saner [23] determined whether organic and conventional apricot cultivation is economically viable in Malatya province of Turkey. Data were collected through a questionnaire in Malatya. Organic and conventional apricot investment project values were calculated as profitable. They subjected the two project results to sensitivity analysis and found that the parameters were subject to variability in costs and revenues (20% cost increase, 20% revenue decrease) under various conditions. Gül and Özen [11] investigated the effect of agricultural credit utilisation on socio-economic indicators of apricot producers in Mut district of Mersin province. Özen and Gül [16] reported that a significant portion of the apricot produced in Mut district is utilized in the domestic market and mostly consumed fresh.

The financial viability of investing in apricots in Turkey's Malatya area was examined by Uçar and Engindeniz [22]. In the 2012–2013 crop year, the researchers conducted in-person interviews with 159 farmers in the central, Akçada, and Darende districts of Malatya province. They found that the Net Present Value was positive, the Benefit Cost Ratio was greater than 1 and the Internal Rate of Return was 16%.

Isparta has 0.83% of Turkey's total land area and 0.75% of the agricultural areas cultivated throughout the country. In Isparta, 20% of the total land area is fruit areas. It ranks 31st with a share of 1.26% in plant production in Turkey. Isparta has 1.1% of Turkey's fruit planted areas [20].

Apricot production is developing in Isparta province. This is among the reasons why Isparta province was selected as the research region. However, there are insufficient researches for the province evaluating farm practices in the province on the subject.

In this framework, in this study; (i) production techniques used in apricot cultivation by apricot farms in the research region, (ii) education, age, number of family members, crop production experience of farms, (iii) apricot varieties grown, (iv) inputs used in production, (v) information on the future of apricot cultivation in Isparta province in line with the information obtained from apricot producing farms were aimed to be examined.

MATERIALS AND METHODS

In the study, apricot planting area and production values among the districts of Isparta province were analyzed at the stage of determining the research region. As a result of the examination, Yalvaç and Senirkent districts, which meet more than half of the production in terms of planting area (91%) and production (87%), were determined as the research region. The main material of the study consisted of primary data obtained from apricot producing farms in these districts by face-to-face survey method.

Stratified sampling Neyman method was used to determine the number of farms interviewed and it was found that the number of samples representing the main population was 138 with a margin of error of 5% and 99% confidence interval. A total of 138 apricot farms were surveyed in Aşağıkaşıkaşıkara, Yukarıkaşıkara, Taşevi, Aşağıtırtar, Yukarıtırtar, Kumdanlı villages in Yalvaç district and Gençali and Büyükkabaca villages in Senirkent district. These data belonged to the 2021 production period.

In the Neyman method, since more samples were taken from the stratum with high variance, the arithmetic mean applied in the calculations would not reflect the average of the research area, the coefficient calculation was made for each stratum by proportioning the number of frequencies falling into the farm strata to the total number of frequencies. In the research, the data obtained for each stratum were multiplied by the calculated coefficients and the general farm average value was calculated as the regional average [8] [9].

Apricot farms were divided into three groups. The farms with apricot planting area of 7.50 decares (1 decare equal 0.1 hectare) or less (21 farms) were defined as group I. group, II. group farms had apricot planting area between 7.51-20.00 decares (55 farms). Group III farms were defined as farms with apricot planting area of 20.01 and more decares (62 farms).

The socio-demographic characteristics of the producers, apricot production structure of the farms, input use, problems encountered during the production phase and solution suggestions for the elimination of these problems and the data obtained for the development of apricot production were cross tabulated and analyzed with apricot planted area groups.

RESULTS AND DISCUSSIONS

In line with the information obtained as a result of the interviews, the average age of apricot producers was determined as 55.07 years. The regional average was found to be 56.74 years. The average age of the operators in the first stratum was found to be 60.43 years, the second stratum 54.98 years and the third stratum 53.32 years. The average education level of the producers in the enterprises was found to be 7.71 years. The average agricultural production experience of apricot producers was 25.48 years, while the regional agricultural production experience was 24.57 years. The average experience of the producers in apricot cultivation was found to be 21.28 years. While the average apricot cultivation experience in the region was 19.85 years, it was found to be 17.29 years in the first stratum, 20.91 years in the second stratum and 22.97 years in the third stratum (Table 1).

Demirtaş [5] found that the average age of apricot farmers in Mersin province was 50.00 years and the duration of apricot farming experience was 18.3 years. Fidan [7] calculated the average age of apricot farmers in Iğdır province as 47.58 years and their apricot farming experience as 14.28 years. Sarıbaş [17] calculated the average age of apricot farmers in Malatya province as 46.57 years and their apricot farming experience as 25.58 years. Uçar [21] determined the average age of apricot farmers in Malatya province as 52.36 years, their apricot cultivation experience as 27.67 years and their agricultural experience as 29.57 years. Çatı [2] determined the age of the operators engaged in organic apricot production in Malatya province as 53.05 years.

Of the farms examined, 2.17% had received training on apricot cultivation. While the farms in the first stratum did not receive training on apricot cultivation, 1.82% of the farms in the second stratum and 3.23% of the farms in the third stratum received training. It was determined that the operators received training from district agriculture and forestry directorates, agricultural engineers and public education centre courses.

Of the farms analyzed, 17.39% were engaged in cattle breeding, 5.07% were engaged in small ruminant breeding and 3.62% were engaged in both cattle and small ruminant breeding. It was determined that 73.91% of the farms did not engage in animal husbandry. It was determined that 9.52% of the farms in the first stratum were engaged in animal husbandry, 21.82% of the farms in the second stratum and 35.48% of the farms in the third stratum were engaged in animal husbandry.

It was determined that 21.01% of the farmers had agricultural income outside their farms. The rate of farms having non-agricultural income was 90.48% in the first stratum, 69.09% in the second stratum and 75.81% in the third stratum. 97.10 percent of the farmers had social security. In addition, it was determined that 60.87% of the farmers were retired. According to the planted area width, 76.19% of the farmers in the first stratum, 60.00% in the second stratum and 56.45% in

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the third stratum were retired. Therefore, a large proportion of the non-agricultural income of the farmers was due to this situation.

It was found that 33.33% of the analyzed farms kept records about the operations they performed during the apricot production process. 23.81% of the farms in the first stratum, 23.64% in the second stratum and 45.16% in the third stratum were doing this.

All of the farmers interviewed owned a mobile phone. 16.67 percent of the farmers had computers and 65.22 percent had internet. The rate of computer ownership was 14.29% in the first stratum, 14.55% in the second stratum and 19.35% in the third stratum. The rates of internet ownership were 42.86%, 61.82% and 75.81% in the strata, respectively (Table 1).

While the average number of tractors of the farms analyzed was 0.83, this value was 0.71 in the average of the region. The tractor model became newer as the apricot planted area increased. The average number of spraying machines in the farms was 0.84 while it was 0.74 in the regional average. As the apricot planted area increased, the number of machinery-equipment of the farms also increased. The farm group with the highest number of machinery-equipment was in the third stratum. The use of drone was determined as 0.02 units in the farms in the third stratum.

It was determined that 40.58% of the analyzed farms used agricultural loans. The rate of credit utilization according to planted area width was 28.57% in the first stratum, 36.36% in the second stratum and 48.39% in the third stratum. As the scale of the enterprise increased, the rate of credit utilization also increased. Enterprises obtained credit from public and private banks and Agricultural Credit Cooperatives. Of the farms that used credit, 75% used credit for crop production, 19.64% used credit for special needs, 3.57% for machinery-equipment purchase and 1.79% for animal production.

Demirtaş [5] reported that 30.68 percent of the apricot farms in Mersin province used credit for apricot production. Gül and Özen [11] determined that 32.97% of the surveyed farmers used agricultural credits in Mersin.

The average household size in the surveyed farms is 3.54 persons. The regional average was determined as 3.13 persons. The household size of the first stratum farms was 2.71 persons, 3.20 persons in the second stratum and 4.13 persons in the third stratum. It was determined that the household size increased as a result of the increase in farm size (Table 1).

The average household population of the farms was 47.03 percent female and 52.97 percent male. In the farms analyzed, 3.39% of the average family population was 0-6 years old, 12.13% was 7-14 years old, 43.18% was 15-49 years old and 41.20% was 50 and over.

Demirtaş [5] determined the average population of apricot farms in Mersin province as 5.43 persons. He calculated that the family population varied between 4.70 and 5.82 people according to enterprise groups. Fidan [7] determined the household size of apricot farms in Iğdır province as 4.74 persons and calculated that the average family population varied between 4.40 and 4.97 persons according to enterprise groups. Sarıbaş [17] found it as 4.41 persons in his study conducted in Malatya province.

Table 1. Age, education level and experience of producers in the farms analysed

	I	II	III	FA	RA
Farmers age (year)	60.43	54.98	53.32	55.07	56.74
Farmers education level (year)	7.48	8.18	7.37	7.71	7.84
Household size (head)	2.71	3.20	4.13	3.54	3.13
Experience in agriculture (years)	22.57	25.51	26.44	25.48	24.57
Experience in apricot production (year)	17.29	20.91	22.97	21.28	19.85
Participation in training activities for apricot cultivation (%)	0.00	1.82	3.23	2.17	1.33
Record keeping in apricot growing (%)	23.81	23.64	45.16	33.33	26.19
Non-farm income (%)	90.48	69.09	75.81	75.36	77.51
Off-farms agricultural income (%)	4.76	23.64	24.19	21.01	16.96
Computer ownership (%)	14.29	14.55	19.35	16.67	15.01
Internet ownership (%)	42.86	61.82	75.81	65.22	56.66
Agricultural credit utilisation rate in farms (%)	28.57	36.36	48.39	40.58	34.97

FA: Farm Average, RA: Regional Average
Source: Own calculation.

Household size was found to be lower in the study region compared to the studies conducted in other regions. The reason for this was that the number of households in the 0-6 and 7-14 age groups was quite low. At the same time, the proportion of the age group of 50 years and over was higher compared to other studies.

This situation showed that the young population in agriculture was decreasing.

In the farms, 62.16% of the family population were primary school graduates, 13.11% were secondary school graduates, 14.80% were high school graduates, 2.96% were college graduates and 6.98% were university graduates.

The limited factor in increasing agricultural products is agricultural land. The basic condition for obtaining more yield from unit area and increasing production is the improvement of enterprise structures consisting of very fragmented and small units. For all these, land consolidation is necessary. Thanks to land consolidation, the number of parcels will decrease, the average parcel size will increase, farms will reach a certain economic scale and infrastructure works for farms will be realized [14].

In agricultural production, land is extremely important in terms of agricultural mechanization elements, production, product yield, quality and other elements. In this direction, the number of parcels, average parcel size, irrigation status, land saving patterns and crop patterns of the farms examined were examined.

The average number of parcels of the farms analyzed in the research region was 6.02. The average number of parcels in the region was 4.27. The average number of parcels in the first stratum was 2.43, in the second stratum 4.60 and in the third stratum 8.50. The average parcel size of the farms was 5.65 decares. The average parcel size of the region was 4.58 decares. The average parcel size of the farms in the first stratum was 2.99 decares, 4.36 decares in the second stratum and 6.53 decares in the third stratum. The number of plots and plot size increased with the width of the planted area of the farms.

Demirtaş [5] determined the average number of plots of apricot farms in Mersin province as 3.53 and the average plot size as 13.92 decares. Fidan [7] found that the average number of plots of apricot farms in Iğdır province was 3.49 and the average plot width was 14.53 decares. Uçar [21] calculated the average land width as 52.68 decares, the average number of parcels as 5.79, and the average parcel width as 9.83 decares in Malatya province. Çatı [2] found the average land holding in Malatya province as 57.9 decares.

The average number of parcels in the research area was lower than the number of parcels determined in other studies. This showed that the land in the region was very fragmented.

The average irrigable land of the farms analyzed was 33.99 decares. Irrigable land within the total land was 95.08% in the first stratum farms and 100% in the second and third strata (Table 2).

The irrigation status of the lands in the research region was found to be higher than the other regions.

It was determined that 93.76% of the total land holdings of the farms consisted of owned land. While the proportion of rented land was 1.28%, the proportion of jointly managed land was found to be 4.96%. The farms in the first and second stratum did not have any land held for rent and co-operation, while the third stratum had land held for rent and co-operation depending on the width of the planted area. Due to the scarcity of land in the study area, the rate of renting and co-operative land cultivation remains at a very low level (Table 2).

Demirtaş [5] found that 91.63% of the farms producing apricot in Mersin province consisted of owned land, while the proportion of land operated by renting and co-ownership was very low. Fidan [7] found that 72.78% of the apricot farms in Iğdır province had property land and 27.22% had land operated by renting and co-ownership. Uçar [21] found that in apricot farms producing apricot in Malatya province, there was no land cultivated by renting and sharecropping, and all of the farm land consisted of property land.

When the production pattern of the farms in the research area was analysed, the largest production area within the farm land belonged to apricot gardens with 28.63 decares. Apricot production area was 5.86 decares in the first layer, 15.65 decares in the second layer and 47.85 decares in the third layer. After apricot, the most produced product was apple with 4.94 decares. It was determined that 83.98% of the farm land was apricot production area. Apricot was followed by apple with 14.49%, sugar beet with 1.12%, plum with 0.23% and peach with 0.06%.

The average number of apricot land parcels of the farms examined was determined as 5.25 pieces. The regional average was found as 3.72 parcels. The average number of parcels in the first stratum was 2.19, 3.93 in the second stratum and 7.47 in the third stratum (Table 2).

The average parcel size for apricot planted areas of the enterprises was 5.44 decares. The average parcel size in the region was 4.26 decares. The average parcel size in apricot planted areas was 2.67 decares in the first stratum, 3.96 decares in the second stratum and 6.41 decares in the third stratum. It was observed that there was a positive relationship between the apricot planted area group and the number and size of pieces.

Demirtaş [5] found that the average number of apricot orchard plots of apricot producing farms in Mersin province was 1.49 pieces and its width was 15.19 decares. Fidan [7] calculated the number of apricot garden plots of apricot farms in Iğdır province as 1.13 pieces and the width of the plots as 8.12 decares. Uçar [21] calculated the average apricot area of apricot farms in Malatya province as 26.41 decares. Çatı [2], in his study conducted in Malatya province, determined the average apricot area of farms producing organic apricot as 41.6 decares.

The average number and width of apricot parcels in the research region were generally lower than other studies.

The total land size of the farms analyzed was found to be 28.63 decares. There was no land operated with rent in the interviewed farms. Apricot planted areas cultivated in partnership were 1.73 decares. In the enterprise groups, apricot planted areas cultivated in partnership were found in the farms in the third stratum (Table 2).

In the average of the farms examined, 93.95% of the apricot planted areas consisted of property land. In apricot farming, where there is no land operated with rent, the share of apricot planted areas cultivated by partnership was calculated as 6.04%. It was determined that the share of land cultivated in partnership increased with the increase in the scale of the enterprise. All of the apricot lands of the farms in the first and second strata are property lands. In the farms in the third stratum, 92.15% of the apricot planted areas of the farms in the third stratum were property land and 7.85% were jointly managed land (Table 2).

Apricot production on farms

The average apricot production in apricot farms in the research area was 93,509.09 kg (Table 2).

Apricot yield per decare was determined as 3,266.07 kg. Apricot yield per decare was 2,343.11 kg in the first layer, 2,697.25 kg in the second layer and 3,469.40 kg in the third layer (Table 2).

The average total number of trees was 1,023.67 and the number of fruiting trees was 935.57 trees. The number of fruit bearing trees in the first stratum was 185.67, in the second stratum 454.78 and in the third stratum 1 616.08. The number of trees increased with the width of the planted area (Table 2).

The average yield per tree in the farms was 91.35 kg. The yield per tree was 71.64 kg in the first stratum, 89.07 kg in the second stratum and 92.59 kg in the third stratum (Table 2). The reasons for the different yields per unit area and per tree in the farms examined were climatic conditions (late spring frosts), establishment of apricot orchards in unsuitable areas, differences in rootstock varieties, proportional distribution of apricot varieties in planted areas, presence of new varieties and different tree ages.

Demirtaş [5] determined the average yield per decare of apricot farms in Mersin province as 372 kg and the average yield per tree as 25 kg. Fidan [7] calculated the yield per decare of apricot farms in Iğdır province as 1,281 kg.

Sarıbaş [17] found the average yield per decare of apricot farms in Malatya to be 902 kg. Uçar [21] calculated the total number of trees of apricot farms in Malatya province as 247.45 and the number of apricot trees per decare as 9.37, and determined the average fresh apricot production as 23,168.34 kg, yield per decare as 877.26 kg and yield per tree as 93.63 kg. Çatı [2] calculated the average yield of farms producing organic apricot as 1,281 kg in Malatya province.

The apricot planted area width of the enterprises and the number of apricot trees per unit area differ. The average number of trees per decare in the farms was 35.75. The number of trees per decare was 32.71, 30.28 and 37.47 in the first, second and third stratum, respectively (Table 2).

Table 2. Various characteristics of farms

	I	II	III	FA	RA
Operating land (decares)	7.26	20.07	55.52	34.05	19.59
Property land (%)	100.00	100.00	91.49	93.76	97.21
Irrigated land (%)	95.08	100.00	100.00	99.84	99.35
Number of land parcels (pcs)	2.43	4.60	8.50	6.02	4.27
Share of apricot planted area in total enterprise land (%)	80.66	77.57	86.20	83.98	80.79
Share of apple planted area in total enterprise land (%)	18.03	20.63	12.35	14.49	17.58
Number of apricot parcels (pcs)	2.19	3.93	7.47	5.25	3.72
Apricot area (decare)	5.86	15.65	47.85	28.63	15.87
Total number of apricot trees (pcs)	191.57	474.07	1 793.06	1 023.67	525.54
Number of fruit-bearing apricot trees (number)	185.67	454.78	1 616.08	935.57	492.81
Total apricot production (kg)	13 723.90	42 224.25	166 027.71	93 509.09	46 346.52
Apricot yield (kg per decare)	2 343.11	2 697.25	3 469.40	3 266.07	2 919.53
Apricot yield (kg per tree)	71.64	89.07	92.59	91.35	88.19
Apricot tree number per decare	32.71	30.28	37.47	35.75	33.11

Source: Own calculation.

Demirtaş [5] found that the average number of trees per decare in farms producing apricot in Mersin province was 14.81. Uçar [21] calculated the total number of trees in apricot farms in Malatya province as 247.45 and the number of apricot trees per decare as 9.37. Çatı [2] calculated the average number of trees of farms producing organic apricot as 399.6 trees and the average number of trees per decare as 9-10 trees in Malatya province.

The number of trees per decare in the research area was found to be higher than the number of trees determined in other studies. The number of trees per decare was also found to be different due to different planting intervals.

Apricot varieties and yields grown in farms

Among the apricot varieties grown by the interviewed farms, Şekerpare, Roxana, Aprikoz, Orange Ruby and Alyanak varieties were determined as the most produced varieties. According to the average of the farms, 23.11% of the total apricot area of 28.63 decares was Şekerpare, 21.20% was Roxana, 16.34% Aprikoz, 11.68% Orange Ruby, 11.38% Alyanak, 6.86% Milörd, 3.24% was Memphis varieties (Table 3).

According to the enterprise groups, the share of Şekerpare variety in apricot planted area was 21.95% in the first layer, 21.96% in the second layer and 23.49% in the third layer. Roxsana variety was 27.24% in the first layer, 24.40% in the second layer and 20.02% in the third layer. Aprikoz (shalak) variety had a share of 17.48% in the first layer, 20.68% in the second layer and 15.03% in the third layer. Orange Ruby variety had a share of 11.79% in the first layer, 14.17% in the second layer and 10.95% in the third layer. Alyanak variety had a share of 18.29% in the first layer, 11.97% in the second layer and 10.92% in the third layer. Milörd, which is one of the new varieties and is generally an export product, was the most renewed apricot variety in the third layer with a share of 8.97%. Apricot producers uprooted the old varieties and planted varieties such as Bebeco, Prisya, Oscar, Rubista, Flopria, Farbaly, Bigred and Bolero in order to produce high-yielding and export-oriented varieties instead of the varieties that they could not get the desired yield (Table 3).

Demirtaş [5] found that the apricot varieties grown in farms producing fresh apricots in Mersin province were 32.10% of I. Tokalı, 22.47% of Septic, 15.23% Tyrinthe, 13.14% Tokaloğlu, 11.51% Karacabey, 5.55% Şekerpare. Fidan [7] determined the varieties grown in apricot farms in Iğdır province as Şalak, Tebereze, Ağerik. Sarıbaş [17] determined the apricot varieties of the farms producing apricots in Malatya province as Hacıhaliloğlu, Kabaaşı, Hasanbey, Çataloğlu, Soğancı. Çatı [2] determined the apricot varieties grown by farms producing organic apricots as Hacıhalil, Kabaaşı, Çataloğlu in Malatya province. According to calculations by Özen and Gül (2020), the apricot cultivar "Alyanak" came in top place with 32.27%. With 22.32%, the "Tyrinthe" cultivar came in second, while the "Bebeko" cultivar, with 15.42%, came in third. The "Şekerpare" cultivar had the lowest cultivation rates among the farmers surveyed in the province of Mersin, at 4.15%.

Apricot cultivars grown for table use in the study area were found to be different from the cultivars identified in other studies. In the studies carried out in Malatya region, varieties for drying were generally grown more. It was determined that too many apricot varieties were grown in the research region.

Table 3. Apricot varieties grown in enterprises

Varieties	Strata groups			FA	RA
	I	II	II		
	Proportion (%)				
Şekerpare	21.95	21.96	23.49	23.11	22.49
Roxsana	27.24	24.40	20.02	21.20	23.25
Aprikoz	17.48	20.68	15.03	16.34	18.29
Orange Ruby	11.79	14.17	10.95	11.68	12.74
Alyanak	18.29	11.97	10.92	11.38	12.44
Milörd	0.00	0.58	8.97	6.86	3.43
Memphis	0.00	1.74	3.81	3.24	2.23
Karacabey	0.00	1.51	0.13	0.43	0.83
Bebeco	3.25	0.58	1.31	1.21	1.19
Prisya	0.00	0.58	2.97	2.35	1.34
Oscar	0.00	0.00	0.17	1.01	0.47
Rubista	0.00	0.58	0.57	0.56	0.50
Flopria	0.00	0.70	0.17	0.28	0.42
Farbaly	0.00	0.58	0.10	0.20	0.34
Bigred	0.00	0.00	0.17	0.13	0.06
Bolero	0.00	0.00	0.03	0.03	0.01
Total	100.00	100.00	100.00	100.00	100.00

Source: Own calculation

The total number of trees in apricot orchards in the research area was 1,023.67 and the number of fruit bearing trees was 935.57. Among the apricot varieties which have a large share in production, Şekerpare variety had 180.34 trees out of 205.79 trees, Roxsana variety had 177.51 trees out of 198.53 apricot trees, Aprikoz variety had 122.14 trees out of 122.48 trees, Orange Ruby variety had 121.64 trees out of 136.21 apricot trees, Alyanak variety had 90.44 trees out of 91.31 trees and Milörd variety had 103.78 trees out of 126.25 trees.

The average tree age of Aprikoz (shalak) variety, which is the oldest cultivated variety in the region, was 16.78 years, Alyanak 11.36 years, Şekerpare 10.23 years, Roxsana 9.28 years, Orange Ruby 4.20 years. Since the other apricot varieties were new varieties, the tree ages were quite low.

Çatı [2] determined the average age of the trees grown by farms producing organic apricot as 15.4 years in Malatya province.

The yields obtained from apricot varieties were determined as Alyanak 101.41 kg, Şekerpare 95.76 kg, Aprikoz 87.99 kg, Roxsana 86.82 kg, Orange Ruby 35.73 kg, Bebeco 6.92 kg, Karacabey 4.60 kg, Milörd 1.72 kg per tree. It was thought that high yields would be obtained from other varieties in the following years if the climatic conditions were good. The highest yields were realized in the farms in the third stratum. Alyanak, one of the important varieties, yielded 52.38 kg per tree in the first layer, 71.18 kg in the second layer and 144.84 kg in the third layer.

The yield per tree of Şekerpare variety was 39.48 kg in the first layer, 82.24 kg in the second layer and 126.82 kg in the third layer, while the yield per tree of Aprikoz variety was 42.38 kg in the first layer, 77.33 kg in the second layer and 112.90 kg in the third layer; the yield per tree of Orange Ruby variety was 19.57 kg in the first layer, 31.27 kg in the second layer and 45.16 kg in the third layer.

Demirtaş [5] determined the yield per tree in farms producing apricot in Mersin province as 66 kg for I. Tokalı variety, 56 kg for Septik, 63 kg for Tyrinthe, 59 kg for Tokaloğlu, 61 kg for Karacabey and 59 kg for Şekerpare variety. In order to realise fruit production with the desired quality and yield in fruit growing, it is necessary to pay attention to issues such as the number of trees, rootstock selection and planting spacing.

When the planting spacing of the apricot orchards of the farms examined was analyzed, 27.86% of the orchards were planted with 7 m x 7 m planting spacing, 25.76% with 6 m x 6 m and 14.89% with 5 m x 5 m planting spacing. It was determined that there were many different planting spacing practices in the region. The rate of farms with 4 m x 5 m planting spacing was 4.39%, 5 m x 4 m planting spacing was 3.63%, 5 m x 6 m planting spacing was 3.44% and 6 m x 5 m planting spacing was 3.24%. Other planting spacings were 3.5 m x 3.5 m, 5.5 m x 6 m, 5 m x 7 m, 6.5 m x 6.5 m, 3 m x 5 m, 5.5 m x 5.5 m, 6 m x 7 m, 5 m x 7 m, 8 m x 8 m, 10 m x 10 m, 9 m x 7 m. Since the enterprises did not have sufficient knowledge about planting spacing, they kept the planting spacing too wide during the establishment period. However, in recent years, the producers, whose level of knowledge and awareness has increased, changed the planting method and rootstock of their gardens with wide planting intervals and started to plant more frequently.

Demirtaş [5] found that 58.4% of the apricot farms in Mersin province established gardens with 8 m x 8 m, 23.7% with 7 m x 7 m or more planting spacing. Uçar [21] determined that 43.67% of apricot farms in Malatya province established gardens with 10 m x 10 m, 39.87% with 11 m x 11 m, 5.70% with 8 m x 8 m planting spacing.

In addition to the similarities between the planting spacings in the research region and the planting spacings in other studies, very different planting spacings were found in the research region compared to other regions. Factors such as the structure of the planted tree, soil tillage, pruning, spraying, knowledge of the grower were effective in the difference of planting intervals.

Apricot varieties produced in the region are table varieties. In order to increase product yield and quality, to avoid being affected by adverse climatic conditions, to respond to changing consumer preferences, to facilitate production, maintenance, harvesting and marketing processes, the sapling varieties that apricot producers have recently planted are generally semi-dwarf apricot varieties. Accordingly, there were also newly planted apricot trees in the farms.

Technical applications of farms in apricot cultivation

In the farms examined, tillage in apricot cultivation starts in March-April and continues until October-November. Hoe, plough, crowbar, chisel, disc plough, disc harrow, rotovator were used in tillage.

The average number of tillage in the interviewed farms was 3.23 times, while the regional average was 3.16 times. The farms in the first stratum used tillage 2.86 times, in the second stratum 3.35 times and in the third stratum 3.26 times (Table 4).

Demirtaş [5] found that farms producing apricot in Mersin province cultivated the soil an average of 2.45 times per year.

In the research region, fertilization was carried out in autumn and spring seasons with solid and liquid fertilizers. Nitrogen, phosphorus, potassium and potassium were found to be 8.86 kg, 12.92 kg and 4.33 kg per decare, respectively. Nitrogen, phosphorus and potassium were 248 g, 361 g and 121 g, respectively, per tree. According to the enterprises, nitrogen, phosphorus and potassium use per decare were calculated as 8.75 kg, 11.93 kg and 4.21 kg in the first layer. In the second stratum, nitrogen, phosphorus and potassium use per decare were 8.91 kg, 13.24 kg, 4.87 kg and in the third stratum 8.85 kg, 12.86 kg, 4.18 kg, respectively (Table 4).

Demirtaş [5] found that farms producing apricot in Mersin province used an average of 11.76 kg nitrogen, 10.48 kg phosphorus and 5.12 kg potassium per decare as pure matter. Fidan [7] calculated that an average of 6.15 kg nitrogen and 8.7 kg phosphorus were used per decare as pure matter in Iğdır province. Uçar [21] determined the amount of fertilizer used as pure matter per tree per decare in Malatya province as 0.31 kg nitrogen, 0.19 kg phosphorus and 0.25 kg potassium.

The rate of foliar fertilizer use in the farms examined was found to be 9.17% in the first layer, 30.28% in the second layer and 60.55% in the third layer. As the apricot planted area increased, the rate of foliar fertilizer use increased (Table 4).

In addition to chemical fertilizer, animal manure is also used in the enterprises. Animal manure was used by 40% of the enterprises (Table 4). Some of the enterprises used the manure obtained from the animals they raised and some of them used it by purchasing. The fertiliser they used was sheep and cattle manure.

Demirtaş [5] found that 63% of the farms producing apricot in Mersin province used animal manure. Uçar [21] determined that 22.41 kg of animal manure was used per tree in Malatya province. Çatı [2] determined that farms producing organic apricot in Malatya province use only animal manure due to the breeding system.

The 60.14% of the enterprises had soil analysis. 47.62% of the farms in the first stratum, 56.36% in the second stratum and 67.74% in the third stratum had soil analysis (Table 4).

Demirtaş [5] determined that 13.6% of the apricot farms in Mersin province had soil analyses. However, 86.4% of the farms decided on fertilisation according to personal experience and recommendations without soil analysis. Fidan [7] found the same situation in apricot farms in Iğdır province.

As a result of the interviews with the enterprises, it was determined that the apricot planted areas of the farms were irrigable land and there was no non-irrigable land. It was determined that the enterprises irrigated an average of 9.91 times during the apricot production period. It was determined that the regional average was 9.85 times irrigation. According to the enterprise groups, it was calculated that the farms in the first layer irrigated 9.86 times, in the second layer 9.80 times and in the third layer 10.03 times (Table 4).

Demirtaş [5] found that 48.1% of the farms producing apricot in Mersin province irrigated 8-10 times and 24.6% irrigated more than 8-10 times. Fidan [7] found that apricot farms in Iğdır province irrigated between 5 and 15 times in a production period. Uçar [21] determined the number of irrigations as 6 times in farms producing apricot in Malatya province. The number of irrigations in the research area is similar to the number of irrigations determined in other studies.

In apricot cultivation, drip irrigation, bowl irrigation, pan irrigation and sprinkler irrigation systems can be used. With drip irrigation method; it provides irrigation of large areas with little water where water is scarce. In the irrigation of apricot orchards, 98.55% of the farms used drip irrigation system. 1.45% of the farms prefer furrow irrigation system. All of the farms in the first and third stratum use drip irrigation system. In the second stratum, 96.36% of the farms prefer drip irrigation system and 3.46% prefer furrow irrigation system. Therefore, the majority of the farms use drip irrigation system. This shows that education and extension activities are effective in the research region and the level of awareness of the producers on the correct use of water is quite high.

The most important apricot diseases and pests in the investigated farms are flower monilias (*Monilinia laxa*), fruit monilias (*Monilinia fructigena*), leaf borer/rust (*Wilsonomyces carpophilus*), sapling dipworm (*Capnodis tenebrionis*), black spot, powdery mildew (*Sphaerotheca pannosa*), plum kohl/shell weevil (*Sphaerolecanium prunastri*) Armillaria root rot (*Armillaria mellea*), monkey worm (*Otiorhynchus spp.*), red spider (*Tetrancyhus spp.*), internal worm, rootworm and pig.

It was determined that 15.22% of the farms examined fought against monilia, 14.49% against black spot, 13.04% against leaf borer and monkeyworm, 11.59% against borer, 10.87% against red spider, 7.25% against crustacean, 6.52% against pig, 4.35% against root rot and 3.62% against gumming.

The amount of spraying applied by the farms in the research region against apricot diseases and pests in a production season was found to be 8 on average. Within the apricot planted area width groups, the number of chemical pesticide use in a season varied between 6.24

and 9.26. In the average of the region, 7.12 spraying operations were performed. The farms in the first stratum sprayed 6.24 times, 7.25 times in the second stratum and 9.26 times in the third stratum (Table 4). It was found that there was a parallel increase between apricot planted area width and chemical spraying. In all farms, Bordeaux slurry was applied and fungicides, insecticides and acaricides were used. Spraying started in February and continued until June. According to Özen and Gül [16], agrochemicals were used 4.97 times a year in the region of Mersin to produce apricots.

Pruning is done to ensure that fruit trees form a more uniform and strong crown and remain in the productive age for many years, and to strengthen the trees that have begun to weaken and to obtain yield for a while longer. The farms examined generally start pruning by giving special shape from the age of 3 and do it regularly every year. The pruning process starts when the trees shed their leaves. Pruning is done by using a ladder since the trees are classical trees, which increases the use of labour.

Since not all apricot fruits ripen on the tree at the same time, harvesting is done gradually in apricot gardens. According to the findings obtained from the farms examined, it was determined that 42.75% of the producers decided the harvest time according to colouring, 20.29% according to ripeness, 0.72% according to market conditions and 36.24% by considering all the criteria mentioned above. Harvest time starts in June and continues in September for new varieties.

After the apricot harvest, the collected fruits are made ready for sale in wooden and plastic packages for sale. 87.69% of the enterprises used plastic crates, 2.17% used wooden crates and 10.14% used both types of crates.

It was stated that 95.65% of the farms had product loss during harvesting or transport. The rate of product loss was 95.24% in the first layer, 94.55% in the second layer and 96.77% in the third layer.

It was determined that the average of the producers who responded to the product loss rate as 1% was 26.81%, those who responded as 2% was 34.78%, those who responded as 3% was 23.19%, those who responded as 4% was 3.62% and those who responded as 5% was 5.80%.

In the apricot marketing channels in the research region, 55.07% of the farms sold their products to brokers. The rate of sales through wholesaler+trader channel was 31.16%. The rate of sales to brokers coming from outside the district was found as 13.77%. Due to the short shelf life of apricot, the producer wants to sell apricot as soon as possible. In this case, he/she prefers the most attractive sales method for him/herself.

Demirtaş [5] determined the method of apricot sales in Mersin province as 69.1% of the farms to the trader, 28.4% to the broker and 2.5% to the consumer. Özen and Gül [16] determined that 13.1% of the farms sold apricots to traders, 74.7% to brokers, 5.4% to traders from outside the province and 5.4% to direct consumers in Mersin province. Fidan [7] determined that 56.92% of the apricot sales of apricot producing farms in Iğdır province were to traders, 30.77% to brokers and 12.31% to consumers. Uçar [21] determined that apricot farms producing apricots in Malatya province sold dried apricots to traders by 38.99%, to brokers by 30.19% and to exporters by 30.82%. Çatı [2] found that 6.5% of the organic apricots were sold to traders, 87.5% to exporters and 6.5% to processors in Malatya province.

There was no broker or company to which 97.10% of the farms examined were affiliated. It was determined that 2.90 percent of the farms were affiliated to a broker or a company. The rate of dependence to a broker or firm was 4.76% in the first stratum, 1.82% in the second stratum and 3.23% in the third stratum.

In the farms examined, the producers classified the apricots they produced as first class, export product and industrial apricots and offered them for sale. The producers were making sales by mutual agreement on the amount of the product in the garden, by retail sale or by weighing the total product and making sales by kilo calculation. During the fruiting period, the proportion of sales by

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kabala was 10.87 percent. It was determined that 88.41% of the farms and 0.72% of the farms realized sales by weight and retail sales, respectively. In general, producers preferred to sell apricots by weight.

The enterprises were selling to İstanbul, Ankara, İzmir, Manisa, Bursa and other provinces in the domestic market. As for the foreign market, it was reported that apricots were sold to Russia, Ukraine, Iraq, Turkmenistan and Azerbaijan.

Demirtaş [5], in his study conducted in Mersin province, determined the apricot sales method of the farms as 82.7% kilo and 17.3% kabala sale. Fidan [7] reported that 73.85% of apricot farms in Iğdır province sell apricots by kabala and 26.15% by kilo.

The operators categorized the apricots grown as table apricots in the field and offered them for sale. In the apricot classification of the farms; 57.97% buyer request, 34.06% exporting company request and 7.97% technical staff were effective. Buyer's request was effective 66.67% in the first layer, 54.55% in the second layer and 58.07% in the third layer. The most important factor in the classification stage was determined as buyer's request.

It was stated that 57.25% of the farms examined sold apricots in cash, 32.61% sold some of the apricots on credit and some in cash, 4.35% sold on credit and 5.80% sold according to the conditions. The enterprises made cash sales to a great extent. The rate of cash sales was 57.14% in the first stratum, 65.45% in the second stratum and 50.00% in the third stratum.

Demirtaş [5] determined that 92.6% of the farms in Mersin province sold apricots in cash and 7.4% of the farms sold apricots on credit. Çatı [2] determined that 17.7% of the farms sold organic apricots in cash and 82.3% sold them on credit in Malatya province.

The 2.90 percent of the farms received advance payments from traders. The rate of receiving advance payment from traders was 4.76% in the first stratum, 3.46% in the second stratum and 1.61% in the third stratum. It was determined that the farms obtained information about apricot market from other growers (31.88%), exporter companies (13.77%), media (10.87%), internet (2.17%) and chamber of agriculture and district agricultural directorate (1.45%).

It was determined that the enterprises used machinery for 1.97 hours per decare in apricot production. Family labour force was 27.57 hours per decare and foreign labour force was 27.00 hours per decare. According to the average of the region, machine use per decare was 1.90 hours, family labour use was 32.00 hours and foreign labour use was 26.92 hours (Table 4).

In the farms in the first stratum, machine use was 1.80 hours, family labour use was 41.73 hours and foreign labour use was 31.63 hours. In the second stratum, machine use was 1.86 hours, family labour 34.19 hours, foreign labour 25.51 hours. In the third stratum, machine use was 2.01 hours, family labour 25.07 hours and foreign labour 27.24 hours (Table 4).

Table 4. Technical practices of the farms in apricot cultivation

	I	II	III	FA	RA
Number of tillage	7.26	20.07	55.52	34.05	19.59
N usage per decare (kg)	8.75	8.91	8.85	8.86	8.87
P usage per decare (kg)	11.93	13.24	12.86	12.92	12.93
K usage per decare (kg)	4.21	4.87	4.18	4.33	4.54
N usage per tree (g)	268.00	294.00	236.00	248.00	268.00
P usage per tree (g)	365.00	437.00	343.00	361.00	391.00
K usage per tree (g)	129.00	161.00	112.00	121.00	137.00
Farms having soil analyses (%)	47.62	56.36	67.74	60.14	54.55
Foliar fertilizers usage (%)	66.67	76.74	82.50	78.99	73.81
Manure usage (%)	20.00	30.23	48.75	39.86	28.72
Number of irrigation (times)	9.86	9.80	10.03	9.91	9.85
Number of chemical spraying (times)	6.24	7.25	9.26	8.00	7.12
Family labour used per decare (hour)	46.12	35.22	28.09	33.68	38.29
Foreign labour used per decare (hour)	27.41	25.49	25.00	25.56	26.12
Total labour used per decare (hour)	73.53	60.71	53.09	59.23	64.41
Machinery power used per decare (hour)	1.90	1.84	2.04	1.94	1.89

Source: Own calculation.

Demirtaş [5] found that apricot farms in Mersin province used 49.20 hours of labour and 6.01 hours of traction power per decare in apricot production. According to Özen and Gül's [16] estimation, 37.20 hours of labour were required for the apricot production in Mersin. Using data from 1998, Demirtaş and Gül [6] estimated that 49.20 hours of labour were used per decare in the province of Mersin. Fidan [7] estimated that 33.85 hours of labour and 2.80 hours of machinery power were used per decare in apricot production in Iğdır province.

The Future of Apricot in the Enterprises Investigated in the Research Area

Among the farms in the study region, 49.28% of the farms learnt apricot cultivation from their families, 48.55% learnt it on their own and 2.17% learnt it through education. Apricot cultivation, which started in 1989 and continues today, has been one of the important sources of livelihood in the study region.

The 47.83% of the farms preferred apricot cultivation because it is suitable for the climate of the region. Apricot cultivation was preferred by 18.12% of the farms due to having a job, 14.49% due to providing additional income, 8.70% due to the low cost of apricot production, 6.52% due to being a family cultivation, 4.35% due to the good return. The fact that the climate of the region was suitable for apricot cultivation was the leading factor for the farms to cultivate apricot.

The majority of the farms (99.28%) were engaged in classical apricot cultivation. It was determined that the enterprises were not dependent on any person or company in contracted production in apricot cultivation.

A very low proportion (0.72%) of the enterprises reported that they had private consultants for apricot orchard maintenance, disease and pest control. While the farms in the first and second stratum did not have a private consultant, the farms in the third stratum had a private consultant.

The 2.17% of the farms had organic product certificate in apricot cultivation. As the scale of the enterprise increased, the rate of organic product certificate ownership increased.

The 93.48% of the farms examined stated that they were satisfied with apricot cultivation, 3.62% were very satisfied, 1.45% were not satisfied, 0.72% were moderately or not satisfied at all. It was determined that the satisfaction level of the farms increased as the planted area increased.

Apricot and apple production are the most important agricultural production branches in the region. When farmers were asked about the most profitable production branch, 99.28% of the farms reported apricot cultivation and 0.72% reported apple cultivation. 30.43% of the farms stated that apricot production is more profitable due to its high return, 21.01% due to the short harvest period, 18.84% due to the high yield, 15.94% due to the lower cost compared to apple production cost, and 13.77% due to the different yield periods of the varieties.

The geographical conditions and climate of Isparta province enable the cultivation of more than one fruit. Some farms have started to establish apricot gardens instead of apple gardens due to the reasons such as lower input costs in apricot production compared to apple cultivation, shorter harvest time, better price compared to apples, and receiving the product price in a shorter time.

The farms in the research region stated that the most suitable apricot variety for cultivation in their region is Şekerpare (42.03%). Other apricot varieties are Roxsana, Aprikoz (shalak), Orange Ruby, Alyanak and Oscar.

While 78.99% of the farms are satisfied with the apricot variety they grow, 9.42% are not satisfied and 11.59% are partially satisfied. It was determined that 66.67% of the farms in the first layer, 81.82% of the farms in the second layer and 80.65% of the farms in the third layer were satisfied with the apricot variety they grew. The farms that were partially satisfied and dissatisfied with the apricot varieties they cultivated stated that they would change the apricot varieties in general.

It was determined that 11.59% of the farms examined had agricultural insurance for apricot. According to the planted area width, 4.76% of the farms in the first stratum, 5.45% in the second stratum and 19.35% in the third stratum had agricultural insurance. It was found that the rate of farms having agricultural insurance for apricot increased as the scale of the enterprise increased.

The reasons for not having agricultural insurance were deemed unnecessary, distrust in experts, high fees and small size of planted land.

Weaknesses and strengths of enterprises

The 18.84% of the farms stated that there is no market in their region, 18.12% stated that there is insufficient government support, 13.77% stated that there is lack of information in cultivation, 13.04% stated that there is no processing facilities, 12.32% stated that there is lack of storage system, 11.59% stated that there is insufficient consultant services, 9.42% stated that producers cannot determine the price, 2.90% stated that there is no co-operation as the weaknesses of apricot production. According to Şirikçi and Gül [18], the use of agricultural subsidies by farmers has a beneficial impact on the profitability indices of fruit production.

Farms stated that they could not receive sufficient counselling services from provincial/district directorates. For this reason, it was stated that the information deficiencies in apricot cultivation were not eliminated. The fact that apricot prices are determined by buyers, brokers, traders and exporters rather than producers, lack of cooperatives, inability to store the harvested product, lack of processing facilities and loss of product were identified as weaknesses in apricot production.

The 21.02% of the farms stated that the climate is suitable, 18.12% stated that the land conditions are suitable, 15.94% stated that the soil is fertile, 13.04% stated that apricot cultivation is easier than apple cultivation, which is another product grown significantly in the region, 10.87% stated that the yield is high and the production period is suitable for sale, 10.14% stated that it prevents rural-urban migration as the strengths of apricot production in the region.

The climate, soil structure and land condition of the region where the farms are located are very suitable for apricot cultivation. These favourable features provide high yields in production if frost does not occur and other conditions are met. The fact that the young population makes a living with apricot cultivation prevents migration from rural to urban areas and reduces the demand for foreign labour to a certain extent.

Opportunities and threats foreseen by the enterprises

Of the farms examined, 26.09% of the farms expressed the following criteria as the opportunities they foresee in apricot production in the region: 26.09% for new business opportunities, 24.64% for branding, 21.01% for having a say in exports, 14.49% for increasing the local market share, 13.77% for increasing the promotion of the region. The enterprises thought that apricot cultivation could provide job opportunities in areas such as processing, storage, packaging, case production, sapling cultivation. Increasing the market share through branding in foreign and domestic markets and increasing the promotion of the region with the sales made were among the foreseen opportunities.

Late spring frosts (29.71%), diseases and pests (27.54%), irrigation shortage (17.39%), drought (17.39%), decrease in apricot price (11.59%), failure of new varieties (8.70%), decrease in yield (5.07%) were the threats foreseen by the farms in apricot production.

Apricot price varies according to the supply-demand situation. Although apricot prices have been at or close to the level desired by the producers for the last few years, apricot production will be adversely affected in case of a decrease in prices. Producers see it as a threat that the new varieties they offer to the domestic and foreign market are not preferred. Late spring frosts, diseases and pests, irrigation shortage and the possibility of a decrease in yield due to drought are perceived as other threat factors.

The thoughts of the enterprises about the future in apricot cultivation

The 2.17% of the apricot farms stated that they would completely quit apricot cultivation in the future, 1.45% stated that they would reduce the planted area, 32.61% stated that they would not change it and 63.77% stated that they would expand their planted areas. The farms that thought that they would give up completely were 4.76 percent in the first stratum and 3.64 percent in the second stratum. In the third stratum, there is no idea of quitting apricot cultivation. It was determined that the rate of giving up cultivation decreased as the scale of the enterprise increased. There were no farms in the first stratum, 1.82% in the second stratum and 1.61% in the third stratum. The rate of those who thought that they would not change was 52.38% in the first stratum, 36.36% in the second stratum and 22.58% in the third stratum. The tendency to increase was 42.86% in the first layer, 58.18% in the second layer and 75.81% in the third layer. It was determined that the number of farms willing to expand the planted area increased as the scale of the enterprise increased.

The 47.83% of the farms tend to change the rootstock used in apricot cultivation. It was determined that 23.81% of the farms in the first layer tended to change the rootstock used in apricot cultivation, 40.00% of the farms in the second layer and 62.90% of the farms in the third layer tended to change the rootstock used in apricot cultivation. It was determined that the idea of changing the rootstock increased as the scale of the enterprise increased.

The 66.67% of the farms tended to make changes in the apricot varieties they had already grown. 33.33% of the farms in the first stratum tended to change the apricot varieties they had already grown, 56.36% of the farms in the second stratum and 87.10% of the farms in the third stratum tended to change the apricot varieties they had already grown. It was found that the idea of changing varieties increased as the scale of the enterprise increased. The enterprises were in search of growing apricot varieties that were less affected by late spring frosts, had high yields and had good yields instead of trees with low yield levels or trees that had completed their economic life.

The idea of making changes in marketing was investigated in the analyzed farms. 78.99% of the enterprises stated that they would like to sell their products to the market in case of the establishment of a market. The thought of the enterprises to sell their products to the market was determined as 80.95% in the first layer, 74.55% in the second layer and 82.26% in the third layer. The rate of farms that answered that they would sell according to market conditions was 21.01%. Among the farms, 19.05% of those in the first stratum, 25.45% of those in the second stratum and 17.74% of those in the third stratum stated that they would sell according to market conditions. In quince farming, Şirikçi and Gül [19] discovered a favourable correlation between relative profitability and the marketing structure variable. The same condition, it might be said, applies to the production of apricots.

The 7.25% of the farms have a tendency to change the apricot production technique. In the first stratum, there are no farms with a tendency to change apricot production technique. In the second stratum, 3.64% of the farms and 12.90% of the farms in the third stratum had the tendency to change the apricot production technique. It was observed that the tendency to change the production technique increased as the scale of the enterprise increased. Those who wanted to change the production technique stated that they wanted to grow apricots with modern or organic production technique.

16.67% of the farms analyzed had the tendency to make changes in the irrigation system. The tendency to change the irrigation system was 4.76% in the first stratum, 14.55% in the second stratum and 22.58% in the third stratum. It was determined that the thought of making changes in the irrigation system increased as the planted area width increased. The farms that wanted to make changes in the irrigation system were in favour of irrigation by drilling.

The 76.09% of the farms stated that they would make changes in the fertilization applied in apricot cultivation according to the fertilizer prices and the guidance of the drug dealer. On the other hand, 23.91% of the farms stated that even if the fertilizer prices increased, they would continue the fertilization process by considering their own knowledge and experience in order to avoid a decrease in product yield and quality.

The 82.61% of the analyzed farms stated that they would make changes in spraying according to the prices of pesticides, the guidance of the pesticide dealer and the condition of diseases and pests.

The idea of the farms to make changes in labour use was also investigated. 10.14% of the farms stated that they would not change the use of labour and 89.86% stated that they might change. It was stated that foreign labour would be needed depending on the increase in yield. As the scale of the enterprise increased, the idea of not making changes decreased. The opinion of making changes in the use of labour force was determined as 66.67% in the first stratum, 87.27% in the second stratum and 95.16% in the third stratum. As the scale of the enterprise increased, the idea of making changes in labour force also increased. Enterprises have to make use of foreign labour force in case of an increase in product yield depending on the size of the planted area.

The 17.39% of the analyzed farms have the idea of making changes in machinery-equipment. The farms that want to make changes in the machinery-equipment assets are considering to have tractors, spraying machines and other agricultural mechanization tools or to renew them within the possibility.

In general, it was determined that the producers will continue apricot cultivation. It was determined that 63.77% of the producers would expand. In the apricot varieties that the enterprises have already grown, 66.67% of the producers think of changing the variety. It was determined that 78.99% of the farms were planning to make changes in the marketing phase. 47.83% of apricot growers have the idea of changing rootstock. The majority of the producers (92.75%) do not think to change the production technique. 16.67% of the farms have the idea of making changes in irrigation system. According to the findings obtained, 76.09% of the farms stated that they would make changes in fertilization according to fertilizer prices and the guidance of the drug dealer. 82.61% of the farms stated that they would make changes in spraying according to the prices of pesticides, the guidance of the pesticide dealer and the condition of diseases and pests. 17.39% of the farms would not make changes in spraying. It was found that 10.14% of the enterprises would not make changes in the labour force and 89.86% would make changes.

Isparta province ranked eighth in apricot production in Turkey in 2020 and ranked fifth in 2021 with the increase in yield and production. In the light of all the findings obtained, it was determined that apricot yield increased in the research region. It was determined that producers will expand in the coming years and there will be an increase in production and yield. The fact that the enterprises prefer drip irrigation method shows that their level of awareness is high and reflects that they will show the necessary importance and sensitivity to water use in order to avoid problems in production in the coming years. Eliminating the lack of counselling services in the region will prevent wrong practices in production.

Table 5. Farms' views on the future of apricot cultivation

	I	II	III	FA	RA
Proportion of farms to increase apricot cultivation area (%)	42.86	58.18	75.81	63.77	54.74
Proportion of farms to reduce apricot cultivation area (%)	4.76	3.64	0.00	2.17	3.62
Proportion of farms that will reduce apricot cultivation (%)	0.00	1.82	1.61	1.45	1.15
Farms considering to change rootstock in apricots (%)	23.81	40.00	62.90	47.83	36.86
Those who have the idea of changing the apricot variety of the farms (%)	33.33	56.36	87.10	66.67	51.68
Those who have the idea of making changes in the apricot production technique of the farms (%)	0.00	3.64	12.90	7.25	3.41
Those who have the idea of making changes in the irrigation system of the farms (%)	4.76	14.55	22.58	16.67	11.98
The farms' intention to make changes in machinery-equipment assets (%)	33.33	18.18	11.29	17.39	22.80
Farms' intention to change labour use (%)	66.67	87.27	95.16	89.86	80.82

Source: Own calculation.

CONCLUSIONS

In this study, some social indicators and technical practices of apricot cultivation in Isparta province were evaluated. In addition, farmers' predictions about apricot cultivation in the future periods were determined.

In the research area, there is a tendency of farms to continue apricot cultivation. As a matter of fact, it was determined that 63.77% of the farms would expand their apricot planted areas. There may be future changes in apricot varieties and rootstocks. In terms of the development of apricot cultivation in the region, the fact that most of the farms prefer to produce late or early varieties will create a surplus in apricot supply. In cases such as low seasonal demand and shortage of sales, it will cause the producer to sell the product at very low prices. Therefore, the fact that the producers in the research region do not concentrate on a certain variety will prevent the negativity that may be experienced in the future. In the region, land fragmentation was high and small scale was dominant. The awareness that natural resources are not unlimited in the region should be increased and measures should be taken to protect the soil and water. The fact that the farms preferred drip irrigation method showed that their level of awareness was high. On the other hand, it was observed that climate changes have been effective in the region especially in recent years. At this point, more sensitivity should be shown to the use of water in order to avoid problems in apricot production in the coming years.

Fruit cultivation is an agricultural endeavour covering long years. The selection of the place where the orchard will be established, the procedures in the establishment process, production and marketing process are very important. In order to increase the efficiency of fertilization in apricot cultivation, soil analysis should be given enough importance. For this reason, producers should have sufficient knowledge about the factors that are effective in the production cycle such as choosing the place where the garden will be established, the rootstocks to be used, the apricot variety to be grown, the control of diseases and pests, soil tillage, pruning, irrigation, harvesting, spraying and fertilization. In order to prevent producers from making wrong choices and practices, consultancy services should be increased and extended by institutions and organizations related to the agricultural sector. In addition, apricot producers should be encouraged to organize themselves in order to be more effective in the price formation and sales of their products.

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THE STUDY OF EROSION PROCESSES IN THE HILLY AREA OF BUZĂU COUNTY (ROMANIA) IN THE SPECIFIC CLIMATIC CONDITIONS OF YEAR 2022

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Abstract

The research was carried out in 2022 in the Valea with Drum hydrographic basin, located on the Buzău county, in the area of Aldeni - Romania. The Station for the Study of Soil Erosion, established in 1971, operates in this perimeter. Starting from the fact that the intensity of the erosion phenomenon is determined by: precipitation, the slope and length of the slopes, the degree of erodibility of the soil and the agricultural practices used, research in the field of erosion has become very important in this area. The research carried out within this stationary follows a complex range of processes such as: quantifying runoff and erosion processes on sloping land produced by torrential rains, the influence of crops and cultivation technologies on erosion processes, on the Chernozem subtype argic. The main objectives of this study were to present and interpret the data regarding the annual rainfall regime and the vegetation period, the study of the rains that produced runoff and erosion, respectively the surface runoff determined by these rains and the annual amount of soil washed from the plots control, differentially cultivated. The analysis of the experimental results shows that the year 2022 was dry, the recorded temperatures exceeded 22.6 ^{0}C in the May-September period, out of 46 rains recorded at the station during the summer period, 60.9 % were less than 5 mm. Quantitative and qualitative study of the erosion process allowed the assessment of the amount of material washed from the soil surface (this being 26 t ha^{-1} on a 15% slope and 28.1 t ha^{-1} on a 20 % slope recorded in uncultivated plots) by the runoff produced by the rains that fell during the summer.

Key words: *watershed, chernozem, erosivity, slope, turbidity*

INTRODUCTION

The phenomenon of erosion, as a natural process, has occurred since the emergence of land and continues to occur, being one of the main shaping agents of the earth's crust. The deleterious influence of accelerated soil erosion on agricultural societies was recognized by Plato and Aristotle, and several classical studies attributed the bare rocky slopes of the classical world to ancient soil erosion [1].
Degraded soil means less food. As a result of soil degradation, an estimated 11.9–13.4% of global agricultural capacity has been lost over the past five decades [8]. Knowing the particularities of the erosion process, the consequences on soil degradation and the reduction of agricultural productivity, as well as the rational use of sloping soils, determined the intensification and expansion of extensive research in the field [2].
Globally, soil erosion has been addressed as one of the most destructive processes of soil degradation. It was found that almost 12% of the European territory (115 million hectares) is subject to erosion, while the impact of erosion in terms of financial cost has been calculated at several billion euros [3].
The rate of water erosion on a mollisol in China was 1.24–2.41 mm/year, and soil loss in farmland with 1°, 5°, and 15° slopes was 3 t/ha/year, 78 t/ha/year and 220.5 t/ha/year respectively [9]. The loss of soil from a landscape located on a slope through erosion depends to a great extent on the intensity and duration of the precipitation that occurs in that place. The detachment force of raindrops striking the land surface and its contribution

to runoff is primarily responsible for soil loss through rain or subsequent water erosion [11].

Recent studies [14] have shown that human activities and climate change are increasing the risk of soil erosion worldwide and that global Environmental Science &Policy services are facing serious challenges.

Montgomery (2007), looks like geological erosion rates increase from gently sloping lowland landscapes on continents (from <10−4 to 0.01 mm/year), to steep hills (from 0.001 to 1 mm/year) and on steep alpine ridges they reach values between 0.1 and >10 mm /year [10].

Soil and water conservation practices are widely used to prevent erosion and protect soil and water resources, which is significant for ecological restoration and food security [4].

In general, decreasing tillage depth and plowing along contour lines substantially reduce soil erosion rates and can be considered effective soil conservation strategies. The erosivities caused by agricultural machinery, characterized by the soil transport coefficient, are very consistent and vary between 400–800 kg $m^{-1}year^{-1}$ for mechanized agriculture and 70–260 kg $m^{-1}year^{-1}$ for non-mechanized agriculture [19].

The result of soil erosion estimation is affected by several factors such as climate, vegetation and human activities that can cause fluctuations in water erosion. Therefore, changes in soil erosion allow the establishment of thresholds, which are based on the standard for classification and grading of soil erosion. According to a study, the levels of soil water erosion in China are divided according to the following thresholds. For Water Erosion <200 t x km^{-2} x a^{-1} we find the level 1 classification, between 200 – 2,500 t x km^{-2} x a^{-1} we have level 2, between 2,500 – 5,000 t x km^{-2} x a^{-1} we have level 3, between 5,000 – 8,000 t x km^{-2} x a^{-1} we have level 4, and at >15,000 t x km^{-2} x a^{-1}, water erosion is the strongest, being classified at level 6 [8].

In the Soil Thematic Strategy (COM (2006) 231) of the European Commission, the EU Biodiversity Strategy for 2030 within the European Green Pact has as objectives: erosion reduction; restoration of degraded soils; protecting soil fertility; increasing soil organic matter; defining what constitutes "good ecological status" for soil. The basis of this strategy was the data obtained from the studies conducted and centralized at the EU level. Thus, the share of soil losses (as a general average): erosion E (t h^{-1} $year^{-1}$) is 7.43 in Slovenia, 7.9 in Austria, 8.46 in Italy, 6.0 in Malta, 4.13 in Greece, 2.84 in Romania, 1.25 in Germany, 0.31 in Poland, 0.5 in Denmark, 0.06 in Finland, etc. [17].

In Romania, out of a total agricultural area of 14.8 million ha, over 6 million ha are located on land with a slope greater than 5 %, being affected by various degradation processes through erosion and landslides. The total annual soil loss in the entire country is about 126 million tons of eroded solid material, with an average of 16.3 t ha^{-1} [6].

The zonal distribution of erosion on the territory of our country is differentiated, the highest values of this damaging process are those in the area of the Subcarpathians of Curvature, in the Moldavian Plateau and in Transylvania, Thus, in the Hilly area of Buzau county, the specific erosion has a value of 41.5 t ha^{-1} $year^{-1}$ against the allowed specific erosion value of 3-6 t ha^{-1} $year^{-1}$ [12].

In this context, the aim of the paper is to present the negative effects of the climatic features of the year 2022 on soil erosion and the productivity of agricultural ecosystems in the hilly area of Buzău [15].

MATERIALS AND METHODS

Study Area

The agricultural lands located on the slope in the hilly area of Buzău county are susceptible to degradation through the erosion produced by the torrential rains that fell in the area, the intensity and pace of manifestation depending on the climate conditions. The research undertaken in 2022 was carried out in the Valea with Drum hydrographic basin, located on the left slope of Slănicu de Buzău in the area of Aldeni, at the Soil Erosion Study Station, with an area of 840 m^2.

The station for the Soil Erosion Study is located on the left side of the Valea with Drum hydrographic basin, with geographical coordinates 45°19'38'N and 26°44'15'E.

The researched area falls into the continental climate sector, with an average annual temperature of 10.5 ^{0}C and an average precipitation of 512 mm. As for the wind regime, Crivățul (from the northeast) predominates, followed by those from the southwest [16]. From a geological point of view, the formations encountered in this region belong to the Paleo-Neogene period, the predominant ones being the Neogene deposits made up of conglomerates, sandstones, gypsum and clay deposits.

In the Sarmatian, limestones, marls, sandstones and conglomerates were formed, and in the Quaternary, clays and loessoid deposits were formed [18]. The Valea with Drum hydrographic basin (HB) has an area of 83.87 ha, with a length of 1,375 m, the density of the hydrographic network of 4.63 km/km^2, the length of the left slope of 375 m, and of the right slope of 450 m, the hydrographic basin being strongly elongated [13].

Soil study

The environmental factors specific to the hydrographic basin led to the formation of a soil cover made up of: Chernozem subtype argic in the stationary area, Phaeozom subtype pelic on the right slope and Antrosol subtype argic in the upper third of the watershed [7].

Morphological description of the chernozem argic profile

Horizon Am (0-20 cm). Clay, color 10YR 2/2 when wet and 10 YR when dry, soft, moderately developed glomerular structure, friable when wet, moderately plastic, adhesive and compact, frequent cervotocins and larval nests, frequent thin root, straight net passage.

Horizon A/B (20-30 cm). Clay, color 10YR 2/3 in the wet state and 10YR 4/3 in the dry state, moderately developed columnoid-prismatic structure, discontinuous clay films, moderately cohesive, moderately plastic, adhesive and compact, rare cracks, straight transition.

Horizon Bt$_1$ (30-67 cm). Clay, color 10YR 3/3 wet and 10YR 4/4 dry, soft, columnoid-prismatic structure, continuous clay films, hard wet, hard dry, plastic adhesive and compact, frequent fine cracks, straight transition.

Horizon Bt$_2$ (67-120 cm). Clay loam, color 10YR 3/4 wet and 10YR 4/6 dry, soft, columnoid-prismatic structure well developed, continuous clay films, hard dry, plastic, adhesive and compact, straight gradation.

Cni horizon (>120cm). Clay loam, color 10YR 4/4 in the wet state and 10YR 6/6 in the dry state, unstructured, hard in the wet state, hard in the dry state, plastic, adhesive and compact, discontinuous ferric clay laminae are found.

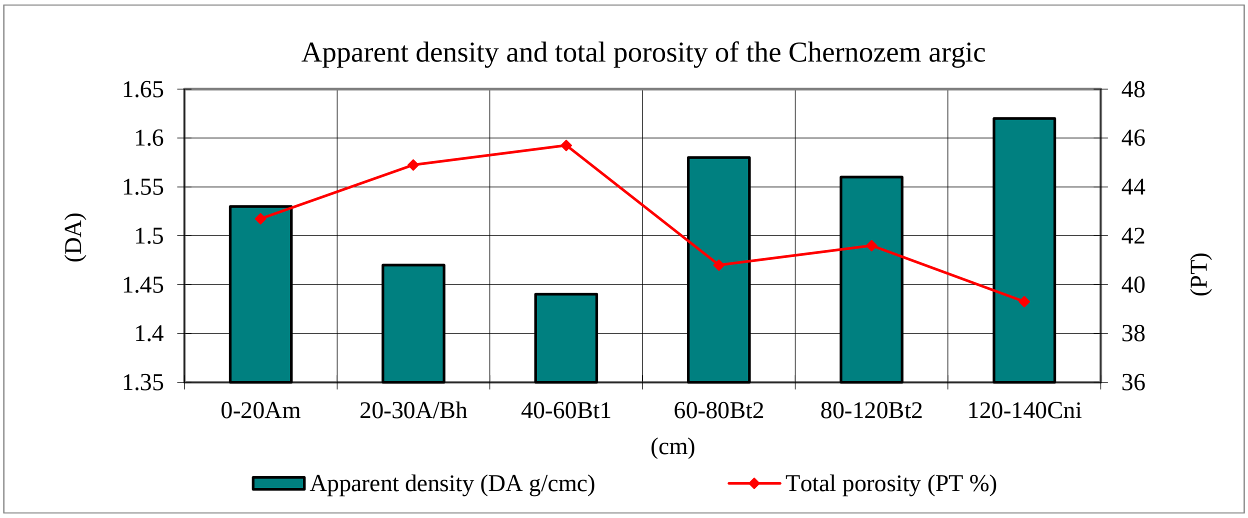

Fig. 1. The aparent density and total porosity values to Chernozem argic
Source: own research.

Deep very strongly argic subtype chernozem, moderately water-eroded, on clay shales, medium loam/medium clay loam, on arable and belongs to the class Chernisols. It occupies an area of 27 ha on the right side of the Valea with Drum hydrographic basin where the Station for the Study of Soil Erosion is located, whose operation scheme is presented in point 2.3.

The ratio between the total porosity and the apparent density (Figure 1) highlights a moderate subsidence in the upper part and a strong subsidence starting from 60 cm, corresponding to the argic horizon [15]. The factors with a determining role in triggering or intensifying the erosion process are: climate, soil, relief, vegetation and applied technology.

Experimental scheme

The 840 m^2 area of this Soil Erosion Study Station is divided into 12 plots for erosion control, of which 6 plots (4 x 25 m) on a 20 % slope and 6 plots (4 x 10 m) on a 15% slope (Photo 1) [20].

To highlight the role of agricultural crops in reducing runoff and erosion, in 2022, the control plots located on the terrane with a slope of 15 % and 20 % were cultivated as follows:

V1 - maize,
V2 – sugar beet,
V3 - cultivated sugar beet in strips,
V4 – uncultivated land,
V5 – alfalfa,
V6 – wheat.

The plots are equipped downstream with capture devices in order to determine the volume of runoff and soil loss recorded after each rain event. After each runoff rain, the volume of the water + soil mixture collected at each runoff collection facility was determined.

To determine the amount of washed soil, from the well-homogenized mixture collected in the facility, samples of one liter are taken, in three repetitions, which are dried and weighed for quantitative determinations [22].

Methods of estimating erosion

Estimation of surface erosion is done by indirect and direct methods.

V3 - cultivated sugar beet in strips,
V4 – uncultivated land,
V5 – alfalfa,
V6 – wheat.

The plots are equipped downstream with capture devices in order to determine the volume of runoff and soil loss recorded after each rain event. After each runoff rain, the volume of the water + soil mixture collected at each runoff collection facility was determined.

To determine the amount of washed soil, from the well-homogenized mixture collected in the facility, samples of one liter are taken, in three repetitions, which are dried and weighed for quantitative determinations.

Photo 1. Plots for erosion control. The Aldeni-Buzău Soil Erosion Study Station, Data, 2023 [20].
Source: original photo.

Estimation of surface erosion is done by indirect and direct methods.

(a) Indirect methods are used in the quantitative assessment of erosion by different models for estimating the amount of soil washed away annually by torrential rains. Such a model was adapted for the conditions of Romania through the universal erosion formula [12].

$E = Ka \times S \times L^m \times I^n \times C \times Cs$ (t $ha^{-1} year^{-1}$)……………………………………….(1)

where:

E-refers to the average surface erosion; Ka-coefficient of climatic aggressiveness determined according to rain erosivity and the amount of washed soil from the standard plot; L^m- the correction coefficient according to the runoff length measured in the direction of the greatest slope; I^n-correction coefficient according to the slope of the land in the drainage direction; S-correction coefficient for soil erodibility; C-correction coefficient for crop uses and structure; Cs = correction coefficient for soil erosion control measures and works ;m and n represent the constants, which for Romanian conditions have values of: m = 0.3 and n = 1.5

The allowed erosion for chernozem-argic soil and arable use is 6 - 8 t ha^{-1} $year^{-1}$.

(b) Direct methods of drain plots is the most effective method of determination of the volume of surface runoff and the amount of washed soil. The study includes the analysis of the climatic parameters in the premises of the station compared to the data from the meteorological station Buzău [5].

The calculation methods are as follows:

$As = h/S$ l m^{-2} ....(2)

where:

As refers to the Surface leaks; h refers to the amount of water drained (l) and S refers to the surface of the plot (m^2):

$Cs = As/P$ ....(3)

where:

Cs refers to the runoff coefficient determined by the rainfall and P refers to the total rainfall (l/m^2):

$T = As \times Mp$ g l^{-1}....................................... (4)

where:

T refers to the turbidity; As refers to the surface runoff and Mp refers to the mass of solid material transported:

$E = T \times As$ kg m^{-2} .... (5)

where:

E refers to the Erosion on the control plots cultivated differently; T refers to the turbidity; As refers to the Surface leaks. The determination model is based on the result obtained in the field and is derived from the Universal Soil Loss Equation (USLE), introduced by Ene (1987), through long-term experimental [5].

RESULTS AND DISCUSSIONS

Climatic conditions

Analyzing the dynamics of the air temperature during the vegetation period and presented in Figure 2, it is found that the values recorded at Aldeni are lower than those at the Buzău weather station.

The lowest temperatures were recorded in April at both recording stations, 7.8 ^{0}C in Aldeni (lower than the normal 10.7 ^{0}C) and 13 ^{0}C in Buzau (Figure 3).

The highest air temperature values were recorded in May, 24.8 ^{0}C in Aldeni and 25.3 ^{0}C in Buzau. The dynamics of air temperatures characterize a period of warm weather.

In the year 2022, the climatic parameters, such as precipitation and temperatures, had a different dynamic compared to previous periods, presenting numerous particularities, radically differentiating them from previous conditions. The total annual amount of precipitation recorded at stationary was 352.4 mm, 274.2 mm less than 2021 and 429.5 mm less than the climatically normal year 2014. The dynamics of precipitation during the

months of the vegetation period (April-September) are shown in Figure 3.
The values recorded at Aldeni are higher compared to those at the Buzău weather station. In April, the difference is the largest, 62.2 mm, and in June the values are close. The decreasing trend of monthly precipitation values starting from June at both recording points is noted. The reduced amounts of precipitation in 2022 are highlighted by comparison with those recorded in 2014.

A special feature of the summer precipitation, which fell this year at the station, is the large number of rains smaller than 5 mm.

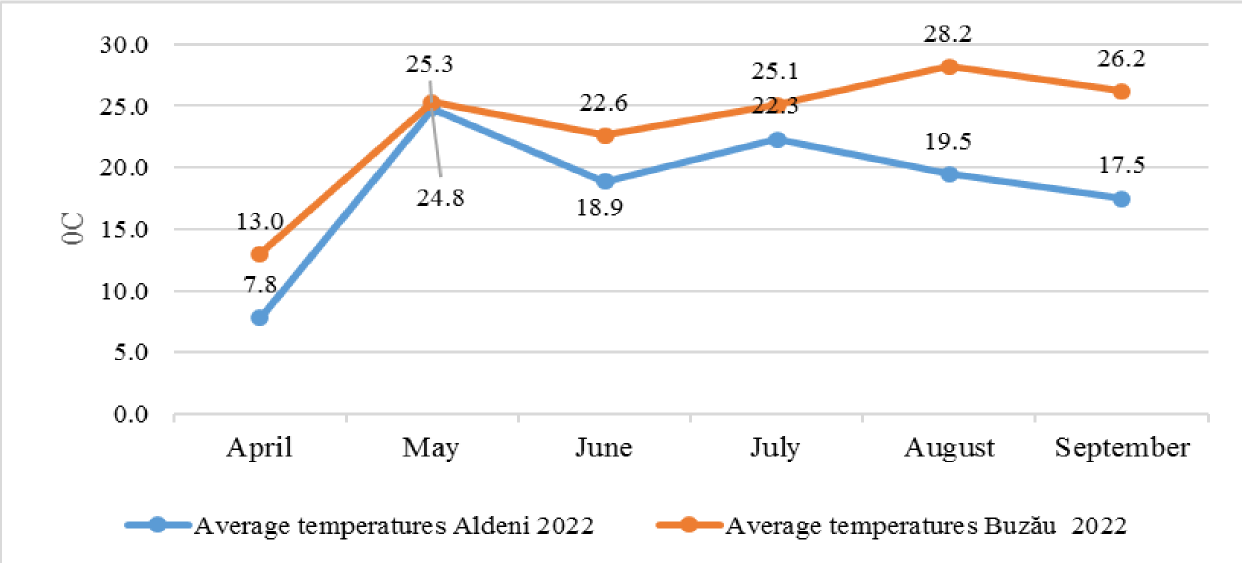

Fig. 2. Air temperature dynamics during the vegetation period in 2022 at the Aldeni-Buzău Soil Erosion Study Station (^{0}C) (recorded data)
Source: data, collected from the Study Station for Soil Erosion, Aldeni-Buzău.

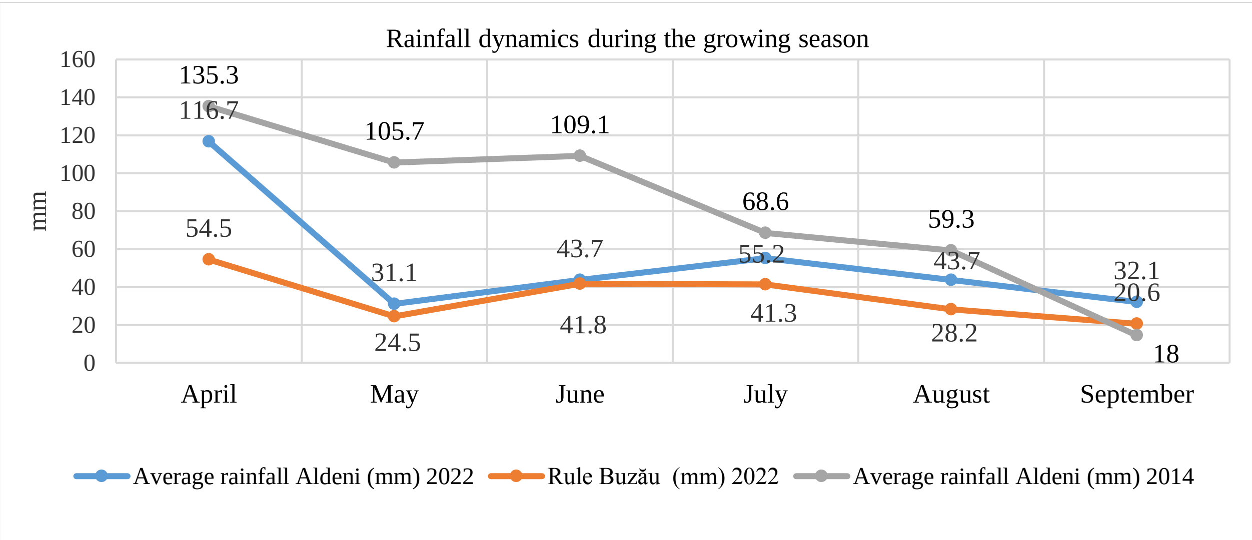

Fig. 3. Rainfall dynamics during the vegetation period (April-September) in 2022 at the Aldeni-Buzău Soil Erosion. Study Station (mm) (recorded data)
Source: data, collected from the Study Station for Soil Erosion, Aldeni-Buzău.

Following the data in Table 1, which includes the grouping of rains according to the amount of water, we find that 60.9 % of their number are smaller than 5 mm, i.e. 46 rains.
There were 7 rains with an amount of water between 5.1 mm and 10 mm and as many with an amount between 10 mm and 20 mm.
Of the 46 rains, only 4 produced leaks (Figure 4) (none of them were torrential).

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They were concentrated in the first part of the vegetation period, from April to June, which shows the climatic particularity of this year.

Table 1. Grouping of rain during the growing season (April-September) according to the amount of water - Aldeni Buzău (mm) (recorded data)

Month	**Grouping of rain during the vegetation period (April-September) 2022, according to the amount of water**						**Total**	**%**
	Under 5 mm	5.1-10 mm	10.1-20 mm	20.1-30 mm	30.1-40 mm	Over 40.1mm		
April	5	1	1	2	1	-	10	21.7
May	5	1	1		-	-	7	15.2
Getting	6	1	-	1	-	-	8	17.5
July	3	2	2	-	-	-	7	15.2
August	4	1	2	-	-	-	7	15.2
September	5	1	1	-	-	-	7	15.2
Total	28	7	7	3	1		46	100
%	60.9	15.2	15.2	6.5	2.2	-		

Source: data, collected from the Study Station for Soil Erosion, Aldeni-Buzău.

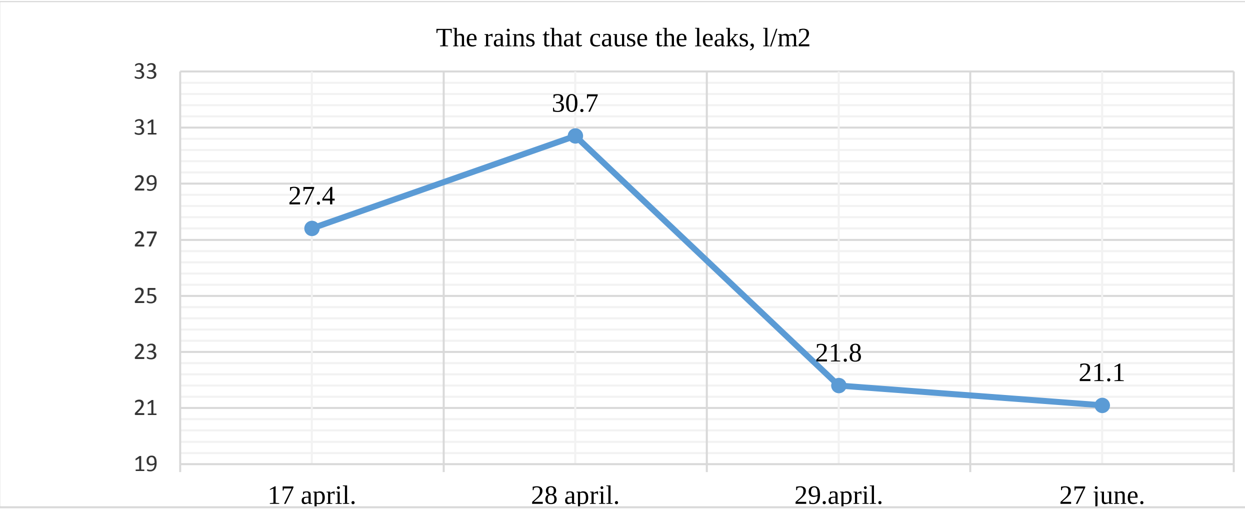

Fig. 4. The rains that produced runoff (l m^{-2}) (recorded data)
Source: data, collected from the Study Station for Soil Erosion, Aldeni-Buzău.

Analysis of surface runoff

The experimental data obtained, regarding the amount of water spilled on the control plots, are presented in Figure 5. Runoff amounts from the control plots have low values for all crops.

The highest amount of runoff water was recorded in the fields cultivated with alfalfa, 10.56 l m^{-2} in the plot with a 15 % slope and 10.4 l/ m^{-2} in the plot with a 20 % slope.

High values of surface runoff were recorded in the maize crop of 7.75 l m^{-2} and 7.73 l m^{-2} respectively and in beet 7.8 l m^{-2} and 8.78 % respectively. For the two cultures, the amounts of runoff water are similar on both slope categories.

In the field, the highest amount of runoff water was recorded on the plot with a 20 % slope, 8.1 l m^{-2}. The lowest runoff values were recorded on the plots with a slope of 15 % beet grown in strips and the wheat crop 1.66 l m^{-2} and 1.31 l m^{-2}, respectively.

The differences recorded in the amounts of runoff from the control plots are due to the specific climate of this year, three of the rains that produced runoff were in April, at the beginning of the vegetation period, and only one at the end of June.

The same conclusions can be drawn from the analysis of the leakage coefficient values presented in Figure 6.

In the alfalfa crop the runoff coefficient is 0.1 and in the beet crop sown in strips on a 15 % slope it is 0.02 (Figure 6).

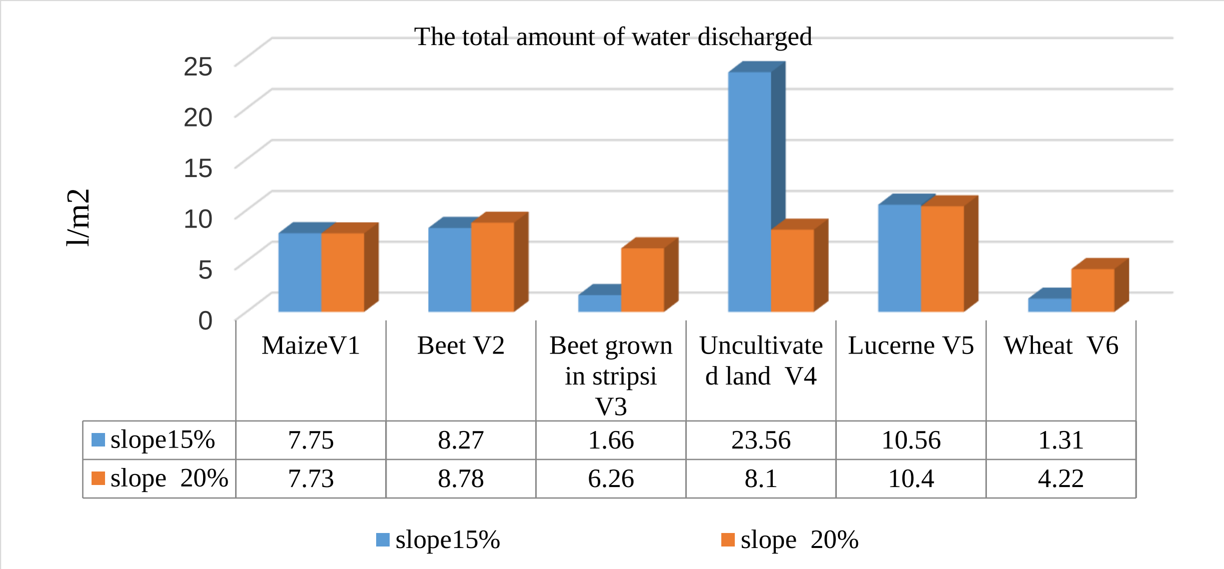

Fig. 5. The total amount of water drained from the control plots depending on the slope and culture, in the year 2022 – Aldeni- Buzău (l m^{-2}) (calculated with formula 2)
Source: Own calculation.

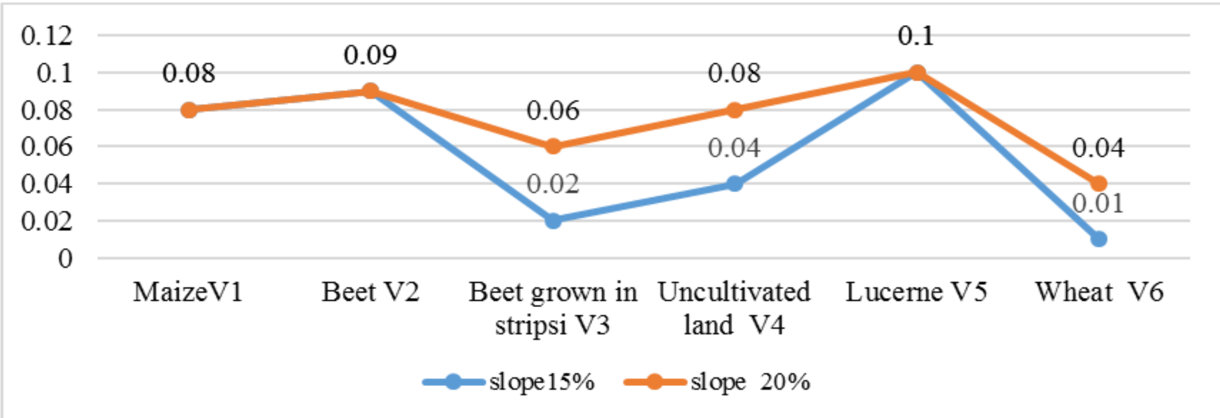

Fig. 6. The variation of the runoff coefficient on the control plots depending on the slope and crop, in the year 2022 Aldeni, Buzău (calculated with formula 3)
Source: Own calculation.

Soil loss analysis

The data on the amount of soil washed by the 4 rains that fell in the first part of the vegetation period are presented in Figure 7. Under this year's conditions when most of the rains that produced runoff were of short duration and quantitatively reduced, the soil losses recorded from the control plots located on the 15 % and 20 % slope land were different compared to the records of the past years.

In the green field, the highest amount of washed soil was recorded this year, 26.8 t ha^{-1} on the plot with a 15 % slope and 28.1 t ha^{-1} on the one with a 20% slope, compared to 2014 when the amount of washed soil was 58 t ha^{-1}.

In the beet crop, the amount of soil washed from the 15 % plot was 17.6 % and 21.7 t ha^{-1} from the 20 % slope.

In the maize crop, the amount of washed soil was 4.7 t ha^{-1} from the plots with a 15 % slope and 10.3 t ha^{-1} from the 20 % slope.

In the alfalfa crop, the amount of washed soil was greater in the case of the plot with a slope of 15 % 6.9 t ha^{-1} compared to 5.1 t ha^{-1} on

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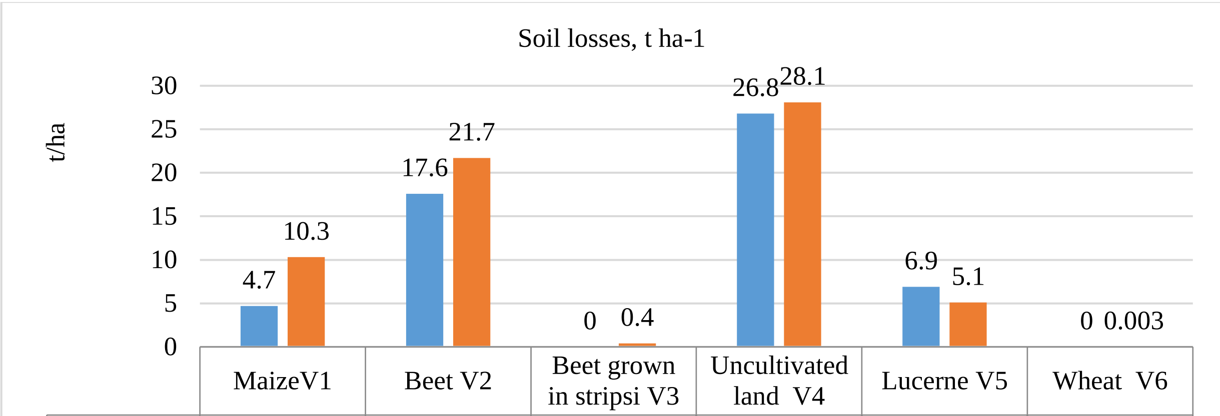
the plot with a slope of 20 %. In strip-grown beet and maize the amount of washed soil was insignificant, 0.4 t ha^{-1} from the plot with 20% slope and in wheat 0.003 t ha^{-1} from the plot with the same slope.



	MaizeV1	Beet V2	Beet grown in stripsi V3	Uncultivated land V4	Lucerne V5	Wheat V6
slope15%	4.7	17.6	0	26.8	6.9	0
slope 20%	10.3	21.7	0.4	28.1	5.1	0.003

Fig. 7. Soil losses from control plots caused by torrential rains depending on slope and crop, in 2022 - Aldeni, Buzău, (t ha^{-1}) (calculated with formula 5)
Source: Own calculation.

The estimated erosion values, for 2022 by the indirect method (a) and those calculated by direct methods (b) in the parcels located on the 15 % slope cultivated differently, are presented in Figure 8.
The estimated erosion compared to that determined by direct methods in the case of the plots located on the 15 % slope, shows significant positive differences in the case of the plot kept fallow and significantly negative in the case of the plot cultivated with beet sown in strips.
Note the close values of the two values, in the plot cultivated with normal culture beet.

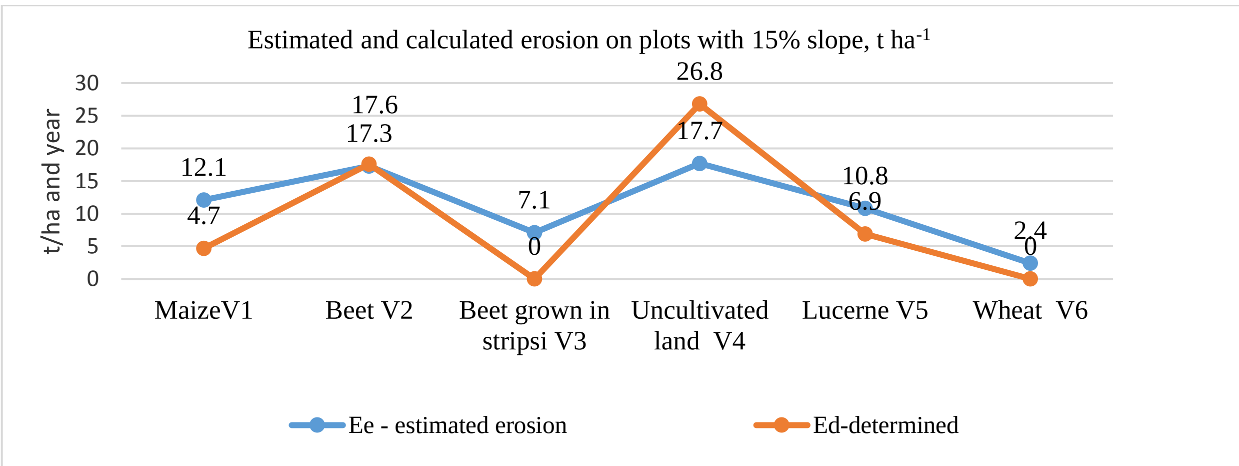


Fig. 8. Estimated erosion [1] and calculated erosion [5] at plots with a 15% slope (t ha^{-1} and year^{-1}) (calculated values)
Source: Own calculation.

The estimated erosion values, for 2022 by the indirect method (a) and those calculated by direct methods (b) for plots located on a 20 % slope, are % presented in Figure 9.

In the case of the control plots located on the 20 % slope, the estimated erosion has, in most cases, values below those determined by direct methods, only in the field plot the values are close.

Although this year's rainfall was reduced in quantity, it was a dry and hot year, but there were still 4 rains that produced runoff. In these climatic conditions, the plots cultivated with beet in strips and with wheat had the least amounts of water runoff and the least amounts of washed soil (they were insignificant).

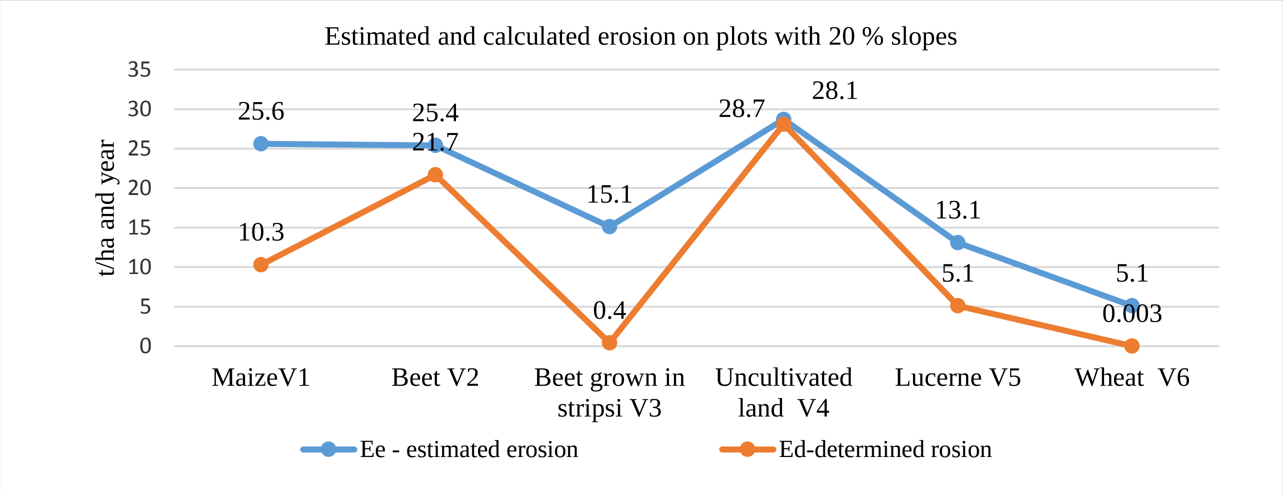


Fig. 9. Estimated erosion [1] and calculated erosion [5] at plots with a 20 % slope (t ha^{-1} and $year^{-1}$) (calculated values)
Source: Own calculation.

Table 2. The economic impact of soil erosion on the productions obtained from the agricultural crops on the control plots – Aldeni-Buzău Soil Erosion Study Station, recorded data)

Indicator \ Crop	Maize	Sugar beet	Cultivated sugar beet in strips	Alfalfa	Wheat
Calculated average erosion (t ha^{-1})	7.5	19.7	0.2	6.0	0.0002
Average degree of coverage (%)	18.8	23.2	61.1	20,5	73.5
Production losses (kg ha^{-1})	370	420	27	300	18
The value of production losses (RON t^{-1})	448	630	41	900	22

Source: data, collected from a The Aldeni-Buzău Soil Erosion Study Station and own calculations.

The economic impact of soil erosion is significant. Soil erosion reduces the productivity of sloping lands, the recorded production losses vary depending on the crop and the anti-erosion variant of cultivation. The data obtained in 2022 (Table 2) shows that the biggest loss of production was recorded in sugar beet (420 kg ha^{-1}) followed by maize (370 kg ha^{-1}) and alfalfa (300 kg ha^{-1}). The highest value of this production is in alfalfa, where production losses were of 900 RON t^{-1}.

CONCLUSIONS

The research undertaken in 2022 was carried out in the Valea with Drum hydrographic basin, located on the left side of the Slănic river basin in Buzău county in the area of Aldeni.

In 2022, during the vegetation period, 46 rains were recorded, of which 28 had an amount less than 5 mm and only 4 produced leaks, none of them were torrential.

The total amount of water drained from the control plots was below 10.5 l m^{-2}, the highest values, under the given conditions, were recorded in the plots cultivated with alfalfa (on both slope categories) and in the plot kept fallow on the 20 % slope.

For alfalfa the runoff coefficient is 0.1 and for beet sown in strips the plot with a 15 % slope is 0.02.

The highest amount of washed soil in 2022 was recorded on the land kept uncultivated of 26.8 t ha^{-1} on the plot with a 15 % slope and

28.1 t ha^{-1} on the one with a 20 % slope, with 30 t ha^{-1} less than the same values recorded 10 years ago.

In the case of plots cultivated with beet, the soil losses exceeded the values allowed for the studied area of 6-8 t ha^{-1} year-1, by 9 t ha^{-1} $year^{-1}$ on the plots located on the 15 % slope and by 13 t ha^{-1} year-1 in plots located on a 20 % slope.

The sugar beet culture, cultivated in strips, as an anti-erosion measure, provided much better protection, by comparison with the version of the beet culture in normal culture.

The specific climatic conditions of 2022, the concentration of precipitation at the beginning of the vegetation period, determined lower soil losses than the allowed average, in the maize crop (slope 15 %) and the alfalfa crop, and in the wheat crop and the beet crop grown in strips, soil losses were insignificant.

The estimated erosion, compared to that determined by direct methods in the case of plots located on a 15 % slope, shows significant positive differences, in the case of the plot maintained with arable land, and significantly negative in the case of the plot cultivated with beet sown in strips. Note the close values of the two values, in the plot cultivated with beets.

The estimated erosion has, in most cases, values below those determined by direct methods, in plots located on a 20 % slope, only in the arable plot the values are close.

For the correct estimation of the amount of soil washed away annually (erosion), in difficult climatic conditions, studies and research are necessary for periods of 5 or 10 year.

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THE ECONOMIC IMPORTANCE OF THE SPONTANEOUS FLORA IN THE AREA OF THE PIEDMONT AND SUBCARPATHIAN HILLS OF OLTENIA, ROMANIA

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Abstract

The research carried out by us had as its main purpose the identification of the way of use of spontaneous flora by the local populations, from the regions studied, on the one hand, and on the other hand, to make people aware of the advantages of using natural products over artificial ones. The work methodology consisted in making trips to different places in Oltenia, from the Getic Piedmont and the Subcarpathian Depression in order to collect information about the phytodiversity of these areas and how the locals use these plants in the local economy. The field survey was made on a sample of 524 persons who were interviewed based on a structured questionnaire including 10 questions regarding the economic importance of spontaneous flora in the region and for their life. The results presented in this present paper represent a segment of a more complex study concerning the importance of spontaneous vascular plants in the local economy of a certain region in Oltenia. The obtained data were compared with those corresponding to the plain region of Oltenia in order to observe, on the one hand, the potential of each area and, on the other hand, the level of interest shown by population towards the capitalization of the natural material found in the area where they live. By analysing the usage of spontaneous plants in the Getic Piedmont and the Subcarpathian hills of Oltenia, the author concluded that the interest shown by the population is greater in these regions than in the lowland. Just as in the plain region, medicinal plants occupy an important place in terms of use. The number of tinctorial species is much lower as compared to the plain region. They are employed only by very poor families, who cannot afford to use commercial products.

Key words: *the Subcarpathian depression, useful flora, Oltenia, the Getic Piedmont, Romania*

INTRODUCTION

Spontaneous plants have been used since the beginning of the evolution of mankind. The human evolution cannot be separated from that of plants because the latter represented a source of food and treatment for various diseases, a fodder source for domestic animals, providing the necessary building materials for homes as well as for boats, with which our ancestors sailed the rivers and the Danube in search of better living conditions. During all these migrations, the spontaneous flora accompanied people in the form of the products that they consumed. The plants that survived can still be found today, while those that failed to adapt have disappeared.

In addition to the scientific importance, the flora of a region also presents an economic significance, taking into account the fact that over time it has been used in the household economic activity [48]. Unlike the plain region of Oltenia, the areas corresponding to the Piedmont and the Subcarpathian hills are characterized by a variety of vegetation types. The surfaces occupied by the spontaneous vegetation of these areas are much larger because the agricultural land in this part of Romania is significantly less extended.

The natural conditions that characterise the Getic Piedmont and the Subcarpathian Depression in Oltenia led to an interesting flora and vegetation, which have drawn the attention of many naturalists [16, 17] and researchers; the results obtained by them were published in numerous specialized works [23, 32, 34, 36, 38].

The founder of higher education from Craiova made contributions from different places of Oltenia, especially Dolj county [5, 6, 7, 8]. From Mehedinți county we find data in the works published by Maloș C. and Costache I.

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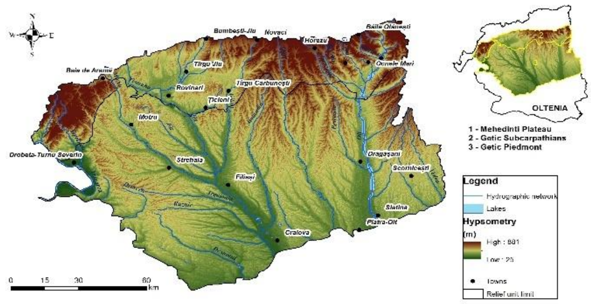
[12, 13, 20], from Vâlcea county, by Ciurchea M. [10, 11] and Popescu Gh. [29, 30, 31], from Olt and Gorj county by Popescu Gh. [35, 37]. Information from the northern part of Oltenia can be found in several works [24, 25, 26, 27, 28, 33]. Alongside these works, other important research papers contributed to the understanding of the repartition of spontaneous plants in this part of Romania [14, 39, 43, 44]. The influence of climate changes in recent years have brought important changes to the chorology of some vascular species in Oltenia [40, 41, 42, 45, 46, 47]. Sporadic research papers were written with the main objective of presenting the importance of spontaneous flora in the economy of a certain region of Oltenia [21, 39, 48]. The human influence and that exerted by domestic animals on the spontaneous flora in this part of Romania is lower [19], as compared to the plain region. The surfaces covered by agricultural lands are much smaller, mowing is generally done only once, rarely two times, and the quality of underground and surface waters is good. In addition, some of these areas are either national parks or Natura 2000 protected areas, where quality tourism is practiced. Thus, we can state that the floristic wealth of this area located in the Piedmont and the Subcarpathian hills in Oltenia surpasses the one characteristic to the plain. The diversification of the tourist offer, as well as the better information of the local population regarding the importance of these areas would significantly contribute to restoring and improving the link between man and nature and it would positively influence the long-term preservation of biodiversity.

MATERIALS AND METHODS

The reasearch was carried out in Oltenia region which represents one of the most interesting areas of Romania, especially in terms of natural conditions. The Getic Piedmont, which borders Oltenia Plain towards the north [1], consists of sedimentary deposits of a very different character [27] and covers areas that administratively belong to Olt, Dolj, Vâlcea, Mehedinți, and Gorj Counties.



Map 1. Piedmont and subcarpathian hills of Oltenia
Source: GIS processing after Topographical Map, 1:25,000 [50].

The Subcarpathian hills have a very good representation in Gorj and Vâlcea Counties [2, 3] (Map 1). Insignificant areas are also located in the Eastern part of Mehedinți County [3].
The demographic analyses of these areas show migratory flows from the rural to the urban areas. At the beginning of the '70s, the rural population accounted for 72.1% [26], while the present values are much lower because of the migration of young people to cities or abroad.
The variability of soil types in these regions creates conditions for a diverse vegetation [26].
The climate of these areas is temperate continental, with some sub-Mediterranean influences in the western part.
The hydrographic network is very rich as compared to the plain region [18]. Most of the rivers have their source in the Parâng Massif and they are tributary to the two main rivers: the Jiu and the Olt. Besides these important water courses, there is a particularly developed network of autochthonous origin, characterised by a hydrological regime with great variations [26]. A source of primary importance is also represented by the groundwater reserves, which are shallow in these regions [15].
The areas covered by spontaneous flora in the Piedmont and the Subcarpathian hills are more extensive as compared to those in the plain region. The arable land accounts for about a quarter of the surface, with more than half of the area being covered by natural meadows and orchards. The rest of the surface is covered by forests, which have a good representation in the northern part of the researched area.
By corroborating the data documented from the specialized field literature with the information collected by us over time, we

analysed the importance of the spontaneous flora in the economy of these places. The obtained data were compared with those from the plain area of Oltenia.

The scientific names for the identified plants are in accordance with those in the Romanian specialized literature (various field guides that enable the correct identification of plant species) [9, 49] and the abbreviations used by authors were consistent with those in the work *Authors of plant names* [4].

The methodology was the same as that used for the study of the importance of spontaneous flora within the local economy of the plain region of Oltenia [39]. This time, for this part of Oltenia, the sample consisted of 524 persons, which belong to the same four age groups that were used in the analysis of the plain region (up to 20 years, between 20 and 40 years, between 40 and 50 years, and over 50 years old). The respondents were selected so that both rural and urban environments are represented during the survey. Those from rural areas predominated. The survey was conducted in the following cities and towns: Rm. Vâlcea, Drăgășani, Băbeni, Ocnele Mari, Băile Govora, Horezu (Vâlcea County), Tg. Jiu, Tg. Cărbunești, Novaci, Bumbești Jiu (Gorj County), and Baia de Aramă (Mehedinți County). Almost three quarters of the total of 524 participants in the survey originated in the rural settlements of: Paușești, Pietrari, Bunești, Slătioara, Stroești, Copăceni, Rugetu, Recea, Miloștea, Vaideeni, Folești, Genuneni, Francești, Mateești, etc. (from Vâlcea County), Bumbești Pițic, Ciocadia, Crasna, Larga, Radoși, Aninișul din Vale, Hirișești, Schela, etc. (from Gorj County).

The larger number of people in the analysed sample is explained by the interest shown by the inhabitants of these areas towards the use of spontaneous flora.

The field survey was based on a structured questionnaire, where the questions used for conducting the present analysis were the same as those used in the case of the sample from the plain area of Oltenia:

Q1-Do you use plants from the spontaneous flora?;

Q2- What are the most used plants in nature?;

Q3-You collect plants as ....;

Q4- What category of plants do you collect?

Q4-Since when do you collect plants from the spontaneous flora?

Q5-Do you collect useful plants for your own use or do you sell them?

Q6-Where do you manage to capitalize on the production obtained?

Q7-What is the way to capitalize on production?

Q8-What is your estimated value corresponding to the revenue from spontaneous plant collection (RON)?

Q9-Have you so far accessed European funds for the establishment/ development of crops with useful plants?

Q10-In the next period, do you intend to access European funds for the development of your business?) [39].

Until the 1990s, certain collection and sorting centres existed in the rural settlements. After 1990 they were all abandoned or their destination changed.

RESULTS AND DISCUSSIONS

The analysis of the spontaneous flora within the Getic Piedmont and Subcarpathian hills shows the floristic richness that characterise these places. Among the spontaneous plants that grow in the Getic Piedmont and in the Subcarpathian Depression of Oltenia, there are taxa with important value in the economy of these places.

Among the eight categories of species that are important for the local economy (medicinal, honey, food, aromatic, seasoning, tinctorial, fodder, and ornamental), **the medicinal** ones occupy the leading place. They are traditionally used in the “family’s pharmacy” or are sold in the neighbouring markets and fairs or in the spa towns (e.g. Băile Olănești, Băile Govora (Vâlcea County). Among the most used medicinal plants we mention: *Hypericum perforatum* L., *Matricaria recutita* L., *Tilia tomentosa* Moench, *Chelidonium majus* L., *Crataegus monogyna* Jacq., *Rosa canina* L., *Mentha piperita* L., *Eryngium planum* L, *Sambucus nigra* L., *Urtica dioica* L., *Agrimonia eupatoria* L., *Equisetum telmateia* Ehrh., *Plantago major* L., *P.*

lanceolata L., etc. Some medicinal plants from the spontaneous flora are also used by the local inhabitants in alimentation due to their high nutritional content in vitamins, minerals, proteins, lipids, and sugars (e.g. *Alliaria petiolata* (M. Bieb.) Cavara et Grande, *Allium ursinum* L. subsp. *ucrainicum* Kleopow et Oxner, *Artemisia absinthium* L., *Portulaca oleracea* L., *Rumex acetosella* L., *Taraxacum officinale* Weber ex F.H.Wigg., *Urtica dioica* L.).

The honey plants from the Getic Piedmont and the Subcarpathian hills are found throughout the growing season and they play an important role in the apiculture of these areas. Among them we mention: *Anemone nemorosa* L., *A. ranunculoides* L., *Cichorium intybus* L., *Eryngium campestre* L., *E. planum* L., *Echium vulgare* L., *Leonurus cardiaca* L., *Lamium* spp., *Mentha* spp., *Nepeta* spp. *Tilia cordata* Mill., *T. tomentosa* Moench, *Salvia pratensis* L., *Taraxacum officinale* Weber ex F.H.Wigg., *Symphytum officinale* L., Viola spp. *Robinia pseudacacia* L., *Acer campestre* L., *Alnus glutinosa* (L.) Gaertn., *Castanea sativa* Mill., *Corylus avellana* L., *Rosa canina* L., *Salix fragilis* L., *S. alba* L., *Sambucus nigra* L., Medicago spp., Trifolium spp., *Melilotus albus* Medik., *M. officinalis* (L.) Lam.

The spontaneous plants with **ornamental** value are highly diverse, the decorative character being their habitus. In some urban areas they are used for vegetal compositions such as tree alignments (e.g. *Tilia tomentosa* Moench, *Betula pendula* Roth), pentru înfrumusețarea parcurilor (*Leucanthemum vulgare* Lam., *Bellis perennis* L., *Juniperus communis* L., *Salix alba* L., etc.) and of residential areas, as hedges (*Ligustrum vulgare* or *Cornus sanguinea*) or vegetation covered walls (e.g. *Hedera helix* L.). In some rural settlements, where the erosion process is strong, they are used to fix these unstable lands (e.g. *Hippophae rhamnoides* L., at the level of Stroești settlement, located in Vâlcea County).

There are multiple advantages in using these plants from the spontaneous flora, such as: reducing the financial costs required for maintenance, as well as minimizing the maintenance work and ensuring a chromatic variability throughout the vegetation period [44].

The tinctorial plants from the region under study were used especially for dyeing wool or home-made fabrics, but also for colouring some dishes and soft or alcoholic drinks. The most frequently used were those derived from *Alnus glutinosa* L.) Gaertn., *Juglans regia* L., *Betula pendula* Roth, *Quercus robur* L., *Taraxacum officinale* Weber ex F.H.Wigg., *Origanum vulgare* L., *Sambucus nigra* L., *Tilia tomentosa* Moench, *T. cordata* Mill., *Salix purpurea* L., *Malus sylvestris* (L.) Mill., *Linaria vulgaris* Mill., *Inula helenium* L., *Centaurea cyanus* L., etc. The most beautiful colours were obtained on wool fibres.

The natural colours were stabilised using certain natural auxiliary substances: wood ash, vinegar, wine, kitchen salt, whey, sour cabbage juice, etc. Certain evidence regarding the use of natural dyes still endures in some households, where there can be found needlework on folk blouses, towels, tablecloths, pillowcases, window curtains or carpets that were traditional in Oltenia.

The fodder plants have a very good representation in the Piedmont and the Subcarpathian hills of Oltenia. They are mainly found in meadows, rarely in other vegetation formations. Most of them belong to the Fabaceae (Leguminosae) and Poaceae (Gramineae) families. The most widespread are: *Trifolium pratense* L., *T. repens* L., *Lolium perenne* L., *Poa pratensis* L., *Festuca pratensis* Huds., *F. rupicola* Heuff., *Agrostis capillaris* L., *Anthoxanthum odoratum* L., *Lotus corniculatus* L., *Dactylis glomerata* L., *Medigago lupulina* L., *Lathyrus pratensis* L., etc. They are traditionally used for feeding the domestic animals [22], which provided (and still do) the food necessary for daily consumption, the driving force for certain agricultural works, the means for goods transportation and, sometimes, for personal travel.

The plants with food value, which are characteristic for the spontaneous flora of the researched territory, are known and appreciated especially in the countryside. These plants are present in small number and they and are consumed either fresh, as in the case of *Rumex acetosella* L., *Fragaria viridis* (Duchesne) Weston, *F. vesca* L., *Rubus candicans* Weihe, *Prunus spinosa* L., *Cornus mas* L., *Sambucus nigra* L. species, or in various dishes (e.g. *Urtica dioica* L., *Rumex crispus* L.). Furthermore, the fruits or seeds of *Corylus avellana* L., *C. colurna* L. and *Castanea sativa* Mill.can also be used.

Aromatic and seasoning plants are poorly represented in the Piedmont and the Subcarpathian hills. They are used in various dishes, either in a dry state (e.g. *Origanum vulgare* L., *Thymus pulegioides* L.), or fresh (e.g. *Vitis sylvestris* C.C. Gmel., *Prunus cerasifera* Ehrh.).

The information provided during the survey by the inhabitants of the urban and rural areas in the Getic Piedmont and the Subcarpathian hills, leads to the observation that the importance assigned to the flora of these regions is greater among the population over 40 years old. More than half of them are over 50 years old (Fig. 1).

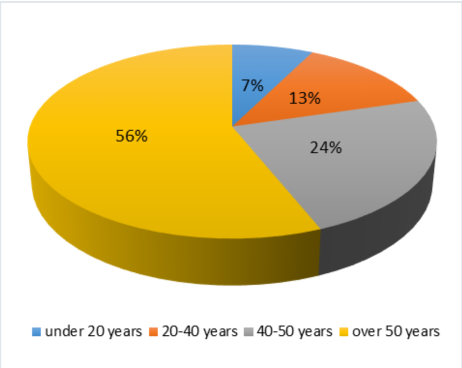


Fig. 1. Share distribution of the economic importance assigned to spontaneous flora, by age groups (%)
Source: Own calculation.

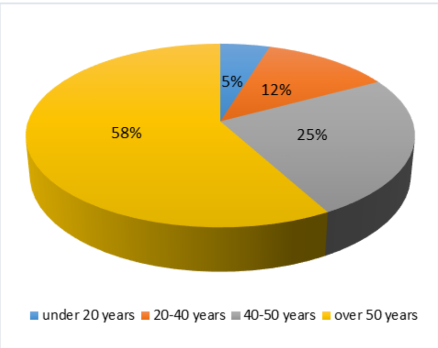


Fig. 2. Share distribution of the way of use assigned to spontaneous flora, by age groups (%)
Source: Own calculation.

As in the case of the study regarding the plain region of Oltenia, the present research reveals the low interest among young people (Fig. 2).

The analysis regarding the share corresponding to each category of used plants in the researched territory reveals the fact that, unlike the in plain region, the fodder plants have the best representation in the Getic Piedmont and the Subcarpathian depression of Oltenia. This situation can be explained by the fact that a good part of the surfaces occupied by natural vegetation belongs to meadows. This first category is followed by medicinal and honey plants (Fig. 3). The other categories have insignificant shares.

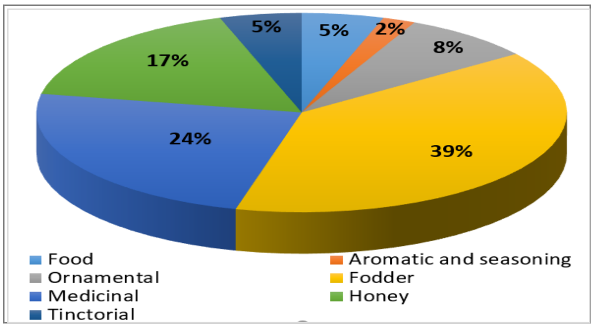


Fig. 3. Analysis of plant categories, based on their use (%)
Source: Own calculation.

The most used plants in nature are: *Matricaria recutita* L., *Hypericum perforatum* L., *Tilia tomentosa* Moench, *Chelidonium majus* L. and *Sambucus nigra* L. Most of the collected plants are used for their own use, a small part of the locals use them in the markets of the towns closest to their hometown (about 5%).

The income obtained from the collection of spontaneous plants is very low (between 100-400 RON). Nicio persoană chestionată nu a accesat fonduri europene în acest sens și sunt sceptici în realizarea acestui demers.

The analysis concerning the importance assigned to these plants by people from the rural environment as compared to those from the urban environment, reveals that, unlike in the plain region, at the level of the Piedmont and the Subcarpathian hills, the interest shown by the urban dwellers is slightly higher (Fig. 4).

The research carried out in the field, as well as in the laboratory reveals, on the one hand, a much greater floristic diversity corresponding to the hills of Oltenia (Photos 1 and 2) and, on the other hand, a greater interest shown by inhabitants with regard to the use of spontaneous plants.

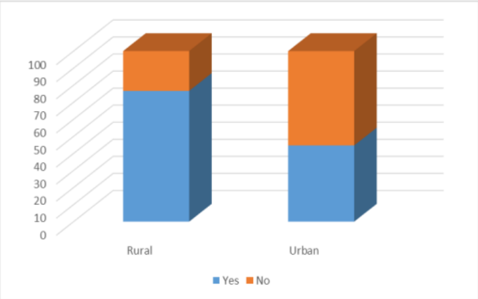


Fig. 4. The importance assigned to spontaneous flora in the rural and urban areas of the regions under study(%)
Source: Own calculation.

The landscape in these regions is sometimes impressive (Photos 3, 4 and 5).

Fig. 1. The physiognomy and use of meadows located in Larga settlement (Gorj County)
Source: Original photo.

Fig. 2. The physiognomy of meadows located in Racovița settlement (Gorj County)
Source: Original photo.

Fig. 3. Orchards with fruit trees, located in the Subcarpathian depression - Rugetu settlement (Vâlcea County)
Source: Original photo.

Fig. 4. General aspect of the meadows located on the outskirts of Stănești settlement (Gorj County)
Source: Original photo.

Fig. 5. Meadows rich in orchards, located in Paușești Otăsău settlement (Vâlcea County)
Source: Original photo.

CONCLUSIONS

The spontaneous plants in the area of the Getic Piedmont and the Subcarpathian hills are of great economic importance because the multiple usage of some of them in a dry or fresh state brings economic benefits to the inhabitants of these areas.

The widespread use of spontaneous flora is more significant in rural areas.

It is to be noticed that the inhabitants assign more importance to the use of spontaneous flora within the Getic Piedmont and the Subcarpathian Depression, as compared to the plain region of Oltenia. This is proven by the various products obtained from plants or to which plants have made a good contribution. The settlements characterised by the highest number of plant collectors are those located in the Subcarpathian hills (Păușești, Vaideeni, Stoenești, Bunești (Vâlcea County) and Crasna, Novaci, Bumbești Jiu, Peșteana (Gorj County).

The use of spontaneous flora on an industrial scale is also absent in these regions of Oltenia.

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STUDY ON THE PERCEPTION OF THE PRODUCERS ON ORGANIC PRODUCTS FROM THE TULCEA AND CONSTANTA COUNTIES, ROMANIA, REGARDING THE POSSIBILITIES OF THEIR VALUATION

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Abstract

In front of climate change and the threat of food shortages, organic farming is an answer to both challenges. On the one hand, organic farming protects and improves environmental conditions, and on the other hand, it can provide food for the entire planet. Of course, the organic farming system is difficult to apply, requiring both financial resources and consumer awareness. The current work aims to carry out an analysis of how organic agriculture has evolved in the counties of Constanța and Tulcea, as well as identifying some particularities at the level of the organic farm, from demand to obtaining and delivering production. The study deepened the situation of organic farming using both published data and information collected with the help of a questionnaire. From the study, it emerged that the two studied counties together own 24.1% of the area certified in the ecological agriculture system of our country, respectively Constanța 6.5% (17,651 ha) and Tulcea 17.6% (47,757 ha) . The number of operators in the ecological system, in 2020, was 280 in Constanța County and 343 in Tulcea County respectively, holding a share of 2.5% and 3.1% respectively of the total per country. The analysis of ways to capitalize on organic production consisted of the assessment of capitalization, the existence of a capitalization plan and the possession of storage spaces, the commercialization of production in the country or for export. Thus, from the answers of the farmers it emerged that out of the 70 respondents, 18 (25.6 %) consider the exploitation of production to be an easy and medium easy activity, and 28 (40 %) consider it a heavy activity and 24 (34 %) as a very hard activity, of which 85% have higher education; out of the farms analyzed, 35 farms have production storage facilities, of which 32 have higher education; the destination of the production is 41.4% only in the country, 11.4% outside the country and 37.1% capitalize the production both in the country and outside the country.

Key words: *ecological agriculture, food security, valorization, sustainability*

INTRODUCTION

Ecological agriculture is a global system of agricultural and food production that combines environmental practices, biodiversity, conservation of natural resources, animal welfare standards, to obtain agricultural products [19]. The objectives of organic agriculture established by European Union Regulations are multiple and aim at the production of food using natural substances and processes. It supports the responsible use of energy and natural resources; preservation of biodiversity; preservation of local ecological systems; increasing soil fertility; and preserving water quality [3]. The role of ecological agriculture is to produce food more suitable for human metabolism, fresh and authentic, in full harmony with the development and preservation of the environment [10, 12]. It is believed that if current trends in classical production and consumption continue, harm will be done to future generations, regardless of country, through an increase in pollution, climate change, temperatures and extreme weather events, as well as reduces the number of species and water and soil resources [2, 11].
Research plays a special role in the development of ecological agriculture. Thus, by using the results of the ORGAP European Project, financed by the 6th Framework Program for Research of the EU, a manual was edited that includes the methodology for

the development, implementation and evaluation of plans in agriculture in an ecological system [14], which was published by FiBL, Research Institute for Organic Agriculture (Frick, Switzerland) and IFOAM EU (Brussels, Belgium). It is worth noting that the Northwest Regional Development Agency (Romania) also participated in the ORGAP project, along with established research institutes in this field, such as FiBL (Switzerland) and INTIA – Institute of Agricultural Technologies of the Navarre Region (Spain).

A study of 57 developing countries, from 28 projects, covering an area of 37 million hectares, showed that family agroecological farming led to an average increase in yields of up to 79%. It should be noted that all projects used ancestral experience, which provided interesting, optimal indications for an adapted agroecology [18].

From a practical point of view, it is considered that the family holding is the only one capable of adopting agricultural practices to transform conventional agriculture into ecological agriculture, for three reasons [13]. First, farmers are willing to produce without major profitability constraints; secondly, they are more adapted to cultivate poorer quality land, with insufficient labor force, with lower energy consumption (in terms of capital and inputs) and the third reason is family unity (responsibility and control through better production techniques) [4]. In the same direction, policies for the practice of ecological agriculture must also include measures to develop the capacities of farmers regarding education and technical skills [8]. Improving farmers' productivity by increasing the supply of ecosystem services through agriculture [20] has been considered a viable alternative since the 1990s [17]. This form of ecological intensification or double green revolution [6] implies a global and integrated approach that is based on the traditional know-how of family farming communities with agricultural practices inspired by agroecology [5, 7, 9] and agriculture conservation or agroforestry [20].

The paper aims to carry out an analysis of how organic agriculture has evolved in the counties of Constanța and Tulcea, as well as identifying some particularities at the level of the organic farm, from demand to obtaining and delivering production.

MATERIALS AND METHODS

The present study analyzes the behavior of the producers of ecological agricultural products, with the help of a questionnaire, to which a number of 70 farmers answered, of which 33 from Constanța county and 37 from Tulcea county. The questionnaire had 33 questions, which sought to establish the main characteristics of agricultural holdings, to analyze the technologies practiced in the ecological system and to analyze the ways of capitalizing on ecological production.

The interpretation of the data was done by grouping the answers according to the weight of the different answers and descriptive univariate analysis of the data, absolute frequencies and relative frequencies, using the $\chi 2$ test (Chi square) [16].

The research methodology assumed the completion of the following stages:

1. Analysis of the data from the questionnaire according to certain criteria: age, level of training and by gender of the respondents which allowed us to establish the size and weight of the respondents by origin and level of training.

2. Data analysis using the $\chi 2$ test (Chi square)

The association test, $\chi 2$, involves checking the hypothesis of a connection between the answers obtained from the questionnaire and checking a particular set of data that can follow a known statistical distribution. The test is calculated after creating contingency tables, in which the data are grouped according to one, two, or more segmentation variables [15]. The test allows highlighting the existence or non-existence of an association link between subgroups created as variables, based on the questions in the questionnaire. The steps taken in the calculation of the test, which I exemplify with data from the thesis, are as follows:

a. *The formulation of the hypothesis,* which states that there is no causal link or association between two variables-segmentation questions: X – the desire to change the ecological system (yes, no) and Y – the level of training (high school and higher education).

b. Evaluation of the significance threshold level α, depending on the number of degrees of freedom of the table, according to the formula (rows - 1) * (columns - 1); (e.g.: GL = (2 - 1) * ((2 - 1) = 1). Based on these data, the value of χ2 is taken from the distribution table or calculated directly with Excel functions: theoretical χ2 = CHIINV(0 ,1;GL).

c. *Calculation of expected theoretical frequencies*

d. *Comparison of the obtained results,* for which there are the following situations: if the null hypothesis is rejected and therefore there is an association or potential relationship between the variables; if the existence of a null hypothesis is admitted and therefore there is no association or potential relationship between the studied variables.

5. *Calculation of the contingency coefficient C,* which has the role of measuring the degree of association between the variables of the contingency table.

RESULTS AND DISCUSSIONS

The questionnaire was applied to 70 farms, 33 of which are located in Constanța county and 37 in Tulcea county (Table 1). Of the 70 respondents, 16 are under 35 years old, 13 between 36 - 40 years old, 24 respondents are between 41 - 50 years old and 17 are more than 50 years old.

Table 1. Thye distribution of respondents who practice ecological agriculture according to age and residence county

Age	U.M.	County		Total	
		Constanta	Tulcea	N0.	%
≤ 35	no.	3	13	16	22.8
36 - 40	no.	5	8	13	18.5
41 - 50	no.	13	11	24	34.2
≥ 50	no.	12	5	17	24.2
Total	no.	33	37	70	100
	%	47.14	52.86	100	*
Indicator	χ2	Threshold of significance			
	≤	0,2	0,1	0,05	0.01
CHIINV (Chi teor.); GL = 3	≥	4.64	6.25	7.81	11.3
CHITEST (Sig value)	0.0204	CHIINV (Chi calc.)	9.79	Pearson Coef. The value χ2 Poisson	0.35

Source: own processing.

The Chi square test, indicates a strong correlation between the age and the county of residence of the respondents, the calculated Chi of 9.79 exceeds the theoretical Chi value of 7.81, for a significance threshold of 0.05. It is observed that among those who are from Constanța county, most of them are over 41 years old and even more than 50 years old, on the other hand, in Tulcea county there are a larger number of those under 40 years old.

Table 2. The distribution of respondents by age and gender categories

Gender	U.M.	Vârsta				Total	
		≤ 35 yers	36 - 40 yers	41 - 50 yers	≥ 50 yers	nr.	%
Female	no.	9	6	5	4	24	34,29
Male	no.	7	7	19	13	46	65,71
Total	no.	16	13	24	17	70	100
	%	22.86	18.57	34.29	24.29	100	*
Indicator	χ2	Threshold of significance					
	≤	0.2	0.1	0.05	0.01	0.001	
CHIINV (Chi teor.); GL = 3	≥	4.64	6.25	7.81	11.34	16.27	
CHITEST (Sig value)	0.0707	CHIINV (Chi calc.)		7.04	Pearson Coef. The value χ2 Poisson		0.302

Source: own processing.

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Among those who participated in the survey, 46 respondents are male and 24 female (Table 2). Calculation of the Chi-square test indicates a marginally significant association between respondents' gender and their age. Differences are observed between the ages of male respondents, most of whom are over 41 and a significant number are over 50, while most of the female respondents are under 40.

Table 3. The link between the level of training and the respondents age

Age	U.M.	Level of preparation		Total	
		High school studies	Higher studies	no	%
≤ 35	no.	2	14	16	22.8
36 - 40	no.	1	12	13	18.5
41 - 50	no.	2	22	24	34.2
≥ 50	no.	5	12	17	24.2
Total	no.	10	60	70	100
	%	14.29	85.71	100	*
Indicator	χ2	Threshold of significance			
	≤	0.2	0.1	0.05	0.01
CHIINV (Chi teor.) GL = 3	≥	4.64	6.25	7.81	11.3
CHITEST (Sig value)	0.2238	CHIINV (Chi calc.)	4.37	Pearson Coef. The value χ2 Poisson	0.24

Source: own processing.

Most of the respondents have higher education and only 10 have high school education (Table 3). Among those with high school education, half are over 50 years old and only 2 respondents are under 35 years old. Between the age of the respondents and the level of education there is no significant association, as shown by the calculation of the Chi square test, the calculated Chi has a value of 4.37, being lower than that of the theoretical Chi of 7.81 (GL = 3), for a significance threshold of 0.05.

Also, the calculation of the Chi-square test indicates that there is no significant relationship between the gender of the respondents and the level of education. The calculated Chi has the value of 1.28, which is lower than the theoretical Chi of 3.84 (GL = 1), for the significance threshold of 0.05.

Table 4. The link between the respondents age and specialized studies in agriculture or other fields

Age	U.M.	Specialized studies:			Total	
		Agriculture	Other	Not the case	no	%
≤ 35	no.	4	11	1	16	22,8
36 - 40	no.	7	6	0	13	18,5
41 - 50	no.	14	10	0	24	34,2
≥ 50	no.	10	4	3	17	24,2
Total	no.	35	31	4	70	100
	%	50.00	44.29	5.71	100	*
Indicator	χ2	Threshold of significance				
	≤	0.2	0.1	0.05	0.01	0,001
CHIINV (Chi teor.) GL = 6	≥	8.56	10.64	12.59	16.81	22.4
CHITEST (Sig value)	0.0966	CHIINV (Chi calc.)		10.74	Pearson Coef. The value χ2 Poisson	0.36

Source: own processing.

It is observed from the calculation of the Chi square test that between the gender of the respondents and the specialized studies, there is no significant relationship, the value of the calculated Chi of 1.21 is lower than the theoretical Chi of 5.99 (GL = 2) for the significance threshold of 0.05 (Table 4). Among the 35 respondents with studies in agriculture, 25 are male and 10 are female. Also, the distribution of specialized studies in other fields is similar to the one in agriculture, in a larger number, respectively 19 male respondents and 12 female respondents, and for those who do not have such studies, the distribution was in equally by 2 respondents per gender. A very important component in managing a farm is the level of education (Table 4). Of those surveyed, 60 respondents have higher education, of which 32 come from the rural area and 28 from the urban area. There is no association between the level of education and the area of origin of the farmer, the calculated Chi value of 2.49 is lower than the theoretical Chi value of 3.84 (GL = 1) for the significance threshold of 0.05 (Table 5).

Table 5. The link between the training level and the farmer's origin area

Level of preparation	**U.M.**	**The area of origin**		**Total**	
		Rural	**Urban**	**no**	**%**
High-school studies	no.	8	2	10	14.2
Higher education	no.	32	28	60	85.7
Total	no.	40	30	70	100
	%	57.14	42.86	100	*
Indicator	$\chi2$	Threshold of significance			
	≤	0.2	0.1	0.05	0.01
CHIINV (Chi teor.); GL = 1	≥	1.64	2.71	3.84	6.63
CHITEST (Sig value)	0.1147	CHIINV (Chi calculat)	2.49	Pearson Coef. The value $\chi2$ Poisson	0.185

Source: own processing.

Asked about the period since they have been practicing organic farming, a percentage of 41.43% stated that they have been in this field for 6 - 7 years, 24.29% for 3 - 5 years, and 22.86% for 8 - 9 years (Table 6). A smaller share is held by those who have been practicing organic farming for over 10 years. Between the level of education and the period since practicing organic farming there is a slightly significant relationship, with a probability of almost 94%.

Table 6. The correlation between the respondents' level of training and the period since they are practicing ecological farming

Level of preparation	**U.M.**	**Age in organic farming**				**Total**	
		3 - 5 years	**6 - 7 years**	**8 - 9 years**	**> 10 years**	**no**	**%**
High-school studies	no.	1	8	1	0	10	14.2
Higher education	no.	16	21	15	8	60	85.7
Total	no.	17	29	16	8	70	100
	%	24.29	41.43	22.86	11.43	100	*
Indicator	$\chi2$	Threshold of significance					
	≤	0.2	0.1	0.05	0.01	0.001	
CHIINV (Chi teor.); GL = 3	≥	4.64	6.25	7.81	11.34	16.27	
CHITEST (Sig value)		0.061	CHIINV (Chi calc.)		7.35	Pearson Coef. The value $\chi2$ Poisson	0.308

Source: own processing.

Most respondents, regardless of the level of education, have been practicing organic farming for 6-7 years. There is a difference between the level of education in the case of those who practice organic farming for 8-9 years and more than 10 years. Thus, among the respondents with high school education, none has practiced organic farming for more than 10 years and only one for 8 - 9 years, and in the case of those with higher education, 15 respondents have been in this field for 8 - 9 years and another 8 for over 10 years.

Table 7. The correlation between the respondents age and the number of farms visited practicing ecological farming

Age	**U.M.**	**Organic farms visited:**					**Total**	
		0	**1 farm**	**2 - 3 farms**	**4 - 5 farms**	**> 7 farms**	**no**	**%**
≤ 35	no.	1	3	4	3	5	16	22.6
36 - 40	no.	1	3	5	3	1	13	18.5
41 - 50	no.	4	2	10	6	2	24	34.2
≥ 50	no.	2	3	3	2	7	17	24.2
Total	no.	8	11	22	14	15	70	100
	%	11.43	15.71	31.43	20.00	21.43	100	*
Indicator	$\chi2$	Threshold of significance						
	≤	0.2	0.1	0.05	0.01		0.001	
(Chi teor.); GL = 12	≥	15.8	18.55	21.03	26.22		32.91	
(Sig value)		0.398	CHIINV (Chi calculat)			12.6	Pearson Coef. The value $\chi2$ Poisson	0.39

Source: own processing.

The influence of the age of the respondents on the number of farms visited was also analyzed and it was found by calculating the Chi square test that there is no significant relationship between the two (Table 7). The calculated Chi of 12.6 has a lower value for the 0.05 significance threshold than the theoretical Chi of 21.03 (GL = 12). Among those who have not visited any farm, 2 respondents are under 40 years old, 2 over 50 years old, and 4 are in the 41-50 years old category. Those who visited 2 - 3 farms have the highest share, almost half of whom are between 41 - 50 years old. In the case of those who visited more than 7 farms, most are over 50 years old, followed by those under 35 years old. Nor does the gender of respondents influence the number of farms visited, the calculated Chi of 5.06 is lower than the theoretical Chi value of 9.49 (GL = 4) for the significance threshold of 0.05. We note that among those who have not visited any farm, 5 are female and 3 are male.

Table 8. The correlation between the age of the respondents and the degree of difficulty for production capitalization

Specification	**U.M.**	**Valorization of production**				**Total**	
Age		**Light**	**Medium**	**Difficult**	**Very difficult**	**no**	**%**
≤ 35	no.	1	4	5	6	16	22,86
36 - 40	no.	1		2	10	13	18,57
41 - 50	no.	3	6	10	5	24	34,29
≥ 50	no.	1	2	11	3	17	24,29
Total	no.	6	12	28	24	70	100
	%	8.57	17.14	40.00	34.29	100	*
Indicator	Test $\chi 2$	Threshold of significance					
	≤	0.2	0.1	0.05	0.01	0,001	
CHIINV (Chi teoretic); GL = 9	≥	12.24	14.68	16.92	21.67	27.88	
CHITEST ((Sig value))	0.0506	CHIINV (Chi calculat)		16.88	Pearson Coef. The value $\chi 2$ Poisson		0.441

Source: own processing.

The conducted survey showed that a percentage of 40% of respondents hardly capitalize on the production achieved and another percentage of 34.29% very difficult. Only 6 farmers, representing 8.57% of those interviewed, believe that they have no problems in capitalizing on production, and for 17.14%, this operation assumes an average degree of difficulty. The answers given to this question are influenced by the age of the respondents as indicated by the calculation of the Chi-square test in Table 4, 5, 6. The calculated Chi of 16.88 has a value close to the theoretical Chi of 16.92 (GL = 9) for the significance threshold of 0.05, which indicates a strong correlation between the age of the respondents and the answers given to assess the degree of difficulty in capitalizing production with a probability of about 95 % (Table 8).

Table 9. The assessment of the degree of difficulty for capitalizing the production according to the level of training and the gender of the respondents

Specification	**U.M.**	**Valorization of production**				**Total**	
Level of preparation		**Light**	**Medium**	**Difficult**	**Very difficult**	**no**	**%**
High-school studies	no.	1	2	5	2	10	14.29
Higher education	no.	5	10	23	22	60	85.71
Gender	**U.M.**	**Light**	**Medium**	**Difficult**	**Very difficult**	**no**	**%**
Female	no.	2	1	9	12	24	34.29
Male	no.	4	11	19	12	46	65.71
Total	no.	6	12	28	24	70	100
	%	8.57	17.14	40.00	34.29	100	*

Source: own processing.

The level of education or the gender of the respondents have no influence on the answers given by the respondents regarding the degree of difficulty in capitalizing on production (Table 9). Following the calculation of the Chi square test, it was found that the calculated Chi has a lower value compared to the theoretical Chi for a significance threshold of 0.05. Among the 6 respondents who considered that they capitalize their production easily, 5 have higher education, 4 are men, and half of them belong to the age group of 41 - 50 years.

In the case of the 24 respondents who rated this operation as very difficult, we note that most of them belong to the age group between 36 and 40 years old, 22 of them have higher education and 50% are male and the other half are female female.

Table 10. The respondents' structure according to the planning way of the production structure

Specification	U.M.	Are you planning your production structure based on previously concluded capitalization contracts?		Total	
Level of preparation		**Yes**	**No**	**no**	**%**
High-school studies	no.	2	8	10	14.29
Higher education	no.	28	32	60	85.71
Age	**U.M.**	**DA**	**NU**	**no**	**%**
≤ 35	no.	8	8	16	22.86
36 - 40	no.	7	6	13	18.57
41 - 50	no.	9	15	24	34.29
≥ 50	no.	6	11	17	24.29
Gender	**U.M.**	**DA**	**NU**	no.	**%**
Female	no.	8	16	no.	34.29
Male	no.	22	24	no.	65.71
Total	no.	30	40	no.	100
	%	42.86	57.14	no.	*

Source: own processing.

From the conducted survey, it emerged that 42.86% of the farms make their production plan based on the contracts already concluded, and the remaining 57.14% plan their structure according to other criteria (Table 10). From the analysis of the influence of the level of education, the age or the gender of the respondents on the planning of the crop structure based on the capitalization contracts, with the help of the Chi square test, it emerged that there is no statistically significant connection between them. The calculated Chi had lower values than the theoretical Chi for a significance threshold of 0.05. Among the 30 farmers who plan their production based on previously concluded contracts, 28 farmers have higher education, 8 are female and 22 male, 8 farmers are under 35 years old, 7 between 36 - 40 years old, 9 farmers belong to the age category of 46-50 years and 6 have exceeded 50 years.

Table 11. The respondents' structure according to the possession of storage spaces, annexes or constructions

	U.M.	You own storage spaces and other annexes and construction?		Total	
Level of preparation		**Yes**	**No**	**no**	**%**
High-school studies	no.	3	7	10	14.29
Higher education	no.	32	28	60	85.71
Age	**U.M.**	**DA**	**NU**	**no**	**%**
≤ 35	no.	7	9	16	22.86
36 - 40	no.	5	8	13	18.57
41 - 50	no.	12	12	24	34.29
≥ 50	no.	11	6	17	24.29
Gender	**U.M.**	**DA**	**NU**	**no**	**%**
Female	no.	9	15	24	34.29
Male	no.	26	20	46	65.71
Total	no.	35	35	70	100
	%	50.00	50.00	100	*

Source: own processing.

Of the studied farms, only half also have storage spaces, annexes or other constructions (Table 11), from which it can be deduced that the other half utilizes their production immediately after harvesting.

Among the 35 farmers who own such premises, 32 have higher education, and most are over 40 years old, and most of them are male and only 9 are female.

Calculating the Chi-square test, it was found that there is no statistically significant correlation between the level of education, age or gender of the respondents and the possession of storage spaces.

Table 12. The correlation between the respondents' level of training and the destination of ecological products

Level of preparation	**U.M.**	**Commercialization of ecological products is done in:**				**Total**	
		In the country	**Out of the country**	**Both**	**No**	**no**	**%**
High-school studies	no.	3	1	1	5	10	14.29
Higher education	no.	26	7	25	2	60	85.71
Total	no.	29	8	26	7	70	100
	%	41,43	11,43	37,14	10.00	100	*
Indicator	Test χ2	Threshold of significance					
	≤	0,2	0,1	0,05	0.01	0.001	
CHIINV (Chi teoretic); GL = 3	≥	4.64	6.25	7.81	11.34	16.27***	
CHITEST ((Sig value)	0.0001	CHIINV (Chi calculat)		21.37	Pearson Coef. The value χ2 Poisson		0.484

Source: own processing.

The structure of the respondents, according to age and gender, according to the destination of organic agricultural production, is presented as follows: among those who sell production outside the country, 17 are men and 12 are women, 8 are under 35 years old and 15 are over 40 years old; those who trade in the country 6 are men and 2 women, of which 3 are under 35 years old, 2 are between 36 - 40 years old and 3 are between 41 - 50; among the farmers who sell their production both in the country and outside it, 20 are men and 6 are women, and most are over 41 years old (Table 12).

Table 13. The respondents' structure according to the destination of ecological products from the farm

Age	**U.M.**	**Commercialization of ecological products**				**Total**	
		In the country	**Out of the country**	**Both**	**No**	**no**	**%**
≤ 35	no.	8	3	4	1	16	22.86
36 - 40	no.	6	2	3	2	13	18.57
41 - 50	no.	10	3	10	1	24	34.29
≥ 50	no.	5		9	3	17	24.29
Gender	**U.M.**	**In the country**	**Out of the country**	**Both**	**No**	**no**	**%**
Female	no.	12	2	6	4	24	34.29
Male	no.	17	6	20	3	46	65.71
Total	no.	29	8	26	7	70	100
	%	41.43	11.43	37.14	10.00	100	*

Source: own processing.

As specified, 7 respondents do not market the production obtained, of which 3 are men and 4 women, 1 is under 35 years old, 2 between 36 - 40 years old, 1 between 41 - 50 years old and 3 over 50 years old. No significant correlation was observed between the gender or age of the respondents and the destination of the production, after calculating the Chi-square test (Table 13).

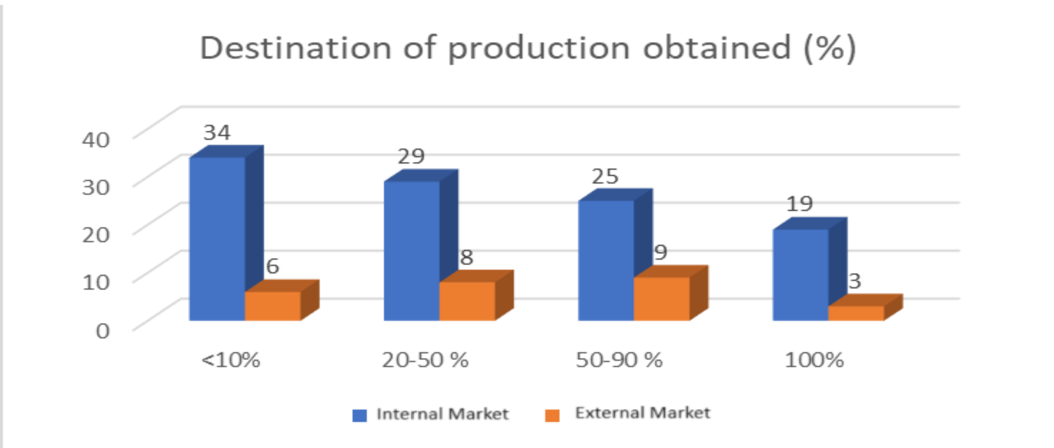

Fig. 1. The ecological agricultural production percentage sold on the domestic or foreign market
Source: own processing.

Regarding what % of the organic agricultural production obtained is sold on the domestic or foreign market, it was found that: among those who sell production on the domestic market, 34 farmers sell below 10%, 29 between 20 - 50%, 25 between 50 - 90 % and only 19 respondents sell all production in the country; among those who export the production obtained, the percentage that goes outside the country is below 10% for 6 farms, between 20 - 50% in the case of 8 farms, 50 - 90% for 9 farms and only 3 farms sell their entire production on the foreign market (Figure 1).

CONCLUSIONS

The principles of ecological agriculture refer to: the principle of human, soil, plant and animal health; the ecological principle based on living ecological systems; the principle of the correctness of relations between man and the environment, of respect for the chances of life, of equity, respect, justice and solidarity among people, as well as in their relations with other living beings and the principle of precaution in the sense that ecological agriculture must be practiced prudently and responsibly in order to protect the soil and the health and well-being of current and future generations.

Organic farming could feed Europe until 2050 and still export grain to countries that need it for human food. The research team that issued such a thesis is based on three levers [1]. The first would involve a change in the diet with 30% protein intake of animal origin and 70% protein intake of vegetable origin; the second lever refers to bringing cereal crops and livestock closer to each other, returning to mixed farming to enable closed cycles of organic and nutrient import and export from the soil, and establishing crop rotations and legumes, which have the advantage of fixing nitrogen in the soil.

In Romania, ecological agriculture represents a dynamic sector, which has seen an upward evolution, the cultivated areas represented about 2.18% in 2010, and in 2020 it will reach a share of 3.15%.

The conducted study highlighted the fact that the motivation for practicing ecological agriculture in order of importance were: subsidies, winning a project, the high price of ecological products and the production of healthy food; according to the degree of satisfaction: a percentage exceeding 68% have a high or very high degree of satisfaction; 28.57% have an average degree and only 2.8% (2 respondents) are a little satisfied with their work; regarding the descendants, it is found that out of the 70 respondents, 32 are certain that they will have someone to take over the business, on the other hand, for 22 of them there is no such certainty and 16 respondents stated that it is possible.

Regarding the exploitation of ecological production, it turns out that the destination of production is 41.4% only in the country, 11.4% outside the country and 37.1% both in the country and outside the country.

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THE INFLUENCE OF FOLIAR FERTILIZER APPLICATION ON THE MACRO AND MICRO NUTRIENT CONTENT AND YIELD OF WHEAT PLANTS (*TRITICUM AESTIVUM*)

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Abstract

In 2022, on the chernozem from Caracal, in the wheat soils sown on 1,100 ha in the production farms of SCDA Caracal, the non-didactic department of the University of Craiova, in two locations: Caracal and Stoenești, FOLIQ 36 Nitrogen was administered to 7 wheat varieties: Glosa, Otilia, Izvor, Avenue, Gabrio, Euclide and Caro line. Leaf samples were taken from 13 physical blocks (one not treated with foliar fertilizer and 12 fertilized with foliar in two doses) in accordance with the leaf sampling instructions approved by the Analitycal Services Laboratory of Yara UK Limited-Packlington. Macro- and micro-nutrients were determined by laboratory analysis in England as follows: nitrogen (%), phosphorus (%), potassium (%), calcium (%), magnesium (%), sulphur (%), iron (ppm), zinc (ppm), manganese (ppm), boron (ppm), copper (ppm), molybdenum (ppm). Interpretation of the results showed that a dose of 1 l/ha significantly increased the zinc content, iron content and nitrogen content of the plant; significantly distinctive also the copper and sulphur content of the plant was increased; very significantly increased were the boron content and phosphorus content of the plant. The same dose also influenced yield very significantly. In general, Gabrio, Avenue and Euclide varieties showed high yields but also high nitrogen, boron, copper, calcium and phosphorus contents.

Key words: *foliar fertilizers, increase, macroelements, microelements, wheat, yield*

INTRODUCTION

Among cereals, common wheat (*Triticum aestivum ssp. vulgare*) is the most important crop, constituting the basis of human nutrition. The large share of the world's wheat-growing area also highlights the economic importance of this particular crop compared to other cereals. About 60% of wheat production is used for food and the concentration of macro- and microelements found in grains is, therefore, of great importance. In developing countries, it contributes to the edible dry matter and daily net intake of calorie consumption by 28% and 60%, respectively [27].
To increase crop yields, an important role is played by mineral fertilization (especially nitrogen and phosphorus), which is also the most expensive input in crop management, given the exaggerated increase in their prices over recent years. Fageria et al. [7] concluded that essential crop nutrients are applied to the soil to be taken up by the root system. It is also possible to use macro- and micronutrients as foliar fertilizers, which has an important economic and environmental impact [23].
Foliar fertilization is a procedure frequently and increasingly used recently for plant cultivation technologies. In agricultural practice, foliar spraying is often preceded by an assessment of the plant's nutritional status and field architecture. Various methods, both destructive and non-destructive, serve this purpose [23]. Jankowski et al. [10] pointed out that foliar fertilizers allow increasing

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wheat yield without damaging the natural environment.

The effectiveness of foliar fertilizers depends on several factors such as: soil nutrient reserve, previous crop type, applied dose, date of fertilization, weather conditions at the time of fertilization [11]. Tsvey et al. [29] found that spring fertilization has the most importance for winter wheat.

Foliar application of nutrients is an important crop management strategy to maximise crop yield and increase nutrient concentration for the edible parts of plants. The production of cereals with sufficiently high concentrations of mineral nutrients is of great importance for human and animal nutrition.

Foliar fertilizers are increasingly used in agricultural practice to maximize yield potential for *Triticum aestivum* L. Foliar fertilization can effectively reverse nutrient (macronutrient) deficiencies, and can be used as the main method of supplying the micronutrients needed by plants [10, 17, 18].

Nutrient content is an important quality characteristic of edible and fodder cereals [23], so that the production of healthy cereals is a high priority in maintaining human and animal health.

Many of the nutrient accumulation studies regarding wheat and other cereal crops have typically investigated only macronutrients. Investigations in this regard, including micronutrient accumulation for cereals date back more than 20 years and have involved older varieties that may differ considerably from modern varieties in terms of nutrient metabolism.

Updated knowledge on the accumulation of macro- and micronutrients for wheat during growth, especially under N fertilization conditions, is important and may have implications for crop nutrient management [9].

The economic value of wheat varieties is determined by yield size and its quality.

In this context, the objective of this study was to determine the effect of foliar fertilizer use on the yield and macro- and micronutrient content of wheat plants grown on a chernozem soil at SCDA Caracal - Romania.

MATERIALS AND METHODS

Characteristics of the experimental site and climatic trend

The experiments were set up in 2022, on a chernozem soil in the production farms of SCDA Caracal, the non-didactic department of the University of Craiova (Romania), in two locations: Caracal and Stoenești.

Caracal region is located in the South of the country (Coordinates: 44°06′45″N 24°20′50″E), on the plains between the lower parts of the Jiu and Olt rivers. The region's plains are well known for their agricultural specialty in cultivating grains.

Stoenești is a commune in the Olt county, Romania, being located in the South of the country (Coordinates: 44°05′54″N 24°29′02″E).

The climatic characteristics of the studied regions are presented in Table 1.

During the months in autumn and winter, temperatures were much higher than the multiannual average. In spring, monthly average temperatures deviated from the multiannual average, with negative deviations in March and April. Since May, temperatures have been above normal, combined with a lack of precipitation just during the grain filling period.

The number of days with temperatures ≥30^0C was extremely high: 9 days in May and 26 days in June in Caracal, an absolute record in the last 5 years. In terms of rainfall, 364 mm were recorded in Caracal between October 1, 2021 and June 30, 2022, by only 25.5 mm less than the multiannual average, but with uneven distribution. In Stoenești, the difference was far greater, over 70 mm for the entire growing season.

Rainfall in October (101.4 mm and 92.0 mm respectively) contributed to a good seedbed preparation and uniform plant emergence. Heavy rainfall, above normal, was recorded only in December and April. The climatic conditions did not ensure favourable development of the wheat crop, with yields being quite low for the area's soil potential.

Table 1. The climatic characteristics of the studied regions*

	Specification	X	XI	XII	I	II	III	IV	V	VI	TAY	AAY
CARACAL												
T °C	Monthly average	10.2	7.4	2.6	2.0	4.2	4.3	11.1	18.1	23.0		9.2
	The absolute minimum	-0.6	-2.3	-8.6	-9.2	**-9.8**	-8.5	-3.5	3.5	12.2		
	The absolute maximum	23.9	23.1	14.3	15.5	17.4	22.5	26.0	32.4	**38.6**		
	No of days with $T^0 \geq 30^0C$	-	-	-	-	-	-	-	9	26	35	
	No of days with $T^0 \leq -10^0C$	-	-	-	-	-	-	-	-	-		
	Normal	11.7	5.1	0.3	-1.3	0.8	6.0	12.0	17.7	21.6		8.2
	Difference ± Normal	-1.5	+2.3	+2.3	+3.3	+3.4	-1.7	-0.9	+0.4	+1.4		+1.0
Pp (mm)	Monthly total	101.4	28.0	60.8	19.2	4.8	13.2	77.8	44.6	14.2	364.0	
	Multiannual average	46.0	37.0	39.1	30.8	26.3	34.2	47.8	58.6	69.7	389.5	
	Difference ± Normal	+55.4	-9.0	+21.7	-11.6	-21.5	-21.0	+30.0	-14.0	-55.5	-25.5	
STOENEȘTI												
T °C	Monthly average	10.3	7.9	2.9	2.3	4.8	5.0	11.3	17.5	21.6		9.0
	The absolute minimum	-0.1	-1.2	-7.8	**-10.8**	-7.6	-8.6	-1.3	5.0	11.6		
	The absolute maximum	22.8	23.7	15.2	16.2	16.6	23.2	24.3	31.2	**35.3**		
	No of days with $T^0 \geq 30^0C$	-	-	-	-	-	-	-	3	14	17	
	No of days with $T^0 \leq -10^0C$	-	-	-	-	-	-	-	-	1	1	
	Normal	11.7	5.1	0.3	-1.3	0.8	6.0	12.0	17.7	21.6		8.2
	Difference ± Normal	-1.4	+2.8	+2.6	+3.6	+4.0	-1.0	-0.7	-0.2	0.0		+0.8
Pp (mm)	Monthly total	92.0	18.0	62.4	10.3	2.0	5.6	50.4	45.0	26.5	312.2	
	Multiannual average	46.0	37.0	39.1	30.8	26.3	34.2	47.8	58.6	69.7	389.5	
	Difference ± Normal	+46.0	-19.0	+23.3	-20.5	-24.3	-28.6	+2.6	-13.6	-43.2	-77.3	

*T^0 = Temperature; Pp = Precipitations; TAY = Total agricultural year; AAY = Average of the agricultural year.
Source: Own calculation.

Treatments, Experimental Design, and Crop Management

The FOLIQ 36 Nitrogen foliar fertilizer containing 36% N + 4% MgO + microelements (boron, copper, iron, manganese, molybdenum and zinc) - producer and distributor Agrii Romania - was applied to 7 wheat cultivars: Glosa, Otilia, Izvor, Avenue, Gabrio, Euclide and Caro line in wheat soils sown on 1,100 ha in production farms at the two locations.

Three leaf samples were taken from 13 physical blocks (one not treated with foliar fertilizer and 12 foliar-fertilised at 0.5 l/ha and 1 l/ha) in accordance with the sampling instructions approved by the Analitycal Services Laboratory of Yara UK Limited-Packlington (York, YO42 1DN).

Three hundred grams of clean, pathogen-free flag leaves were randomly sampled, stored in ziblock bags and labeled with field data: sample reference, location, physical block, sample number, culture, date received.

Half of the samples were taken from physical blocks fertilised with 0.5 l/ha at various fertilisation rates (Glosa BF 301, Glosa BF 27, Glosa Stoe BF 304, Izvor Stoe BF 292, Izvor + Otilia BF 291, Otilia BF 515) and the other 6 from physical blocks with the second treatment (total dose of 1 l/ha) (Caro 1, Caro 2, Caro 4, Avenue, Gabrio, Euclide).

The macro- and micro-nutrient content of the plants was determined by laboratory analysis in England as follows: nitrogen (%), phosphorus (%), po-tassium (%), calcium (%), magnesium (%), sulphur (%), iron (ppm), zinc (ppm), manganese (ppm), boron (ppm), copper (ppm), molybdenum (ppm).

Starting from the implications of macro- and microelements on the development of the wheat plant, their values were analysed in relation to the reference value, the correlations between yield and each element, as well as the influence of treatment on yield according to the application rate of foliar fertilizer.

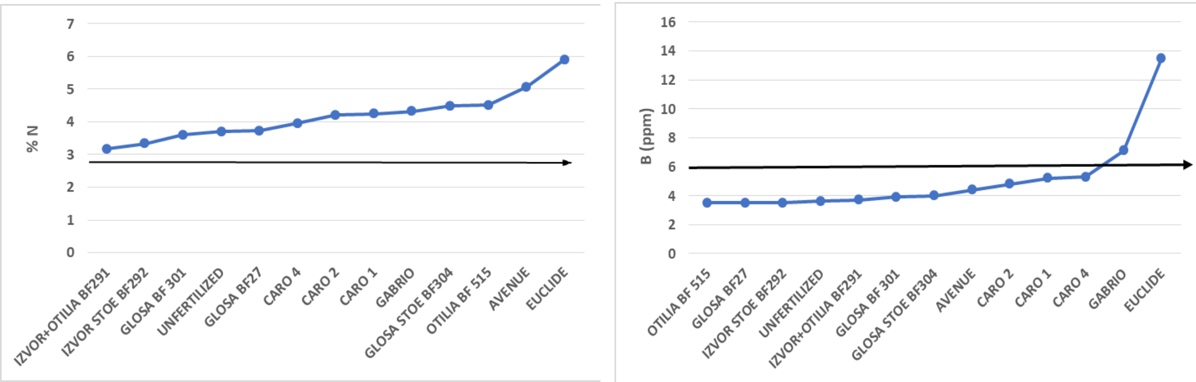
Statistical Analysis

To process the data, the limiting differences (LD) were calculated through the analysis of variance for three variants: unfertilized, one treatment with Folique 36 Nitrogen and 2 treatments with Folique 36 Nitrogen in 6 repetitions; to determine a linear relationship between two variables, Pearson's test was used to indicate the direction and strength of the relationship through correlation coefficients; the amplitude of the macro and microelement content was graphically displayed and correlated with the reference value.

RESULTS AND DISCUSSIONS

Macro and microelement content of wheat plants

The *nitrogen* content ranged from 3.17% to 5.9%, with a reference value limit of 3 (Figure 1a). All variants analysed had values above this limit. Thus the formation of chlorophyll, essential for photosynthesis, took place, resulting in greener, well-developed crops in all variants but especially for Avenue and Euclid. The boron content ranged from 3.5% to 13.5%, with a limit of 6 (Figure 1b). Of the variants analysed, only Gabrio and Euclide were well above the reference value, indicating that the two had a higher capacity for grain formation, boron being important for pollen germination and pollination.



(a) (b)

Fig. 1. Nitrogen content (%) (a) and boron content (%) (b) for the wheat plants analysed
Source: Own calculation.

In terms of *calcium* concentration, whose reference value is 0.4%, the variants analysed ranged from 0.28 to 0.57 (Figure 2a). Half of the variants were above the reference value, the highest values being recorded by Otilia BF515, Avenue and Euclid. Calcium in higher concentration helped the development of roots and aboveground parts.

Copper, another extremely important macro-element in plant development, including disease resistance, recorded values between 5.6-12.1%, the reference value being 7% (Figure 2b). Half of the values obtained were above this limit but Otilia, Avenue, Gabrio and Euclid stood out clearly. These were also the most productive, with copper playing an important role in grain development and its number.

The *iron* content ranged from 89 ppm to 194 ppm, with the reference value limit being 50 ppm (Figure 3a). All variants analysed had values above this limit. Plants in all variants showed healthy vegetative growth, especially Caro and Avenue.

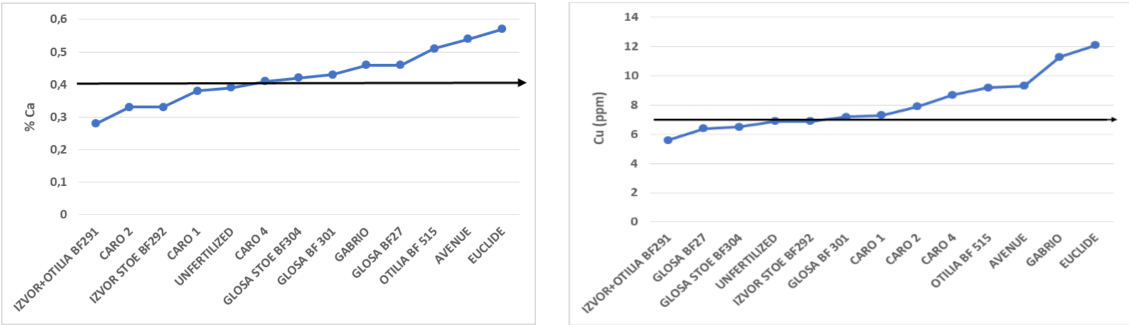
Phosphorus content, also extremely important, had values between 0.25 and 0.47 ppm, the reference value being 0.3 ppm (Figure 3b). Most of the variants were above this limit. The highest values were recorded by Gabrio and Euclid which explains the high active uptake of other elements in these varieties, with them having in most cases high values of macro and mi-croelements.

Magnesium recorded values of 0.08-0.21 ppm, the reference value being 0.12 ppm. With the exception of two, both belonging to the Izvor variety, all others were above the reference value (Figure 4a).

Manganese, which is important for root and aboveground growth, recorded values between 34.1-129 ppm. With one exception (Izvor + Glosa mixture), all values were above the reference value - 35 ppm (Figure 4b).

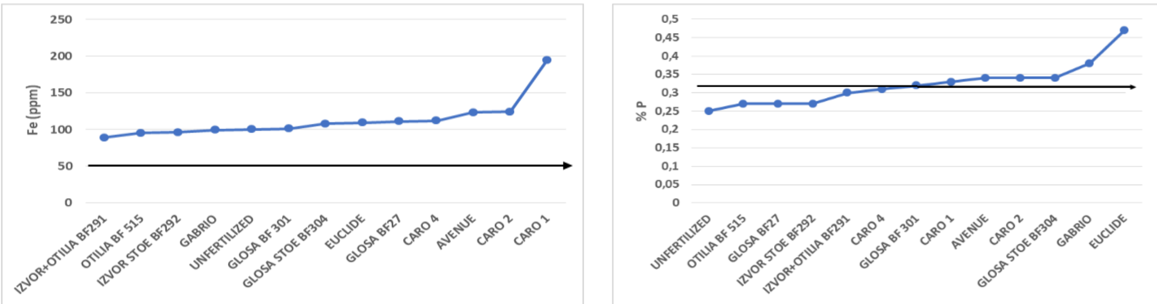
Molybdenum values ranged from 0.08-0.56 ppm, compared to a reference value of 0.1 ppm. As for manganese, with one exception (Glosa variety), all molybdenum values are above the reference value (Figure 5a).

Potassium, an extremely important macroelement in the development of disease resistance, was quite low for wheat plants (2.48-4.6%). Only the variety Euclid recorded values above the reference limit - 3.6% (Figure 5b).



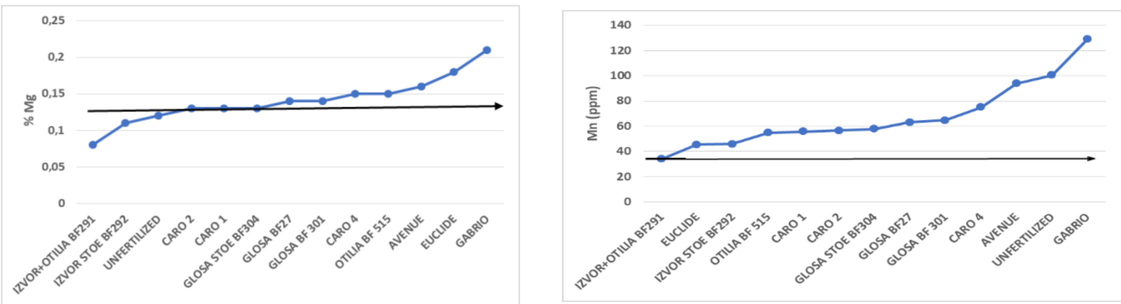
(a) **(b)**

Fig. 2. Calcium (%) (a) and copper (%) (b) content for the wheat plants analysed.
Source: Own calculation.



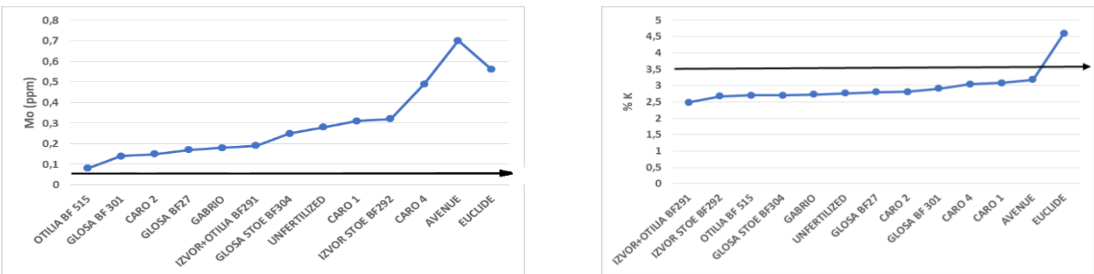
(a) **(b)**

Fig. 3. Iron (ppm) (a) and phosphorus (ppm) (b) content for the wheat plants analysed.
Source: Own calculation.



(a) **(b)**

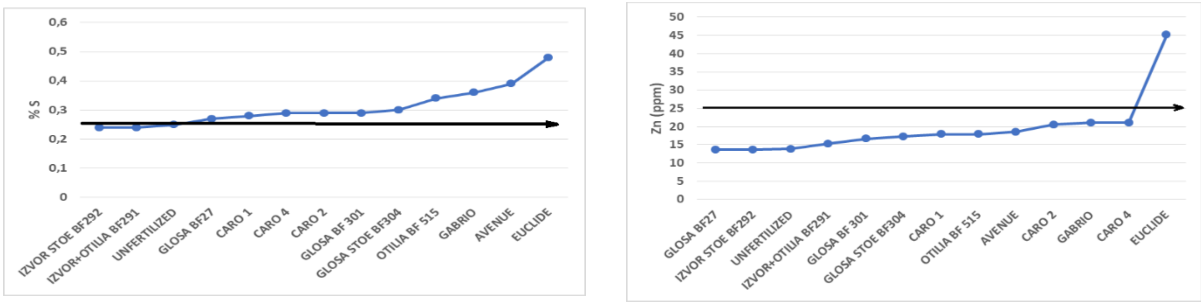
Fig. 4. Magnesium (ppm) (a) and manganese (ppm) (b) content for the wheat plants analysed.
Source: Own calculation.



(a) **(b)**

Fig. 5. Molybdenum content (ppm) (a) and potassium content (%) (b) for the wheat plants analysed.
Source: Own calculation.

Sulphur is much more present in plants, with values ranging from 0.24 to 0.48 ppm. Besides two exceptions, both related to the Izvor variety, all the others recorded values above the reference limit - 0.25 ppm (Figure 6a). As in the case of potassium, *zinc* is found in lower concentration at wheat plants (13.7-45.2 ppm). Above the refer-ence value of 25 ppm, only Euclid is found (Figure 6b).



(a) **(b)**

Fig. 6. Sulphur (ppm) (a) and zinc (pm) (b) content for the wheat plants analysed.
Source: Own calculation.

Regarding the influence of foliar fertilizer treatment on wheat on the content of macro and microelements, it was observed that a single treatment with a dose of 0.5 l/ha is not sufficient to improve their content. Moreover, it leads to a distinctly significant decrease in manganese content, thus seriously damaging the chlorophyll forming process.

Treatment with 1 l/ha foliar fertilizer significantly improves nitrogen content, zinc content, iron content; distinctly significantly improves copper content, sulphur content, very significantly improves boron content. Thus, the treatment has a major influence on healthy vegetative growth, grain and yield formation and on raising the level of disease tolerance (Figure 7).

Influence of foliar fertilizer treatment on wheat yield

In terms of yield, it ranged from 3,500 kg/ha for the variant not treated with foliar fertilizer, to 5,897 kg/ha for the variant treated with 1 l/ha, the increase being very significant (Figure 8). This increase in yield was recorded when each of the physical blocks analysed had a base fertilisation provided by solid chemical fertilisers, as shown in Table 2.

The two aspects highlighted below show that Avenue, Euclide and Gabrio varieties benefited from a much higher nitrogen input, resulting in significantly higher yields. In conclusion, the analysis of the yield obtained is based on its variability according to the nitrogen supply, which is also variable. The correlation coefficient (r = 0.723) shows that the two elements are highly positively correlated. An increase in the nitrogen supply also brought with it an increase in production. Figure 9 shows the amount of wheat yielded at an input of 1 kg nitrogen active substance (a.s.)/ha, differentiated from 31.8 kg to 58.5 kg. Although with a lower yield, the Izvor variety made better use of each kg of nitrogen a.s./ha on the Caracal chernozem (58.5 kg wheat/1 kg nitrogen a.s.). Hypothetically, equalizing the amount of nitrogen applied by solid chemical fertilizers, the results suggest that the variability of yield is given by the foliar fertilizer input. In practice, the genetic contribution of the variety in terms of production capacity, its capacity to valorise nitrogen and the climatic conditions that have been differentiated from one location to another must be taken into account.

The N nutritional status of wheat is affected not only by the amount of N accumulated in the plant, but also by other nutrients that are responsible for its uptake and subsequent transformation in plant [1]. This applies to nutrients such as Ca, P, K, Mg, S and micronutrients. The availability of these nutrients depends on the pH of the soil, which also affects the architecture of the root system [14].

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Fig. 7. Influence of foliar fertilizer treatment on the content of macro- and microelements for wheat plants grown at Caracal.
Source: Own calculation.

Following foliar fertilization with FOLIQ 36 Nitrogen, from our experience, all the variants tested recorded plant nitrogen content values above the reference limit, with two of the varieties standing out as greener and better developed crops. As other studies have suggested, intensive wheat fertilization with N is a common strategy to achieve high yield and high N content in the grain [21]. The wheat management strategy requires an in-depth assessment of the effectiveness of the applied rates of N fertilizers, as other authors have also noted [28].

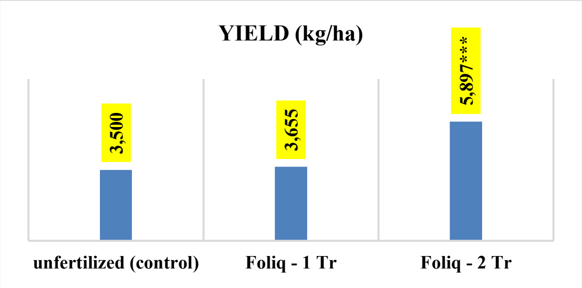

Fig. 8. Influence of foliar fertilizer treatment on wheat yield (Kg/ha)
Source: Own calculation.

Table 2. Fertilisation level of the variants analysed

Variant	Foliar fertilizer dose (l/ha)	Intake N	Intake P
Unfertilized (Control)	0	99	34
GLOSA BF301	0.5	65	0
GLOSA BF27	0.5	65	0
GLOSA STOE BF304	0.5	65	0
IZVOR STOE BF292	0.5	65	0
IZVOR+OTILIA BF291	0.5	65	0
OTILIA BF515	0.5	99	34
CARO 1	1	140.00	50
CARO 2	1	140.00	50
CARO 4	1	140.00	50
AVENUE	1	130.00	40
EUCLIDE	1	130.00	40
GABRIO	1	130.00	40

Source: Own calculation.

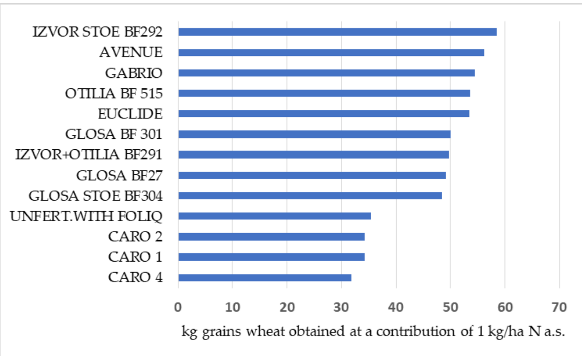

Fig. 9. Nitrogen valorisation in terms of the quantity of wheat obtained per 1 kg nitrogen a.s. administered/ha
Source: Own calculation.

Boron is an important element for pollen germination and pollination [20]. Our results showed that only two variants passed well above the reference value, indicating that they had a higher grain forming capacity. However, as some studies show, the boron applied to the soil was more effective than boron foliar applications [25]. On the other hand, the application of calcium in higher concentrations helped the development of roots and aboveground parts of the wheat variants tested. This is also consistent with other results obtained both for wheat [16] and other plants [30].

In the case of copper, half of the values obtained were above the reference limit, but four variants stood out in terms of productivity. This confirms the importance of copper in grain development and its numbers.

Iron content was above the reference value, with direct implications for vegetative growth in all wheat variants analysed. This is also supported by other authors, as iron is essential for the formation and function of chlorophyll and, therefore, for healthy vegetative growth [5, 15].

From experience, it has been found that a single treatment with 0.5 l/ha FOLIQ 36 Nitrogen is not sufficient to improve the macro and micro nutrient content of wheat plants. On the contrary, it leads to a distinctly significant decrease in the manganese content, thus causing serious damage to the chlorophyll forming process, as has been reported by other authors [32].

Potassium, an extremely important macro-element for the absorption and redistribution of water and nutrients of plants, was rather low for the wheat plants tested, with only one variety showing a value above the reference limit. Treatment with 1 l/ha foliar fertilizer improved the macro and microelement content of wheat plants suggesting major influence on healthy vegetative growth, grain and yield development and increased disease tolerance levels, in line with other results from the field [3, 4, 14].

The proper management of nutrients is necessary for a successful wheat crop production. Generally, the cautious nutrient supply at the right time, right rate and right place has a tremendous effect on wheat yield and ensures the health and consistency of soils and the environment [19, 22].

Wheat grain yields show a linear, and at the same time, a strong depend-ence on grain density, especially for modern wheat varieties

[24]. The size of wheat grain yields depends on the nitrogen supply to plants over a period of time from stem elongation to heading [8, 31]. The results of our study showed that an increase in the nitrogen supply also resulted in an increase in yield, with the results suggesting that the variability in yield is due to foliar fertilizer supply, as noted by other authors [2, 28]. In practice, however, the genetic contribution of the variety in terms of its production capacity, its ability to utilize nitrogen, and the climatic conditions that differed from one location to another must be taken into account. This hypothesis is also supported by other authors [11, 29].

The economic value of wheat varieties is determined by the size of production and its quality. In this sense, in order to assess the extent to which the content of macro- and microelements of the plant influences wheat yield, the correlations between them were analysed, highlighting the varieties that responded best to the fertilizer input through the content analysed.

It should be noted that the correlation between iron content and yield was not revealed, the coefficient of determination and the correlation coefficient being practically insignificant. The results suggest that high iron content for the plant does not necessarily ensure a high yield, as iron is only essential for healthy vegetative growth. However, similar to other essential plant nutrients, iron plays multiple roles within a plant [6, 12, 13, 26]. Following the results presented and by analysing them, some clear recommendations for improving the content of macro and microelements in the plant in the sense of balance were outlined for each wheat variety tested. This could be particularly essential for increasing wheat yield, especially on low to medium fertility soils. In this context, we plan to further research this topic in the future, at other locations and on other soil types.

CONCLUSIONS

The results showed that a dose of 1 l/ha foliar fertilizer significantly improved the zinc content, iron content and nitrogen content of the wheat plant; distinctly significantly improved the copper content and sulphur content of the plant; very significantly improved the boron content and phosphorus content of the plant. These results suggest that the treatment has a major influence on healthy vegetative growth, grain formation and yield, and increased disease tolerance levels.

High coefficients of determination showed relationships between yield on the one hand and copper and sulphur content on the other hand. In general, Gabrio, Avenue and Euclide varieties showed high yields but also high nitrogen, boron, copper, calcium and phosphorus contents.

A single treatment with 0.5 l/ha foliar fertiliser is not sufficient to improve the plant's macro and micronutrient content. On the contrary, it leads to a distinctly significant decrease in the manganese content, thus seriously damaging the chlorophyll forming process.

Hypothetically, equating the amount of nitrogen applied by solid chemi-cal fertilizers, the results suggest that yield variability is driven by foliar fertilizer input. In practice, however, the genetic contribution of the variety in terms of its production capacity, its nitrogen utilisation capacity and climatic conditions must be taken into account.

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ECONOMIC IMPORTANCE AND PHYTOSANITARY MONITORING OF FIRE BLIGHT

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Abstract

Fire blight (FB) caused by Erwinia amylovora, is a bacterial plant disease that poses a significant threat to pome fruit production worldwide. It can cause extensive losses in fruit yields, damage orchards and lead to trade restrictions on fruit exports. Fire Blight (FB) can also affect the longevity and productivity of fruit trees, further exacerbating the economic burden on growers and increasing management expenses. Because Erwinia amylovora is a regulated pest in most countries of the EPPO region its phytosanitary monitoring is mandatory in order to prevent the disease extension and new outbreaks. The inspections were required during the growing season (from after flowering until late summer), when the signs were obvious to find the disease. Thus, during 2022 a phytosanitary monitoring plan of Fire Blight was organized by Phytosanitary Office from Dolj County, Romania and the results emphasized that the apple area infected with Erwinia amylovora represents 3.85% from the total apple trees area (1,558 ha), 27% from the total surface of pear trees (36 ha) and 100 % for quince trees (2 ha). Comparatively with the results of Fire Blight monitoring realized previous year (2021), in 2022 was identified one new outbreak, but only for apple trees. Also, among all assessed trees (348) 260 trees include Malus domestica (apple). Among the measures applied for Fire Blight control the most effective were reducing the bacterial inoculum by manual removal of infected shoots and even uprooting of trees.

Key words**:** *Erwinia amylovora, Fire Blight, apple, economic impact, integrated management*

INTRODUCTION

Fire Blight (FB) or Twig Blight of Apple (TBA) caused by *Erwinia amylovora* (Burrill), is a bacterial plant disease that poses a significant threat to pome fruit production worldwide, causing extensive losses in fruit yields, damage orchards, and lead to trade restrictions on fruit exports [4][24][30][28].
First reported in the United States in 1780 in the Hudson Valley, New York State, the disease has become a major concern for fruit growers due to its rapid spread, high infection rates, and potential to cause severe economic losses [3]. Since Fire Blight (FB) has spread around the world at date the disease has been officially recorded in more than 50 countries, mainly in western and eastern Europe and the eastern Mediterranean region, but also in South America, most African and Asian countries and Australia [10, 11].
The first signs of Fire Blight in Romania were discovered in the country's southern region in 1992 [22].
According to [15] the years 2016–2018 in the southern part of Romania were very favourable for the apple Fire Blight attack.
According to European and Mediterranean Plant Protection Organization, the pathogen is “black” listed as quarantine pest, code ERWIAM (Annex III), RNQP (Annex IV), 2022, (EPPO, http://www.eppo.org/QUARANTINE/quarantine.htm) [12]. Currently, the best ways to slow

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the development of disease and prevent losses are phytosanitary control and early eradication of any Fire Blight.

Fire Blight (FB) infect apple (*Malus domestica*), pear (*Pyrus communis*), quince (*Cydonia oblonga*), crab apple (*Malus sylvestris*), hawthorn (*Crataegus*), cotoneaster (*Cotoneaster divaricatus*), mountain ash (*Sorbus aucuparia*), firethorn (*Pyracantha coccinea*) and some other members of the Rosaceae family [5][16].

Among all host plants, apple (*Malus domestica*) and pear (*Pyrus communis*) are the most affected worldwide, especially in favourable climatic conditions for bacterial disease development (4°C–37 °C), the optimal temperature being 28 °C [29]. Thus, the Fire Blight epidemics depends on favourable environmental conditions, the amount of bacteria inoculum and host susceptibility.

The disease can be spread easily by vectors (wind, rain, insects, birds), but also by contaminated pruning tools and infected plant material [25]. However, the bacteria that cause Fire Blight are capable of surviving in the orchard without infecting or manifesting symptoms on apple trees.

Bacteria swiftly multiply and invade tissue that is vulnerable once the favourable environmental conditions are established, leading to infection and disease.

[20] came to the conclusion that the risk of spreading *E. amylovora* through commercial apple fruits to disease-free areas is negligible using a predictive model under several scenarios.

The symptoms of the disease might vary depending on the plant section and phenological stage, including blossoms, leaves, shoots, branches and roots, being able to devastate apple trees within one season, especially on sensitive genotypes [13]. Also, the bacteria *Erwinia amylovora* attacks fruits in all stages and reduces their size and quality [18][19].

Only infected host plants experience overwintering by the Fire Blight (FB) virus. When the average temperature rises over 15°C in early spring, apple trees often start to exhibit their first signs. Blossoms that are infected get soggy, shrivel, wilt, and turn orange or brown to black. Additionally, peduncles can appear water-soaked, turn dark green, then turn brown or black, occasionally oozing sticky bacterial exudates in the infectious process. It's possible for the oozing from infected apple branches to be golden colour [1]. Infected leaves wilt and apple whole spurs turn brown or black, as well as young fruitlets that continue to be attached to the tree. Cankers that are brown to black and somewhat depressed develop on the bark of diseased trees' trunks, branches, and twigs. Later, these cankers develop fissures along the boundary between the diseased and healthy tissue.

The endophytic *E. amylovora* can spread to bacterial-free areas by attaching to interior tissues of multiplication material. Thus, the host plants that are latently infected or have invisible cankers are the principal vehicles for the Fire Blight pathogen's long-distance transmission.

One of the most effective ways to reduce the spread of Fire Blight and fruit tree losses is phytosanitary control. The development of warning systems based mostly on meteorological data has been made possible by the need to effectively and economically control the disease [14].

Considering the aspects above mentioned, the paper provides a comprehensive overview of the economic importance of Fire Blight (FB) and its broader implications for the agricultural sector and international trade, as well as crop surveillance and monitoring of the disease and its impact on apple trees in the conditions of integrated disease management.

MATERIALS AND METHODS

The current study's research, which is reported in this paper, used a qualitative informational methodology that included books, scientific publications, news items, reports, and websites. Thus, to offer an integrated assessment of the current state of knowledge on the topic of the paper, pertinent literature was found and synthesized [26].

To achieve this goal, systematic, semi-systematic, and integrative research approaches were used to compare current literature, papers, studies, reports, and statistics [23]. Additionally, the text mining approach, a well-known text analysis methodology used to draw connections and knowledge from a vast number of textual sources, was applied.

During 2022 a phytosanitary monitoring of Fire Blight (FB) was organized in Dolj County, Romania in apple, pear and quince orchards for preventing the spread of *E. amylovora* into uninfested areas. The monitoring was organized during the growing season when the symptoms were visible in the orchards.

There was assessed the total number of Fire Blight infections per apple tree. Fresh samples of diseased young shoots, flower clusters, leaves, and fruits with visible Fire Blight symptoms (necrosis, wilting, and bacterial ooze), were taken for the pathogen isolation and identification. Isolation of the pathogen was made from fresh samples (symptomatic shoots, flowers, leaves, fruits) according to the EPPO protocol (EPPO, 2013) [10]. Detection of the bacterium was done using PCR assays and MALDI-TOF mass spectroscopy protocols [21][27].

RESULTS AND DISCUSSIONS

Fire blight can cause severe economic losses for fruit producers due to reduced crop yields, fruit quality deterioration, and increased management expenses.

Even Fire Blight (FB) outbreaks may be sporadic due to specific environmental conditions (springs characterized by an extremely warm and wet weather), when they occur, they can cause significant losses in terms of lost trees or lost money. Moreover, Fire Blight (FB) is not only harmful to the trees that will be harvested this year, but it is also quite dangerous to the trees themselves. The

loss of fruiting spurs has a substantial impact on productivity the next year as well.

The economic impact is difficult to quantify because it depends on the intensity of the epidemic and a Fire Blight attack can have repercussions over several years.

Infected orchards may experience up to 60-90% yield losses and costs of controlling Fire Blight (FB) exceed $100 million annually, leading to decreased revenues and profitability for growers [17].

The disease also affects the longevity and productivity of fruit trees, further exacerbating the economic burden on growers. For example, in 2000, in Michigan, USA, serious Fire Blight issues occurred and that led to a $42 million regional economic loss and the eradication of 350,000–450,000 apple trees that covered roughly 626–930 ha. Previously, in 2019, the Fire Blight outbreak in Michigan, USA, resulted in losses of over $3.8 million. Also, apple and pear growers reported losses of over $68 million in 1998 as a result of fire blight outbreaks that were detected in Washington and northern Oregon, USA [6]. In Switzerland, the financial impact of control measures (from quarantine to diagnostics), along with compensation payments for destroyed trees, were estimated to be 35 million EUR over a 14-year period, from 1989 to 2003 [8]. Economic losses due to Fire Blight impact worldwide include direct losses from reduced yields and quality, as well as indirect losses from trade disruptions and management costs. This increases year by year from $500 million in 2018 to $800 million in 2022. Fire Blight (FB) has also far-reaching consequences for international trade in tree fruits (Table 1).

Table 1. Economic Losses Caused by Fire Blight in Tree Fruit Agriculture Worldwide

Year	Total Global losses (USD Million)	No. of Affected Countries	Yield loss (%)	Management costs (USD million)	Trade Disruptions (USD million)
2018	500	25	30	150	50
2019	600	30	35	180	70
2020	700	35	40	210	100
2021	750	40	45	225	120
2022	800	45	50	240	150

Source: own calculations.

Countries worldwide have imposed stringent phytosanitary regulations to prevent the introduction and spread of *Erwinia amylovora*.

Outbreaks of fire blight in exporting regions can lead to temporary or permanent trade embargoes, disrupting established supply chains and affecting economies on a global scale. Loss of market access may result in surplus fruit in affected regions, leading to lower prices and economic hardships for local growers. The interconnectedness of the global economy makes it susceptible to disruptions caused by fire blight outbreaks. Supply chain vulnerabilities in the tree fruit industry can be exposed when key exporting regions are affected. These vulnerabilities may result in food shortages, increased prices, and adverse economic impacts, especially in regions heavily reliant on tree fruit imports.

Moreover, the economic impact of Fire Blight (FB) can extend beyond the tree fruit industry to affect related sectors, such as logistics and retail, making the overall economic consequences even more complex to quantify accurately. Despite the sporadic occurrence of Fire Blight (FB), there is a trend toward increasingly frequent and destructive outbreaks, which can be associated to a number of aspects that have enhanced the susceptibility to Fire Blight, such as: a)increased orchard density (currently, fruits growers plant up to ten times as many apple trees per ha - 250-1,500 -instead of the previous 100-200 trees/ha); b) rootstocks susceptibility (M.9 and M.26 are two of the most popular rootstocks, but they are also quite vulnerable to fire blight); c) varieties (many of the most popular apple varieties that meet the demands of the fresh fruit market (e.g., Gala, Fuji, Jonagold, Braeburn, Pink Lady, Idared, Jonathan) are also highly susceptible to Fire Blight; d) unusual weather conditions in spring, which included a heat wave during bloom followed immediately by frost [14]. The injuries caused by Fire Blight in apple trees have a long-term effect because it is occasionally necessary to remove substantial pieces of the tree and thus the risk of dieback for the entire tree is increased.

Actually, during a fire blight outbreak, infections can occur in one of five different ways (Canker, flower, shoot, trauma, and rootstock blight). Meanwhile, not all infection types, manifest themselves throughout every disease outbreak. The sources of the inoculum, the tissues that are affected, and the meteorological factors that affect the infection process vary among these types. The signs of each form of infection can be very distinct, but once an epidemic is under way, it gets harder to differentiate them apart.

It is crucial to be able to identify the infection type in order to choose the best control strategy because not all infection types respond to the same control measures.

The infection spreads through susceptible hosts so quickly that once infected, trees cannot be saved, even by immediate and drastic surgery, and they die shortly after exhibiting the first signs of infection. Therefore, inspections are required during the growing season (from after flowering until late summer), when the signs are obvious, to find the disease. Thus, during 2022 in Dolj County, Romania the Fire Blight monitoring was done on 522 ha with the most susceptible hosts (500 ha apple, 200 ha pear and 2 ha quince).

The assessed surface was considered contaminated with *Erwinia amylovora* after pathogen isolation and positive results of laboratory test using PCR assays and MALDI-TOF mass spectroscopy protocols [21][27]. The results emphasized that the apple area infected with *Erwinia amylovora* represents 3.85% from the total apple trees area from the whole county (1,558 ha), 27% from the total surface of pear trees (36 ha) and 100 % for quince trees (2 ha).

Comparatively with the results of Fire Blight monitoring realized previous year (2021), in 2022 were identified new outbreaks only for apple trees. Also, among all assessed trees (348) 260 trees include *Malus domestica* (apple). Almost 26 ha of apple trees recorded moderate infection with *Erwinia amylovora* (20% attack degree), while 70 ha of apples recorded low infection level with the pathogen (5% attack degree) (Table 2).

Table 2. The Phytosanitary Monitoring of Fire Blight in 2022 in Dolj County, Romania

April – September 2022	Total orchard area (ha)	Assessed area (ha)	Complete monitoring area (ha)	Contaminated area (ha)	New outbreaks (ha)	No.of infected trees	Percent of area affected by Fire Blight				
							1	2	3	4	5
Apple	1,558	500	90	60	1	260		60		26	
Pear	36	20	10	10	-	60		10			
Quince	2	2	2	2	-	28			2		
TOTAL	1596	522	102	72	1	348		70	2	26	

Source: Dolj Phytosanitary Office, 2022 [7].

Previous research emphasized that Fire Blight progress in concerning issue in Africa too since 2013. [2] reported that Fire Blight has progressed most in rosaceous region from Morrocco affecting a total area of about 4,000 ha. Also, the Moroccan Plant Protection services reported that, he area of uprooted and incinerated orchards in the various affected provinces across the country was in the order of 2,312 ha [3].

Current control methods are diverse, but each has a limited effectiveness. Phytosanitary control and reducing the bacterial inoculum by manual removal of infected shoots or even uprooting of trees, seems to be the most effective (Table 3).

Table 3. The applied measures as a result of Phytosanitary Monitoring of Fire Blight in 2022, Dolj County, Romania

Host	**Fire Blight infected area (ha)**	**Trees uprooting (ha)**	**Non curative Manual removal of infected shoots (ha)**	**Curative Manual removal of infected shoots (ha)**
		April-Sept. 2022	April-Sept. 2022	April-Sept. 2022
Apple	60	10.5	60	170
Pear	10	0	10	120
Quince	2	0	2	80
Total	72	10.5	72	370

Source: Dolj Phytosanitary Office, 2022 [7].

Previous findings show that continuous monitoring, research, and international collaboration are essential to mitigate the economic impact of fire blight and ensure sustainable tree fruit production worldwide.

CONCLUSIONS

Fire blight, caused by *Erwinia amylovora*, is a critical concern for the global tree fruit industry, significantly impacting fruit producers and international trade. Understanding the economic importance of the disease and its implications on global trade is essential for designing sustainable strategies to mitigate losses and secure the supply of pome fruits in the global marketplace. Efforts to manage and control Fire Blight (FB) come with considerable financial investments. Growers often implement measures such as pruning infected branches, applying antibiotics, and using resistant cultivars. These approaches not only incur direct costs but may also require specialized training and equipment. The financial burden is particularly challenging for small-scale farmers, potentially leading to reduced competitiveness and consolidation in the industry. Addressing the economic importance of fire blight requires collaborative efforts and proactive strategies. Research and development focused on identifying resistant cultivars and exploring alternative control measures can reduce the reliance on chemical interventions and enhance long-term sustainability. Implementing early detection and surveillance systems can help contain outbreaks and prevent further spread, minimizing economic losses. However, effective policy frameworks at national and international levels are essential to coordinate efforts in fire blight management and trade facilitation. Collaboration among stakeholders and continuous research efforts are necessary to safeguard the economic viability of the tree fruit industry and ensure food security on a global scale.

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NEOINDUSTRIALIZATION OF THE AGRICULTURAL SECTOR OF THE ECONOMY AS A NECESSARY CONDITION FOR INNOVATIVE TRANSFORMATION OF PRODUCTIVE FORCES AND ACHIEVING TECHNOLOGICAL SOVEREIGNTY

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Abstract

The article is devoted to the problem of ensuring technological sovereignty in the agrarian sector of the Russian economy, its neoindustrialization. The purpose of the work is a scientific and theoretical substantiation of the possibilities of innovative and investment development of the agro-industrial complex in the context of modern trends in neoindustrialization. Empirically, the assessment of the scale of neoindustrialization in the agricultural sector was carried out, a conclusion was made about its initial stage, characterized by a lag in the technological development of agriculture from other sectors of the economy, insufficient use of the results of intellectual activity, and a lower scale of innovative products. A mathematical model of a two-factor regression is constructed that characterizes the process of neoindustrialization in agriculture in Russia, and a predictive assessment of the dynamics of indicators of neoindustrialization of agriculture based on trend analysis is presented. The calculations show that with an increase in the level of labor productivity by 1%, the share of innovative products in the shipped agricultural products will increase by 0.23 percent. The necessity of improving the organizational and economic mechanism for implementing the strategies of innovative and scientific and technological development in order to increase the innovative activity of enterprises in the agricultural sector is substantiated. The practical significance of the results of the study is to develop measures to improve innovation and science and technology policy in order to achieve positive effects from neo-industrialization in the agricultural sector during the transition to Industry 4.0.

Key words: *agro-industrial complex, innovation and investment development, neoindustrialization, technological sovereignty, mathematical modeling*

INTRODUCTION

The priority direction of neoindustrialization in the agricultural sector is the implementation of the Federal Scientific and Technical Program for the Development of Agriculture for 2017-2030, which is aimed at achieving sustainable growth in agricultural production as a result of the widespread use of breeding and seed production, cross-industry technologies and digital solutions. One of the priorities of the program is to stimulate scientific and technical activities in order to achieve technological sovereignty. At the same time, the introduction of breakthrough technologies in the agricultural sector of Russia is also possible if conditions are created for the production of high-tech tools that ensure the innovative transformation of productive forces. It is expected that the mass introduction of domestic innovative technologies will significantly reduce the risks of food security by 2030 [4].

The relevance of the development of the methodological provisions of neoindustrialization in relation to the agro-industrial complex and the justification of the mechanisms for managing innovative systems at the sectoral and intersectoral levels is predetermined by the presence of trends in the scientific and technological development of agriculture and other sectors of the agro-industrial complex.

Achieving the technological sovereignty of the agro-industrial complex of Russia in order to implement the policy of import substitution is possible as a result of a radical modernization of agricultural systems based on neoindustrialization with a predominance of investment-innovative type of economic growth [12,13,19].

Neoindustrial transformation reflects a complex process of structural adjustment and the creation of a vertically integrated economy that produces competitive products. The policy of neoindustrialization of the economy should be aimed at creating conditions for increasing the innovative activity of predominantly science-intensive and high-tech industries, as well as at justifying program solutions in the field of modernization [6].

Theoretical aspects of the technological development of economic systems and the formation of the foundations of a new industrialization are reflected in the works of such foreign scientists as J. Galbraith, K. Clark, A. Coomaraswamy, A. Penty, D. Bell, M. J. Enright, V.M. Juhi and others. In particular, D. Bell noted that for a post-industrial society, the most significant sign is the change in the nature of knowledge itself in the direction of the dominance of theory, which is a prerequisite for changing the structure of social and economic systems. According to his point of view, the process of modernization of production precedes the development of neoindustrialization, covering the industrial sector [2].

In modern conditions, there has been a change in the paradigm of neoindustrialization, which is viewed from different positions as a system, process, mechanism, strategy [5,7]. The approach to considering neoindustrialization as a system is based on new knowledge and human resources that effectively use progressive technologies that radically change the structure of production resources and provide positive trends in socio-economic development. This theoretical approach develops the provisions of D. Bell and J. Galbraith [28].

The main characteristics of neoindustrialization as a system are: orderliness in order to form a certain structure of interrelated elements, emergence or the possibility of the emergence of new qualities and properties of the system, the realization of the potential of participants in achieving relevant goals.

Neoindustrialization as a process reflects a radical technological re-equipment of the economy through the use of breakthrough technologies and the transition to a new stage of production robotization [24].

To assess neoindustrialization trends, it is recommended to use indicators of technological modernization, human capital, and inter-sectoral interaction. The positive trends of neoindustrialization are reflected in the steady increase in the volume of innovative products, the growth of labor productivity, and the widespread introduction of technological innovations [21].

In the development of this topic, some authors focus on the priority role of such parameters as the introduction of technological and managerial innovations [9]increasing labor productivity [17], increasing the role of human capital in technological development [1].

Some scientists consider neo-industrialization as a complex mechanism for the formation of an effective process control system for industrial sectors in accordance with the principles of vertical integration [10].

Research confirms that the share of advanced knowledge materialized in technologies, equipment, production process in developed countries reaches 70 -90% [11].

The mechanism of neoindustrialization is aimed at deepening the process of transformation of productive forces during the transition to a new technological order, stimulating the effective use of the potential of knowledge, science, results of intellectual activity, innovative technologies [23]. The strategy of neoindustrialization involves the formation of conditions and factors for investment and innovative economic growth using effective models of public-private partnership [8].

In modern conditions, a significant number of scientific works are devoted to the problems of neoindustrialization in relation to various sectors of the economy, including the agro-industrial complex. This topic is widely represented in the studies of Russian and foreign scientists. Some authors consider neo-industrialization as the main factor in the development of the Russian agro-industrial complex and the achievement of food security [20].

Foreign researchers are exploring the possibilities and prospects for the development of Industry 4.0 in developed countries, where the state supports the introduction of advanced technologies in various sectors of the economy within the framework of relevant programs (Industry 4.0 in Germany, SmartFactory in the Netherlands, UsineduFutur in France). A rather effective model of cooperation between the government, business, universities and research centers operates in Australia. For example, the scientific agency CSIRO Futures, together with the government, has developed a roadmap to address the problems of food security and the development of the agricultural sector. Agricultural start-ups that implement breakthrough technologies in agriculture have become widespread in developed countries. Thus, the SoftBank Vision fund, in cooperation with representatives of large Japanese businesses, invested $200 million in vertical agriculture [3].In order to maintain the continuous development of agricultural production, effective solutions are needed for the problems that Romanian agriculture is currently facing [14,15]. Thus, foreign researchers are guided by the strategy of technological leadership and the positive experience of forming cluster structures in which large companies and agricultural holdings supply science-intensive products to agribusiness enterprises [26]. Based on the study of foreign experience, mechanisms for stimulating investment activity are systematized and ways are proposed in relation to the agro-industrial complex of Russia [27]. A significant problem is the lack of effective mechanisms to stimulate the process of neoindustrialization [30].Neoindustrialization is considered as the most important scenario for involving developing countries in the global fourth industrial revolution based on breakthrough technologies. It is emphasized that this scenario will ensure the sustainable development of African countries in the long term. The positive experience of Kenya and Ethiopia is noted, which were the first to apply the Livestock Index Insurance Program (IBLI) as one of the sensor technologies, which can significantly reduce the risks of animal husbandry [25]. In developed a concept and proposed an algorithm for the neoindustrialization of African countries based on the breakthrough technologies of Industry 4.0. [16]. The purpose of the work is the scientific and theoretical substantiation of new opportunities for innovative and investment development of the agro-industrial complex in the context of modern trends in neoindustrialization.

MATERIALS AND METHODS

The methodological basis of the study was state legislative acts, resolutions, studies of domestic and foreign scientists-economists and experts of the agrarian market on this issue. In the course of the study, monographic, abstract-logical, analytical, economic-statistical, expert research methods were used. Legal and legislative acts, information from Rosstat, National Research University Higher School of Economics, the Ministry of Agriculture of the Russian Federation, as well as regulatory documents and materials from periodicals were used as the information base for the study.

RESULTS AND DISCUSSIONS

One of the conditions for achieving Russia's technological sovereignty is an increase in patent activity. The dynamics of the indicator of technological self-sufficiency of the country, calculated as the ratio of the number of domestic patent applications filed for inventions and their total number, reflects positive trends: for 2015-2022. indicator increased from 0.64 to 0.7)[22].

It is necessary to note the positive trends associated with the development of advanced production technologies (Table 1).

Table 1. Number of developed advanced manufacturing technologies in Russia in 2017-2021

Typesofeconomic activities	2017	2018	2019	2020	2021	2022
Developedadvancedmanufacturingtechnologies						
Economy as a whole	1,402	1,565	1,620	1,989	2,186	2,621
Manufacturing industries	442	502	532	666	737	823
Including: foodproduction	16	24	25	52	65	65
Including fundamentally new advanced production technologies						
Economy as a whole	190	180	217	201	260	307
Manufacturing industries	33	34	35	39	76	93
Including: foodproduction	0	0	0	0	10	7

Source: Own calculations based on data [29].

So, in 2022, 2621 advanced production technologies were developed in Russia, i.e. almost twice as many as in 2017. The positive dynamics is accompanied by an almost unchanged intensity of activity of organizations developing new technologies. Therefore, there are approximately three new technologies per organization per year. Organizations of the research sector are the most active [18].

Advanced production technologies are being developed in the following areas: automated production, transportation and assembly; design and engineering; communication, management and geomatics. During the period under review, from 10% to 13.5% of the total number of developed production technologies were fundamentally new, having no analogues in the world. At the same time, fundamentally new technologies in food production were developed only in 2021-2022, which indicates the uneven nature of neoindustrial transformation. According to research by Russian scientists, unique advanced technologies are created in the field of research and development, and technologies new only to Russia are generated in the manufacturing industry. It is also necessary to note the continuing gap between the availability of advanced technologies and their use. There are frequent cases when an innovative product produced on the basis of advanced technologies is not in demand by the market, which is associated with insufficient stimulation of demand for innovations.

In the process of research, the author's hypothesis was realized: the scale of neo-industrialization in the agricultural sector is determined by the scale of production of innovative products; the pace of renewal of fixed production assets as an indicator of the innovative transformation of the material and technical base; the level of labor productivity as a materialization of the achievements of the research sector. Under the conditions of neoindustrialization, the growth of labor productivity and a decrease in the degree of depreciation of fixed assets should be accompanied by an increase in the share of innovative products in the total output of industrial organizations.

As a result of the research, a mathematical model of two-factor regression was built, which characterizes the process of neoindustrialization in Russian agriculture:

$$Y=-7.38 -0.0002\ X1+0.23\ X2 \quad ....(1)$$

$$R^2= 0.8$$

where:

Y - is the share of innovative products in the shipped agricultural products, %

X1 - the degree of depreciation of fixed production assets in agriculture,%

X2 - labor productivity in agriculture, thousand rubles. (gross agricultural output per one employed in agriculture, thousand rubles).

The coefficient of determination R^2 shows that the calculated parameters of the model explain the dependence of the function change on the factors under study by 80%, which indicates the significance of the developed model.

Some indicators of agricultural development and statistical data on the release of innovative products for 2017-2022 were used as primary data. The calculations show that with an increase in the level of labor productivity by 1%, the share of innovative products in the shipped agricultural products will increase by 0.23 percent. Depreciation of fixed assets has a much smaller impact on the release of innovative products: an increase in the degree of depreciation of fixed production assets by 1% will lead to a reduction in the share of innovative products in shipped products by 0.0002%, i.e. the correlation is rather weak.

It should be noted that the weaker impact of the depreciation factor of fixed assets is explained by the unsatisfactory state of the material and technical base of agriculture, which indicates a low level of innovative transformation of productive forces and insufficient efficiency of technological modernization mechanisms: during 2017-2022. the share of depreciation of fixed assets in agriculture ranged from 40% to 43.2percent.

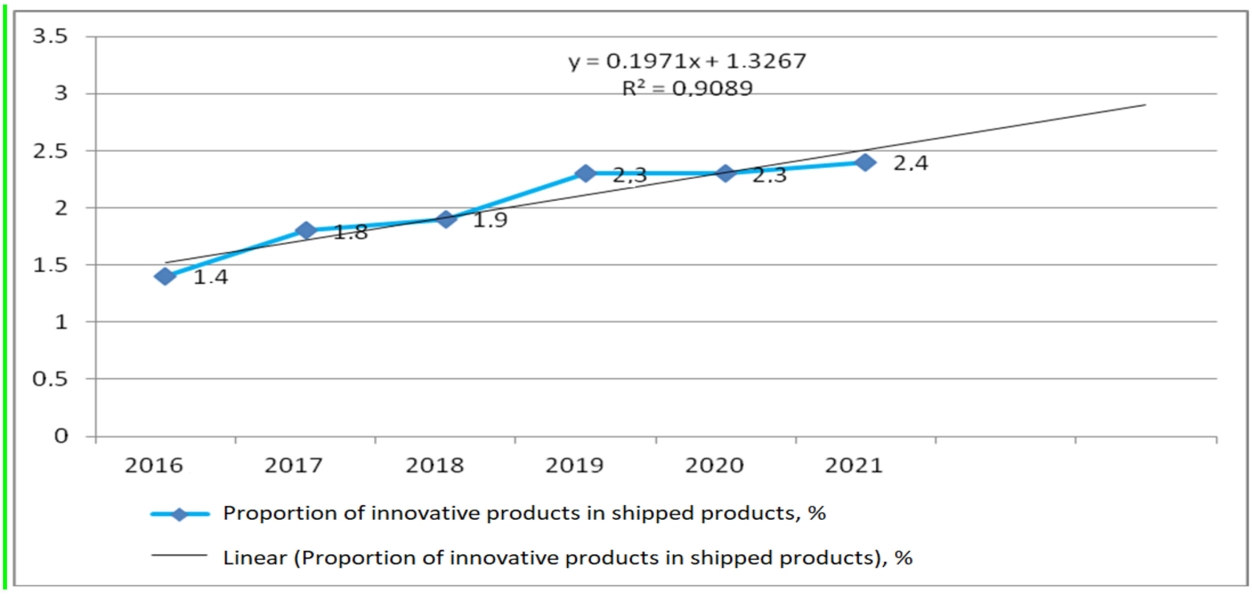

Fig. 1. Trends in the share of innovative products in the total volume of shipped products, work performed and services of Russian agriculture
Source: Own calculations based on data [29].

A more detailed study of the model components was carried out using trend analysis. On the basis of official statistics data, series of dynamics and trend equations were constructed, on the basis of which a predictive assessment of the change in the above indicators in the short term was presented (Fig. 1, 2 and 3).

The trajectory of changes in the share of innovative products in the total volume of shipped products, work performed and agricultural services reflects a slight positive trend, although the scale of its output is much lower than in manufacturing, where this indicator is 3–3.5 times higher. A fairly high coefficient of determination (0.91) characterizes the sustainable nature of the increase in the volume of innovative products, although there is a rather significant intra-industry differentiation: in 2021, the indicator in question ranged from 1.4% for the type of activity “mixed agriculture” to 3.1% for type of activity "growing of perennial crops".

Calculations showed that, under unchanged conditions, the indicator under consideration will reach 2.7% in 2024, and 2.9% in 2025.

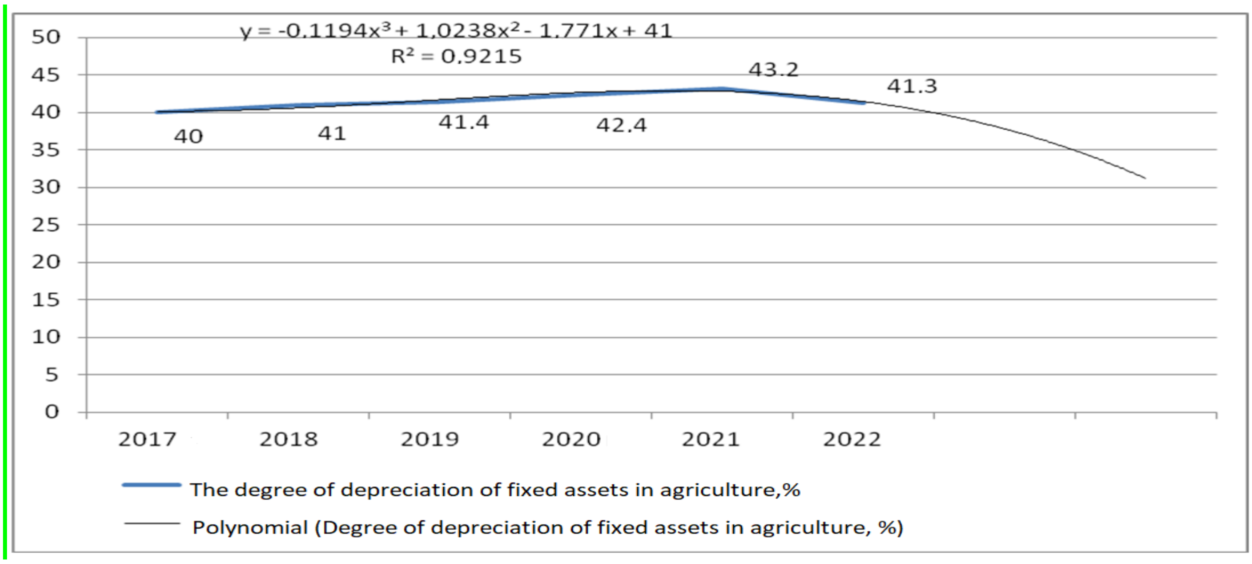

Fig. 2. Trend analysis of the degree of depreciation of fixed assets in agriculture in Russia
Source: Own calculations based on data [29].

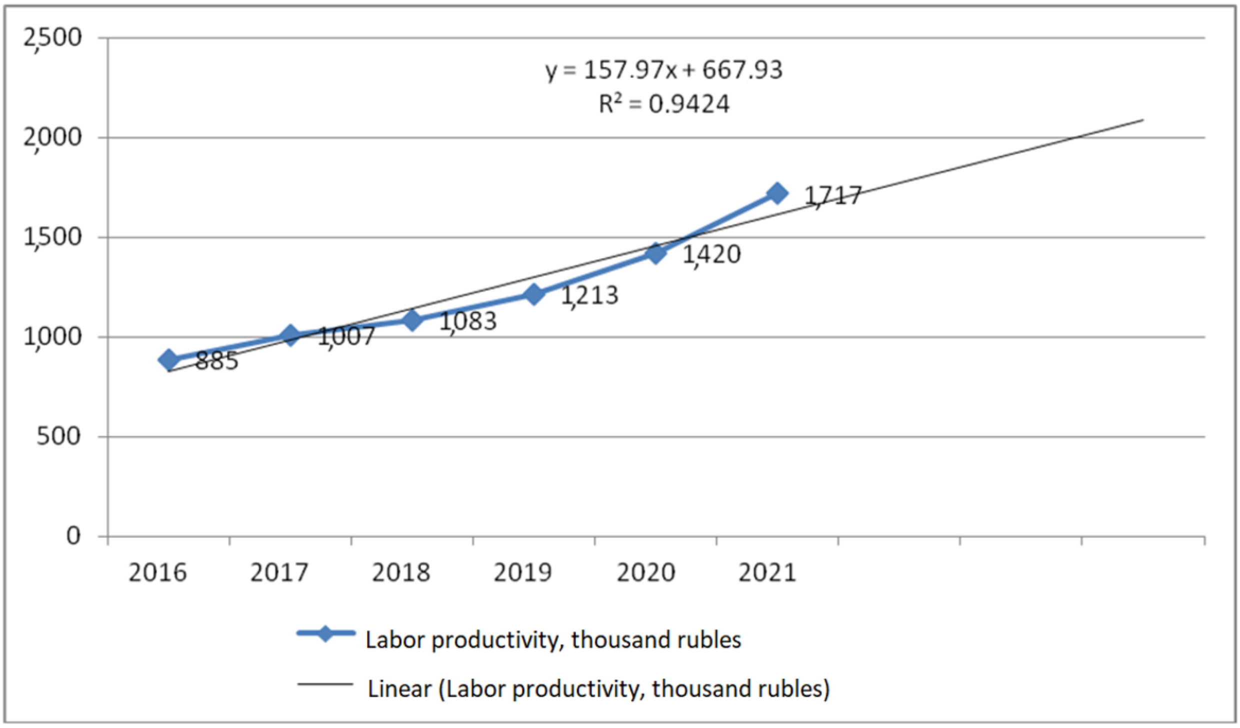

Fig. 3. Trend analysis of labor productivity in Russian agriculture
Source: Own calculations based on data [29].

The dynamics of the depreciation of fixed assets reflects a non-linear nature, which is confirmed by a polynomial trend model with a high degree of significance (the determination coefficient is 0.92). In the event of a large-scale technological renewal of fixed assets, depreciation in the short term may decrease by almost 10 percentage points.

The dynamics of the labor productivity indicator is also characterized by a positive linear trend with a high coefficient of determination equal to 0.94. Prolongation of the current trend, according to our calculations, will increase labor productivity in the short term by 12-15 percent.

The calculations performed showed a certain relationship between the share of innovative products in the shipped agricultural products and labor productivity, which reflects the use of advanced technologies, although the processes of production, distribution and implementation of innovations are still characterized by a point distribution and strong interregional differentiation. It should be noted that the increase in the number of advanced technologies used is not always associated with the replacement of fixed assets with a high degree of depreciation, which limits the production of innovative products. Scientific research has proven a direct linear relationship between the advanced technologies used and labor productivity. At the same time, an increase in the number of advanced technologies used is not always associated with the modernization of the material and technical base of the agricultural sector, which negatively affects neoindustrialization trends: a high degree of depreciation of fixed production assets remains, and the production of innovative products stagnates. The lack of dependence between the use of advanced technologies and the level of renewal of fixed production assets can be explained to a certain extent by the investment decisions of enterprises on the introduction of innovative service technologies that do not require a radical modernization of the material and technical base.

Thus, there is a gap between the introduction of advanced technologies and the production of innovative products in the agricultural sector. Another situation is possible that explains the lack of a synergistic effect from the introduction of advanced technologies: an innovative product produced on the basis of advanced technologies is either not in demand on the market, or is not promoted effectively enough on it. The problem of marketing innovations arises, for the solution of which it is necessary to study the trends in demand and consumer behavior, as well as the problems of interaction and competition of enterprises participating in the value chain [21].

The successful implementation of the neoindustrialization policy in the agricultural sector necessitates the development of an organizational and economic mechanism for improving the strategies for innovative and scientific and technological development. Organizational instruments are associated with the regulation of fiscal, monetary policy, foreign economic policy at the macro level, forming a certain institutional environment for innovative and scientific and technological development. The economic incentive mechanism should be aimed at developing clustering processes to organize various forms of integration associations of the subjects of the innovation process, which will increase the competitiveness of regional agro-innovation systems. An important role is given to the creation of small innovative enterprises, support for research and development work, stimulation of diffusion of innovations and technology transfer, development of innovative infrastructure. To overcome the gap between the dynamic growth of advanced production technologies and the stagnation of the material and technical base in the domestic industry in the country's agricultural sector, it is necessary to ensure the expanded reproduction of high-tech means of production.

CONCLUSIONS

The most important processes that ensure the successful development of the agricultural sector in the context of neoindustrialization are the development of high-tech production in the domestic industry, contributing to the achievement of technological sovereignty: the growth of labor productivity, the innovative transformation of productive forces. The scale of neoindustrialization in the agricultural sector is determined by the volume of production of innovative products, the pace of renewal of fixed production assets as an indicator of the innovative transformation of the material and technical base, the level of labor productivity as the materialization of the achievements of the research sector, and intersectoral interaction between the subjects of the innovation process. It is concluded that the synergistic effect of neoindustrialization is reflected in an increase in the production of innovative products, an increase in labor productivity, and an increase in intersectoral exchange.

The necessity of improving the organizational and economic mechanism for implementing strategies for innovative and scientific and technological development in order to increase the innovative activity of enterprises in the agricultural sector, achieve a close relationship between the use of advanced technologies and the release of innovative products, enhance the processes of transfer and implementation of innovations, improve the efficiency of innovation and investment processes with taking into account innovation marketing approaches.

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ANALYSIS OF THE LABOUR RESOURCES USAGE IN AGRICULTURAL ENTERPRISES OF UKRAINE: A CASE STUDY OF THE VOLYN REGION

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Abstract

The article examines the specifics of the use of labor resources in the agricultural sector of Ukraine. The problems associated with ensuring the proper level of efficiency in the use of labor resources at agricultural enterprises of Ukraine have been identified, the demographic aging of the rural population is particularly important. The state of use of labor resources at agricultural enterprises was analyzed using the example of the Volyn region. The dynamics of the specific weight of employees of agricultural enterprises and the dynamics of personnel turnover indicators were determined. An econometric model of the dependence of personnel wages on the efficiency of agricultural production has been developed. The problems of ensuring proper working conditions for the personnel of agricultural enterprises of the Volyn region and the dynamics of compensation payments were considered.

Key words*: *labor resources, agricultural enterprises, wages, personnel qualifications, working conditions

INTRODUCTION

The specificity of the current state of economic relations in Ukraine shows that the sphere of agriculture is one of the key branches of the economy and an important source of work for the rural population. At the same time, ensuring the appropriate level of productivity of the labour in the field of agricultural production is an important element of ensuring the effective operation of enterprises in this field. This is due to the fact that labour productivity helps to increase productivity, reduce costs, and generally increase the competitiveness of enterprises. Accordingly, the analysis of the use of labour resources makes it possible to identify problematic aspects that prevent the achievement of optimal efficiency and to form ways of solving them. In addition, in recent years, a dynamic trend towards an increase in the level of competition in the market of agricultural products has been constantly observed. This also puts agrarian enterprises in front of the task of ensuring quality work with employees and requires clarification of problematic aspects of personnel management, such as insufficient training, low level of work motivation irrational distribution of working time, etc. It is on the basis of such studies that enterprises can develop strategies for solving problems with labour resources.

It should also be noted that currently, in the sphere of agriculture of Ukraine, there is a significant demographic aging of workers. Many agricultural enterprises face the problem of dependence on older workers because the younger generation prefers moving to cities or emigrating. That is why assessment of the effectiveness of the use of the company's employees makes it possible to form approaches regarding the key principles of the personnel turnover management strategy, including the quality of working conditions and the innovative orientation of the business entity. Accordingly, the relevance of the study of the principles of the use of personnel in the sphere of agricultural production in Ukraine is predetermined by the need to identify problematic aspects of staffing in the agricultural sector, which prevent the achievement of optimal efficiency of economic entities.

Studies of the use of labour resources in agricultural enterprises are disclosed in many works by modern scientists and practitioners. This problem concerns many aspects related to the efficiency of the use of labor resources, including their key importance in the formation of the effectiveness and profitability of agricultural enterprises. The main research is aimed at studying the role of human capital in agricultural enterprises. Scientists have analyzed the impact of education, skills, and professional training of employees on the work efficiency and competitiveness of agricultural enterprises. Issues of effective labour organization and rationalization of the work process in agricultural enterprises are also considered.

The works of such scientists as I. Britchenko [1], M. Dziamulych [2-10], N. Khomiuk [11], A. Marcuta [13], A. Popescu [14-23], M. Rudenko [24], T. Shmatkovska [25-29], R. Sodoma [31-32], I. Tofan [33], I. Tsymbaliuk [34] and many others, who studied the influence of certain factors on labour productivity at agricultural enterprises, including the study of the motivation of workers in the agricultural sector, should be especially noted. Research data shows which factors have the greatest impact on job satisfaction, motivation, and involvement of employees in achieving organizational goals.

MATERIALS AND METHODS

In the process of carrying out the research, methods of economic and mathematical modelling were used. After the linear regression model $y = b_0+b_1x$ was constructed, it was checked for adequacy, that is, whether the constructed model corresponds to the available statistical data.

First, consider the variation (scatter) of the dependent indicator y with respect to its average value. The deviation is equal to $y_i - \bar{y}$. It is possible to write: $y_i - \hat{y}_i + \hat{y}_i - \bar{y}$, where $y_i = b_o + b_1 x$ are calculated values. That is, the variation of the dependent indicator Y around its average value can be divided into two terms: $\hat{y}_i - \bar{y}$ – a variation of the estimated values around the average; $y_i - \hat{y}_i$ – a variation of calculated values around the actual ones.

We denote:

$\sigma_p^2 = \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$ – the variation explained by the regression with the number of degrees of freedom $k_1 = 1$;

$\sigma_e^2 = \sum_{i=1}^{n}(\hat{y}_i - y_i)^2$ – residuals, unexplained variance, with the number of degrees of freedom $k_2 = n - 2$;

$\sigma_y^2 = \sum_{i=1}^{n}(y_i - \bar{y})^2$ – total variation with the number of degrees of freedom $k_3 = n - 1$ [35].

The coefficient of determination is usually used to analyze the overall quality of the estimated linear regression:

$$R^2 = 1 - \frac{\sigma_e^2}{\sigma_y^2}, \quad 0 \le R^2 \le 1$$

The numerator is the sum of squares of deviations of the regression line from the actual values and the denominator – is from the average value. The smaller the deviation of the calculated values from the actual values, the smaller the fraction, and the closer the coefficient of determination value is to 1.

Based on the coefficient of determination, the value of the Fisher's test can be given in the form of the following formula:

$$F_{observ} = \frac{R^2}{1 - R^2}(n - 2)$$

If $F_{observ} > F_{kr}$, then the H_0 hypothesis is rejected, which means $b_1 \neq 0$, y depends on x, therefore, the model $y = b_0+b_1x$ is adequate (with reliability $(1 - \alpha)\times 100\%$).

The method of least squares (LSM) guarantees that the parameters found using it are:

– Not displaced. This means that b_0 and b_1 are random because they are found in the sample, but on average they are as if they were found in the population;

– Effective. MNC ensures rapid convergence of model parameters to exact values that could be calculated from the general population;

– Reasonable. As the sample volume increases, the accuracy of the calculated parameters increases.

Since b_0 and b_1 are random variables, it is necessary to check their statistical significance. This can be done using specially constructed statistics distributed according to the Student's law [35].

RESULTS AND DISCUSSIONS

The modern problems of providing agricultural enterprises with labour resources require in-depth research related to the aging of the workforce, the problems of attracting young workers to enterprises, and the development of the socio-economic infrastructure of rural areas in order to achieve sustainable development of agriculture in Ukraine. In particular, according to the results of the analysis of Fig. 1, it was established that during the analyzed period there were qualitative changes in the educational and qualification structure of the personnel of agricultural enterprises of the Volyn region.

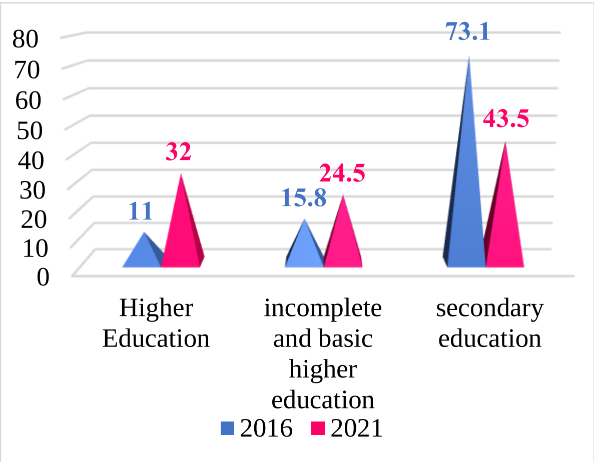

Fig. 1. Comparison of the specific weight of employees of agricultural enterprises of the Volyn region of Ukraine by education in 2016 and 2021
Source: own development based on statistical reports of the [12].

In particular, the specific weight of specialists with higher education has increased significantly, which in 2021 was 32%. This is caused by the general complication of working conditions associated with the introduction of new technologies and new equipment into the activities of agricultural enterprises. As a result, there is a growing need for qualified specialists who are able to service this equipment and practically use the latest technological solutions. In addition, the development of processing production, which is more technologically complex than the primary processing of agricultural raw materials, because it includes technological processes that require the use of specialized equipment and technologies. In addition, during the same period, a change in the share of personnel with incomplete and primary higher education was recorded. In general, its specific weight increased to 24.5%. The specific weight of employees with secondary education, which dominated among the personnel of agricultural enterprises of the Volyn region, decreased from 73.1% to only 43.5% at the end of the period. Such a trend means that in the agrarian sphere of the region there is a gradual increase in the complexity of work, as a result of which the prerequisites for the use of the latest, more productive technologies are being formed. The future consequence of such changes is an increase in the share of finished products with a higher level of added value, the basis of which is currently the processing enterprises of large agricultural holdings.

Analyzing the change in the dynamics of professional development by employees of agricultural enterprises of the Volyn region of Ukraine (Fig. 2), it can be argued that the growth of the share of personnel who carried out this development directly in production is becoming important.

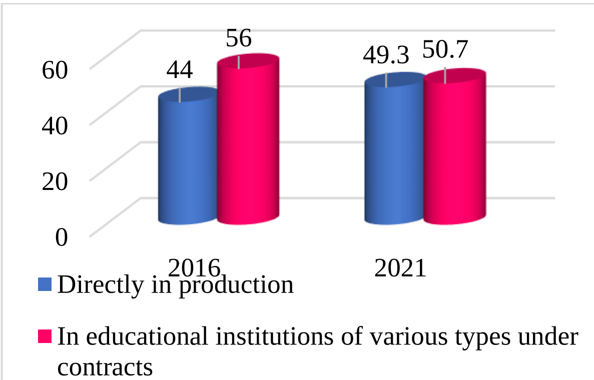

Fig. 2. Comparison of the specific weight of employees of agricultural enterprises of the Volyn region of Ukraine who increased their qualifications in 2016 and 2021
Source: own development based on statistical reports of the [12].

This is due to the need to master new technologies, which during the analyzed period were intensively implemented at agricultural enterprises of the Volyn region, in particular, such as "Volyn-Zerno-Produkt", "Rat", POSP named after Shevchenko, "Zakhidnyi Bug" and others. Taking into account the trends regarding the complication of the system of industrial relations at the agricultural enterprises of the region, we come to the conclusion that in the future the share of employees who will be involved in the processes of professional development on the basis of existing productions will increase, as the volume of new equipment that will be put into operation in the agricultural sector of the Volyn region will increase.

Analyzing labor turnover indicators for the analyzed period (Table 1), it can be stated that the general trend in the field of employment in the Volyn region of Ukraine is positive.

Table 1. Dynamics of labor turnover indicators in agricultural enterprises of the Volyn region of Ukraine, 2016-2021.

Indicators	For the period since the beginning of the year, persons	
	2016	2021
The average registered number of full-time employees, persons	39,673	36,482
Employees, persons are accepted	19,888	10,201
of them to newly created jobs	735	3,494
Employees, persons left	21,864	10,974
among them for the following reasons: changes in the organization of production and work (reorganization, reduction in the number of staff of employees)	929	853
personnel turnover (at one's own will, by agreement of the parties, violation of labor discipline, etc.)	20,478	9,302
dropped out for other reasons	457	819
Number of full-time employees at the end of the reporting period, persons	35,603	35,709
Reception turnover rate	0.5	0.3
Turnover rate from dismissal	0.6	0.3
Total turnover ratio	1.1	0.6
Staff turnover rate	0.5	0.3

Source: systematized, analyzed, and summarized by the authors based on the materials of statistical reports of the [12].

This is due to a significant increase in the number of new jobs - from 735 in 2016 to 3,494 in 2021. A decrease in staff turnover rates at agricultural enterprises was also recorded. In particular, from the table 1 we can see that in 2021 the overall staff turnover rate was 0.3, while in 2016 its value was 0.5. at the same time, reducing the number of personnel at agricultural enterprises of the Volyn region during this period amounted to only 3.2 thousand people, or 8.1%.

It is important to note that during the analyzed period there was a slight reduction in the number of dismissed employees due to reorganization of production or downsizing. If in 2016 the number of such dismissed employees was 929, then in 2021 – 853. This indicates the stabilization of the employment situation in agricultural enterprises of the Volyn region of Ukraine, which does not require them to make drastic decisions on changing the number of personnel.

The efficiency of agricultural production largely depends on the motivation of employees of agricultural enterprises. This type of dependence was investigated by the method of correlation regression analysis. The result of the action is given as a function of the factors affecting it. Such factors include profit per hectare (X_1), production costs per 1 ha (X_2), sales revenue per employee (X_3), and profitability of agricultural activity (X_4). We chose the wage indicator (Y) as the effective factor. The model of interdependence of factors was built on the database of agricultural enterprises of the Volyn region for 2021 (Table 2).

Table 2. Parameters of the econometric model of the dependence of wages on the efficiency of agricultural production

Variable	Regression equation	R^2	F		t	
			calc.	tab.	calc.	tab.
Profitability, %	$Y_1 = 974.2x + 13{,}233$	0.55	27.7	4.3	5.3	1.7
Profit per 1 ha, UAH.	$Y_2 = 0.2x + 18{,}862$	0.51	24.2	4.3	4.9	1.7
The volume of gross production per 1 employee, hryvnias.	$Y_3 = 107.6x - 14{,}325$	0.53	25.6	4.3	5	1.7
Production costs per 1 ha, UAH.	$Y_4 = 0.03x + 18{,}070$	0.52	25.2	4.3	5	1.7

where: R_2 – coefficient of determination; $F_{calc.}$ – calculated Fisher's criterion; $F_{tab.}$ – tabular Fisher criterion; t_{calc} – Student's calculation test; $t_{tab.}$ – Student's tabular test; Y is salary

Source: calculated based on the materials of statistical reports of the [12].

From the regression equations (Table 2), it was established that with an increase in production costs per 1 hectare, labour wages increase. When wages are increased, the amount of profit increases, and the profitability of agricultural enterprises increases. A particularly close, directly proportional relationship between wages and gross output per person (labour productivity) was revealed. All calculations of the parameters of the econometric model of the dependence of the efficiency of agricultural production on wages were carried out for agricultural enterprises of the region.

The existence of a dependence between the dynamics of economic efficiency indicators of the enterprise and the motivation of personnel in the field of agricultural production was determined. The wages of this industry in the Volyn region have a tendency to increase with the increase of the main economic indicators. According to the results of our research, the factor that has the greatest impact on labour remuneration has been determined – profit per 1 hectare.

At agricultural enterprises, in addition to the basic salary, bonuses, allowances, and other rewards are paid in accordance with the current legislation. Paying for work is not the only goal of work.

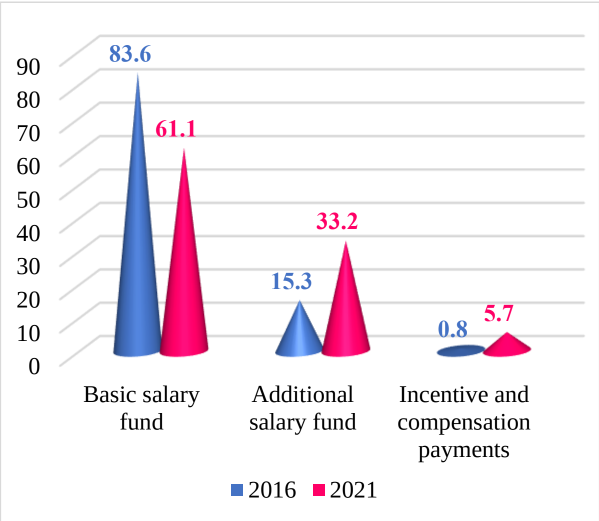

Fig. 3. Composition of the wage fund in agriculture of the Volyn region, 2016-2021, %
Source: [12].

So, we can see that for the years 2016–2021, as part of the wage fund of the agrarian sector of the Volyn region, the specific weight of the basic salary decreased significantly – by 22.5% (Fig. 3). This is due, on the one hand, to the aspiration of agricultural producers to transfer production to a higher-quality system of labour payment by introducing progressive forms of it, which is reflected in the growth of the specific weight of the fund of additional labour by 17.9% over the corresponding period. On the other hand, such a change involves the orientation of employees of agricultural enterprises to higher quality work results, which are paid precisely at the expense of the additional salary fund. It is also necessary to note a significant increase in the share of payments for work in harmful conditions, which in 2021 amounted to 5.7%, which is 4.9% more than in 2016. Such a change is caused by an increase in the specific weight of processing industries in the agricultural sector of Ukraine, which is associated with the intensification of the activities of large agricultural companies after the conclusion of the association agreement with the EU and the opening of the European market for Ukrainian agricultural producers. In general, the change in the structure of the wage fund in the agricultural sector indicates qualitative changes in production and the reorientation of Ukrainian enterprises to their own processing of agricultural products, which brings them a significantly higher income compared to the simple export of raw materials.

Estimating the number of personnel of agricultural enterprises of the Volyn region of Ukraine, who worked in improper working conditions in 2021 (Fig. 4), it can be stated that their total number was 14.8 thousand people or 37.4% of all personnel of agrarian enterprises. Such a value is quite critical, as it implies the need for business entities to incur additional costs for payment of labour for work in difficult conditions. At the same time, objectively certain production processes related to agricultural production and processing of raw materials require the presence of such jobs. However, as the practice of developed agricultural production in the countries of Western and Central Europe shows, it should not exceed 10-12% of the total number of employees.

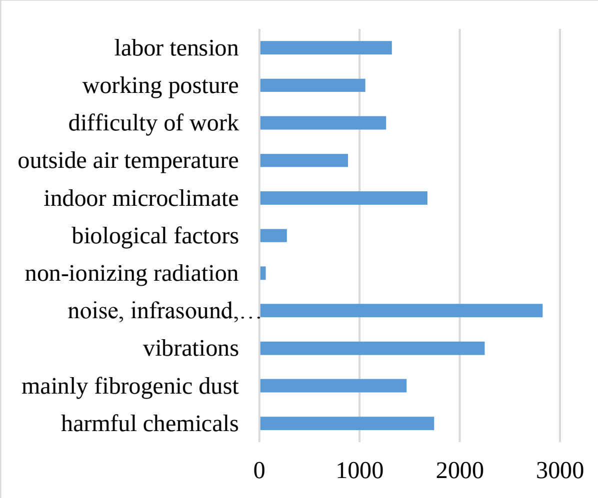

Fig. 4. The number of farm workers in the Volyn region of Ukraine who worked in improper working conditions in 2021
Source: systematized by the authors.

If we evaluate the specific working conditions that are defined as difficult, then in 2016, the largest number of employees worked in negative conditions of noise, infrared, and ultrasound – 2,828 people, as well as in conditions of increased vibration – 2,249 people (Fig. 4).

It is assumed that in the process of updating the production base of agricultural enterprises of the studied region, which is currently being carried out, there will be a general reduction in the number of employees working in harmful working conditions. That is, the quality of the work of the personnel directly depends on the quality of the applied technologies and specific production equipment. On the other hand, the speed of such renewal of production is determined solely by the investment opportunities of enterprises.

In addition, it should be noted that in the existing programs of state support for the agricultural sector in Ukraine, insufficient attention is paid to the analyzed parameter of working conditions, and the main emphasis is on stimulating enterprises to increase the level of wages.

This requires adjustment and selection of the principle of ensuring the appropriate level of labour quality among the priorities in support programs for agricultural producers of Ukraine.

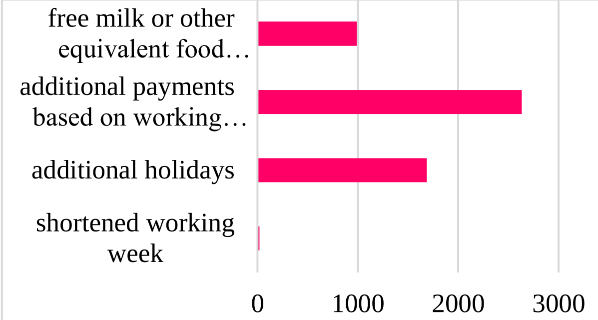

Fig. 5. The number of employees who received benefits and compensation for work with harmful working conditions in agricultural enterprises of the Volyn region of Ukraine in 2021.
Source: systematized by the authors.

If we evaluate the number of personnel of agricultural enterprises of the Volyn region of Ukraine, who received material and monetary compensation for working in harmful conditions (Fig. 5), then it is lower than the total number of people employed in such working conditions and amounted to 5,326 people or 35.9%.

At the same time, the most common form of compensation for working in harmful conditions was additional payments for working in harmful conditions - it was received by 2,633 persons or 49.4%.

Other 1,686 people or 31.7% were entitled to additional leave as compensation. 988 people received milk or other equivalent food products as material compensation.

Only 19 people (0.36%) of the total number of those who received benefits for working in harmful conditions had the right to a reduced working week.

Improving the system of compensation for work in difficult working conditions is a problematic aspect, since, on the one hand, it is determined by legislation, and on the other hand, few enterprises agree to voluntary additional payment for work in harmful conditions [30].

However, in the context of the need to adapt the labour legislation of Ukraine to the EU norms in connection with the acquisition of the status of a candidate country for joining the European Union, the future necessity of changes in this area is foreseen.

CONCLUSIONS

According to the results of the study, it was found that the level of remuneration of employees of agricultural enterprises in the Volyn region of Ukraine is low compared to other branches of production and service. This leads to high labour mobility, a decrease in employment in the industry, insufficient motivation, and a decrease in the effective use of labour resources. Thanks to regulated labour mobility, the personnel composition of employees of the Volyn region of Ukraine is being updated: hiring more qualified and dismissing violators of labour discipline, etc. However, several negative factors affect the economic development of the agricultural enterprises of the region: an increase in costs, a slowdown in the work process, a decrease in the efficiency of the use of labour resources, and basic economic indicators.

With the help of a questionnaire survey, a score assessment of the importance of intangible labour motives in agricultural enterprises of the Volyn region was carried out. At the same time, respondents gave the greatest importance to such specific elements of work motivation as continuous seniority, interest in work results, availability of responsibility for work results, and the possibility of professional training.

In addition, in the process of research of the study of the state of working conditions, it was established that a large number of employees of agricultural enterprises in the studied region of Ukraine work in inappropriate working conditions. Noise, vibrations, harmful chemicals, microclimate in the room, etc. interfere with the work the most, which requires the development of a whole system of special measures at the legislative level and their successful practical implementation.

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FROM SOIL TO TABLE: EVALUATING CONVENTIONAL AND ECOLOGICAL CULTIVATION SYSTEMS IN SOUTH-WEST OLTENIA, ROMANIA

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Abstract

In the context of rising concerns about sustainability and environmental impact, this article focuses on analyzing two remarkable agricultural systems in the South-West Oltenia Development Region: the conventional and the ecological, and emphasizes one of the foundational crops for the region, wheat. The research was derived from a comprehensive questionnaire applied on 18 farms in the South-West Oltenia region: half of them employing ecological practices and the other half using conventional methods. Our primary focus was to determine the most economically viable agricultural system for the area. Through this analysis, the article not only illustrates the evolution of this crop's production from 2020 to 2022, but also provides insights into production costs and their valorization in the market. Moreover, it underscores the importance and advantages of each agricultural system, highlighting potential long-term benefits from both economic and sustainable perspectives. To provide a solid and well-grounded analysis, statistical methods were employed, combined with data obtained fromthe questionnaire administered directly at the farm level in the region. This methodology offers a clear perspective on the profitability and efficiency of the two agricultural systems in the specific context of South-West Oltenia.

Key words: *ecological agriculture, conventional agriculture, agricultural systems, conversion, wheat cultivation, sustainability, profitability*

INTRODUCTION

Sustainability has become a cornerstone in discussions related to agriculture [7] as there's an acknowledgment of the impact that conventional farming methods can have on the environment and biodiversity. Ecological farming, for instance, aims to present an alternative to these conventional techniques, [5] emphasizing the preservation of natural resources and minimizing environmental impact [11, 12].

In the EU, there's a noticeable shift from traditional to organic farming, [8, 15] hinting at a brighter future for the organic sector. This trend is especially strong in countries like France, Spain, Italy, and Romania [1].

In 2020, a big part of the EU's organic farmland was dedicated to permanent grassland, predominantly in Spain, France, and Germany [10]. This grassland mainly supports organic livestock. Other areas focus on crops like feed for livestock, cereals, and long-standing crops such as fruits and olives [18].

Some crops, like dry pulses, have a large portion grown organically, standing at 24%. From 2014 onwards, there's been a surge in the organic cultivation of grains and industrial crops. When it comes to farm sizes, organic ones in the EU tend to be larger than traditional farms [14] (Figure 1).

On average, organic farms cover 41 hectares, compared to 16 hectares for traditional farms.

In today's agricultural paradigm, the choice between conventional and ecological systems is more than just a matter of farming practices [3]; it is a reflection of the broader socio-economic and environmental priorities [9]. Within the scope of this article, we cast our analytical gaze on these two distinctive agricultural models as they find expression in the South-West Oltenia Development Region. The South-West Oltenia Region offers ideal conditions for growing fertile crops, particularly cereals and oil-producing plants [13].

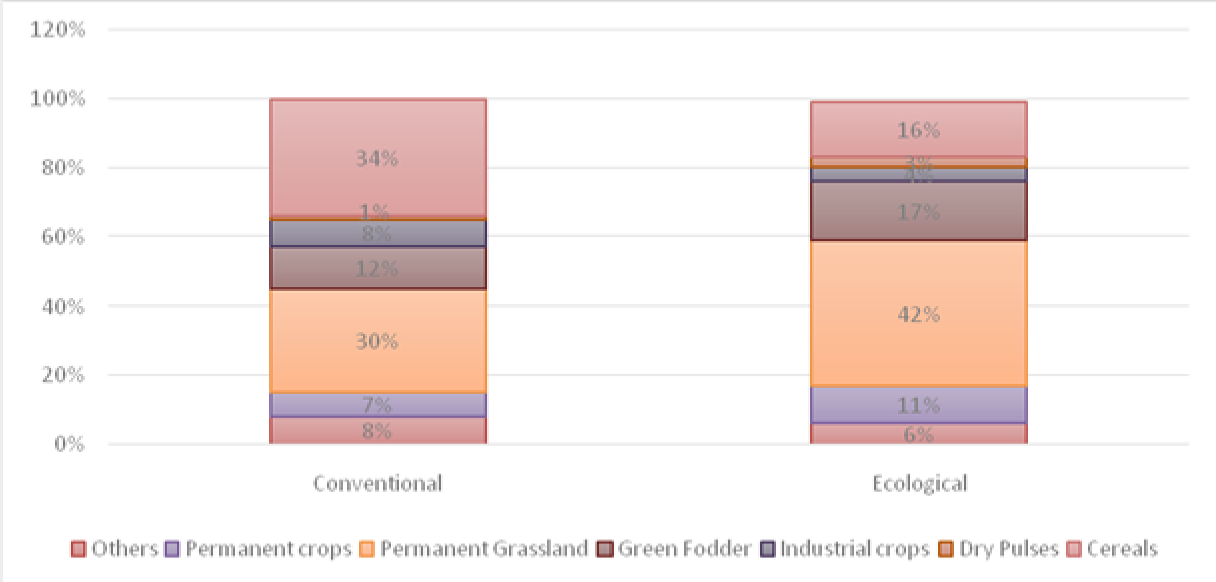

Fig. 1. Land use of conventional and organic agriculture, in 2020, by crop (%)
Source: European Comission, DG AGRI calculation based on Eurostat, p. 6 [6].

In this paper it is mainly paid attention to the cultivation and performance of an integral crop, very important in Romania, namely wheat which is noteworthy that it is the predominant cereal crop cultivated and used to make bread for around 40% of the global population [22].

Exploration lies a multi-faceted aim: First, we want to highlight the inherent characteristics and merits of both the conventional and ecological systems. This involves assessing how each system aligns with modern agricultural goals, from sustainability to yield maximization. Second, by examining the period between 2020 and 2022, we provide a temporal snapshot of the dynamics at play, offering readers a clear trajectory of how this crop has fared in recent years within each system. This includes a critical look at the costs of production, which often serve as a deciding factor for many farmers pondering between these two systems. Beyond the costs, the method of valorization and the consequent pricing strategies offer a window into the broader market mechanics and how each system integrates within it.

In this context, the purpose of the paper is to comparatively analyze conventional and the ecological wheat croping in 18 farms in the South-West Oltenia region of Romania, based on a structured questionnaire used in field survey.

MATERIALS AND METHODS

In conducting our study, we leaned on documentation, analytical review, and the refinement of data.Grounded in the practices of synthesis, drawing analogies, and contrasting analysis, we structured our research approach. To ensure the depth and accuracy of our insights, our study draws on empirical data. By leveraging statistical tools and methodologies, we have analyzed data sourced from a meticulously designed questionnaire. This questionnaire was administered across 18 agricultural operations in the region, specifically divided into 9 conventional and 9 ecological farms. Each of these farms was further segmented based on three different size dimensions (between 1-30 hectares, between 30-50 hectares and over 100 hectares).The data gathered from the questionnaire was analyzed using Microsoft Excel's pivot table feature. This software aids

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in organizing and showcasing data efficiently and coherently, making it suitable for detailed study and documentation. The examination focused on factors like the scale of the farm operations, educational background, average yields, cost of production, and the pricing of the produce.Ultimately, the study's findings are geared towards helping stakeholders, be it farmers, policymakers, or investors, make informed decisions based on the profitability and sustainability of the conventional and ecological agricultural systems in the South-West Oltenia Development Region.

RESULTS AND DISCUSSIONS

In order to make the analysis more relevant, we chose to examine farms focusing solely on wheat. It is well known that wheat holds a significant place in the agricultural landscape of Romania, [21] not just due to the favorable climatic conditions that allow it to thrive. This crop has become an integral part of the country's economy, having a consolidated status not only through its yield but also its role in exports. [16, 17, 20]. Traditionally, Romania has had a close relationship with the land, with agriculture always being one of its main sectors [2].
In this context, Romanian farmers are highly efficient in cultivating wheat, thus maximizing profits and profitability. Wheat, being used in a wide range of products, is extremely versatile and, therefore, very attractive to farmers. The profitability of this crop is a key factor. The fact that wheat is relatively resistant to climatic variations, especially drought, makes it less risky for farmers. This is a major consideration in a country where the irrigation infrastructure has been and continues to be a challenge. Last but not least, the economic context plays a significant role. Wheat benefits from government subsidies or other forms of support, [4] making it even more attractive to those involved in the agricultural sector. The fact that wheat represents a valuable export for Romania establishes its importance in the agrarian and economic structure of the country [19].
Table 1 shows the proportions concerning the main crops cultivated at the level of the surveyed farms, based on the category of owned land area. It is evident that wheat enjoys greater popularity, being present in a higher percentage, both at the conventional and ecological systems level.
Furthermore, it can be observed that there are farms that cultivate wheat and sunflower in parallel and others that focus solely on wheat cultivation. Among the chosen farms, we note that in the conventional system, there is a farm (5.56%) with an area of over 100 hectares that also grows corn. Meanwhile, in the ecological system, we find a small-sized farm that has also opted for this crop.

Table 1. The main crop cultivated at the level of the farms interviewed

	Conventional agriculture			Ecological agriculture		
	10-30 ha	50-100 ha	over 100 ha	10-30 ha	50-100 ha	over 100 ha
Sunflower	▼ 0%	▬ 5.56%	▼ 0%	▬ 5.56%	▼ 0%	▬ 5.56%
Wheat	▲ 16.67%	▬ 11.11%	▬ 11.11%	▬ 5.56%	▲ 16.67%	▬ 11.11%
Corn	▼ 0%	▼ 0%	▬ 5.56%	▬ 5.56%	▼ 0%	▼ 0%

Source: Questionnaire on the sustainability of conventional and ecological agricultural systems, applied in the South-West Oltenia region, (2023)

If we talk about predominant crops, wheat clearly dominates, covering over 70% of all farms (72.22%), regardless of the type of agriculture practiced. This is followed by sunflower, which is found in approximately 17% of the farms (16.67%), and corn, with 11.11%.

Table 2 presents the ways in which agricultural production is valorized in the South-West Oltenia region, whether were discussing conventional or ecological agriculture.
For conventional agriculture, 33.33% of the production is capitalized through intermediaries, with only 11.11% processed

directly in factories and 5.56% capitalized on their own farms. Breaking it down further by education level and type of operation, we observe that respondents with high school education capitalize 11.11% of their production through intermediaries. LLCs (S.R.L.) account for 11.11% of the capitalization through intermediaries. Those with higher education tend to diversify their capitalization methods, with 22.22% using intermediaries, 11.11% opting for processing factories, and 5.56% capitalizing at their own farms. Self-employed person(P.F.A.) predominantly rely on intermediaries, accounting for 5.56%. Meanwhile, non-authorized individuals (P.F.N.) focus exclusively on capitalizing at their own farms, contributing 5.56%. LLCs play a larger role in this sector, managing 16.67% through intermediaries and 11.11% in processing factories.

Regarding ecological agriculture, 44.44% of the production is capitalized through intermediaries. Among these, individuals with higher education dominate this category, capitalizing 44.44% of their production through intermediaries and 5.56% directly at processing factories. Sole enterprises (I.I.) focus strictly on intermediaries, accounting for 5.56%. Sole proprietors capitalize 11.11% of their production through intermediaries. LLCs, as evident, have a dominant role, managing 27.78% through intermediaries and 5.56% in processing factories.

The questionnaire incorporated an analysis from the perspective of education level to assess its influence. From the results, it is clear that individuals with higher education, both in conventional and ecological sectors, have a broader approach in capitalizing their production, balancing between direct processing in factories, capitalizing at their own farms, and intermediaries. In contrast, those with high school education seem to rely more heavily on intermediaries. The choice of capitalization method might be influenced by the depth of knowledge, access to resources, or networks that higher education might offer.

Table 2. The main way of capitalizing the production

	Processing factory	Own farm	Intermediaries	Total
CONVENTIONAL AGRICULTURE	**11.11%**	**5.56%**	**33.33%**	**50.00%**
High school studies	0.00%	0.00%	11.11%	11.11%
L.L.C.	0.00%	0.00%	11.11%	11.11%
Highereducationstudies	11.11%	5.56%	22.22%	38.89%
Self-employedPerson (PFA)	0.00%	0.00%	5.56%	5.56%
Non-authorized individuals (PFN)	0.00%	5.56%	0.00%	5.56%
L.L.C.	11.11%	0.00%	16.67%	27.78%
ECOLOGICAL AGRICULTURE	**5.56%**	**0.00%**	**44.44%**	**50.00%**
Highereducationstudies	5.56%	0.00%	44.44%	50.00%
Sole enterprises (I.I.)	0.00%	0.00%	5.56%	5.56%
Self-employedPerson (PFA)	0.00%	0.00%	11.11%	11.11%
L.L.C.	5.56%	0.00%	27.78%	33.33%
TOTAL	**16.67%**	**5.56%**	**77.78%**	**100%**

Source: Questionnaire on the sustainability of conventional and ecological agricultural systems, applied in the South-West Oltenia region, (2023).

Table 3 presents the distribution of respondents based on the type of agriculture practiced, average production per hectare, production cost, and average selling price for the year 2020. If we analyze the average production in tons per hectare, we see that in the case of conventional agriculture, 4 respondents recorded a production between 5-6 t/ha, while for ecological agriculture, 4 respondents fell within the 2-3 t/ha range. Production costs also differ. All 4 respondents from ecological agriculture with yields of 2-3 t/ha have costs under 2,000 RON, while in conventional agriculture we see a wider range of costs. For instance, one respondent with a yield of 4-5 t/ha had costs between 2,500-3,000 RON, while another, with the same yield of 4-5 t/ha, had costs between 4,000-

4,500 RON. Regarding selling prices, the two types of agriculture have a similar spectrum. For instance, for ecological agriculture with a yield of 2-3 t/ha, the price varies between 0.7-0.9 RON/kg, while for those in conventional agriculture with a yield of 5-6 t/ha, prices range between 0.8-1.2 RON/kg. Thus, the collected data indicates that conventional agriculture offers higher production but often at greater costs, while ecological agriculture appears to be more economical from a production cost perspective, but with a smaller yield. The selling price per kg does not differ significantly between the two practiced types of agriculture.

Table 3. Distribution of respondents by type of agriculture practiced, average production per ha, cost of production and average selling price of wheat, 2020

WHEAT	**Conventional agriculture**			**Total conv**	**Ecological agriculture**			**Total eco**	**Total**
Average production (t/ha)/ cost of production 000 RON/ average price RON/kg	10-30 ha	50-100 ha	over 100 ha	No.	10-30 ha	50-100 ha	over 100 ha	No..	conv + eco
2-3 t					3	1		**4**	**4**
under 2,000 RON					3	1		**4**	**4**
0.7-0.8					1			**1**	**1**
0.8-0.9					1			**1**	**1**
0.9-1						1		**1**	**1**
1.1 - 1.2					1			**1**	**1**
3-4 t						1	1	**2**	**2**
3.5-4,000 RON							1	**1**	**1**
1.3-1.4							1	**1**	**1**
under 2,000 RON						1		**1**	**1**
0.8-0.9						1		**1**	**1**
4-5 t	1		1	**2**			2	**2**	**4**
2.5-3,000 RON	1			**1**			1	**1**	**2**
0.7-0.8	1			**1**					**1**
1.1 - 1.2							1	**1**	**1**
3-3,500 RON							1	**1**	**1**
1.3-1.4							1	**1**	**1**
4-4,500 RON			1	**1**					**1**
0.8-0.9			1	**1**					**1**
5-6 t		2	2	**4**		1		**1**	**5**
2.5-3,000 RON		2		**2**					**2**
0.8-0.9		2		**2**					**2**
3-3,500 RON			1	**1**		1		**1**	**2**
0.8-0.9						1		**1**	**1**
0.9-1			1	**1**					**1**
under 2,000 RON			1	**1**					**1**
1.1 - 1.2			1	**1**					**1**
over 6 t	2	1		**3**					**3**
2.5-3,000 RON		1		**1**					**1**
0.8-0.9		1		**1**					**1**
3.5-4,000 RON	1			**1**					**1**
0.6 0.7	1			**1**					**1**
under 2,000 RON	1			**1**					**1**
0.7-0.8	1			**1**					**1**
Total	3	3	3	**9**	3	3	3	**9**	**18**

Source: Questionnaire on the sustainability of conventional and ecological agricultural systems, applied in the South-West Oltenia region, (2023).

The data from Table 4. provides information about the average yield per hectare, production cost, and average selling price for wheat in 2021, distributed, of course, across the two systems, conventional and ecological. When analyzing the average production, we

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notice that most farmers practicing conventional agriculture have a higher average production, with 5 out of the respondents (approximately 56%) producing between 5-6 t/ha. On the other hand, in the case of ecological agriculture, 4 respondents (approximately 44%) report a production between 2-3 t/ha. Regarding production costs, there is a greater diversity in the case of conventional agriculture, with values ranging from under 2,000 RON to 3,500-4,000 RON. Ecological agriculture has lower costs, with 3 out of the 4 respondents who produce 2-3 t/ha having costs under 2,000 RON. Selling prices are within a fairly narrow range, generally varying between 0.7-1.2 RON/kg, regardless of the type of agriculture.

Table 4. Distribution of respondents by type of agriculture practiced, average production per ha, cost of production and average selling price of wheat, 2021

WHEAT	**Conventional agriculture**			**Total conv**	**Ecological agriculture**			**Total eco**	**Total**
Average production (t/ha)/ cost of production 000 RON/ average price RON/kg	10-30 ha	50-100 ha	over 100 ha	No.	10-30 ha	50-100 ha	over 100 ha	No..	conv + eco
2-3 t					2	2		**4**	**4**
2-2,500 RON					1			**1**	**1**
1.1 - 1.2					1			**1**	**1**
under 2,000 RON					1	2		**3**	**3**
0.8-0.9					1	1		**2**	**2**
0.9-1						1		**1**	**1**
3-4 t	1			**1**	1		2	**3**	**4**
2-2,500 RON	1			**1**					**1**
0.7-0.8	1			**1**					**1**
3.5-4,000 RON							1	**1**	**1**
1.3-1.4							1	**1**	**1**
4-4,500 RON							1	**1**	**1**
1.3-1.4							1	**1**	**1**
under 2,000 RON					1			**1**	**1**
0.7-0.8					1			**1**	**1**
4-5 t	1			**1**			1	**1**	**2**
2.5-3,000 RON							1	**1**	**1**
1.1 - 1.2							1	**1**	**1**
3-3,500 RON	1			**1**					**1**
0.7-0.8	1			**1**					**1**
5-6 t		3	2	**5**		1		**1**	**6**
2.5-3,000 RON		2		**2**					**2**
0.8-0.9		2		**2**					**2**
3-3,500 RON		1	1	**2**		1		**1**	**3**
0.8-0.9		1		**1**		1		**1**	**2**
0.9-1			1	**1**					**1**
under 2,000 RON			1	**1**					**1**
1.1 - 1.2			1	**1**					**1**
over 6 t	1		1	**2**					**2**
3.5-4,000 RON	1			**1**					**1**
0.6 0.7	1			**1**					**1**
4-4,500 RON			1	**1**					**1**
0.8-0.9			1	**1**					**1**
Total	3	3	3	**9**	3	3	3	**9**	**18**

Source: Questionnaire on the sustainability of conventional and ecological agricultural systems, applied in the South-West Oltenia region, (2023).

Thus, we can conclude that conventional agriculture provides a higher average yield but at higher costs, while ecological agriculture exhibits both lower production costs and a smaller average yield. Selling prices, just as in 2020, are relatively similar between the two agricultural systems.

In Table 5, we have a dataset referring to wheat production in 2022. Looking at the average yield per hectare for conventional agriculture, most of the production falls between 4-5 tons/ha and over 6 tons/ha. For ecological agriculture, the average yield is smaller, with most respondents reporting a production of 2-3 tons/ha. From this, it emerges that conventional agriculture is more productive in terms of yield per hectare. Production costs vary in both types of agriculture. In the case of conventional agriculture, the costs are spread between 2,500-3,000 RON and 4,500-5,000 RON. For ecological agriculture, the majority of costs fall between 2-2,500 RON.

Table 5. Distribution of respondents by type of agriculture practiced, average production per ha, cost of production and average selling price of wheat, 2022

WHEAT	**Conventional agriculture**			**Total conv**	**Ecological agriculture**			**Total eco**	**Total**
Average production (t/ha)/ cost of production 000 RON/ average price RON/kg	10-30 ha	50-100 ha	over 100 ha	No.	10-30 ha	50-100 ha	over 100 ha	No..	conv + eco
2-3 t					3	2		5	5
2.5-3,000 RON					1			1	1
1.7-1.8					1			1	1
2-2,500 RON					1	2		3	3
1.5-1.6					1	2		3	3
under 2,000 RON					1			1	1
1.1 - 1.2					1			1	1
3-4 t							2	2	2
3-3,500 RON							1	1	1
1.5-1.6							1	1	1
4.5-5,000 RON							1	1	1
1.7-1.8							1	1	1
4-5 t	2	2		4		1	1	2	6
2.5-3,000 RON	1			1					1
1.4-1.5	1			1					1
3.5-4,000 RON						1		1	1
1.7-1.8						1		1	1
3-3,500 RON		1		1					1
1.5-1.6		1		1					1
4-4,500 RON	1			1			1	1	2
1.4-1.5	1			1					1
1.7-1.8							1	1	1
4.5-5,000 RON		1		1					1
1.5-1.6		1		1					1
5-6 t		1	1	2					2
4-4,500 RON		1		1					1
1.7-1.8		1		1					1
4.5-5,000 RON			1	1					1
1.7-1.8			1	1					1
over 6 t	1		2	3					3
2.5-3,000 RON			1	1					1
1.7-1.8			1	1					1
4.5- 5,000 RON	1		1	2					2
1.3-1.4	1			1					1
1.6-1.7			1	1					1
Total	3	3	3	9	3	3	3	9	18

Source: Questionnaire on the sustainability of conventional and ecological agricultural systems, applied in the South-West Oltenia region, (2023).

Regarding the selling price, values range between 1.1 and 1.8 RON/kg for both types of agriculture. However, higher prices (1.7-1.8 RON/kg) are more frequently reported in the case of ecological agriculture.

CONCLUSIONS

From the analysis of conventional and ecological agricultural systems in the South-West Oltenia Development Region, a clear narrative emerges around the significance of wheat cultivation. While the conventional system holds its ground in terms of production volumes, the ecological paradigm is carving out its space in the backdrop of growing sustainability concerns. Intermediaries play a pivotal role in the market, pointing to opportunities for more direct producer-consumer links. Notably, education levels appear to shape decisions on how production is valorized, hinting at the value of expanded knowledge networks in the sector. As the global emphasis on sustainability grows, the evolution of these agricultural systems in the region will be a testament to the balance between economic robustness and environmental responsibility.

On the other hand, based on the data presented for the years between 2020 and 2022, and taking into account past developments, the following conclusion can From the analysis of conventional and ecological agricultural systems in the South-West Oltenia Development Region, a clear narrative emerges around the significance of wheat cultivation. While the conventional system holds its ground in terms of production volumes, the ecological paradigm is carving out its space in the backdrop of growing sustainability concerns. Intermediaries play a pivotal role in the market, pointing to opportunities for more direct producer-consumer links. Notably, education levels appear to shape decisions on how production is valorized, hinting at the value of expanded knowledge networks in the sector. As the global emphasis on sustainability grows, the evolution of these agricultural systems in the region will be a testament to the balance between economic robustness and environmental responsibility.

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BIBLIOMETRIC ANALYSIS OF SUSTAINABILITY AND PROFITABILITY IN CONVENTIONAL AND ECOLOGICAL AGRICULTURE

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Abstract

In the context of the growing interest in sustainable agricultural practices, this study highlights a detailed bibliometric analysis regarding the intersection between sustainability and profitability in conventional and ecological farming.While the ecological farming model clearly emerges as a frontrunner in terms of sustainability, profitability assessments present challenges due to varying regional costs, lack of standardized metrics, and short-term versus long-term value evaluations. Drawing from international sources and top-tier academic literature, the article reveals prevailing trends as well as under-researched areas in the field of agricultural research. The results indicate a clear acknowledgment of the benefits of ecological farming from a sustainability standpoint. However, the paper discusses the challenges related to assessing the profitability of these practices and identifying the most efficient strategies for supporting and expanding alternative farming systems. Thus, it underscores the imperative of a multidisciplinary perspective for deep understanding and informed action in the field.

Key words: *sustainability, profitability, conventional agriculture, ecological agriculture, alternative cultivation systems, bibliometric analysis*

INTRODUCTION

In recent decades, the global agricultural sector has experienced significant transformations, driven largely by the ever-increasing demand for sustainable and profitable practices [24, 31]. As the world's population continues to grow, so does the pressure on our agricultural systems to produce food in an efficient and sustainable manner [23]. This balance between sustainability – ensuring that our actions and decisions do not deplete resources or harm future generations – and profitability – ensuring that agricultural activities remain economically viable – has become a focal point of discussions, research, and policymaking [5].

Conventional farming, long celebrated for its high yields and efficiency, has come under scrutiny for its environmental implications and long-term unsustainability [11]. the other hand, ecological farming, which excludes the use of synthetic pesticides, herbicides, and genetically modified organisms, promotes a holistic approach to agriculture 4, 32]. While it is lauded for its environmental benefits, doubts persist regarding its economic viability on a large scale [2].

In this complex landscape, multidisciplinary studies emerge as very important tools, offering a more comprehensive understanding by integrating various aspects, from the natural sciences to the economic and social realms. Moreover, as the global community seeks viable solutions, alternative cultivation systems are being researched and proposed as potential paths forward [12, 18].

This paper embarks on a detailed bibliometric analysis of the existing literature, aiming to shed light on current trends, gaps, and future directions in the intertwined realms of sustainability, profitability, and farming practices. Through this exploration, we aim to

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provide valuable insights for researchers, policymakers, and practitioners alike.

MATERIALS AND METHODS

Bibliometric analysis is a research method that quantitatively evaluates specialized literature based on categories of topics of interest, providing information extracted from various databases (Web of Science, Scopus, Science Direct, etc.). The method involves, on one hand, scientific mapping, which determines the structure and dynamics of the analyzed scientific fields, and on the other hand, performance analysis, which assesses the performance of authors and the institutions to which they belong [7, 30]. Another important aspect is the analysis of citations, through which scientific research is highlighted and its value recognized [29]. The results obtained from conducting a bibliometric study on citations allow for determining the number of citations as well as establishing the connections between authors, which can be identified through simultaneous citations.

RESULTS AND DISCUSSIONS

Since the current research aims to analyze studies related to conventional and ecological agricultural systems, we assessed their relevance in scientific literature using bibliometrics. In this endeavour, we extracted available information from the ISI Web of Science and Scopus databases, which are two of the most popular platforms hosting scientific publications from around the world. These are managed by Clarivate Analytics and are used as research tools. The advantages of these databases include the high scientific level of the publications, the accuracy of the information, and the relevance of the results obtained. The platforms house a significant number of scientific papers that span an extended period of research (1900 to present). The consultation of the Web of Science and Scopus databases took place on September 13, 2023. The key terms used were "conventional agriculture" and "ecological agriculture," resulting in 1,486 articles. Subsequently, we refined the search to select only publications containing comparative studies between the two agricultural systems, yielding 62 articles. By adding the term "sustainability," we arrived at a total of 15 articles. Using the period of 2000-2023 as a filter, 1,392 articles were identified, of which 95.61% are written in English. In Figure 1, both the number of publications and citations are illustrated.

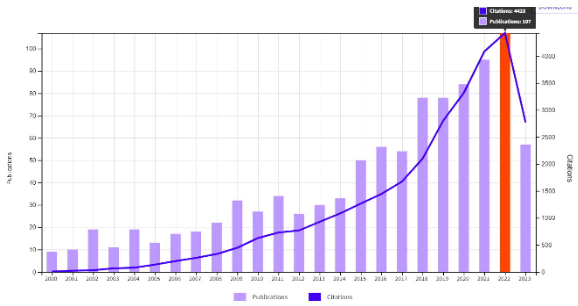

Fig. 1. Evolution of citations and scientific research articles from the period 2000-2023
Source: own representation, WOS.

Thus, we observe that the interest in studying both conventional and ecological agriculture has been on a rising trend from 2000-2023, with the highest number of articles, totalling 107, recorded in 2022. Regarding the number of citations, the highest count was also registered in 2022, amounting to 4,428.

Table 1 presents the overview of the main authors who have shown interest in the comparative analysis between conventional and ecological agriculture. The authors are listed in descending order based on the number of citations found in the specialized literature. The criterion applied in this case was a minimum of 25 citations per article.

After determining the sample of scientific papers, we conducted the actual bibliometric analysis using the mapping methodology and the VOS viewer software (Centre for Science and Technology Studies, Leiden University, Netherlands, 2020). This software allows the construction and visualization of bibliometric networks.

We first examined the collaboration network between authors from the perspective of their countries of origin to identify researchers' interest in the comparative analysis of the two agricultural systems.

Table 1. Citation overview for scientific articles, by authors, for the period 2000-2023

Authors	Citations
Koch, M.S., Ward, J.M., Levine, S.L., Baum, J.A., Vicini, J.L., Hammond, B.G. [14]	**140**
Agostinho, F., Diniz, G., Siche, R., Ortega, E. [1]	**105**
Parra-López, C., Calatrava-Requena, J., De-Haro-Giménez, T. [20]	**84**
Loeser, M.R.R., Sisk, T.D., Crews, T.E. [16]	**81**
Smolik, J.D., Dobbs, T.L., Rickerl D.H. [26]	**77**
Wilson A.L., Watts R.J., Stevens, M.M. [34]	**52**
MacRae, R.J., Frick, B., Martin, R.C. [17]	**44**
González-Pérez, J.A., González-Vila, F.J., González-Vázquez, R., Arias, M.E., Rodríguez, J., Knicker, H. [10]	**39**
Xu, Q., Ling, N., Chen, H., Duan, Y., Wang, S., Shen, Q., Vandenkoornhuyse, P. [35]	**38**
Marx, H., Gedek, B., Kollarczik, B. [19]	**37**
Watson, C.A., Walker, R.L., Stockdale, E.A. [32]	**35**
Singh, U., Choudhary, A.K., Sharma, S. [25]	**34**
Flores, C.C., Sarandón, S.J. [8]	**29**
Jennings, N., Pocock, M.J.O. [13]	**28**

Source: own representation, WOS.

We set a minimum threshold of 25 papers published in the same country, resulting in a total of 127 countries. By adding a minimum number of 25 citations per country, the number of countries reduced to 19. It appears that the USA has the highest interest in this subject, with a total of 319 scientific papers that accumulated 16,320 citations, establishing 128 links. It is followed by China, with 224 studies, 4,668 citations, and 70 links, and Germany, with 126 studies, 4,810 citations, and 92 established links. In Romania, 26 studies were published, cited 145 times, with 5 established links.

The research from these 19 countries is grouped into 4 clusters, with a total of 118 links and a combined link strength of 434.

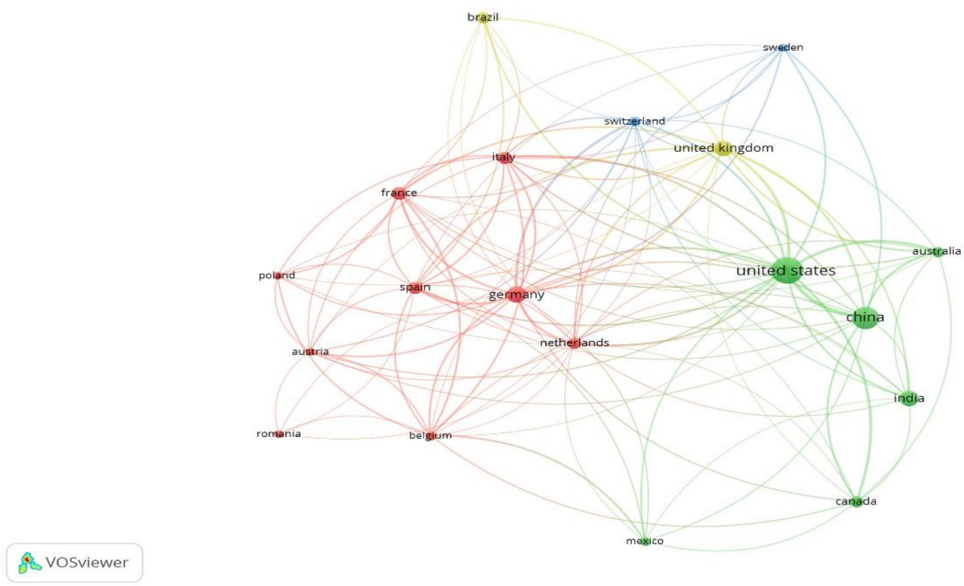

Fig. 2. The network of links between authors and their countries of origin
Source: own representation, WOS.

The size of the nodes corresponding to each country reflects its significance in research on conventional and ecological agriculture. The thickness of the lines and the distance between nodes indicate the collaboration links between authors. The graphical representation identifies four groups of countries, each coloured differently, sharing scientific collaborations related to conventional and ecological agriculture (groups are formed based on collaboration intensity).

The red group, which includes Romania, comprises 9 countries: Germany, France, Italy, Spain, Netherlands, Poland, Austria, Belgium, and Romania. The most significant country in terms of international collaboration is the United States, which appears in the green group, alongside China, India, Australia, Canada, and Mexico. American authors collaborated with authors from all 19 countries, having stronger ties with countries such as China, India, and England. The third group consists of England and Brazil (yellow), and the fourth of Sweden and Switzerland (blue). England is also one of the countries with noteworthy studies in this field. Romanian authors collaborated with researchers from Germany, France, Italy, Spain, Poland, the Netherlands, Belgium, and Austria. Subsequently, we analyzed the distribution of the most used keywords in the published research to determine their connections. We set a minimum threshold of 25 simultaneous appearances. Out of the 1,392 scientific papers, 9,972 keywords were identified, of which 883 surpassed the minimum threshold. We selected the top 25 keywords with the strongest connections to other keywords, resulting in a total of 122 keywords grouped into 3 clusters with 5,872 links and a combined link strength of 28,832.

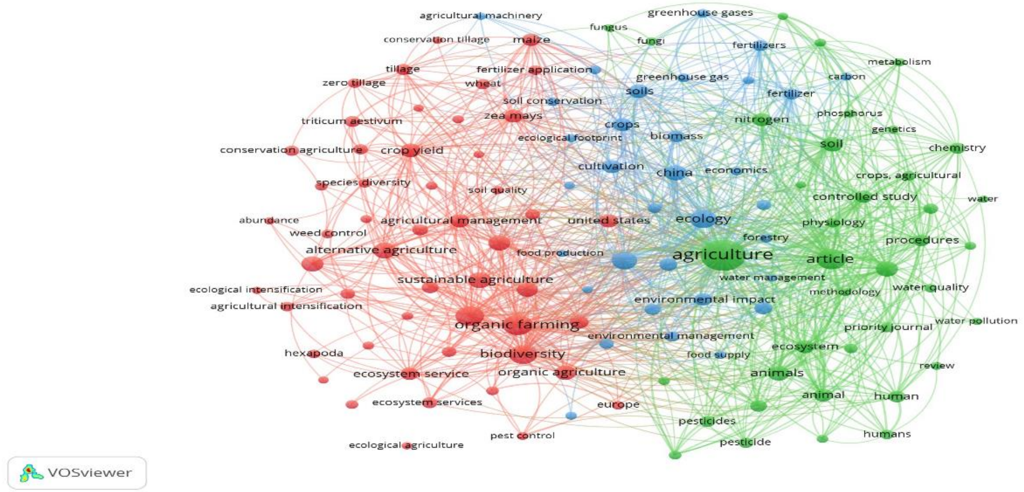

Fig. 3. The network of links between authors and keywords
Source: own representation, WOS.

The coauthor ship analysis aims to identify collaboration ties between researchers, organizations, countries, or regions. To discern these connections, we set certain criteria: a document may mention up to 25 organizations, an organization should have at least 10 papers, and garner a minimum of 50 citations. From these criteria, 125 countries were identified, of which 36 matched our standards.

These countries were then segmented into six clusters based on the intensity of coauthor collaborations. The USA, China, and Germany notably emerge with the most robust coauthor networks.

The first cluster highlights European collaborations, including countries such as Austria, Czech Republic, Denmark, Germany, Hungary, Netherlands, Norway, Romania, Portugal, and Spain. In contrast, the second cluster amalgamates countries from various regions, like Argentina, Italy, Kenya, South Africa, Sweden, Switzerland, the UK, and Zimbabwe. The third cluster focuses on Asia and the Pacific, including Australia, China, Malaysia, New Zealand, and Pakistan.

Cluster 4 groups authors from Belgium, Canada, India, Japan, and Mexico, hinting at a mix of transatlantic and transpacific collaborations. Cluster 5 represents strategic

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links between countries like Iran, Poland, Turkey, and the USA. Lastly, cluster 6 underscores intense collaboration between Brazil and France.

Notably, the strongest ties are established between authors from the USA, China, and Australia, underscoring these nations' influence in the research field.

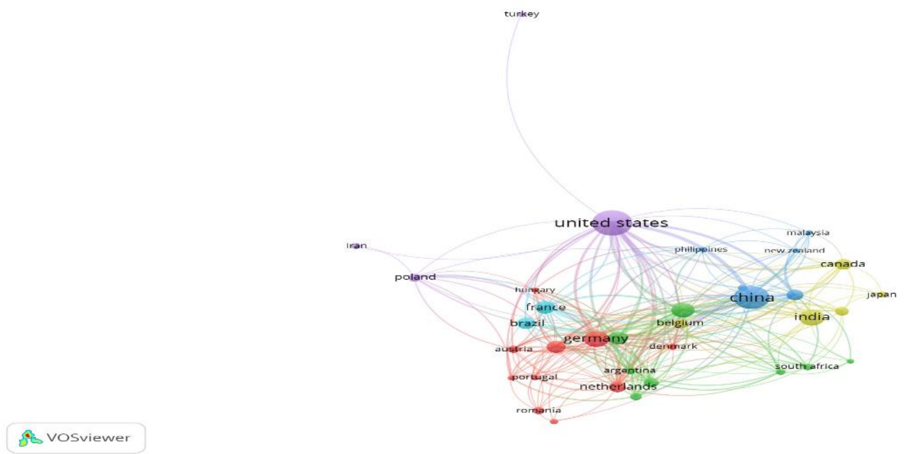

Fig. 4. Details the network of collaborations between coauthors and their respective countries of origin
Source: own processing based on Scopus data

In the process of identifying information related to ecological and conventional agriculture, as well as their comparison, we deemed co-occurrences with keyword groups essential, meaning those words that simultaneously appear in the same article or study. Figure 5 illustrates the relevance of keywords. By imposing a restriction of a minimum of 25 keywords, a total of 9,972 words resulted, of which 122 met the restrictions. Three clusters were identified, establishing 5,872 connections between them. Among the most significant keywords identified are agriculture, conventional agriculture, ecological agriculture, ecological farm, biodiversity, alternative agriculture, ecology, agroecology, and management.

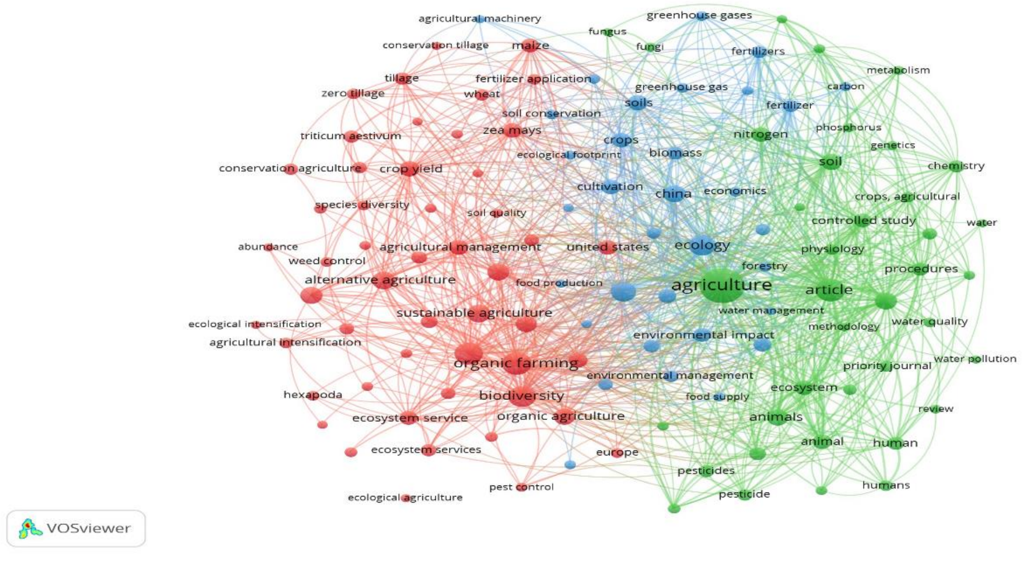

Fig. 5. The network of connections between co-occurrence and the keyword group
Source: own processing based on Scopus data.

To identify, on one hand, research gaps and, on the other hand, to harness the results of conducted studies, we analyzed the most relevant scientific papers. The results were synthesized in Table 2. In achieving this objective, we used the Scopus database, selecting research from the period 2000-2023. Additionally, we incorporated an extra criterion: the evaluation of the sustainability of the practiced agricultural systems. The search and filtering yielded a total of 14 articles. These were reviewed based on their authors, publication, year of release, title, number of citations, and the results obtained.

Table 2. Scientific research in the field of sustainability and profitability of conventional and ecological agriculture

Authors	Year of public.	Publication name	Title	Results obtained	Citations
Bai, X., Wen, Z., An, S., Li, B. [3]	2015	PLoS ONE, 10 (3)	Evaluating sustainability of cropland use in Yuanzhou County of the Loess Plateau, China using an emergy-based ecological footprint	Starting from the fact that assessing the sustainability of cropland use is essential for ensuring food security and sustainable agricultural development, the study conducted in the Loess Plateau region of China evaluates its sustainability based on an ecological footprint model that integrates emergy analysis, enhancing the ecological footprint method. The new method considered both the surface energy of the soil and the net loss of topsoil for human consumption. The paper assesses the overuse or sustainable management of farmland from 1981-2009	14
Gómez Betancur, L.M., Márquez Girón, S.M., Restrepo Betancur, L.F. [9]	2018	Idesia, 36 (1), pp. 123 - 131	The milpa as a agricultural conversion alternative of conventional agroecological systems of bean (Phaseolus vulgaris), in the municipality of Carmen viboral, Colombia	The study is participatory, based on the application of ecological principles, transferred from one farmer to another. Its purpose was the development and implementation of an agro-ecological project within a farm that, based on the multidimensional variance analysis and the dimensional descriptive process, established the arithmetic mean, standard deviation, and variation coefficient for the experiment conducted on zucchini and bean crops, grown after corn.	8
Flores, C.C., Sarandón, S.J. [8]	2004	Journal of Sustainable Agriculture, 24 (2), pp. 77 - 91	Limitations of neoclassical economics for evaluating sustainability of agricultural systems: Comparing ecological and conventional systems	The study highlights weaknesses in the application of both ecological and conventional agriculture, based on research conducted in La Plata, Argentina, which examined ecological, productive, and social aspects using a set of sustainability indicators. The cost-benefit analysis showed that the ecological farm was more profitable only when the prices of ecological products reached 340% compared to conventional ones. The agro-ecological analysis indicated that the ecological system achieved sustainability goals more efficiently than the conventional one. At the same time, it highlighted the fact that some aspects cannot be quantified through cost-benefit analysis, necessitating a new holistic approach that should be incorporated into agricultural education institutions	29
Redlichová, R., Bečvářová, V., Pociovălișteanu, D.M., Vinohradský, K., Zdráhal, I. [22]	2018	World Sustainability Series, pp. 319 - 341	Green-growth policies and economic effects: lessons learnt from ecological	The paper analyzes the findings of research that investigates the comparative economic performance of ecological and conventional farms in the Czech Republic. The ecological farming system has expanded, driven by the granting of subsidies. During the analyzed period, 2001-2012, ecological	0

			farming in the Czech Republic	farms achieved an agricultural production value per hectare of 30-40% of the value produced in conventional agriculture. The research also explains the concept of the "ecological paradox," showing how ecological farms create an ecological footprint per capita that is 1.5 times greater than in the case of conventional farms. The analysis of economic indicators raises the issue of the economic sustainability of ecological farms.	
Herrero, A., Wickson, F., Binimelis, R. [11]	2015	Sustainability (Switzerland), 7 (8), pp. 11321 - 11344	Seeing GMOs from a systems perspective: The need for comparative cartographies of agri/cultures for sustainability assessment	Starting from the fact that agricultural biotechnologies cannot be assessed as isolated technological entities, but must be in the context of the socio-ecological system, the paper explores, compares, and contrasts some of the available methodological tools for promoting this system-based perspective. The work has made a significant theoretical and methodological contribution by promoting a system-based approach to conceptualizing and evaluating genetically modified organisms (GMOs) and proposing a methodology for mapping the networks of relationships between different crops	9
Le, Q.V., Cowal, S., Jovanovic, G., Le, D.-T. [15]	2021	Frontiers in Sustainable Food Systems, 5, art. no. 712733	A Study of Regenerative Farming Practices and Sustainable Coffee of Ethnic Minorities Farmers in the Central Highlands of Vietnam	The study aims to highlight the benefits of regenerative agriculture, which plays a crucial role in adapting to and mitigating the effects of climate change. The research conducted by the authors, aiming to pinpoint the pros and cons of both conventional and ecological farming systems, suggests that regenerative farming practices boost biodiversity. However, these practices also create microclimates that foster the growth of the Roya fungus. The economic analysis concerning production costs and net profitability shows that regenerative farming practices lead to reduced reliance on external inputs. This reduction is a result of diversified crop systems and integrated production (both animal and plant-based), enhancing overall productivity and economic profitability while preserving ecological and environmental integrity.	1
Speiser, B., Stolze, M., Oehen, B., Gessler, C., Weibel, F.P., Bravin, E., Kilchenmann, A., Widmer, A., Charles, R., Lang, A., Stamm, C., Triloff, P., Tamm, L. [27]	2013	Agronomy for Sustainable Development, 33 (1), pp. 21 - 61	Sustainability assessment of GM crops in a Swiss agricultural context	The purpose of this study conducted in Switzerland was to assess the sustainability of genetically modified (GM) crops, highlighting: the gaps concerning the risks and benefits of production systems used for rotating field crops, and orchards; the socio-economic impact of agricultural systems for GM crops. The study involved the creation of new agricultural practice scenarios associated with the use of GM crops in conventional, integrated, and ecological farming systems, drawing from the United Kingdom's experience in this field.	12
Parra-López, C., Calatrava-Requena, J., de-Haro-Giménez, T. [20]	2008	Ecological Economics, 64 (4), pp. 820 - 834	A systemic comparative assessment of the multifunctional performance of alternative olive systems in Spain within an AHP-extended framework	The paper had three objectives: to present a methodology for the comparative assessment of the multifunctional performances of various agricultural systems; to expand the methods for improving decision-making processes regarding the choice of cropping systems; and to compare the performances obtained in different	84

				alternative cropping systems based on a study conducted for an olive plantation in Andalusia, Spain. The study tested the sustainability of ecological agriculture compared to conventional farming, highlighting a higher overall performance of ecological and integrated agriculture, thus providing a scientific basis for the promotion and implementation of these farming techniques. However, some conflicting issues were identified, especially in areas related to environmental performance, leaving room for further research.	
Pergner, I., Lippert, C. [21]	2023	Agronomy for Sustainable Development, 43 (2), art. no. 24	On the effects that motivate pesticide use in perspective of designing a cropping system without pesticides but with mineral fertilizer—a review	The paper proposes a complementary cropping system to conventional and ecological farming, called the Mineral-Ecological Cropping System (MECS), which allows for the continued use of mineral fertilizers with the aim of ensuring high yields. The system can be considered a compromise between current conventional and ecological cropping systems. The research provides a comprehensive analysis of specialized literature regarding the economic, social, and environmental effects of pesticides and the reasons why farmers should or shouldn't use them. The strengths of using this system are as follows: productivity and stability of yields are higher compared to ecological farming, but lower than conventional farming; profitability decreases due to the high costs of inputs and energy consumption; increase in soil fertility and biodiversity protection as a result of applying alternative pest and disease control measures; crop rotations will be broader and more diverse than in conventional farming; mineral fertilizers cannot be used optimally by crops unless there is a balanced nitrogen input. The research presents an innovative and sustainable cropping system and proposes measures to compensate farmers when deciding to abandon pesticides in favor of using mineral fertilizers.	2
Xu, Q., Ling, N., Chen, H., Duan, Y., Wang, S., Shen, Q., Vandenkoornhuyse, P. [35]	2020	mSystems, 5 (4), art. no. e00337-20	Long-term chemical-only fertilization induces a diversity decline and deep selection on the soil bacteria	The study analyzes the widespread use of fertilizers, establishing new perspectives on conservation, restoration, and management efforts for cultivated and microbiologically degraded lands.	38
Daelemans, R., Hulsmans, E., Honnay, O. [6]	2022	Journal of Environmental Management, 303, art. no. 114191	Both ecological and integrated pest management of apple orchards maintain soil health as compared to a semi-natural reference system	Starting from the negative impact that agriculture has on the environment, the research identifies those agricultural systems that try to reconcile production with environmental sustainability. Considering that the functioning of ecological management is still little understood in terms of maintaining soil health in real and heterogeneous commercial agricultural environments, compared to conventional management, and especially compared to a natural reference system, the research conducts an analysis based on a set of soil health indicators. The study establishes that perennial cropping systems can be managed sustainably without jeopardizing soil health, because of measuring certain soil variables.	4

Singh, U., Choudhary, A.K., Sharma, S. [25]	2022	European Journal of Soil Biology, 99, art. no. 103197	Comparative performance of conservation agriculture vis-a-vis ecological and conventional farming, in enhancing plant attributes and rhizospheric bacterial diversity in Cajanus cajan: A field study	The study evaluates the performance of conservation agriculture and makes a comparison between conventional and ecological agriculture. The research compares the three agricultural practices, establishing the relationship between agricultural management practices and the cropping system.	34
Spiegelaar, N.F., Tsuji, L.J.S. [28]	2013	Rural and Remote Health, 13(1), 2211	Impact of euro-canadian agrarian practices: In search of sustainable import-substitution strategies to enhance food security in subarctic Ontario, Canada	The paper analyzes food insecurity among the aboriginals living in the northern communities of Canada, which is due to their dependence on the industrialized food system based on imports. The study evaluated the soil properties in this area associated with the use of agricultural lands and productivity. The conclusions indicate that agro-ecosystem management practices and autonomous food security programs have the potential to increase the availability of locally grown food in a sustainable manner.	18

Source: Own processing, based on Scopus and WOS [3, 6, 8, 9, 11, 15, 20, 21, 22, 25, 27, 28, 35].

The analysis of specialist articles highlighted the researchers' concerns regarding conventional and ecological farming systems, but also in identifying other alternative, regenerative systems that contribute to both achieving the profitability of agricultural enterprises and respecting sustainability and food security. However, the information provided by international databases shows that multidisciplinary studies are insufficient. Although they are based on case studies carried out in different agricultural areas of the world, on different crops, resulting in technological aspects or agricultural practices, they are not correlated with economic aspects. Some reasons include the lack of sufficient indicators to measure the economic sustainability of ecological farming enterprises, the ongoing conflicts between areas related to environmental performance, or the absence of policies supporting alternative cultivation systems.

CONCLUSIONS

In the world of agriculture, striking the right balance between profitability and sustainability is pivotal for a resilient future. This investigation delves into the pronounced contrasts between conventional and ecological farming methodologies, elucidating their unique merits and challenges. Conventional farming, often marked by enhanced yields thanks to its dependence on state-of-the-art technology and chemical fertilizers, faces scrutiny over its environmental and health repercussions.

On the other side, ecological farming, with its environmentally conscious stance, occasionally faces doubts over its economic feasibility. Notably, this exploration unveils gaps in current knowledge, especially in harmonizing economic and technological aspects within ecological practices.

For a deeper and more nuanced understanding of the multifaceted agricultural systems and their interrelations, it's imperative for the research community to adopt an interdisciplinary approach, integrating insights from agricultural sciences, economics, sociology, and ecology. With this comprehensive perspective, we can navigate towards an agricultural model that seamlessly blends profitability with sustainability.

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WINTER WHEAT CROP YIELD AND ITS INFLUENCE ON PROFITABILITY

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Abstract

In order to obtain a good yield and high profitability for the winter wheat crop, a good interaction between the plant and the environment is needed for carrying out a strategic planning of the best agricultural practices. The most representative ones aim at the choice of varieties with genetic characteristics and high production capacity, the application of an optimal level of fertilization and the integrated fight against pathogens, which are key factors that contribute to increasing the productivity and quality of wheat harvests. The paper presents the analysis of the yield and profitability of the wheat crop in three large crop farms of different sizes in Romania. From the analysis carried out, in order to reach the profitability threshold, the following results were highlighted: on the farm of 60 ha, in the year 2021, on a cultivated area of 35.5 ha, the total production realized and sold must be 214.41 tons; on the farm of 600 ha, the cultivated area being 86 ha, the total production obtained and sold must be 514.24 tons; on the 3,000 ha farm, which had a cultivated area of 709.62 ha, the total cultivated and sold production must be 4,209.48 tons. It is necessary to specify the fact that in 2019 and 2020 the profitability threshold could not be reached, in most cases. This situation was due to drought, high production costs and low farm gate prices. The conclusion of the study is that the profitability of the winter wheat crop is difficult to be increased, taking into account the high and growing production expenses registered annually by farmers. In this situation, the increase in farm dependence on subsidies to ensure a favourable raw product for the winter wheat crop has clearly emerged.

Key words: *winter wheat crop, yield, profitability, subsidies*

INTRODUCTION

Cereals present a series of characteristics that are highly appreciated by the world's population, representing the most valuable group of plants for human activity and existence. Cereals are grown on almost all continents, but on different surfaces. The cereal category includes: wheat, triticale, rye, millet, oat, rice, corn, sorghum) [4, 9, 14].

The cereal sector holds a key position in the agriculture of the European Union. It is necessary to mention the fact that the EU is in the first position in terms of the production and trade of cereals worldwide. In order to ensure the stability of the cereal sector at the EU level, income support is granted to farmers [13]. The cereal sector supplies important raw materials both for human food and for animal feed. In this context, worldwide commercial exchanges with grains have a dynamic character and hold a significant share of the total trade in agri-food products [1].

According to published studies, wheat was domesticated more than ten thousand years ago, which attests to the fact that this crop has maintained its status as an essential plant in terms of ensuring global food security [3].

Worldwide, wheat is the most important cultivated plant from which bread is obtained, being cultivated annually on an area of 217 million hectares [3, 4, 6]. Regarding the wheat crop at the level of the European Union, according to official sources, it is in the first place, representing over 50% of the obtained grain production [13].

At present, bread is the basic food for 40% of the world's population. Wheat culture presents a series of advantages such as: the grains show good convertibility over long periods of time; the grains are easily transported over long distances; cultivation technology is mechanized; wheat is a precursor plant for many crops; wheat lends itself to different pedoclimatic conditions etc. [4, 6, 10, 11].

Regarding the importance of wheat, it has been found that, currently, it provides a fifth of the protein and dietary calories for humans [3].

Cereal producers, implicitly wheat producers, have to face several challenges, namely: changing climatic conditions; large variations related to valuation prices on the international market; increasing profitability in the conditions of increasing competitive pressure; reducing the cost of production in the conditions of increasing prices of production factors, preserving biodiversity, reducing soil works in order to regenerate and conserve the soil [2].

The profitability of the winter wheat crop is influenced by a number of factors such as: yield per hectare; pedoclimatic conditions; soil fertilization; seed quality; production cost; the capitalization price etc. It is necessary to specify the fact that soil fertilization is a key solution that determines the elimination of many problems related to agricultural land [7, 12].

Another obvious aspect in the current context is represented by the growth of the world's population, implicitly by the increase in demand for wheat [3]. In this situation, producers: either focus on increasing the productivity of this crop; or look for solutions to replace wheat. None of the previously presented options represent a simple way to ensure food security, because they are conditioned by a series of endogenous and exogenous factors.

In terms of increasing the productivity of the wheat crop, while respecting the conditions imposed by the environment, the emphasis can be placed on: irrigation of the crop and on major investments in research [3, 5]. These investments made by the states would represent, on the one hand, the future provision of food for the population, and on the other hand, would represent an indirect form of subsidizing producers.

In Romania, the area cultivated with wheat, the total production of wheat and the average production per hectare have registered variations over time. In 2021, Romania cultivated an area of 2,175 thousand hectares with wheat, achieving a total wheat production of 10,433 thousand tons. Romania obtained 7.5% of the total wheat production achieved at the level of the European Union, in the year 2021. These results placed Romania in fourth place both in cultivated area and in wheat production achieved, after the following countries: France, Germany and Poland. The average production per hectare for the wheat crop was 4,797 kg/ha in 2021. These results were possible on the one hand, due to the concentrated efforts of the producers and farmers, and on the other hand, due to the subsidies received by the producers for this crop [8].

It is necessary to mention the fact that, in unfavorable agricultural years, the granting of subsidies represents a helping hand to producers in order to maintain the viability of wheat farms.

MATERIALS AND METHODS

The present paper focused on the yield of winter wheat production and the influence on profitability, at the level of three large crop farms in Romania that are sized differently. The main indicators that were analyzed are: cultivated area; average production; total production; production value; subsidies; raw product; total expenses; gross income; net income; production cost and recovery price. These indicators were taken from the wheat crop budget and the annual financial statements of each farm under study. The period for which the analysis of these indicators was carried out was 2019-2021. Within the study, the variation of the indicators in absolute and relative value was followed. In order to present the research results as relevant as possible, they were presented in tabular and graphic form. It is necessary to mention the fact that specialized studies were consulted to highlight, on the one hand, the importance of the wheat crop, and on the other hand, the correlation between the yield of the crop and profitability.

RESULTS AND DISCUSSIONS

The three large crop farms are located in Romania, South-Muntenia Region, Ialomita County, the agricultural area that creates favourable conditions for the cultivation of winter wheat. The data that were the basis of the analysis were provided by the farmers, based on the culture budgets and annual financial statements.

Within the large crop farm of 60 ha, the evolution of the main technical-economic indicators for the winter wheat crop is presented in Table 1.

Table 1. The budget of the winter wheat crop on the 60 ha farm

Specification	U.M.	Year			2020/2019		2021/2020	
		2019	2020	2021	Absolut -ha-	Relative -%-	Absolut -ha-	Relative -%-
Surface cultivated with winter wheat	ha	10	40.5	35.5	+30.5	+4.05	-5.00	-0.88
Average production	kg/ha	5,000	2,000	6,000	-3,000	-0.40	+4,000.00	+3.00
Total production	kg	50,000	81,000	213,000	+31,000	+1.62	+132,000	+2.63
Production value	lei	34,000	62,370	174,660	+28,370	+1.83	+112,290.00	+2.80
Subsidies	lei	29,881.80	50,081.49	105,944.78	+20,199.69	+1.68	+55,863.29	+2.12
Raw product	lei	63,881.8	112,451.5	280,604.8	+48,569.7	+1.76	+168,153.30	+2.50
Total expenses	lei	47,413.9	148,495.7	175,818.4	+101,081.8	+3.13	+27,322.70	+1.18
Gross income	lei	16,467.90	-36,044.2	104,786.4	-52,512.1	-2.19	+140,830.60	+2.91
Net income	lei	15,907.6	-37,075.3	10,2389.8	-52,982.9	-2.33	+139,465.10	+2.76
Production cost	lei/kg	0.95	1.83	0.83	+0.88	+1.93	-1.00	-0.45
Capitalization price	lei/kg	0.68	0.77	0.82	+0.09	+1.13	+0.05	+1.06

Source: Own data processing.

During the analyzed period, total production also increased, respectively by 62% in 2020 compared to 2019 and by 162.96% in 2021 compared to 2020 (Figure 1).

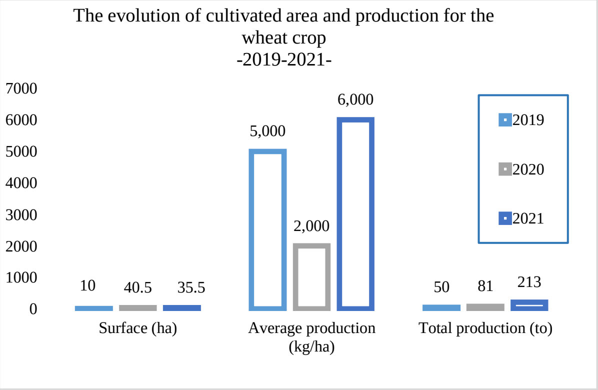

Fig.1. 60 ha farm: areas and productions for winter wheat culture
Source: Own results.

In the period 2019-2021, the analysis highlighted an oscillation of the cultivated area: an increase of 305% in the year 2020 compared to 2019; a decrease of 12.35% in 2021 compared to 2020.

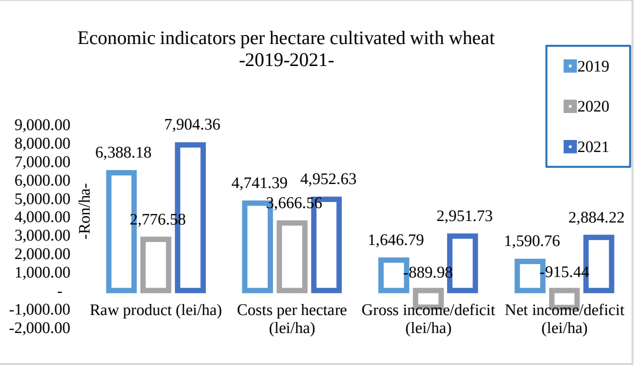

Fig. 2. 60 ha farm: income and expenses per hectare cultivated with winter wheat
Source: Own results.

Production also had the same evolution in the analysed period. There is a decrease in average production in 2020 compared to 2019, i.e. by 60%, followed by an increase in 2021 by 200% compared to 2020.

Regarding the gross product made for each hectare cultivated with wheat, it was found that in 2020 the most unfavorable economic situation was recorded for this crop, with a gross product located at a level of 56.54% compared to the level recorded in year 2019 and at a level of 64.87% compared to the gross product of 2021 (Figure 2).

The production expenses per hectare varied during the analysis period, decreasing by 22.67% in 2020 compared to 2019 and increasing by 35.08% in 2021 compared to 2020. The total expenses per area cultivated with winter wheat framed on an upward trend, given that the area cultivated with winter wheat varied during the analysis period as follows: (+) 213.19% in 2020 compared to 2019 and (+) 18.4% in 2021 compared to 2020 (Figure 3).

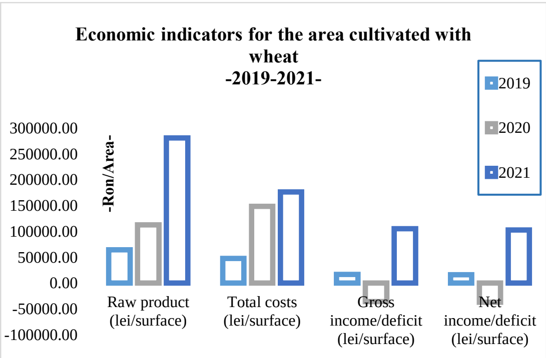

Fig. 3. 60 ha farm: income and expenses for the area cultivated with winter wheat
Source: Own results.

Considering that the productions were small, as of 2020, the 60ha farm recorded a deficit in the wheat crop, which could not be compensated either by capitalizing on the production or by the subsidies received. In this context, it was decided to reduce the areas cultivated with winter wheat. The best year for the winter wheat crop in terms of income was 2021, with a net income that exceeded the net income in 2019 by 543.7%.

The cost of production, influenced both by the total expenses incurred on the wheat crop and by the productions achieved, increased significantly in 2020 compared to 2019 and 2021. This aspect was highlighted based on the small quantitative productions, the production cost being 1.83 lei/kg in 2020 compared to 0.95 lei/kg in 2019 and 0.83 lei/kg in 2021. The analysis showed that the years 2019 and 2021 were good agricultural years for the winter wheat crop, in which the farm obtained quantitatively significant productions. As for the capitalization price, it was mainly influenced by the market, the quality of the product and the negotiation with the customers that the farm carried out. It is noted that, with the exception of 2021, the year in which the capitalization price for winter wheat was approximately equal to the production cost, in 2019 and 2020 the farm capitalized on wheat production at lower prices than the expenses incurred, as follows: with 0.27 lei/kg in 2019 and 1.06 lei/kg in 2020 (Figure 4). It is necessary to underline the fact that the deficit in spending on the winter wheat crop was partially covered by the operating subsidies received, but the results were not positive.

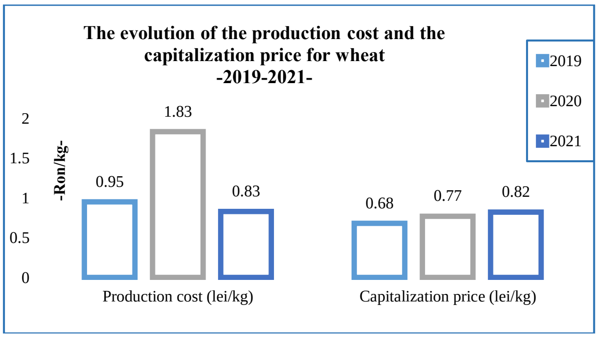

Fig. 4. 60 ha farm: production cost and selling price for winter wheat
Source: Own results.

To cover the production expenses, the 60ha farm was required to have a minimum production as follows: 69.72 tons (2019), 192.85 tons (2020) and 214.41 tons (2021).

Under these conditions, on the 60ha farm, it was found that it did not record favorable financial results for the winter wheat crop, in the entire analyzed period, because a yield deficit was recorded in 2019 (-19.72 tons), in 2020 (-111.85 tons) and in 2021 (-1.41 tons) (Table 2 and Figure 5).

Table 2. Yield and profitability for the winter wheat crop on the 60 ha farm

Specification	MU	2019	2020	2021
The production yield necessary to cover expenses	tons	69.72	192.85	214.41
The production surplus/deficit after covering production expenses		-19.72	-111.85	-1.41

Source: Own data processing.

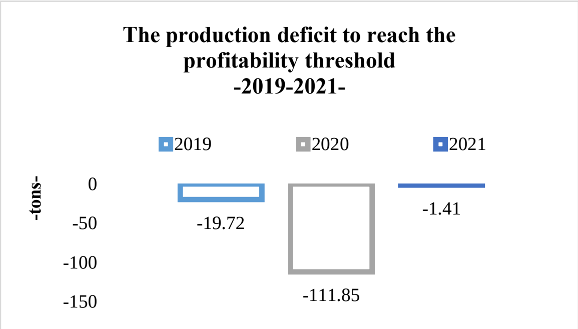

Fig. 5. 60 ha farm: production deficit for the winter wheat crop
Source: Own results.

Within the large crop farm of 600 ha, the main technical-economic indicators for wheat cultivation are presented in Table 3.

At this farm, the area cultivated with wheat varied in the period 2019-2021, by 32.65% (2020 compared to 2019) and by 45.22% (2021 compared to 2020).

At the same time, the productions had an oscillating evolution during the analysed period, noting the reduction of both the average productions and the total production in 2020.

This situation was due to the pedological drought but also to unfavourable meteorological phenomena (Table 3).

It is necessary to specify the fact that the total production achieved in the agricultural year 2019-2020, insignificant quantitatively and qualitatively, was mostly used for the payment of the lease, according to the signed contracts (Figure 6).

Table 3. The winter wheat crop budget at the large crop farm of 600 ha

Specification	**U.M.**	**Year**			**2020/2019**		**2021/2020**	
		2019	2020	2021	Absolut -ha-	Relative -%-	Absolut -ha-	Relative -%-
Surface cultivated with winter wheat	ha	203	157	86	-46	-0.77	-71.00	-0.55
Average production	kg/ha	6,129	246	7,066	-5,883	-0.04	+6,820.00	+28.72
Total production	kg	1,244,187	38,622	607,676	-1,205,565	-0.03	+569,054	+15.73
Production value	lei	854,756.47	26,533.31	498,294.32	-828,223	-0.03	+471,761.01	+18.78
Subsidies	lei	258,115.43	201,097.76	122,637.13	-57,017.7	-0.78	-78,460.63	-0.61
Raw product	lei	1,112,871.90	227,631.07	620,931.45	-885,241	-0.20	+393,300.38	+2.73
Total expenses	lei	815,726.31	557,243.66	503,955.55	-25,8483	-0.68	-53,288.11	-0.90
Gross income	lei	297,145.59	-329,612.58	116,975.90	-626758	-1.11	+446588.48	+0.35
Net income	lei	289,466.10	-334,039.98	91,728.88	-623,506	-1.15	+425768.86	+0.27
Production cost	lei/kg	0.66	14.43	0.83	13.77	+21.86	-13.60	-0.06
Capitalization price	lei/kg	0.69	0.80	0.98	0.11	+1.16	+0.18	+1.23

Source: Own data processing.

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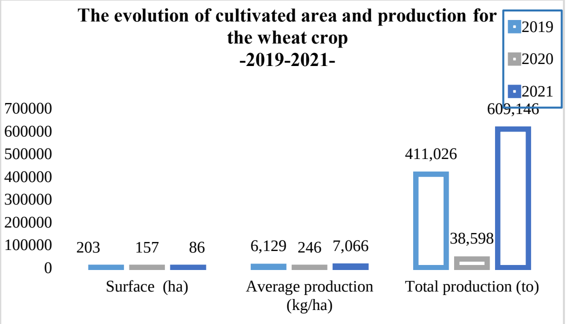

Fig. 6. 600 ha farm: areas and productions for the wheat crop
Source: Own results.

The agricultural year 2020-2021 is notable for high productions in the wheat crop, an average production of 7.066 kg/ha which contributed to compensating the production deficit in the winter wheat crop, so that it exceeded the level of total productions in previous years (48.20% higher than in 2019).
Regarding the gross product per hectare cultivated with winter wheat, an unfavourable situation is observed in 2020, the gross product being 73.64% lower compared to the gross product recorded in 2019 and 397.98% higher in 2021 from the previous year (Figure 7).

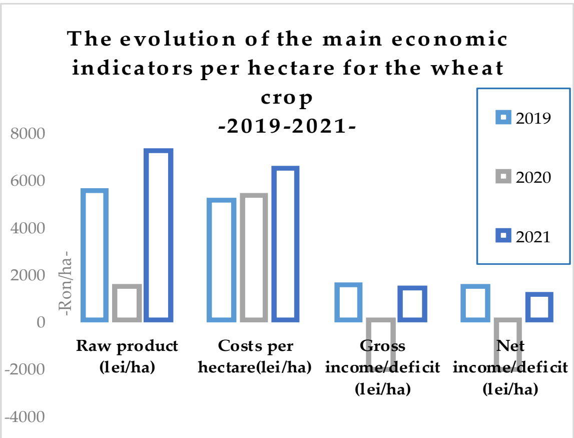

Fig. 7. 600 ha farm: Income and expenses per hectare cultivated with winter wheat
Source: Own results.

Production costs per hectare cultivated with winter wheat registered an upward trend during the analysis period: 3.92% higher in 2020 compared to 2019 and 22.45% higher in 2021 compared to 2020.
At the same time, total expenses evolved downward, taking into account the fact that the area cultivated with wheat decreased during this period and a decrease of 32.69% in 2020 compared to 2019 and 9.56% in 2021 was highlighted compared to 2020 (Figure 7).
The revenues achieved during the period 2019-2021, with the exception of 2020, which marked a loss for this crop and which could not be compensated by the subsidies received, in the years 2019 and 2020, were higher than the expenses, but down by 7.08% in 2021 compared to 2019, considering the cultivation of smaller areas.
In this context, the reduction of the area attracted the reduction of the total production expenses incurred, and the incomes were conditioned in this case, by the average production and implicitly by the total production (Figure 8).

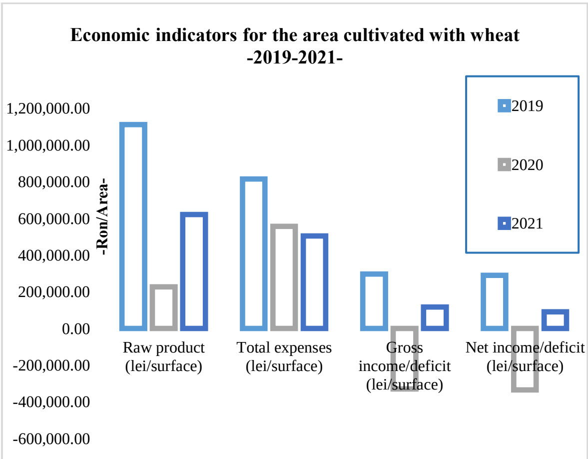

Fig. 8. 600 ha farm: income and expenses for the area cultivated with winter wheat
Source: Own results.

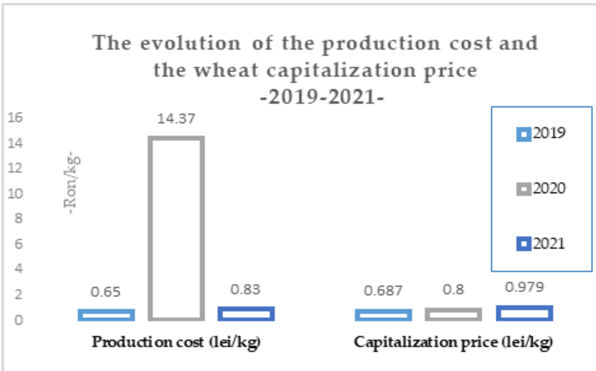

Fig. 9. 600 ha farm: production cost and sale price for winter wheat
Source: Own results.

The cost of production was influenced both by the total costs for the wheat crop and by the productions achieved.

The increase in the cost of production from 2020 is noted based on the low average productions compared to 2019 and 2021, respectively 14.37 lei/kg, compared to 0.65 lei/kg in 2019 and 0.83 lei/kg in 2021, agricultural years in which the farm achieved high yields (Figure 9).

It is noted that the wheat capitalization price increased from one year to another during the analysis period, but it exceeded the production cost in 2019 and 2021. The differences in expenses in 2020 were not covered by the subsidies received by the farm, leading to negative results in 2020 and positive results in 2019 and 2021 (Figure 9).

In order to cover production expenses and reach the profitability threshold for the winter wheat crop, a minimum total production of: 1,182.21 tons (2019) was required within the 600 ha farm; 696.55 tons (2020) and 514.24 tons (2021). In these conditions, the 600 ha farm recorded a profitability for the winter wheat crop in 2019 and 2021.

Table 4. The yield and profitability of the wheat crop for the 600 ha farm

Specification	MU	2019	2020	2021
The production yield necessary to cover expenses	tons	1,182.21	696.55	514.24
The production surplus/deficit after covering production expenses		61.97	-657.93	93.43

Source: Own data processing.

It was highlighted that in the years in which the yield of the crop was exceeded by 61.97 tons (2019) and by 93.43 tons (2020), the profitability threshold was reached.

The production deficit led to the recording of unfavorable results for the winter wheat crop in 2020, being (-) 657.93 tons (Table 4 and Figure 10).

However, productions had an oscillating evolution during the analyzed period.

There is a halving of average production in 2020 compared to 2019, i.e. 49.19%, followed by an increase in 2021 by 119.04% compared to 2020 and by 11.29% compared to 2019.

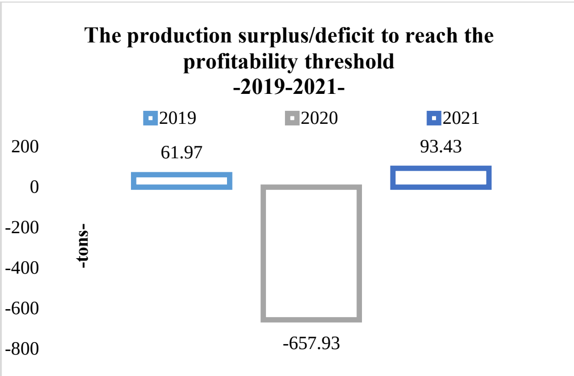

Fig. 10. 600 ha farm: the production deficit for the winter wheat crop
Source: Own results.

Within the large crop farm of 3,000 ha, the evolution of the main technical-economic indicators for wheat cultivation are presented in Table 5.

The total area cultivated with wheat owned in 2019 was of 811.24 ha, and decreased by 11.17 %, (2020) and by 1.52% (2021) compared to the previous year (Figure 11).

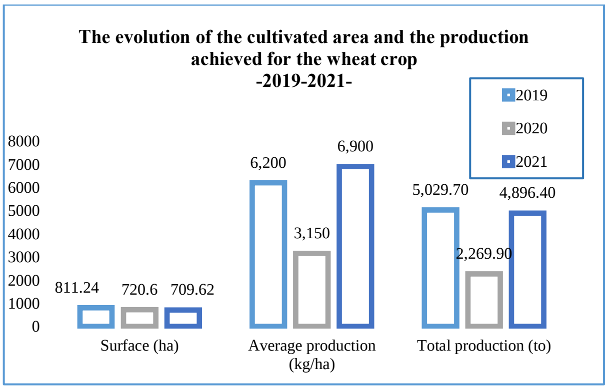

Fig. 11. 3,000 ha farm: areas and productions for winter wheat crop
Source: Own results.

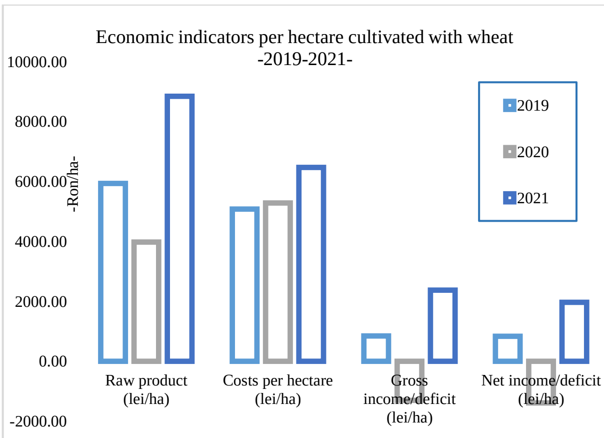

Fig. 12. 3,000 ha farm: income and expenses per hectare cultivated with wheat
Source: Own results.

From the analyzed data, it was observed that the total production followed the same trend, but noting that in 2021 it represented 97.35% of the production in 2019, although the cultivated area decreased by 101.62 ha, which denotes a good yield of this crop (Figure 11).
Production expenses per cultivated hectare registered an upward trend during the analysis period, by 3.92% (2020 compared to 2019) and by 22.45% (2021 compared to 2020). At the same time, the total expenses for the winter wheat crop evolved downward, taking into account that the area cultivated with wheat decreased by 7.78% in 2020 compared to 2019 and by 1.52% in 2021 compared to 2020 (Figure 13).
Considering the small productions in 2020, the 3000 ha farm recorded a wheat crop deficit, a deficit that could not be compensated by the subsidies received. The best year for the wheat crop in terms of income was 2021, with a net income that exceeded the net income in 2019 by 158.50% (Figure 13).
It is noted that, except for the year 2021, when the recovery price for wheat exceeded the production cost by 0.15 lei/kg, in 2019 and 2020 wheat was valued at prices lower than the costs involved, respectively by 0.07 lei/kg in year 2019 and by 0.88 lei/kg in 2020.
It is necessary to underline the fact that in the respective years (2019 and 2020), this deficit of expenses for the wheat crop was covered by the operating subsidies received (Figure 14).

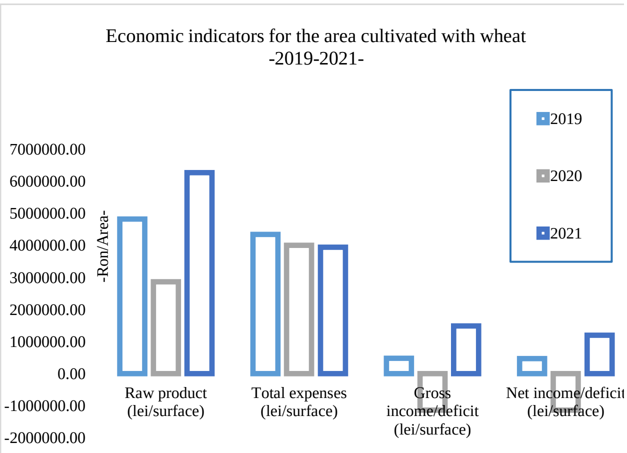

Fig. 13. 3,000 ha farm- income and expences for the area cultivated with winter wheat.
Source: Own results.

The production cost was influenced both by the total expenses incurred and by the productions achieved and recorded an increase in 2020 compared to 2019 and 2021. These aspects were recorded based on the small quantitative productions, the production cost being in this case of 1.68 lei/kg (2020) compared to 0.82 lei/kg (2019) and 0.94 lei/kg (2021) (Figure 14).

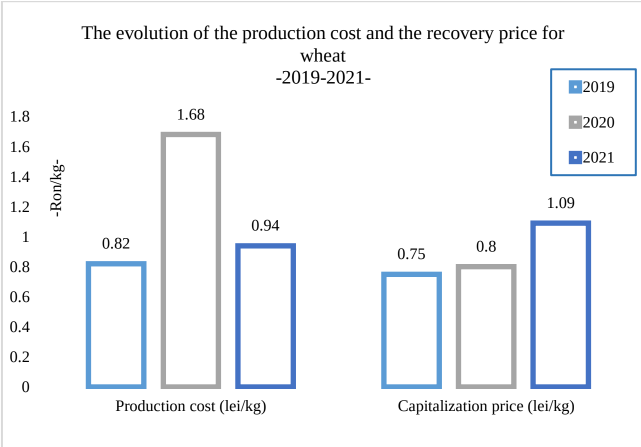

Fig. 14. 3,000 ha farm: production cost and sale price for winter wheat
Source: Own results.

In order to reach the profitability threshold for the winter wheat crop, within the 3000 ha farm, a minimum total production of 5,486.40 tons (2019), 4,756.37 tons (2020) and 4,209.48 tons (2021) was required.

Table 6. The yield and profitability of the winter wheat crop for the 3,000 ha farm

Specification	MU	2019	2020	2021
The production yield necessary to cover expenses	tons	5,496.40	4,756.37	4,209.48
The production surplus/deficit after covering production expenses		-466	-2,486.48	686.89

Source: Own data processing.

Under these conditions, the 3,000 ha farm registered a profitability of the winter wheat crop in 2021, the year in which the yield of the crop exceeded the profitability threshold with 686.89 tons. The production deficit that led to the recording of negative results for the winter wheat crop was recorded in 2019 (-

0.46 tons) and 2020 (-2.48 tons) (Table 6 and Figure 15).

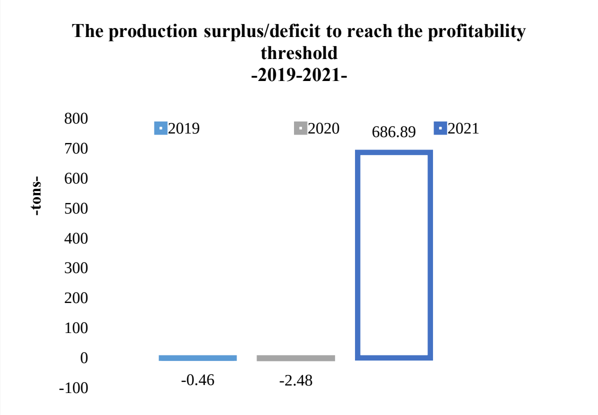

Fig. 15. 3,000 ha farm: the production surplus/deficit for the winter wheat crop
Source: Own results.

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CONCLUSIONS

The analysis regarding the influence of the yield of winter wheat production on the profitability of this crop, carried out on three farms of different sizes in Romania, highlighted that the production expenses generally had a negative impact on the profitability of the wheat crop against the background of the constant increase in the input prices, which significantly increased these costs. In this situation, the farms were unable to find efficient substitutes with lower prices to reduce production costs. Regarding the production of the winter wheat crop, it was found that this also had, in general, a negative impact on the economic efficiency of the winter wheat crop against the backdrop of climate change. The influence of climate changes is more and more visible, difficult to anticipate and control, and has reduced the production of the winter wheat crop quantitatively and qualitatively. In order to reach the profitability threshold for the winter wheat crop, it was highlighted that:

- Within the 60 ha farm, the production yield deficit in 2019 was of 19.72 tons, respectively a loss of 1,360.68 lei; in 2020, the production yield deficit was of 111.85 tons, respectively a loss of 8,948 lei; in 2021, the production yield deficit was of 1.41 tons, respectively a loss of 138.18 lei.
- Within the 600 ha farm, the production yield deficit in 2020 was of 657.93 tons, respectively a loss of 526,346.06 lei; in the years 2019 and 2021, a production yield surplus was found as follows: in 2019 it was of 61.97 tons (42,762.72 lei) and in 2021 it was of 93.43 tons (91,566.93 lei).
- Within the 3,000 ha farm, the production yield deficit in 2019 was of 466.72 tons, respectively a loss of 350,034 lei; in 2020, the production yield deficit was of 2,486.48 tons, respectively a loss of 1,989,187.2 lei, and in 2021, there was a production yield surplus of 686.89 tons, respectively, a surplus of this crop of 748.71 lei.

The paper highlighted the necessity of subsidizing agricultural activities, including the winter wheat crop, regardless of the size of the farms and the favorable agro-pedo-climatic conditions.

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THE INFLUENCE OF THE YIELD OF THE MAIZE HARVEST ON THE PROFITABILITY OF FARMS

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Abstract

The profitability of maize cultivation depends on the production yield of this crop. This paper presents the analysis of the yield and profitability of maize cultivation in three crop farms of different sizes in Romania. From the analysis carried out, a number of results are obtained, which lead to the conclusion that in order to reach the profitability threshold, the production in the 60 ha farm would have to be at least 133.26 tons of maize in 2019, at least 85.83 tons of maize in 2020, and at least 165.56 tons of maize in 2021; in the 600 ha farm, the production in 2019 would have to be at least 2.350.23 tons of maize in 2019, 2,198.44 tons of maize in 2020, and 3,172.33 tons of maize in 2021; and in the 3,000 ha farm, the production should have been at least 4,157.75 tons of maize in 2019, 4,424.70 tons of maize in 2020, and 6,284.46 tons of maize in 2021. These productions were made only by the farm of 3,000 ha, which had a constant profitability of the maize crop, exceeding the profitability threshold every year, as follows: in 2019 with 2,216.85 tons of maize, in 2020 with 2,738.60 tons of maize and in 2021 with 3,887.34 tons. On farms of 60 ha and 600 ha, the profitability threshold could not be reached, in most cases, the major causes being of agropedoclimatic and economic nature. The conclusion of the analysis carried out was that, in order to have a constant profitability of the maize crop, it is necessary to counteract the drought by introducing irrigation to this crop, reducing production expenses and increasing the value of subsidies, so that the gross product highlights the profitability of the maize crop.

Key words*: *maize crop, yield, profitability, subsidies

INTRODUCTION

Maize culture is of great importance throughout the world because this culture represents a major component of animal feed, being at the same time a basic food for the world's population, which is growing. Also, maize is a multifunctional agricultural crop, being used in consumer goods, for industrial products, biofuels, sweetener, but also for the extraction of starch. Maize has a series of particularities that justify its importance among crops: a great ecological plasticity, being cultivated on land and in different climatic conditions; a good resistance to drought and heat; presents a low number of diseases and pests; it supports monocultures, being a good precursor culture for most cultures. This culture makes good use of organic and mineral fertilizers, giving significant productions in an irrigated system, having a high multiplication coefficient, which leads to high harvests [5]. The full mechanization of this crop is another factor that contributes to its existence in most large crop farms, being able to be sown as a second crop, after early-harvesting plants, which leads to the efficiency of agricultural land use. Worldwide, in 2022 the main maize producing countries are the USA, China, Brazil and the European Union [12]. However, one third of the amount of cereals cultivated in the EU is represented by maize. In 2022, Romania achieved the lowest maize production in recent years (8,037,134 tons), down 45.77% compared to the previous year [7], a large part of which was exported [8]. Production costs, increasing due to the increase in the price of inputs, have led Romanian farmers to reduce cultivated areas

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(2,549,281 ha in 2021, with a decrease of 4.63% in 2022 [7].

Currently, the phenomena included in the spectrum of climate changes, such as the prolonged drought, have affected the production of the maize crop. In order to face these challenges, it is necessary to invest in high-performance irrigation systems and to find new innovative technological solutions [6]. Crop rotation is important in this context for improving soil quality [2, 9] and can be successfully applied in farms. By reducing the use of herbicides, we hope to improve the quality of the soil and increase the productivity of crops [1]. The recommendations regarding the technologies applied to crops aim at the use of biological preparations and some resistant hybrids, which will lead to economic efficiency and the preservation of biodiversity in the areas where they are applied [3, 13]. Maize hybrids must be selected so that they have a high productivity even in conditions of reduced availability of water in the soil [4]. Another modern practice aims to practice conservative agriculture to restore the organic substance in the soil and, thus, by improving the quality of the soil that has decreased as a result of the effects of global warming [14]. All these aspects need to be applied in large crop farms, which in the case of maize crop. It is necessary to find technological solutions that counteract these effects [10]. It is essential to support the dermis by granting subsidies, which only in these conditions will be able to survive and maintain profitability [11].

This paper aimed to analyze yield and profitability of maize cultivation in three crop farms of different sizes: 60 ha, 600 ha and 3,000 ha in Romania.

MATERIALS AND METHODS

The present paper highlights the yield of the maize crop and its influence on profitability, the analysis was carried out on three large crop farms of different sizes from the Ialomita area, South Muntenia Region, Romania. This area benefits from a temperate-continental climate, with a relatively high annual and diurnal temperature range, with very hot summers, periodically dry, cold winters, frequently marked by strong blizzards, with a low average annual rainfall (450 mm annually) and with the following types of winds encountered: The Criva, which brings blizzards in winter and droughts in summer, the Austrul, which causes long periods of drought and the Băltarețul which is present in spring. In this county, the existing soil types are: in the range of Mărculești commune, the dominant soil is calcareous Cernoziom, Cernisoluri class, in the radius of Mihail Kogălniceanu commune, the dominant soils are represented by Cernoziomuri, Cernisols and Alluviums class, Protisoluri class and in the radius of Șăndărei commune, the dominant soil is calcareous Cernozium, Cernisols class [9]. A series of technical-economic indicators were analysed and they targeted the areas cultivated with maize by the three large crop farms; the average and total productions as well as the value of the production, the subsidies received, the gross product made in the maize crop, but also the total expenses, gross and net income, the production cost and the price of maize in the period 2019-2021. The present indicators were determined and analysed based on the maize crop budget and the annual financial statements of the three farms. The analysis followed the variation of the indicators presented both in absolute values and in relative values. The results of the research were presented in tabular form, but also graphically, in order to highlight them.

RESULTS AND DISCUSSIONS

Maize culture, which constitutes the basis of the analysis of this work, is analyzed from an economic-financial point of view within three large crop farms, located in a favorable region from the point of view of climatic conditions, in Romania. In order to highlight the profitability indicators of this crop, the data provided by the three farms under study were used, both based on the budgets of the maize crop and from the annual financial statements. The different size of the farms (approximately

60 ha, 600 ha and 3,000 ha) led to specific results.

Within the 60 ha farm, the evolution of the main technical-economic indicators for maize cultivation is presented in Table 1, noting an oscillation of the area cultivated with maize during the analysis period, as follows: a decrease of 3.13% in 2020 compared to of 2019 and an increase of 32.26% in 2021 compared to 2020.

Table 1. *Crop farm of 60 ha*: the budget of the maize crop

Specification		MU	Year			Variation			
						2020/2019		2021/2020	
			2019	2020	2021	Absolute -ha-	Relative -%-	Absolute -ha-	Relative -%-
Surface cultivated with maize		ha	16	15.5	20.5	-0.5	96.88	+5	132.26
Production of maize	Average	Kg/ha	6	2	7.5	-4	33.33	+5.5	375.00
	Total	tone	96	31	153.75	-65	32.29	+122.75	495.97
Production value	Average	lei	3.72	1.46	6.3	-2.26	39.25	+4.84	431.51
	Total	lei	59.52	22.63	129.15	-36.89	38.02	+106.52	570.70
Subsidies		lei	47,810.88	19,166.99	61,179.38	-28,643.89	40.09	+42,012.39	319.19
Total expenses	Per ha	lei/ha	6,708.18	2,696.58	9,284.36	-4,011.6	40.20	+6,587.78	344.30
	Per area	lei	107,330.88	41,796.99	190,329.38	-65,533.89	38.94	+148,532..39	455.37
	Per ha	lei/ha	5,164.04	4,042.59	6,784.03	-1,121.45	78.28	+2,741.44	167.81
	Per area	lei	82,624.64	62,660.15	139,072.62	-19,964.49	75.84	+76,412.47	221.95
Production cost		lei/kg	0.86	2.02	0.9	+1.16	234.88	-1.12	44.55
Capitalization price		lei/kg	0.62	0.73	0.84	+0.11	117.74	+0.11	115.07
Gross income	Per ha	lei/ha	1,544.14	-1,346.01	2,500.33	-2,890.15	-87.17	+3,846.34	-185.76
	Per area	lei	24,706.24	-20,863.20	51,256.77	-45,569.44	-84.45	+72,119.97	-245.68
Net income	Per ha	lei/ha	1,488.11	-1,371.47	2,432.82	-2,859.58	-92.16	+3,804.29	-177.39
	Per area	lei	23,809.76	-21,257.79	49,872.81	-45,067.55	-89.28	+71,130.6	-234.61

Source: Own data processing.

The average productions also fluctuated during the analysed period, noting a decrease in 2020 compared to 2019, by 66.67% and an increase in 2021 by 275% compared to 2020 and by 25% compared to 2019. And the total production follows the same trend, a decrease of 67.71% in 2020 compared to 2019 and an increase of 395.97% in 2021 compared to 2020 was evident (Figure 1).

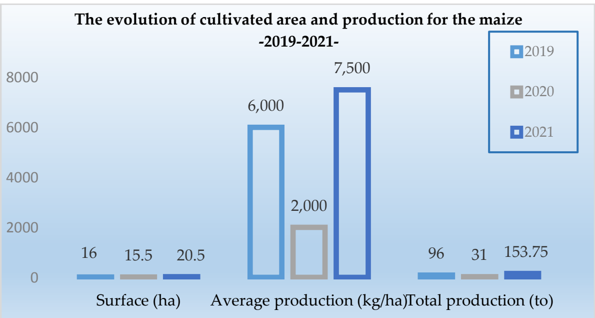

Fig. 1. *Farm of 60 ha*: areas and production in maize crop
Source: Own results.

The gross product achieved per hectare cultivated with maize, in 2020, had the most unfavorable economic situation with a value located 59.80% lower than in 2019 and 70.96% lower compared to the value recorded in 2022 (Figure 2).

Production expenses per hectare also fluctuated during the analysis period, with a decrease of 21.72% in 2020 compared to 2019 and an increase of 67.81% in 2021 compared to 2020 (Figure 2).

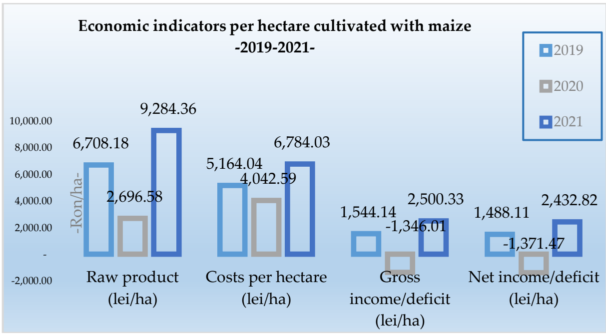

Fig. 2. *Crop farm of 60 ha*: income and productions expenses per hectare cultivated with maize
Source: Own results.

The total expenditure on the maize crop decreased in 2020 compared to 2019 by 24.16% and increased by 21.95% in 2021 compared to 2020 (Figure 3).

Considering that in 2020 the productions were small, the 60 ha farm registered a deficit in the maize crop, a deficit that could not be compensated even by the subsidies received.

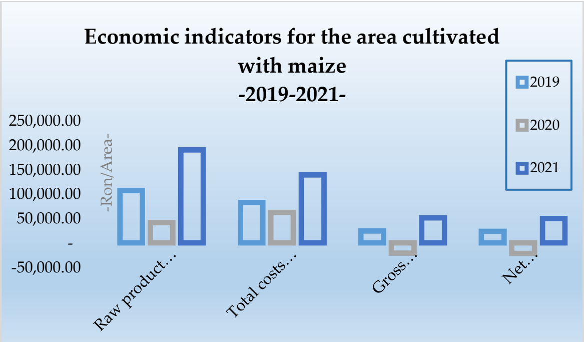

Fig. 3. *Crop farm of 60 ha*: income and productions expenses per area cultivated with maize
Source: Own results.

The best year for the maize crop in terms of income was 2021, the year in which the net income exceeded by 25% the one achieved in 2019. Regarding the cost of production, there was an increase in the year 2020 compared to the years 2019 and 2021, against the background of small and poor quality productions, respectively 2.02 lei (2020) compared to 0.86 lei in 2019 and 0.9 lei in 2021, favorable agricultural years in which the farm also obtained high productions (Figure 4).

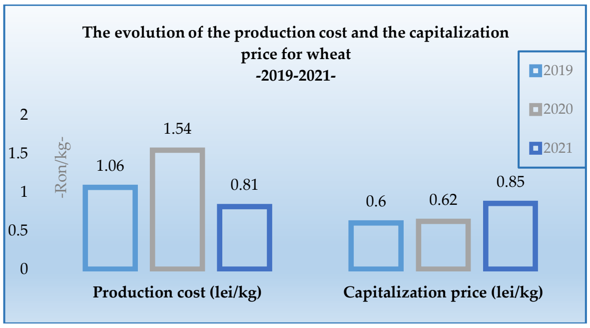

Fig. 4. *Crop farm of 60 ha*: production cost and selling price of maize
Source: Own results.

The capitalization price for maize in the years 2019, 2020 and 2021 were lower than the expenses incurred, which indicates that the farm capitalized the production of maize below the realized production cost, by 0.24 lei lower (2019), by 1, 29 lei (2020) and 0.06 lei (2021) (Figure 4).
It is necessary to emphasize that for this crop, in the respective years, this spending deficit was partially covered by the operating subsidies received, in 2020 losses were recorded for this crop.
Under these conditions, on the 60 ha farm, it was found that the financial results were unfavorable for the maize crop, in the entire analyzed period, the yield deficit recorded was 37.26 tons (2019), 54.83 tons (2020) and 11.81 tons (2021) (Table 2 and Figure 5).

Table 2. *Crop farm of 60 ha*: the yield and profitability of the maize crop

Specification	U.m.	2019	2020	2021
The production yield necessary to cover expenses	tons	133.26	85.83	165.56
The production surplus/deficit after covering production expenses		-37.26	-54.83	-11.81

Source: Own data processing.

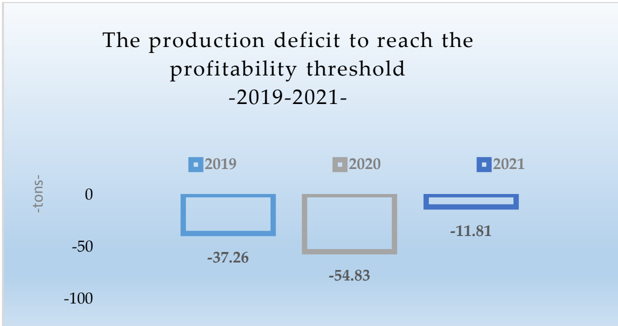

Fig. 5. *Crop farm of 60 ha*: production deficit for the maize crop
Source: Own results.

Within the 600 ha farm, the main technical-economic indicators for maize cultivation are detailed in Table 3. At this farm, the areas cultivated with maize varied in the period 2019-2021, as follows: in 2020 compared to 2019, by 16 .28% higher, and in 2021 compared to 2020 by 7.20% lower.
Maize crop production fluctuated during the analysed period, noting the reduction of both average production/ha (by 42.95%) and total production (by 33.47%) in 2020 compared to 2019 (Table 3).
The year 2020 was decisive and led the farmer to introduce irrigation to this crop, and the results were not slow to appear. In the 2020-2021 agricultural year, the average production of the maize crop was a record, 14,309 kg/ha, respectively 306.04% higher than in the previous year, and the total

production was 204.43% higher than in 2020 (Figure 6).

The gross product achieved for each hectare cultivated with maize has increased annually: in 2020, the gross product was 47.15% higher compared to the gross product recorded in 2019 and in 2021 compared to the previous year by 85.33% higher (Figure 7).

Table 3. *Crop farm of 600 ha*: the budget of the maize crop

Specification		MU	Year			Variation			
						2020/2019		2021/2020	
			2019	2020	2021	Absolute -ha-	Relative -%-	Absolute -ha-	Relative -%-
Surface cultivated with maize		ha	215	250	232	+35	116.28	-18	92.80
Production of maize	Average	Kg/ha	6,177	3,524	14,309	-2,653	57.05	+10,785	406.04
	Total	tone	1,328	881	3,319.68	-447	66.34	+2,438.68	376.81
Production value	Average	lei	3,706.20	6,043.66	12,148.34	+2,337.46	163.07	+6,104.68	201.01
	Total	lei	796,833	1,510,915	2,818,415.11	+714,082	189.62	+1,307,500.11	186.54
Subsidies		lei	273,373.49	320,219.36	330,835.05	+46,845.87	117.14	+1,0615.69	103.32
Total expenses	Per ha	lei/ha	4,977.70	7,324.54	13,574.35	+2,346.84	147.15	+6,249.81	185.33
	Per area	lei	1,070,206.49	1,831,134.36	3,149,250.17	+760,927.87	171.10	+1,318,115.81	171.98
	Per ha	lei/ha	6,558.79	5,452.14	11,622.77	-1,106.65	83.13	+6,170.63	213.18
	Per area	lei	1,410,140.41	1,363,034.95	2,696,483.79	-47,105.46	96.66	+1,333,448.84	197.83
Production cost		lei/kg	1.06	1.54	1.00	0.48	145.28	-0.54	64.94
Capitalization price		lei/kg	0.6	0.62	0.85	0.02	103.33	+0.23	137.10
Gross income	Per ha	lei/ha	-1,581.09	1,872.40	1,951.58	+3,453.49	-118.42	+79.18	104.23
	Per area	lei	-339,933.92	468,099.41	452,766.38	+808,033.33	-137.70	-15,333.03	96.72
Net income	Per ha	lei/ha	4,360.13	4,958.02	6,185.88	+597.89	113.71	+1227.86	124.77
	Per area	lei	-1,618.92	1,844.20	1,658.01	+3,463.12	-113.92	-186.19	89.90

Source: Own data processing.

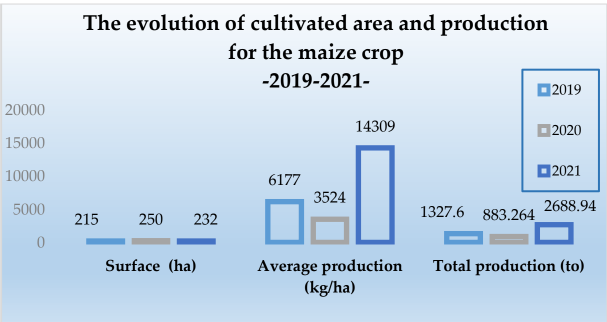

Fig. 6. *Crop farm of 600 ha*: areas and productions in maize crop

Source: Own results.

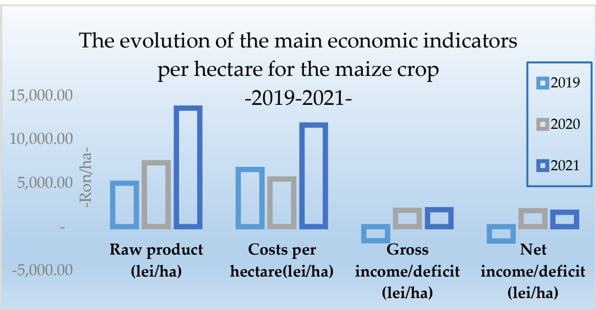

Fig. 7. *Crop farm of 600 ha*: income and expenses per hectare cultivated with maize

Source: Own results.

The expenditure per hectare for the maize crop registered a decrease in 2020 compared to 2019 by 16.87% and an increase in 2021 compared to the previous year, by 13.18%. Total production expenses had the same trend, which registered a slight decrease in 2020 compared to 2019, by 3.35% and an increase of 97.82% in 2021 compared to 2020 (Figure 8).

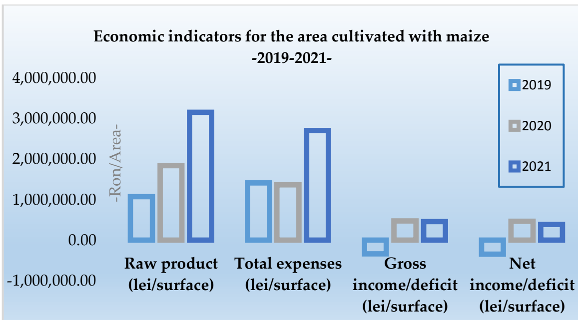

Fig. 8. *Crop farm of 600 ha*: income and expenses on the area cultivated with maize

Regarding the incomes made by this farm from the maize crop, in the period 2019-2021, with the exception of 2019 in which a deficit was highlighted for this crop, a deficit that could not be compensated by the subsidies received, in the years 2020 and 2021 they recorded surpluses. But the reduction of the cultivated area did not attract the reduction of production expenses, because the increase in the prices of inputs led to the increase of expenses in the year 2021 (Figure 7).

Under the influence of the total expenses incurred on the maize crop as well as the productions achieved, the production cost showed the efficiency of the activity carried out by the farm on this crop. An increase in the cost of production was noted in 2020 compared to 2019 against the background of small productions, respectively 1.54 lei/kg compared to 1.06 lei/kg (2019) and 0.81 lei/kg (2021), agricultural years in which yields were high (Figure 9).

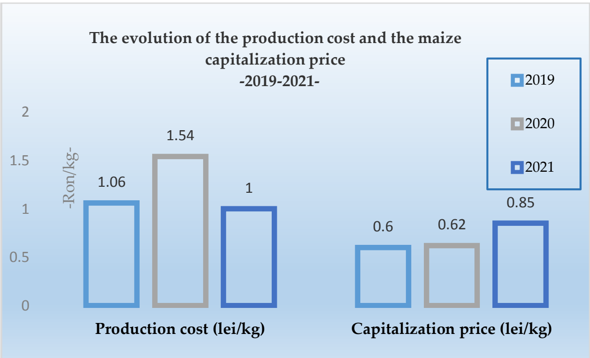

Fig. 9. *Crop farm of 600 ha*: production cost and sale price of maize
Source: Own results.

Under these conditions, on the 600 ha farm, the maize crop was profitable only in 2021 of the analysed period, the year in which the production value (147.34 tons) was the one that brought added value to this crop.

Table 4. *Crop farm of 600 ha*: the yield and profitability of the maize crop

Specification	U.m.	2019	2020	2021
The production yield necessary to cover expenses	tons	2,350.23	2,198.44	3,172.33
The production surplus/deficit after covering production expenses		-1,022.23	-1,317.44	+147.34

Source: Own data processing .

In the years 2019 and 2020, unprofitable years for the maize crop, the production deficit to cover expenses and reach the profitability threshold was 1,022.23 tons (2019) and 1,317.44 tons (2020) (Table 4 and Figure 10).

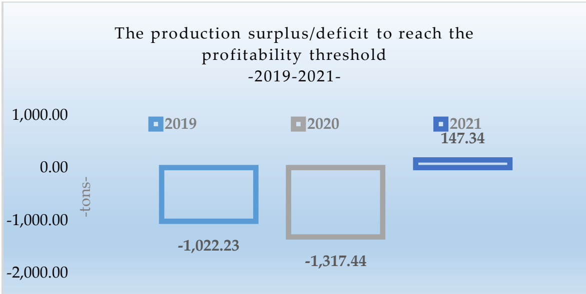

Fig. 10 *Crop farm of 600 ha*: the production deficit in the maize crop
Source: Own results.

Within the large crop farm of 3,000 ha, the evolution of the main technical-economic indicators for maize cultivation are presented in Table 5. The total area cultivated with maize owned in 2019 was of 486.61 ha, in 2020 was of 564 ha and in 2021 was of 759.09 ha (Figure 11).

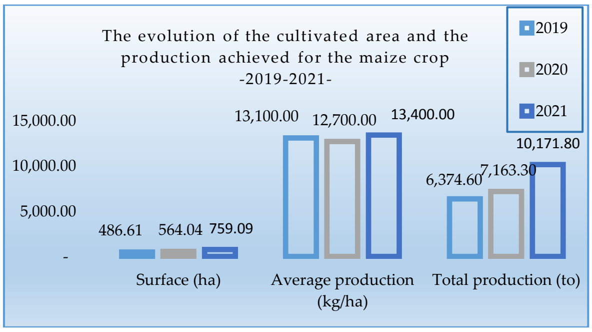

Fig. 11. *Crop farm of 3,000 ha*: areas and productions in maize crop
Source: Own results.

The gross product achieved per hectare cultivated with maize in 2019 was lower than in 2020 (by 7.76%) and 2021 (by 48.39%). Production expenses per hectare registered an upward trend during the analysis period, 1.26% higher in 2020 compared to 2019 and 44.94% higher in 2021 compared to 2020 (Figure 12).

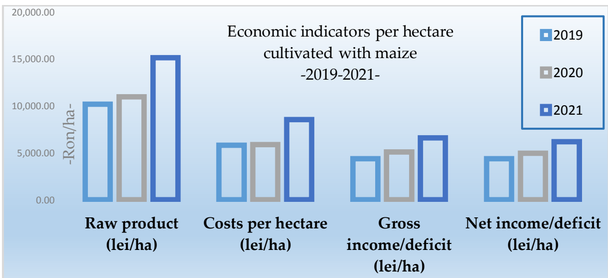

Fig. 12. *Crop farm of 3,000 ha*: income and expenses per hectare cultivated with maize
Own data processing .

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The total expenditure on the maize crop evolved upwards, 17.38% higher in 2020 compared to 2019 and 95.06% higher in 2021 compared to 2020 (Figure 13).

Table 5. *Crop farm of 3,000 ha*: the budget of the maize crop

Specification		MU	Year			Variation			
						2020/2019		2021/2020	
			2019	2020	2021	Absolute -ha-	Relative -%-	Absolute -ha-	Relative -%-
Surface cultivated with maize		ha	486.61	564.04	759.09	+77.43	115.91	+195.05	134.58
Production of maize	Average	Kg/ha	13,100	12,700	13,400	-400.00	96.95	+700	105.51
	Total	tone	6,374.6	7,163.3	10,171.8	+788.70	112.37	+3,008.5	142.00
Production value	Average	lei	8,908	9,525	13,802	+617.00	106.93	+4,277	144.90
	Total	lei	4,334,721.88	5,372,481	10,476,960.2	1,037,759.12	123.94	+5,104,479.2	195.01
Subsidies		lei	622,602.89	819,808.5	998,474.95	+197,205.61	131.67	+178,666.45	121.79
Total expenses	Per ha	lei/ha	10,187.47	10,978.46	15,117.36	+790.99	107.76	+4,138.9	137.70
	Per area	lei	4,957,324.77	6,192,289	11,475,435.1	1,234,964.23	124.91	+5,283,146.1	185.32
	Per ha	lei/ha	5,810.13	5,883.49	8,527.31	+73.36	101.26	+2,643.82	144.94
	Per area	lei	2,827,267.36	3,318,524	6,472,995.75	+491,256.64	117.38	+3,154,471.75	195.06
Production cost		lei/kg	0.44	0.46	0.64	+0.02	104.55	+0.18	139.13
Capitalization price		lei/kg	0.68	0.75	1.03	+0.07	110.29	+0.28	137.33
Gross income	Per ha	lei/ha	4,377.34	5,094.97	6,590.05	+717.63	116.39	+1,495.08	129.34
	Per area	lei	2,130,057.42	2,873,766	5,002,439.38	+743,708.58	134.91	+2,128,673.38	174.07
Net income	Per ha	lei/ha	4,360.13	4,958.02	6,185.88	+597.89	113.71	+1,227.86	124.77
	Per area	lei	2,121,682.86	2,796,520	4,695,63798	+674,837.14	131.81	+1,899,117.98	167.91

Source: Own data processing.

The production cost of maize was 0.46 lei in 2020 compared to 0.44 lei in 2019 and 0.64 lei in 2021, agricultural years in which the farm obtained quantitatively significant productions.

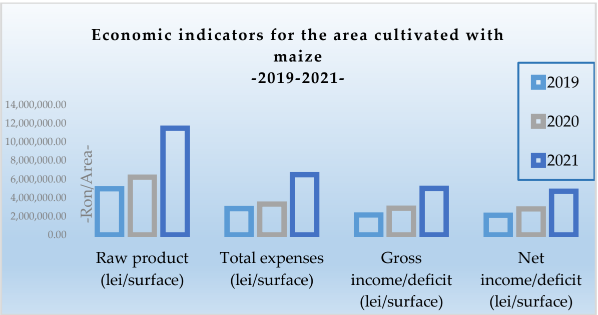

Fig. 13. *Crop farm of 3,000 ha*: income and expenses on the area cultivated with maize
Source: Own results.

Regarding the price of maize, it exceeds the production cost as follows: in 2019 by 0.24 lei, in 2020 by 0.29 lei and in 2021 by 0.39 lei (Figure 14). The production cost of maize was 0.46 lei in 2020 compared to 0.44 lei in 2019 and 0.64 lei in 2021, agricultural years in which the farm obtained quantitatively significant productions. Regarding the price of maize, it exceeds the production cost as follows: in 2019 by 0.24 lei, in 2020 by 0.29 lei and in 2021 by 0.39 lei (Figure 14).

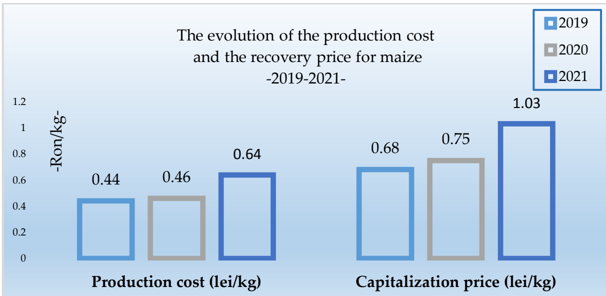

Fig. 14. *Crop farm of 3,000 ha*: production cost and sale price of maize
Source: Own results.

In order to reach the profitability threshold for the maize crop, a minimum total production of 4,157.75 tons (2019), 4,424.70 tons (2020) and 6,284.46 tons (2021) was required within the 3,000 ha farm.

Table 6. *Crop farm of 3,000 ha:* farm yield and profitability of the maize crop

Specification	U.m.	2019	2020	2021
The production maize yield necessary to cover expenses	tons	2,350.23	2,198.44	3,172.33
The production maize surplus/deficit after covering production expenses		-1,022.23	-1,317.44	+147.34

Source: Own data processing.

Under these conditions, the 3000 ha farm registered a profitability of the maize crop throughout the analysis period, the product surplus that led to the recording of positive results for the maize crop in 2019 (2,216.85 tons), in 2020 (2,738.60 tons) and in 2021 (3,887.34 tons) (Table 6 and Figure 15).

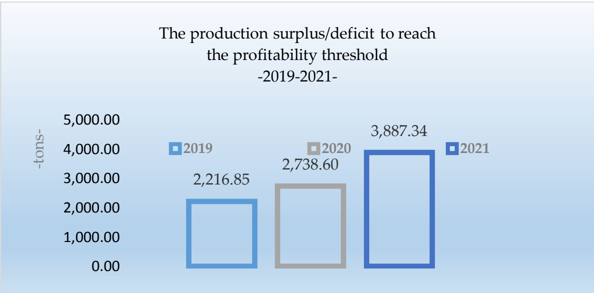

Fig.15. *Crop farm of 3,000 ha*: production surplus in the maize crop
Source: Own results.

CONCLUSIONS

The analysis of the yield of the maize crop and its influence on profitability, led to different conclusions for the three large crop farms in Romania and of different dimensions. In general, the price of the inputs needed to harvest maize in optimal conditions increased the production expenses, which had a negative impact on the profitability of this crop. The production achieved in the maize crop was small in the case of the 60 ha and 600 ha farms, negatively impacting the economic efficiency of maize and surplus in the case of the 3000 ha farm. A major control on the part of farmers is required to counteract the influence of climate change in order to maintain quantitatively and qualitatively the production of the maize crop within optimal limits. Thus, maize culture produced the following effects in the studied farms:

- *Within the crop farm of 60 ha*, the results showed that a deficit of production yield was found in the maize crop in the entire analyzed period, as follows: in 2019 with 37.26 tons, in 2020 with 54.83 tons and 2021 with 11.81 tons; the conclusion being that maize culture was unprofitable.
- *Within the crop farm of 600 ha*, the results showed that in the maize crop, the production yield deficit was: in 2019 (1,022.23 tons) and in 2020 (1,317.44 tons). In the year 2021, the maize crop recorded a production surplus of 147.34 tons, being the only year in the analyzed period in which the maize crop was profitable.
- *Within the crop farm of 3,000 ha*, the results showed that the production yield surplus for the maize crop was: in 2019 of 2,216.85 tons, in 2020 it was 2,738.60 tons, and in 2021 of 3,887.34 tons, ensuring the profitability of this crop over the entire analysis period.

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POTENTIAL FOR EARLY DETECTION OF POWDERY MILDEW IN OKRA UNDER FIELD CONDITIONS USING THERMAL IMAGING

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Abstract

In recent years, apprehensions surrounding the pervasive employment of chemical control methods in global agricultural production have intensified, primarily due to their detrimental effects on non-target organisms. This situation accentuates the importance of technology-driven alternatives for managing plant diseases in agriculture. One such technological innovation, thermal imaging technology, has emerged as a promising tool for the early detection of plant diseases. Infections often induce stress in plants, leading to either elevated or reduced temperatures at the point of infection. It is postulated that thermal imaging may effectively identify such temperature deviations in plant tissues afflicted by disease during the initial stages. The study investigated temperature differences in leaves infected by Erysiphe cichoracearum, with disparities up to 1.6 °C. Over three weeks, the surface temperatures of numerous leaves were analysed at 30-minute intervals. In three weeks period, it was shown that infected leaf surfaces had significantly lower average daily temperatures than ambient and healthy leaf temperatures. Furthermore, healthy leaf temperatures remained consistently lower than ambient temperatures throughout the study.

Key words: *thermal imaging, okra, powdery mildew*

INTRODUCTION

Globally, plant diseases have been responsible for substantial yield losses in agricultural regions where cultivation occurs [18]. For years, pesticides have served as the primary means of mitigating these diseases [29]. However, recent policy decisions by the European Union have led to restrictions on the usage of chemical pesticides that negatively affect non-target organisms [45]; [5]; [38]; [12]. Consequently, these developments have spurred interest in alternative control methods that do not rely on chemical applications. The employment of agricultural technologies, such as Precision Agriculture and Remote Sensing, has emerged as a vital approach for managing diseases within this context [39]; [33]; [14]. Early detection is one of the critical components of Precision Agriculture [9]. By utilizing sensors and other technologies such as thermal imaging, farmers can monitor their crops in real-time and detect signs of disease before they become visible to the naked eye. This allows farmers to take proactive measures, such as applying targeted treatments, adjusting irrigation and fertilization, and implementing other management practices, to mitigate the impact of diseases on crop yields. In summary, early detection of plant diseases is an essential component of Precision Agriculture, which can help to optimize crop production and improve sustainability in agriculture [9]; [6]; [8].

Okra (*Abelmoschus esculentus*) is a mallow family semi-fibrous plant. It is grown as a single in warm climates and as a perennial in hot climates. Okra is a vegetable grown for its fruit, but it is also significant for the economic functions of its leaves, seeds, flower parts, and stems. *Abelmoschus* is thought to have evolved in South and Southeast Asia. It is also a popular vegetable grown in tropical, subtropical, and temperate climates across the world. Commercial cultivation occurs in Turkey, India, Pakistan, Bangladesh, Afghanistan, Iran, West Africa, Burma, Yugoslavia, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus, and the southern United States [22]. In 2018, 9,872,826 tons of okra were produced in the world [32]. Plant diseases are the leading factors that cause yield loss and a decrease in product quality in agricultural areas where okra is grown in the world. Powdery mildew caused by *Erysiphe cichoracearum* can be an important disease of okra, as it can cause significant yield losses and affect the quality of the crop. Although the disease affects the plants' above-ground sections, the leaves are the most impacted [1]. *E. cichoracearum* becomes visible as the infection progresses. Initially, small white spots or patches can be seen on the upper surface of the plant leaves [17]; [30]. These spots may appear as small, raised bumps or as a thin layer of white dust. As the infection progresses, these spots can grow larger and merge with each other, forming a continuous coating over the leaf surface. Eventually, the entire leaf can become covered with a white or greyish powdery coating. It may be difficult to see powdery mildew infection in its early stages, as the initial spots can be quite small and difficult to distinguish from other leaf discolourations. It is important to regularly inspect plants for signs of powdery mildew infection, as early detection and treatment can help prevent the spread of the disease [9]; [7]. As the disease progresses, many conidiospores form on the leaf and can easily spread throughout the plant, causing a secondary infection. The disease factor also spreads intracellularly and intercellularly in the plant tissue, weakening the plant [43]; [23]. Infections caused by diseases in plants reveal temperature differences that can be detected using thermal imaging methods before visible symptoms occur in the regions where infections occur on plants. The use of thermal imaging to examine temperature changes resulting from stressful situations allows for the early detection of pests before their symptoms are noticeable [37]. As opposed to human observation, technology-based automatic detection techniques, such as thermal imaging, can help us gather data more quickly and accurately. Contrasted with human observation, technology-based automated detection methods, such as thermal imaging, facilitate the expeditious and precise acquisition of data [24]. This approach also holds the potential to reduce the costs associated with early detection [25].In a study conducted by Pineda et al. (2020) [37], a localized accumulation of salicylic acid (SA) was observed in areas where the plant exhibited a hypersensitive response (HR) to tobacco mosaic virus (TMV) infection, accompanied by a temperature increase. Likewise, Williamson et al. (2007) [46], demonstrated that *Botrytis* infection led to a moderate elevation in bean leaf surface temperature. Temperature changes caused by fungal diseases in plant parts can potentially be a clue for early diagnosis. Fungal diseases can alter the temperature of the infected plant tissue, and these temperature changes can sometimes be detected with thermal imaging or infrared cameras. This research aims to describe the potential for early detection of *E. cichoracearum* on the okra leaves using thermal imaging. Early detection of this infection may indicate that it is potentially possible to control the infection before it has spread to all other healthy plants. Preventing the disease before it spreads widely could reduce yield loss and damage to product quality as a result.

MATERIALS AND METHODS

This study was carried out in the fields of okra cultivation at Bursa Uludağ University (Figure 1). It was investigated that the possible stress caused by *E. cichoracearum* on okra could potentially be detected by thermal imaging methods, considering the temperature differences in the plant.

Fig. 1. A: The cultivation area. B: The location of the okra cultivation area. Coordinates: lat 40° 13' 36.10" N, long 28° 51' 53.80 "E, alt 50 m asl
Source: Image taken by the authors from field.

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Collection of Temperature Data and Disease Diagnosis

The Near-Infrared (NIR), Mid-Wavelength Infrared (MWIR), and Long-Wavelength Infrared (LWIR) are distinct areas of the infrared spectrum, a subset of the electromagnetic spectrum. In this study, LWIR cameras are deemed more suitable for detecting plant disease for several reasons. In the LWIR range (8-14 m), most items, including plants, have a high emissivity, meaning they emit infrared radiation efficiently. This strong emissivity results in more precise temperature measurements and enhanced thermal imaging. Compared to other infrared bands, LWIR radiation is less absorbed by atmospheric gases such as water vapour and carbon dioxide. This results in less interference and improved image quality while imaging plants and their environment [19]. The study employed a portable LWIR camera with a detector resolution of 464 x 348 pixels and a thermal sensitivity of fewer than 40 millikelvins (mK) (Figure 2).

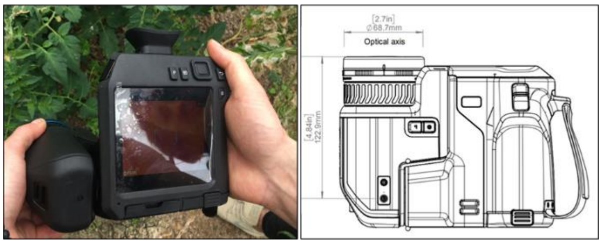

Fig. 2. A portable thermal camera with a detector resolution of 464 x 348 pixels and a thermal sensitivity of fewer than 40 millikelvins (mK).
Source: Image taken by the authors from field.

To obtain more precise results, the emissivity was tuned near to one and a lens with a spatial resolution of 0.90 m/rad pixels was utilized.

In the 200 m^2 okra field, a total of 100 young leaves on 50 plants with homogenous distribution were randomly selected and labelled. Throughout the study, all thermal measurements were made manually on the labelled leaves with a portable camera. The average temperatures of leaf surfaces infected by *E. cichoracearum* and healthy leaf surfaces were monitored and recorded simultaneously with the mean temperature of the environment. The FLIR Thermal Studio software was used to compute the mean temperatures of the leaf surfaces in the thermal images. As a control, leaves that were not infected were used. Powdery mildew infects young leaves more frequently than mature or aged leaves. Young leaves are especially sensitive due to their delicate and fast-expanding tissues, which create optimal conditions for the spores to germinate and invade the plant cells. In addition, immature leaves typically have a thinner cuticle, which makes it simpler for the fungus to start and thrive [13]. For these reasons, in the present study, all measurements were made on the young leaves of okra plants.

Light microscopy can be used to diagnose the powdery mildew disease caused by the fungus *E. cichoracearum* in okra. Typically, field samples of infected leaves are collected and examined under a light microscope to identify the fungus' distinctive features, including mycelium, conidiophores, and conidia. *E. cichoracearum* was identified using the similar methods of Newcombe et al. (2004) [34], using a light microscope. Infected leaves other than *E. cichoracearum* were excluded from the study. Compared to healthy leaves, those exhibiting abnormal temperature differences were monitored, and the presence of the disease was subsequently diagnosed over time using the microscopic examination. Leaves displaying infections caused by agents other than *E. cichoracearum* were excluded from the study, with attention solely given to the target disease and healthy leaves under consideration.

Measurement time

Within the field where the study took place, 100 young okra leaves were randomly marked in the region where the disease began to spread. At least one healthy young leaf and one infected young leaf were tagged for each plant to determine the mean temperature of the surface. The research was conducted on young leaves of okra. The temperature measurements on the leaves may be affected by environmental factors such as the sun's intensity [40]; [15]. Therefore, thermal images of all labelled leaves were taken every 30 minutes between 05:30 and 17:30 for three weeks. A handheld thermometer was used to

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record the ambient temperature at the same time. Due to the distance between plants, it took about 15 minutes to photograph every 30 minutes with a portable thermal camera. All thermal imaging was performed manually.

Measuring distance

Thermal imaging decreases the margin of error in temperature readings by using high-resolution cameras and close-range observations. To increase the sensitivity of the temperature measurement in this investigation, measurements were taken with a thermal camera at 0.4 m from the leaf surface [33]; [26]. All temperature measurements on the leaves were carried out at approximately the same angle (90°) and distance (0.4 m). The "FLIR Thermal Studio" tool was used to compute the temperature averages of infected and healthy leaf surfaces. The JMP®16 software was used to analyse the mean temperature of the ambient air and the leaves.

Statistical analysis

Statistical analysis was performed with the daily averages of the surface temperatures of the leaves infected by *E. cichoracearum* and the leaves without any infection and the ambient temperature measured simultaneously. The statistical significance of the temperature differences was established using the JMP®16 software's analysis of variance (ANOVA) methodology. To examine the difference between the means, the Tukey HSD post hoc test was performed (0.05).

RESULTS AND DISCUSSIONS

In certain leaves infected by *Erysiphe cichoracearum*, while the ambient temperature averaged 16 °C, significant temperature differences were observed between the infected and healthy regions of the leaf. The temperature disparity between healthy and infected areas can be as high as 1.6 °C, as illustrated in Figure 3.

This serves as an example of the localized temperature variations that can occur on the leaf surface.

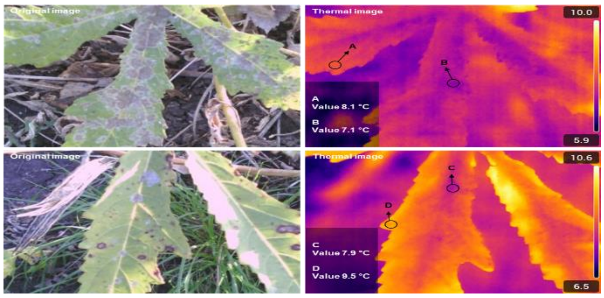

Fig. 3. The region where the mildew disease is intense (B and C) and the region where the infection is not (A and D). The ambient temperature was 16 °C.
Source: Image taken by the authors from field.

Table 1. The average surface temperature of leaves without any infection was measured every 30 min between 5:30 - 17:30 for 3 weeks. (A: Ambient Temperature, B: Healty Leaves Temperature, C: Infected Leaves Temperature, W: Weeks)

Time	A			B			C		
	1W	2W	3W	1W	2W	3W	1W	2W	3W
05:30	9.0	9.7	9.9	7.4	7.9	8.1	6.8	7.3	7.5
06:00	9.5	10.2	10.2	7.5	8.0	8.2	6.8	7.3	7.6
06:30	10.1	10.5	8.4	7.6	8.1	8.3	6.8	7.3	7.6
07:00	11.1	11.6	11.5	7.7	8.2	8.4	6.8	7.3	7.6
07:30	12.1	12.7	12.9	7.8	8.3	8.5	6.9	7.4	7.6
08:00	12.4	12.6	13.1	7.9	8.4	8.6	6.9	7.4	7.6
08:30	13.8	14.3	14.5	8.6	9.1	9.4	7.6	8.1	8.4
09:00	14.7	15.2	15.6	9.3	9.8	10.1	8.3	8.8	9.1
09:30	16.2	16.7	16.9	10.8	11.3	11.6	9.8	10.3	10.6
10:00	18.9	19.5	19.6	11.5	12.0	12.3	10.6	11.1	11.3
10:30	19.6	20.2	20.5	12.2	12.7	13.0	11.3	11.8	12.0
11:00	21.5	22.1	22.0	12.9	13.5	13.7	12.0	12.5	12.7
11:30	22.7	23.2	23.2	14.5	15.1	15.3	12.7	13.2	13.5
12:00	24.2	24.6	25.2	15.2	15.8	16.0	13.5	13.9	14.2
12:30	25.7	26.3	26.2	15.9	16.5	16.7	14.2	14.7	14.9
13:00	26.5	26.9	27.6	16.7	17.2	17.4	14.9	15.4	15.6
13:30	27.7	28.0	28.7	16.8	17.3	17.6	15.0	15.5	15.7
14:00	28.9	29.4	29.6	17.5	18.0	18.3	15.7	16.2	16.5
14:30	29.4	29.8	30.3	18.2	18.7	19.0	16.4	16.9	17.2
15:00	31.1	31.5	31.5	18.9	19.3	19.7	17.2	17.6	17.9
15:30	28.0	28.2	28.8	18.8	19.4	19.5	17.3	17.7	17.8
16:00	25.5	26.0	26.5	17.8	18.2	18.8	16.5	16.9	17.2
16:30	23.2	23.7	24.2	16.9	17.4	17.7	15.7	16.2	16.5
17:00	20.8	21.2	21.6	15.7	16.5	16.5	15.0	15.5	15.8
17:30	19.0	19.4	20.1	14.9	15.4	15.6	14.3	14.8	15.0

Source: The data was obtained by the authors as a result of fieldwork.

However, to obtain more precise data, the average surface temperature of a larger

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number of leaves was analysed between 5:30 and 17:30 hours at 30-minute intervals for 3 weeks.

The weekly averages of surface temperatures for *E. cichoracearum*-infected leaves and healthy leaves, along with the simultaneously measured ambient temperature data between the hours of 5:30 and 17:30, are presented in Table 1.

Drawing upon the data presented in Table 1, the average daily surface temperatures of both infected and healthy leaves, as well as the average daily ambient temperature, were subjected to statistical analysis.

Throughout the three-week thermal imaging period, the infected leaf surfaces' average daily temperatures were found to be statistically lower compared to those of the ambient and healthy leaf temperatures. Moreover, healthy leaf temperatures were consistently and significantly lower than ambient temperatures across all weeks (Figure 4).

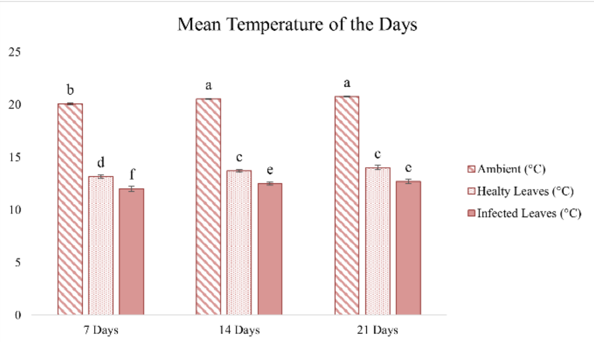

Fig. 4. The daily mean surface temperatures of infected and healthy leaves and the daily mean value of ambient temperature were statistically evaluated over a 3-week period (df: 8;54, F: 612.1962, P < 0001).
Source: The author's JMP®16 program calculations based on field data.

Fungal diseases can cause stress in plants, affecting various physiological processes such as photosynthesis, respiration, and transpiration. These factors can lead to changes in the temperature of the leaf surface [10]; [11]; [16]; [31]. Thermal imaging can be used to detect an increase or decrease in temperature in infected areas compared to healthy areas [44]; [28]; [47]. Therefore, in this study, the thermal imaging method was used for the potential early detection of the powdery mildew disease agents in okra.

Thermal imaging has previously been shown to be capable of detecting certain viruses and fungal infections. In the study by Pineda et al. (2020) [37], localized accumulation of salicylic acid (SA) was observed in the regions of the plant with a hypersensitive response (HR) to Tobacco mosaic virus (TMV) infection and a temperature increase occurred. Like fungal diseases, viruses can negatively affect transpiration, respiration, and photosynthesis in plants through various mechanisms. Thus, the temperature may increase on leaf surfaces that are unable to transpire properly [4]; [20]; [35]. However, in the present study, it was found that the average daily temperatures were lower in okra leaves infected by *E. cichoracearum* compared to healthy leaves. In a manner consistent with our study, Oerke et al. (2006) [36], used thermal imaging to investigate the effects of downy mildew (caused by the fungus *Pseudoperonospora cubensis*) and environmental conditions on cucumber leaves. The study shows that the disease agent can lower leaf temperature. In this study, the temperature decreases on leaf surfaces due to *E. cichoracearum* may result from fungal evaporation. The observed effect may be attributed to the rapid reduction of surface temperature resulting from fungal dehydration through evaporation. Unlike plants, fungi do not possess stomata, a vascular system, or the capacity for transpiration. Although fungi can lose water through evaporation from their hyphae, this process is passive and cannot be equated to plant transpiration in terms of regulation and velocity [42]; [3]; [2].

In contrast, Stoll et al. (2008) [41] report that in studies on wheat canopies, higher temperatures were observed for *Fusarium*-infected ears (containing grains). The increase or decrease in temperature on infected leaves compared to healthy ones may be dependent on the location of the phytopathogenic fungi on or within plant tissues, their developmental stage, or fungal species [36]; [27]. There are other plant pathogenic fungi, like *E. cichoracearum* used in this study, that produce mycelium on the plant leaf or fruit surface. For example, the fungus *Botrytis cinerea* causes gray mold disease in a wide range of plant species, including fruits, vegetables, and ornamental plants. This fungus forms hyphae on the plant surface, leading to the decay of plant tissues [46]. On the other hand, some plant pathogenic fungi, such as *Sclerotinia sclerotiorum*, *Phomopsis spp*., *Venturia inaequalis*, and *Fusarium*, can overwinter inside plant leaves, seeds, or fruits, either as spores, mycelium, or fruiting bodies [1]. In future studies, when investigating temperature differences on the leaf surface, it may be necessary to consider factors such as the type and developmental stage of the phytopathogenic agent, the plant's photosynthesis [9], and some environmental factors that could influence thermal imaging [21].

In summary, although it was found that *E. cichoracearum* caused a temperature decrease in okra leaves, it is evident that there may be many factors affecting the temperature fluctuation.

CONCLUSIONS

Depending on the type of disease agent, environmental temperature, time, or plant, an increase or decrease in temperature on the leaf surface may occur. These temperature differences, which are not detectable by the human eye but can be detected by thermal imaging, may hold considerable potential for the early detection of diseases. Activities that allow early control of diseases in the field before they spread to large areas can greatly prevent economic loss of crops and reduce the use of environmentally harmful chemicals in agricultural control. It is thought that further studies in this field will contribute to sustainable agriculture.

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IS TOURISM DEVELOPMENT A BENEFICIAL ASPECT IN THE EYES OF THE LOCAL COMMUNITY?

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Abstract

Rural development is a key objective of national and European policies, widely debated at political level but also in the academic community. Romania is a predominantly agricultural country which makes agriculture the main pillar of rural development. However, there are many rural areas in the mountains where agriculture cannot be practised at a high performance level, so diversification and the search for new economic sectors is essential. In these areas, tourism can be considered as an alternative to agriculture in rural development. It is important that tourism development is managed responsibly and that the views and concerns of local people are taken into account. Open dialogue and community consultation can help strike a balance between the economic benefits of tourism and the preservation of local values and quality of life. In this context, this paper aimed to carry out a survey in order to identify the opinion of the local population from the commune of Valea Doftanei in relation to the development of tourism and leisure activities as a source of income and with a positive impact on the community development. The survey was based on an interview using a structured questionnaire and addressed to 380 interviewees and the results have been statistically processed with SPSS Software. The results pointed out that the inhabitants of Valea Doftanei Commune have a positive attitude towards the development of tourism and leisure activities and consider that by a well managed tourism strategy it could be assured a beneficial economic development of the locality as well as the preservation of local values and quality of life.

Key words: *tourism development, impact, local community, rural areas*

INTRODUCTION

Tourism is a necessity in people's life being a form of leisure and well being, an alternative for spending week-end and vacations and recover energy, physical body condition and extent the knowledge horizon.

Also, tourism could be seen as a useful tool in local communities for assuring economic and social development valorizing the natural and human resources.

Tourism is an additional source of income for local people, but it can be considered as the basis of rural development for areas that do not allow the development of agricultural or other related activities [8, 12, 5].

From an economic point of view, tourism can bring additional income to rural areas by attracting tourists who spend money in accommodation establishments, catering establishments, for recreational activities and to buy local products. This cash flow can support local businesses and generate additional jobs in rural communities. Tourism can help diversify the rural economy, reducing dependence on agriculture or other single industries [7]. It makes communities more resilient to economic and climate change.

Based on the fact that tourism can make a major contribution to the development of local communities, and thus to rural development, studies have been carried out over the years on local people's perceptions of tourism development in their areas [10, 9, 4, 14].

In this context, the purpose of the paper is research the role of tourism and recreation from a local community perspective and identify the main issues which have to be solved. For this reason the case study was chosen in the commune of Valea Doftanei in Prahova County, Romania, where it is a high tourism potential but less exploited.

MATERIALS AND METHODS

Description of the research area

This study was carried out in the commune of Valea Doftanei in Prahova County, Romania.

In order to better understand the tourism potential of the area, the area was analyzed in terms of tourist attractions, accessibility of the area, potential tourists and activities that can be done for recreation.

Location of the tourist destination

Valea Doftanei commune is situated at 140 km from Bucharest, Romania's capital.

It is located in a picturesque natural setting in the North of Prahova County, in the area of the Curved Carpathians, along the middle course of the river with the same name. It is located in the Northern part of Prahova county, between the Prahova and Teleajen valleys. The commune is flourishing and modernizing from year to year, more and more Romanians discovering the wonderful natural environment, the clean and strong air.

The population of the locality in 2023 was 6,158 persons, of which 3,040 males and 3,118 females [3].

Main tourist attractions

From a tourist point of view, this commune offers several tourist attractions easily accessible for all types of tourists, being located in the hills at an average altitude of 600 meters. The main tourist attractions of the area are: the Paltinu Dam, the Doftana Gorge, the Glodeasa - Teșila Nature Reserve, the Doftana River, the ruins of the old church in Traisteni, the Museum of Fine Arts in Tesila, numerous viewpoints and quiet places in the middle of the forest. The activities tourists can do in the area are limited. We identified few activities, such as ATV rides, bike rides and participation in the “Cașcavea Cheese" Festival and the International Plastic Art Camp “Valea Neagră”.

"Cașcavea" is an unfermented smoked cheese that is made from a sweet, unfermented curd. This product is representative of the area and is not produced in other parts of the country.

As [13] mentioned in their paper, local gastronomy outlets are a viable alternative for rural development in mountain areas and beyond, promoting job creation, preservation of local cuisine, contact with local people, consumption of organic products.

Therefore, besides agricultural activities, handicrafts, local gastronomy, tourism could be another alternative for social and economic development of the localities situated in the rural areas of the mountain regions [11].

Tourism offer

In terms of accommodation units in Valea Doftana, from Figure , it can be seen that the number of accommodation units in 2021 doubled compared to the previous year, reaching a total of 18 units with a total capacity of 301 guests. In the year 2022, 3 more accommodation units were created increasing the accommodation capacity by other 29 places.

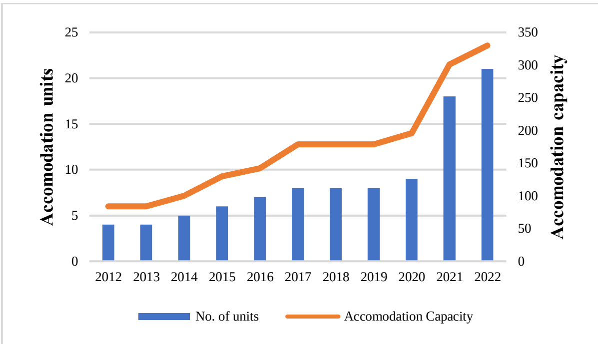

Fig. 1. Number of accommodation units and accommodation capacity in Valea Doftanei
Source: Own design based on the data from [3].

Figure 2 shows the structure of the 21 accommodation units according to their type. The majority of the units are the agrotouristic pensions type, 9 in number, which can accommodate 185 guests.

Fig. 2. The structure of accommodation units in 2022 in Valea Doftanei
Source: Own design based on the data from [3].

At the opposite end is the Tourist Cottage type accommodation with only one unit of this type having a capacity of 20 guests.

A brief analysis of the above shows that this area has a high tourist potential, but it is not exploited to its true value.

The organization of the field survey

Being an area that has been developing recently, in order to identify the opinion of the locals living in Valea Doftanei Commune regarding the promotion of tourism and its development in their area, it was organized a field survey.

The structured questionnaire content

For studying the impact of agrotourism on the community of Valea Doftanei, a structured questionnaire was applied to the inhabitants, including several aspects: economic impact, social impact, cultural impact and environmental impact.

In addition to all these aspects, the degree of current involvement of local people in local tourism and their willingness to get involved if they would be supported and encouraged by the local authorities or a third party was also analyzed.

In the questionnaire, locals had to express on a Likert scale [6] (1 - Total Disagree, 5 - Total Agree) their disagreement/agreement on 18 issues related to the impact of tourism on the community grouped in 4 categories not known by the respondents.

In the second part of the questionnaire, the general opinion of locals on the current state of tourism development in their area was addressed.

The third part of the questionnaire addresses the willingness of locals to take part in the development of local tourism.

The last part of the questionnaire deals with demographic issues.

The sample size

According to the preliminary data of the 2022 Census, Doftana Valley has a population of 6,100 inhabitants.

The population sampling has been determined in order to get the data correctly.

The sample calculation formula used was as follows:

$$n = N * \frac{\frac{Z^2 * p * (1-p)}{e^2}}{N-1+\frac{Z^2 * p * (1-p)}{e^2}} \quad \text{..........}(1)$$

where:

N = Population of Valea Doftanei commune;

Z = score for 95% confidence level;

P = standard deviation;

e = margin of error;

n = sample determined

By substituting customised data for a Z-score of 1.96, corresponding to a 95% confidence level, a standard deviation of 0.5 and a margin of error of 5%, we obtained the following relationship:

$$n = 6{,}100 * \frac{\frac{1.96^2 * 0.5 * (1-0.5)}{0.05^2}}{6{,}100 - 1 + \frac{1.96^2 * 0.5 * (1-0.5)}{0.05^2}} = 361.46$$

Therefore, the calculations showed that in order for the sample to be considered representative and for the information to be extrapolated to the entire population, the minimum number of respondents (the sample determined) must be 361.

The interview based on questionnaire in field survey

The questionnaire was applied in the field to 380 people living in Valea Doftanei Commune.

After checking the correctness of the completion of the questionnaires, it was found that 20 (approximately 5%) of the 380 questionnaires were filled in incorrectly or not completed in full and were excluded from the processing/research.

In the end, 360 completed questionnaires with relevant data to be taken into account in the analysis and interpretation stage were processed.

Following the centralization of the questionnaire responses, the data obtained from the 360 respondents were tested and validated.

At this stage, the 20 questionnaires considered to be inconclusive for the research were eliminated.

The data were processed for input into SPSS.

RESULTS AND DISCUSSIONS

Socio-demographic characteristics of the interviewees

In the first component of the questionnaire, data on respondents' gender, age, education and income categories were addressed to profile the respondents. To create an overview of these questions, descriptive statistics were used to see the frequency of responses to questions in this category, the share of responses in the total and the cumulative share of responses.

As can be seen in Table 1, out of the total of 360 respondents (valid questionnaires) approximately two thirds were female and one third were male. From the stage of the questionnaire application we observed that male respondents were less willing to participate in the questionnaire, citing that they did not have the time, did not have the knowledge to answer, etc..

It can be seen that 48.3% of the total respondents are in the 30-50 age group. The second largest category is the 50-65 age group - 17.8%. The smallest share is in the category 25-30 years (8.3%). It can be explained that young people aged 25-30 are the most active in terms of activities undertaken, most of them having jobs in big cities near the municipality.

When asked about the employment status of the respondents, it was found that 59.4% of them are employed, while only 10.6% have no job and 3.9% of them are unemployed. Through the application of the questionnaire, 12 respondents were identified as having a business in the tourism sector, while another 10 have businesses in other sectors.

A share of 5%, i.e. 18 respondents, stated that they attend a high school/university. An important category is represented by pensioners - 15%. It can be noted that 54 respondents stated that they were retired, while only 48 stated that they were over 65 years old. The difference can be explained by the fact that the retirement age for women starts at 63 years or there is the possibility of early retirement in case of illness.

In terms of income, 43.9% of respondents said that their monthly income was between 1,500 and 3,000 lei, which can be explained by the value of the net minimum wage at the time of the questionnaires, which was 1,524 lei. As the income ranges increase, there is a decrease in the number of people, thus only 52 people stated that their income is between 3,000 and 6,000 lei and 22 people stated that their income is above 6,000 lei monthly.

We recall that in the previous question 214 persons stated that they were employed and in the question on income 232 persons stated that their income was over 1,500 lei. From this correlation, it can be assumed that the respondents completed the questionnaires responsibly.

Table 1. Socio-demographic characteristics of respondents

Respondents characteristics (n=360)		
	f	%
Sex		
Male	124	34.4
Female	236	65.6
Age		
18-25	44	12.2
25-30	30	8.3
30-50	174	48.3
50-65	64	17.8
65+	48	13.3
Profession		
Employed	214	59.4
Not employed	38	10.6
Temporary Unemployed	14	3.9
Retired	54	15.0
Tourism entrepreneur	12	3.3
Entrepreneur in another field	10	2.8
Student >18 years old/Student	18	5.0
Average monthly income		
No income	52	14.4
Under 1,500 lei	76	21.1
Between 1,500 and 3,000 lei	158	43.9
Between 3,000 and 6,000 lei	52	14.4
Over 6,000 lei	22	6.1
Educational level		
Secondary education	68	18.9
Vocational education	72	20.0
Secondary education without a baccalaureate diploma	40	11.1
High school with baccalaureate diploma	104	28.9
Bachelor degree	50	13.9
Master's degree	22	6.1
Doctoral degree	4	1.1

Source: Authors calculation based on survey data.

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The questionnaire content

In the second component of the questionnaire, 18 aspects were addressed, grouped into 4 distinct categories as shown in Table 2.

The first category concerns the perception of local people on economic impact, consisting of 5 aspects: creation of new jobs, income generation, infrastructure development and upgrading, and influence on prices of goods, services and land.

The second category concerns local people's perception of the social impact of tourism and leisure activities on the local community. In this category, 6 aspects were included that address the advantages and disadvantages they experience because of or due to tourism.

Table 2. Clustering of the 18 issues into 4 categories according to impact

Economic Impact
@IE1 Creates jobs in the commune **@IE2 Contributes to increasing local income** **@IE3 Helps improve infrastructure and services in the area** **@IE4 Influences prices (food, goods, products)** **@IE5 Raises the sale price of land**
Social Impact
@IS1 Provides opportunities for further education in tourism @IS2 Provides recreational facilities for both locals and tourists @IS3 Accelerates the process of upgrading the area @IS4 Helps to create a favorable image of the Valea Doftanei community (people, households, places). @IS5 Causes discomfort to local people by disrupting daily life @IS6 Creates discontent related to social differences between tourists and locals
Cultural Impact
@IC1 Stimulates the preservation of traditions and customs @IC2 Encourages continuation of local arts and crafts @IC3 Could influence local specificity in favour of modernity
Environment Impact
@IM1 Encourages care for the preservation of the environment @IM2 Helps to protect and improve the environment @IM3 Causes water pollution, air pollution and contributes to solid waste pollution through non-compliance with local regulations by tourists @IM4 Threatens local flora and fauna species

Source: Authors finding based on research.

The main positive aspects refer to the opportunity for further education as a benefit of tourism, the possibility to enjoy leisure activities like tourists in the area, the acceleration of the modernization process of the area, the creation of a favorable opinion of the local community by tourists.

On the other hand, negative social aspects have also been addressed, such as: the discomfort created by tourists and the creation of discontent related to the discrepancy between the social condition of tourists and locals.

A third category targeted in the first part of the questionnaire was cultural. Here, topics related to the encouragement of the continuation of traditions and craft activities and the abandonment of traditional style in favor of the modern one were addressed.

The fourth category concerns the impact on the environment as perceived by local people as a result of tourism.

Cronbach Alpha reliability test

Table 3 shows that all 360 questionnaires were included in the reliability test, representing 100%. The determination of the Cronbach Alpha reliability coefficient resulted in a value of 0.684, which makes the consistency of the data also considered to be satisfactory. According to the statistical analysis, a Cronbach's Alpha coefficient value higher than 0.6 can be considered.

Table 3. Reliability test on survey data

Summary			
		n	%
Variable	Valid	360	100.0
	Excluded	0	0.0
	Total	360	100.0
Reliability test			
Croenbach's Alpha		N	
0.684		18	

Source: Own calculation with SPSS software.

However, we tried to improve the value of Cronbach's Alpha coefficient by identifying the observation that has a negative impact on it.

The coefficient was recalculated by excluding each of the 18 aspects of the questionnaire in turn. From the analysis of the data obtained it can be seen that the coefficient improves by dropping one of the following 5 aspects: @IE4 - 0.690, @IS6 - 0.709, @IC3 - 0.696, @IM3 - 0.690, @IM4 - 0.692. Consequently, we can admit that the value of Cronbach's Alpha coefficient can be improved by eliminating the @IS6 aspect, which would lead to a value of 0.709 and classify the consistency as good instead of satisfactory. In order to analyze the data correctly, aspect @IS6 (Creates dissatisfaction with social differences between tourists and locals) will be excluded from the analysis for better interpretation of the final results. In the further analysis only 17 aspects out of 18 totals will be considered (Table 4).

Table 4. Reliability test cu coefficient adjustment

Reliability test		
Cronbach's Alpha	Cronbach's Alpha with standardised aspects	N
0.709	0.745	17

Source: Own calculation with SPSS software

Statistical description of the results obtained at the interview

After the data reliability check and adjustment stage, we proceeded to analyze the responses received and organized them into the four categories mentioned above according to the impact of the statements. The analysis of each category was done with the help of descriptive statistics where the following aspects were presented: mean of the responses on each statement, median, deviation or standard deviation, range, minimum value and maximum value. In the last column of the table containing the descriptive statistics of the category, the mean of the category is also shown, which allows the categories to be analyzed and compared with each other.

Table 5. Descriptive statistics of the economic impact category

Statistics		@IE1	@IE2	@IE3	@IE4	@IE5	@IE
Items	Valid	360	360	360	360	360	360
	Missing	0	0	0	0	0	0
Average		4.16	4.09	4.02	3.34	4.16	3.95
Median		4.00	4.00	4.00	4.00	5.00	4.00
St. dev.		1.06	1.02	1.04	1.43	1.10	0.68
Interval		4	4	4	4	4	3.80
Minimum		1	1	1	1	1	1.20
Maximum		5	5	5	5	5	5.00

Source: Own calculation with SPSS Software.

In the first category of indicators addressing the economic impact of tourism and leisure activities on the analyzed area, the 5 aspects mentioned in Table 2 were analyzed.

Table 5 presents the descriptive statistics of the economic impact of tourism.

From Table 5, it can be seen that the mean of the responses varies from an average value of 3.34 (@IE4) to 4.16 (@IE1 and @IE5), which can be correlated with the nature of the statement.

When it came to the statement that tourism and recreational activities can create jobs in the territory of the municipality, the majority of respondents totally agreed with the statement, the two positive degrees: agree and totally agree amounting to 84.44% of the total responses.

Figure 1 shows that 4 out of 5 issues analyzed in this category have a similar structure, with the majority of respondents agreeing/strongly agreeing with the statements.

The only statement that breaks the pattern is the statement @IE4 about tourism and leisure development influencing the prices of goods and services in the study area. Here, the standard deviation falls below 1, which means that opinions are not so different among residents.

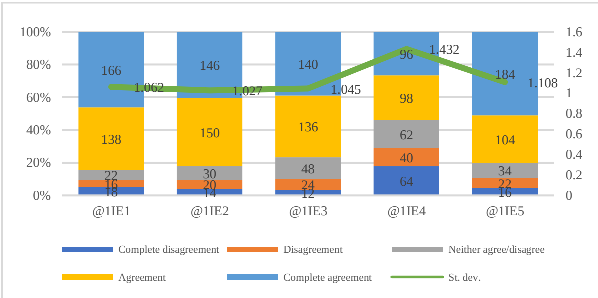

Fig. 1. Structure of Economic Impact aspects responses
Source: Own design based on survey collected data.

In the second category the 5 aspects that analyses the social impact of tourism and leisure activities on the local community from the residents' point of view have been kept - Table 6.

Figure 2 shows that 74.9% of respondents agree/totally agree that tourism development provides opportunities for further education and adoption of new trends in tourism. An equally high percentage of responses where respondents agreed/total agreed 76.6% was also recorded by the statement that locals can enjoy the facilities created for them to relax in the area.

Table 6. Descriptive statistics of the social impact category

Statistics		@IS1	@IS2	@IS3	@IS4	@IS5	@IS
Items	Valid	360	360	360	360	360	360
	Missing	0	0	0	0	0	0
Average		3.97	3.98	4.30	4.45	2.86	3.65
Median		4.00	4.00	5.00	5.00	3.00	3.66
St. dev.		1.06	1.06	0.84	0.70	1.29	0.51
Interval		4	4	3	4	4	2.83
Minimum		1	1	2	1	1	2.17
Maximum		5	5	5	5	5	5.00

Source: Own calculation with SPSS Software.

The next two aspects stating that tourism accelerates the modernization process of the area and that it helps to create a favorable image for the locals had similar percentages where the vast majority agreed. In contrast, on the fifth aspect referring to the discomfort created by tourists, 41% of respondents disagreed/strongly disagreed.

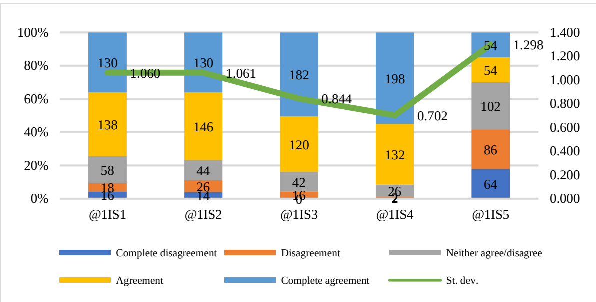

Fig. 2. Structure of Social Impact aspects responses
Source: Own design based on survey collected data.

Table 7. Descriptive statistics of the cultural impact category

Statistics		@IC1	@IC2	@IC3	@IC
Items	Valid	360	360	360	360
	Missing	0	0	0	0
Average		4.11	3.91	3.12	3.71
Median		4.00	4.00	3.00	3.66
St. Dev.		1.09	1.28	1.27	0.82
Interval		4	4	4	4.00
Minimum		1	1	1	1.00
Maximum		5	5	5	5.00

Source: Own calculation with SPSS Software.

In the third category, in Table 7, three aspects related to the cultural impact of tourism on the local community were aggregated. Figure 3 shows that the first two statements are positive aspects, as tourism encourages the preservation of traditions and customs and encourages the continuation of crafts. Respondents agreed/strongly agreed more than 75% with the two statements mentioned above.

The third statement reflects a negative aspect that tourism could have on the local community from a cultural point of view: there is a risk of adopting the modern style against the traditional one.43% of respondents disagree with this statement while a similar percentage agree.

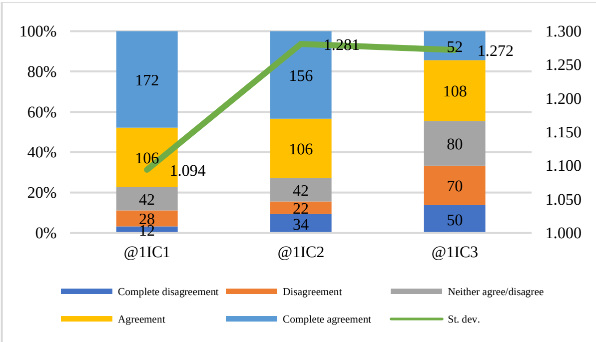

Fig. 3. Structure of Cultural Impact aspects responses
Source: Own design based on survey collected data.

The last category in this analysis aggregates statements on environmental issues. Table 8 shows that the standard deviation is above 1.22, which shows that opinions are quite divided among the locals.

Table 8. Descriptive statistics of the environmental impact category

Statistics		@IM1	@IM2	@IM3	@IM4	@IM
Items	Valid	360	360	360	360	360
	Missing	0	0	0	0	0
Average		3.53	3.44	3.26	2.83	3.26
Median		4.00	4.00	3.00	3.00	3.25
St. dev.		1.30	1.22	1.38	1.33	0.71
Interval		4	4	4	4	4.00
Minimum		1	1	1	1	1.00
Maximum		5	5	5	5	5.00

Source: Own calculation with SPSS Software.

On the first point, 60% of respondents agreed that the development of tourism and recreational activities increases the concern for the preservation of the environment, both for residents and tourists.

Figure 4 shows that in point 2 of this category 50.5% agree with the statement that tourism helps to improve the environment. Point 3 shows that residents are concerned that air, water and solid waste pollution could increase in their locality - 50.5%. This concern is caused by the practices of tourists camping on the banks of the Doftana River near the locality.

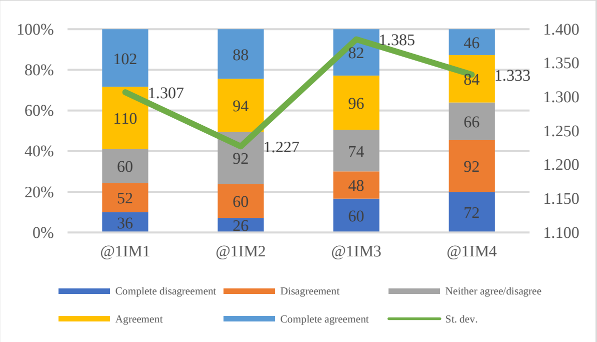

Fig. 4. Structure of Environmental Impact aspects responses
Source: Own design based on survey collected data.

Table 9. Overall perception of residences on tourism development in Valea Doftanei

Statistics		f	%	Valid Percent
Valid	Yes	332	92.2	92.2
	No	10	2.8	2.8
	I don't care	18	5.0	5.0
	Total	360	100.0	100.0

Source: Own calculation with SPSS Software.

At the end of the questionnaire a question was asked to the respondents: Taking into account all the previous aspects, do you consider it a good thing to develop tourism in the area where you live? An overwhelming 92.2% said that developing tourism and leisure activities in their area is a good thing and would help them develop personally and as a community.

CONCLUSIONS

As mentioned in this paper, the area under analysis is an area where tourism can develop, but especially leisure activities. The locality, being no more than two hours away from the capital, can be considered as a day destination or a place to relax. The development of tourism in rural mountain areas can make a decisive contribution to sustainable rural development. The benefits can be quantified in economic, social, cultural, environmental and other terms.

As other studies on the same subject in other parts of the world have shown [1, 2, 6, 9], the present study on the community of Valea Doftanei shows that the inhabitants have a positive attitude towards the development of tourism and leisure activities in the area where they live.

Some locals see tourism development as an important economic opportunity. They believe that tourism can bring additional income by creating jobs in the hospitality sector. This can help improve the community's standard of living. Most locals believe that tourism can help preserve local traditions, culture and history. Tourism development can lead to the preservation and promotion of unique elements of the community. Most locals do not believe that tourism development can lead to an increase in the cost of living in the community.

It is important that tourism development is managed responsibly and that the views and concerns of local people are taken into account. Open dialogue and community consultation can help strike a balance between the economic benefits of tourism and the preservation of local values and quality of life.

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RURAL DEVELOPMENT ANALYZED FROM A BIBLIOMETRIC PERSPECTIVE

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Abstract

This paper aimed to analyze rural development in terms of publications in scientific journals and magazines indexed in international citation databases. The methodology consisted in choosing WoS database as information source, establishing "Rural development" as the key term, searching the bibliometric references in the period 1990-2022, and identifying 2,091 publications, collecting, processing and analyzing the data using VOS Viewer and Microsoft Excel, illustrating the results and making the corresponding comments. The results outline the evolution of the concept of rural development over time, with a focus on the transition from a traditional modernisation-based approach to a more local and quality- and sustainability-oriented perspective. The local perspective has been implemented at EU level through the creation of LEADER where the approach is bottom-up to identify the real problems facing the community.

Key words: *rural development, LEADER, multidisciplinary, rural areas, bibliometric analysis*

INTRODUCTION

The concept of rural development has undergone significant changes from the mid-1960s to the present day, departing from its traditional roots rooted in the notion of modernization.
This traditional perspective held that all societies followed a linear path from a non-rational and technologically limited state to a rational and technologically advanced one. This shift marked a transition from traditional to modern society [14].
Around 1965, some rural areas in France initially linked development with centralized and modernizing policy-making, emphasizing planning [11].
However, during the 1970s and 1980s, the concept of rural development gradually transformed into a more localized, people-centric outlook. Consequently, what was once associated primarily with economic growth and modernization began to embrace a qualitative dimension, placing value on the quality and sustainability of growth [4].
This transformation was accompanied by a shift in regional planning in Europe, moving away from the traditional top-down approach to a predominantly bottom-up approach [6].
The 1990s marked a significant leap forward with the introduction of the LEADER Community Initiative in Europe. This marked the emergence of an endogenous planning approach, characterized by a fresh way of thinking that emerged as modern planning declined and post-modernity took hold [2, 3].
This approach replaced sectoral strategies with territorial rural development, emphasizing environmental considerations and the pursuit of sustainability.
The planning methods implemented in Europe from the 1990s onward, driven by the LEADER approach, are unique and lack a comparable methodology in other parts of the world. It was only in the second decade of the 21st century that new methodological approaches emerged, featuring more contemporary methods than those developed within the European Union countries. These approaches place the individual at the core of sustainable development [13].
In this context, the purpose of this research is to analyze rural development in terms of publications in scientific journals indexed in

international citation databases in order to create an image on the concept of rural development over time and to identify how the traditional modernisation-based approach passed to a new perspective focused especially on a higher quality and sustainability.

MATERIALS AND METHODS

To trace the evolution of the Rural Development concept and predict its future trajectory, an examination of the field's progression has been undertaken. One of the most reliable metrics for gauging a field's advancement is through scholarly research. Bibliometric analysis of rural development entails evaluating and quantifying the influence and significance of scientific research within this domain. This analytical approach involves gathering bibliographic data from academic and research outlets to identify prevailing trends, patterns, and research directions in the field.

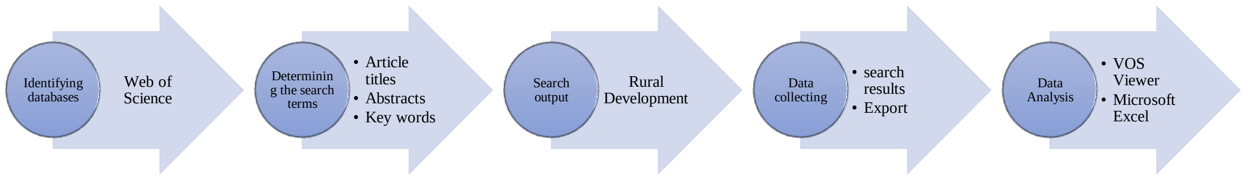

Fig. 1. Stages of bibliometric analysis
Source: Own construction.

To conduct a thorough bibliometric analysis of rural development, the subsequent steps can be employed, as it shown in Figure 1.

a.Identify the database

The most common scientific databases at present are Web of Science, Scopus and Google Scholar, which contain relevant research publications in any field. Web of Science database was used in this analysis because it contains the most numerous and relevant publications. In order to determine the importance and size of the field of rural development, Web of Science database was chosen as source of information. WoS is an online bibliographic database developed and managed by Clarivate Analytics. It is one of the most prestigious and widely used academic databases covering a wide range of scientific and academic disciplines. WoS provides access to information about scholarly articles published in high-quality journals, conferences, books and other sources.

b.Definition of search terms

Key terms relevant to the domain under analysis, "Rural development", were established.

c.Conducting the search

Once the search terms and the bibliometric reference database were established, the searches were carried out. In the first phase, a simple search of the terms in all fields identified 207,382 publications, which shows that there is significant interest in rural development research and publication. This demonstrates that there is a strong knowledge base and community of researchers active in this field. In order to reduce the number of publications, the same terms were searched for in the titles of the articles, keywords and abstracts, resulting in 2,091 publications.

d.Data collection

The data resulting from the searches were exported as bibliographic information about the articles found, such as title, authors, year of publication, journal or conference in which they were published and number of citations, defining aspects that can determine the quality of the research conducted. For further analysis of the collected data, data were exported in Excel format for quantitative data analysis and in text format for analysis using the WOS Viewer software.

e.Data analysis

Bibliometric analysis tools, such as VOSviewer and Microsoft Excel, are used to analyze the collected data. This allows to assess the number of publications per year, geographical distribution of authors, most cited journals, collaborations between authors and institutions, frequency of citations and impact of articles, keywords frequently related to the field, etc.

Interpretation of results: The results obtained should be analysed in the context of. rural development. It is important to note that bibliometric analysis should not be the only method to assess rural development, but should be used in combination with other approaches such as field studies, interviews or qualitative analysis to gain a more comprehensive understanding of the subject.

RESULTS AND DISCUSSIONS

In order to better understand the results, this paper was structured in 3 main section. First section analyses the number of articles and journals which resulted in the search, the second one analyses the articles by period of time and the last one analyses results from a bibliometric approach.

First section - General indicators on the evolution of publications

The search identified 2,091 articles published in 1,101 journals between 1990 and 2022, including the terms "rural development" in the title of article or abstract, it was excluded from the title of journal.

Figure 2 shows a continuous increase in the number of articles over the period 1990-2022. Specifically, between 2010-2022, the number of articles has shown a major increase, which indicates the focus of scientific research on rural development subject.

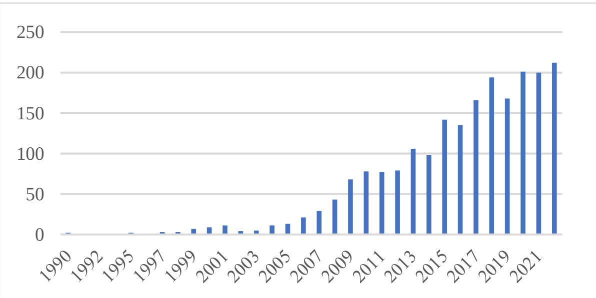

Fig. 2. Number of WoS publications by year
Source: Own construction based on Web of Science data.

The analysis also shows the diversity of journals showing the interdisciplinary approach on subject.

Table 1 shows that the first 25 journals contain 25.25% of the total amount of publications with an average number of articles/journals of 21.12, while the remaining publications - 1,076 total 74.75% with an average number of 1.45 articles/journal.

Table 1. Top 25 journals by number of publications

No.	Journal title	Articles	%	% cumulated
1	Sustainability	119	5.69	5.69
2	Journal of Rural Studies	52	2.49	8.18
3	Scientific Papers-Series Management Economic Engineering In Agriculture And Rural Development	50	2.39	10.57
4	Land Use Policy	49	2.34	12.91
5	Land	25	1.20	14.11
6	Cuadernos De Desarrollo Rural	19	0.91	15.02
7	European Countryside	19	0.91	15.93
8	International Journal of Environmental Research And Public Health	17	0.81	16.74
9	Regional Studies	14	0.67	17.41
10	Ekonomika Poljoprivreda-Economics Of Agriculture	14	0.67	18.08
11	World Development	13	0.62	18.70
12	Fresenius Environmental Bulletin	12	0.57	19.27
13	Journal Of Rural And Community Development	11	0.53	19.80
14	Boletin De La Asociacion De Geografos Espanoles	11	0.53	20.33
15	Conference Rural Development 2017: Bioeconomy Challenges	11	0.53	20.85
16	Journal Of Environmental Protection And Ecology	10	0.48	21.33
17	Eastern European Countryside	10	0.48	21.81
18	Habitat International	10	0.48	22.29
19	Rural Development 2013: Proceedings, Vol6, Book 1	9	0.43	22.72
20	Renewable & Sustainable Energy Reviews	9	0.43	23.15
21	Energy For Sustainable Development	9	0.43	23.58
22	Energies	9	0.43	24.01
23	Agriculture-Basel	9	0.43	24.44
24	Agricultural Economics-Zemedelska Ekonomika	9	0.43	24.87
25	Management Theory And Studies For Rural Business And Infrastructure Development	8	0.38	25.25
26	Other 1076 Jurnals	1563	74.75	74.75
Total		2091	100	100

Source: Own calculation based on Web of Science data.

The most articles published on the chosen topic were found in the journal *Sustainability*, followed by *Journal of Rural Studies* and Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development.

Table 1 shows that the Journal of the Faculty of Management and Rural Development of the University of Agronomic Sciences and Veterinary Medicine of Bucharest brings a significant contribution in terms of scientific research in the field of rural development with a share of 2.39% of total publications, thus managing to occupy third place in the ranking.

Table 2 shows that in terms of the total number of citations of articles in the field of rural development, the *Journal of Rural Studies* ranks first with 12.22% of the total citations of the 2091 articles (22,935 citations). *Land Use Policy* ranks second with 9.78%, followed by *Sustainability* with 5.81%. For an overview of the quality of scientific articles, the average number of citations per article has been calculated in Table 2. As a result, the *Journal of Peasant Studies* has the highest average number of citations per article, managing to total 1,179 citations with its 4 articles.

Table 2. Top 25 journals by number of citations

Crt. No.	Journal name	No. of citations	% of total citations	No. of articles	Average citations/ article
1	JOURNAL OF RURAL STUDIES	2,802	12.22	52	53.88
2	LAND USE POLICY	2,243	9.78	49	45.78
3	SUSTAINABILITY	1,332	5.81	119	11.19
4	JOURNAL OF PEASANT STUDIES	1,179	5.14	4	294.75
5	WORLD DEVELOPMENT	1,035	4.51	13	79.62
6	HABITAT INTERNATIONAL	558	2.43	10	55.80
7	RENEWABLE & SUSTAINABLE ENERGY REVIEWS	480	2.09	9	53.33
8	APPLIED GEOGRAPHY	387	1.69	3	129.00
9	TOURISM MANAGEMENT	380	1.66	6	63.33
10	REGIONAL STUDIES	361	1.57	14	25.79
11	ECOLOGICAL ECONOMICS	348	1.52	6	58.00
12	JOURNAL OF GEOGRAPHICAL SCIENCES	326	1.42	7	46.57
13	JOURNAL OF CLEANER PRODUCTION	317	1.38	6	52.83
14	LANDSCAPE AND URBAN PLANNING	311	1.36	4	77.75
15	FOREST POLICY AND ECONOMICS	292	1.27	8	36.50
16	ENERGY FOR SUSTAINABLE DEVELOPMENT	244	1.06	9	27.11
17	ENERGY POLICY	216	0.94	5	43.20
18	LAND	190	0.83	25	7.60
19	GEOGRAPHICAL JOURNAL	177	0.77	3	59.00
20	MIS QUARTERLY	167	0.73	1	167.00
21	CUADERNOS DE DESARROLLO RURAL	159	0.69	19	8.37
22	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	157	0.68	17	9.24
23	SCIENTIFIC PAPERS-SERIES MANAGEMENT ECONOMIC ENGINEERING IN AGRICULTURE AND RURAL DEVELOPMENT	144	0.63	50	2.88
24	JOURNAL OF TRAVEL RESEARCH	141	0.61	3	47.00
25	SOCIAL INDICATORS RESEARCH	140	0.61	4	35.00

Source: Own calculation based on Web of Science data

Table 3 provides information on the main research directions and the number of publications associated with each direction. The details presented in the table are analysed below.

The table gives an overview of the number of publications in the different research areas mentioned. However, it does not provide detailed information on the content or quality of these publications.

However, based on the articles related to these areas, we can observe and establish the link between each research area and Rural Development.

Table 3. Main research directions identified

Main fields correlated with rural development	Articles
Environment and Ecology	519
Business & Economics	388
Agriculture	312
Territorial planning	187
Public administration	168
Social sciences	165
IT	103
Sustainable development	96
Education and research	85
Medical sciences and health	68
Total	2,091

Source: Own calculation based on Web of Science data.

These correlations will be analysed below:

-Linking Environment and Ecology to Rural Development

Sustainable rural development promotes environmentally friendly and sustainable agricultural practices. It involves the adoption of innovative farming techniques such as organic farming, permaculture and agroecology. Sustainable agriculture aims to protect the soil, reduce the use of chemicals and promote biodiversity, which contributes to food security and environmental protection in rural areas.

-Linking Business & Economy and Rural Development

The link between business & economy and rural development is important and can contribute to the economic growth and sustainable development of rural communities. Here are just a few major issues: diversification of the rural economy, job creation and income growth, access to services and infrastructure, knowledge transfer and innovation, and harnessing local resources.

-Linking Agriculture and Rural Development

The link between agriculture and rural development is close and mutual. Agriculture is one of the main pillars of rural development, having a significant impact on the economy and communities in rural areas. Agriculture is often the main source of income for people living in rural areas. Farmers and agricultural workers contribute to the economic development of rural communities through the production and marketing of agricultural products. Thus, agriculture provides employment opportunities and economic stability in rural areas. Agriculture plays a crucial role in providing food for the population. Local agricultural production in rural areas contributes to the food security of communities and reduces dependence on imports. Sustainable and diversified agriculture in rural areas can ensure long-term food security and reduce vulnerability to fluctuations in international markets.

-Linking Sustainable Development and Rural Development

Sustainable development is about promoting balanced, socially and environmentally sound economic growth in the long term, while rural development focuses on improving living conditions and economic development in rural areas. Protection of natural resources: Sustainable development and rural development focus on the protection and sustainable use of natural resources in rural areas. This includes sustainable agricultural practices, appropriate water management, biodiversity conservation and efficient energy use. Sustainable rural development aims to ensure a balance between the use of resources and their conservation for future generations.

-Linking IT and Rural Development

IT can support rural development by improving access to information, education, business, health services and e-government, as well as by providing an adequate digital infrastructure. The use of information technology contributes to creating opportunities and improving the quality of life in rural communities, thus promoting sustainable and balanced rural development.

-Linking Education and Rural Development

Education has a significant impact on rural development by creating opportunities for learning and personal development, increasing employability, developing community and local resources, stimulating innovation and knowledge transfer, and promoting civic participation and involvement. By investing in education and developing an accessible and quality education system, a significant contribution can be made to sustainable rural development and to improving the quality of life in rural communities.

Second Section - Analysing the context of rural development by period

This section presents an analysis based on historical periods. The most cited articles are analysed for each of them.

Figure 3 shows that in the period 1990-2000 only 30 papers were published on rural development subject, while in the period 2001-2011 12 times more articles were published (360 publications) and in the period 2012-2022 57 times more (1,701 publications).

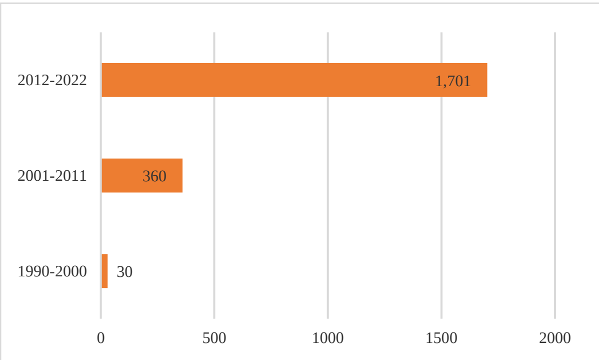

Fig. 3. Number of articles published in the three periods
Source: own processing.

First period 1990-2000

The article with the most citations during this period was written by authors Byrne, J., Shen, B., & Wallace, W. [2] in which they explore the various renewable energy sources used in rural China, such as solar, wind and biogas, and analyse their implications in terms of affordability, cost, environmental impact and socio-economic benefits. The study also examines relevant government policies and programmes in the field of renewable energy and how they influence rural development.

The rural development perspective has been addressed by the author Gegeo, D. W., thus managing to obtain a significant number of citations on this topic. He addresses the perspectives and experiences of indigenous communities in terms of sustainable development, self-reliance and improving the quality of life in rural areas [5].

[5, 8] explored the role and contribution of knowledge in rural development processes, highlighting the importance of recognising and valuing this knowledge in efforts to promote sustainability and social inclusion in rural communities.

Second period 2001-2011

As [1] finds in his paper, during the 1990s, rural development projects were initially seen as leading efforts to enhance rural livelihoods. Nevertheless, subsequent assessments and research have cast a negative shadow on the effectiveness of these projects [7]. In light of these disappointing outcomes, this subsequent era triggered a wide-ranging discourse on how to enhance rural development by introducing fresh approaches and methodologies focused on community involvement and fostering ownership.

With this in mind, the most cited publication from this period looks at the different dimensions of livelihoods, including economic, social and environmental aspects, and explores how these can be integrated into rural development policies and practices. It also examines the complex interactions between economic, social and ecological factors within rural communities and how these interactions can influence development processes [9][10].

Further evidence that rural development became more prevalent in public opinion at the time is the fact that researchers are examining how the state limits or neglects this concept and the implications for rural development and local communities. Thus, [8] explores the relationship between rural development and the role of the UK state, with a focus on the denial of multifunctional agriculture. It examines agricultural policy and rural development in the specific context of the UK and investigates how the state influences and regulates agricultural practices and development in rural areas. The authors examine how the state limits or neglects this concept and the possible negative implications it may have for rural development and local communities.

Third period 2011-2022

In this third phase (2012-2022), there has been a substantial upswing in the publication of articles on this subject, indicating a burgeoning interest and the expansion of an intense international scientific discourse that had its roots in the preceding era.

This period has witnessed the emergence of novel methodological approaches characterized by more advanced techniques, centering on individuals as the focal point of sustainable development, and tailored to this new orientation.

During this timeframe, the concept of integrated rural development has undergone rejuvenation, emphasizing fresh governance models intertwined with spatial planning and skill development. It underscores the significance of bridging the public and private sectors while mobilizing local stakeholders to promote sustainability.

The principles originally established in the EU's LEADER program are being adapted to different contexts, leading to transnational rural development experiments that address novel governance paradigms [3]. New concepts like resilience have surfaced in the context of urban-rural development dynamics, aimed at fostering sustainable rural communities capable of withstanding external pressures. Crucial themes related to economics, local entrepreneurship, social capital, innovation driven by social learning, participatory planning, social structures, and collaborative partnerships for coordinating rural development initiatives and policies are actively debated. Other researchers concentrate on scrutinizing and comprehending rural transformation within the context of emerging economies. Another direction of rural development research is the use of digital technologies as a lever for improving the quality of life in rural areas. As presented above, IT can be a viable solution for sustainable rural development. IT (Information Technology) and rural development are two interlinked areas that can bring significant benefits to rural communities. Integrating IT into rural development can improve access to information, services and economic opportunities, thus contributing to bridging the digital divide and increasing the quality of life in rural areas. Considering the above, the highest number of citations was recorded by an article combining digital technologies and rural development. Thus, [12] examines previous research on the availability of ICT infrastructure, the level of ICT adoption and use in rural communities, and the factors that influence these issues. It examines existing inequalities in internet access, connectivity, infrastructure and digital skills in rural areas. It also explores the implications of ICT inequalities for rural development, including the impact on the local economy, education, health and local governance. The study also discusses possible solutions and interventions that can be implemented to bridge the digital divide and promote sustainable rural development in the digital age.

Part Three - Co-occurrence Analysis of Keywords and Clusters

In this section, we conducted a keyword co-occurrence analysis to identify themes and trends.

We can see in Figure 3 that 4 distinct groupings have been created, which are individually analysed below. At the centre of the network diagram are the terms that are the subject of this research, followed by the term sustainable development.

The red cluster (Figure 4) is a cluster that refers to community-based rural development, from which we can see that the LEADER approach appears distinct from the other policies that are in the blue cluster.

The green cluster (Figure 5) refers to sustainable development and urbanization of rural areas in China. This cluster highlights the connections and relationships between these concepts in the keyword co-occurrence analysis.

The articles in the dataset used for the analysis address topics such as sustainable development in the Chinese context, the impact of urbanisation on regional development and growth issues in specific geographical areas in China.

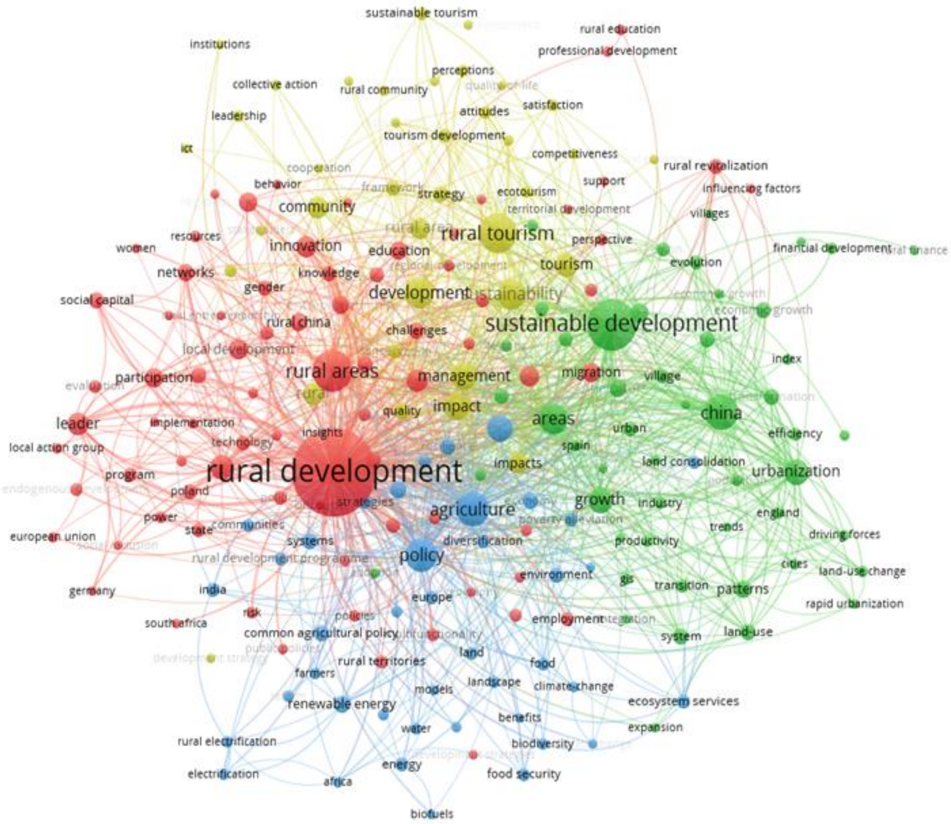

Fig. 3. Network diagram of keyword co-occurrence
Source: Own processing using VoSviewer of information extracted from WoS

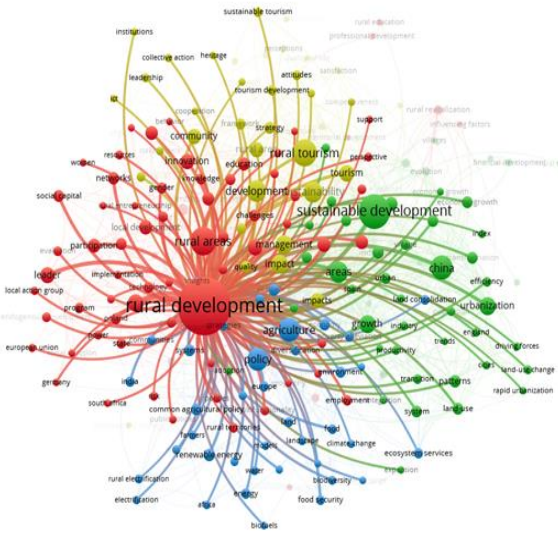

Fig. 4. Network diagram of co-occurrence in the red cluster
Source: Own processing using VoSviewer of information extracted from WoS.

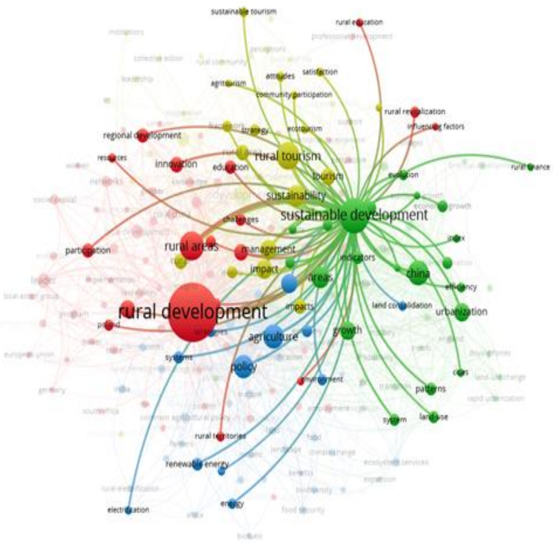

Fig. 5. Network diagram of co-occurrence in the green cluster
Source: Own processing using VoSviewer of information extracted from WoS.

The blue cluster (Figure 6) covers themes related to agriculture, agricultural policy, sustainable rural development and renewable technologies.

This cluster suggests that the articles in the dataset analysed discuss issues related to agriculture, agricultural policy, sustainable rural development and the use of renewable technologies in the context of rural development. These include topics such as the impact of agricultural policy on sustainable rural development, the adoption and implementation of renewable technologies in agriculture, and measures and strategies to promote sustainable agricultural development.

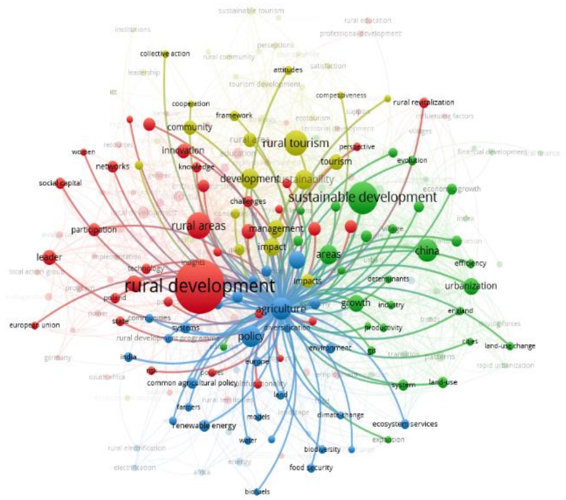

Fig. 6. Network diagram of co-occurrence in the blue cluster
Source: Own processing using VoSviewer of information extracted from WoS.

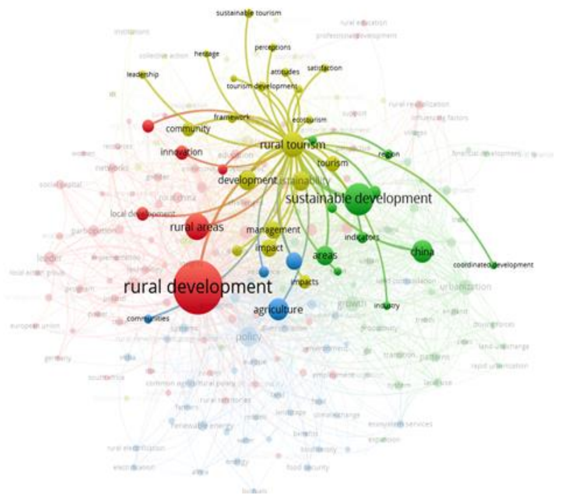

Fig. 7. Network diagram of co-occurrence in the yellow cluster
Source: Own processing using VoSviewer of information extracted from WoS.

The yellow cluster (Figure 7) refers to themes related to rural tourism, development, sustainability, management and impact. This cluster suggests that the articles in the dataset analysed discuss issues related to rural tourism development, sustainability, management of rural activities and the impact that tourism has on rural communities. These may include topics such as planning and implementing rural tourism development strategies, managing the impact on the environment and local communities, and promoting a sustainable approach to rural tourism.

Figure 8 illustrates bibliographic coupling, with countries as the unit of analysis. We generated a network map of co-relationships among countries using VOSviewer software. Each node represents a country, where node size signifies the level of a country's activity, and lines connect two countries with collaborative ties. The thickness of these connecting lines corresponds to the strength of cooperation between the countries.

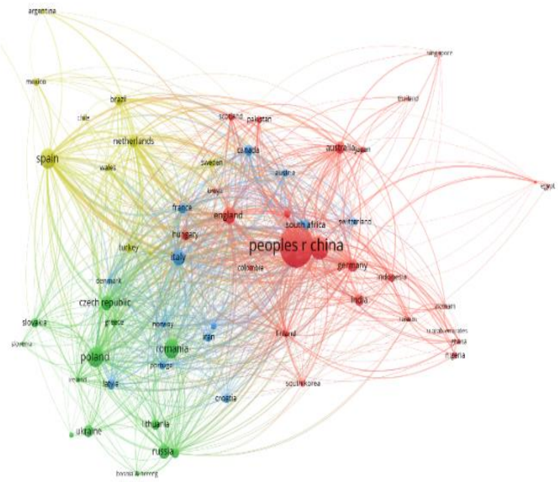

Fig. 8. Network diagram of co-networks by country
Source: Own processing using VoSviewer of information extracted from WoS

Applying a threshold of at least 10 occurrences for each country, it resulted that only 62 countries meet this criterion. VOSviewer categorizes these 62 nodes into four distinct clusters, with each cluster represented by a distinct colour.

Figure 9 presents a visualization depicting the concurrent temporal trends related to the term "rural development."

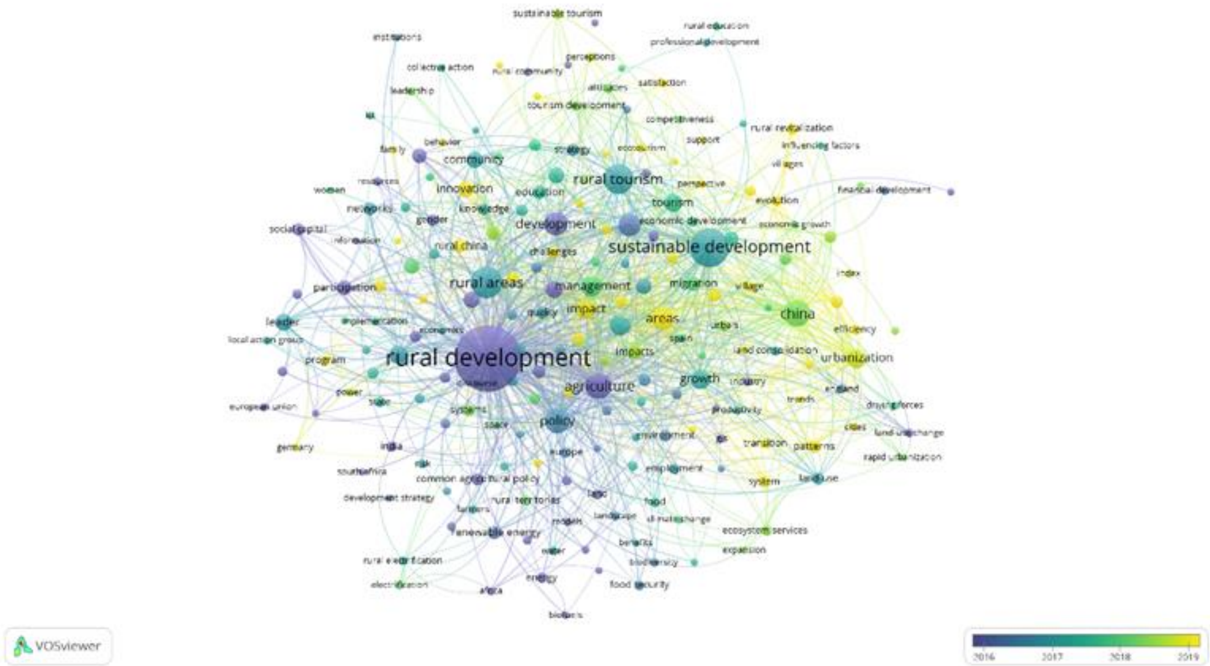

Fig. 9. Overlay view of the temporal trend of the VOSviewer term map in rural development
Source: Own processing with VoSviewer of information extracted from WoS.

The colour of a term indicates the average year of appearance of the publications in which that term appears. The closer the colour of a term is to purple, the older the publications in which that term appears, and the closer the colour of a term is to yellow, the more recent they are. This shows that the terms on the right-hand side (transformation, impact, innovation, urban revitalization, efficiency) of the figure are used more in recent publications. An interesting point in this figure is that agriculture is moving away from rural development, even though it is the main activity with growth potential in rural areas.

CONCLUSIONS

The analysis shows that rural development is a growing field in the academic and research community. Between the 1990s and 2000s, researchers' concerns focused on the search for renewable energy sources for sustainable development and socio-economic impact on local communities. Also, during this period, there was a growing concern about improving the quality of life and policies governing rural development in less developed countries.

Publications in the second period analyse the different dimensions of livelihoods, including economic, social and environmental aspects, and explore how these can be integrated into rural development policies and practices. It also examines the complex interactions between economic, social and ecological factors within rural communities and how these interactions can influence development processes.

The latest period is one in which new methodological approaches have emerged, reflected in more advanced methods and which consider people as the focal point of sustainable development, with planning appropriate to this new direction.

During this period, the concept of integrated rural development has been renewed, based on new governance linked to spatial planning and skills development, reinforcing the importance of integrating the public and private sectors and mobilising local actors when it comes to sustainability.

The principles of the EU's LEADER programme are being applied in other contexts, as transnational rural development experiments that address new types of governance. New concepts such as resilience are emerging in urban-rural development relationships to achieve sustainable rural communities able to survive in the face of external factors. Major themes related to economics, local entrepreneurship, social capital, innovation based on social learning, participatory planning, social structures and partnerships for coordinating rural development projects and policies are debated. Other researchers focused on analysing and understanding rural change in the context of new economies.

The analysis shows the many areas that are interlinked with rural development. Addressing this complex and interlinked issue needs to be done from multiple perspectives and different disciplines in a holistic and effective manner.

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IMPACT OF MALARIA DISEASE ON SWAMP RICE FARM LABOUR SUPPLY AND COPING STRATEGIES UNDER INCAPACITATION BY RURAL FARMERS IN SOUTH EAST, NIGERIA

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Abstract

The study dealt on impact of malaria disease on swamp rice farm labour supply and coping strategies of malaria incapacitated farmers in South East, Nigeria. Multi-stage random sampling technique was employed in the selection of 900 respondents. The study made use of primary data. Data were collected using pre-tested and validated structured questionnaire. The data were subjected to descriptive (means and frequencies) and inferential statistics (Ordinary Least Square regression). Result showed that the mean number of days of malaria incapacitation and distance travelled to health care facilities by the swamp rice farmers in South East, Nigeria were 10.5 days and 1.5km respectively. Majority of the swamp rice farmers hired labourers (93.8%), cultivated less labour intensive crops (78.9%), reduced varieties of crops cultivated (77.2%), reduced area of farm land cultivated (70.8%) and withdrew savings/sold off their farm assets (75.6%) respectively as coping strategies during malaria incapacitation days. The Ordinary Least Square regression estimates of impact of malaria disease on labour supply to swamp rice farms in South East, Nigeria with exponential functional form as the lead equation posted R^2 and F-ratio values of 0.729 and 100.757 respectively. The result showed that health status, access to health information, distance to health facilities, side effects of malaria drugs and annual farm income were significant at varying alpha levels. There should be interventions in form of mobilizing resources, formulating and implementing policies and programmes that will promote awareness and measures that ensure effective prevention and control of the disease.

Key words**:** *incapacitation, labour supply, malaria, rice farmers*

INTRODUCTION

Malaria is prevalent and perennial in all parts of Nigeria with seasonal variations [17]. The duration of malaria transmission season in Nigeria varies from one geographical region to another. This depends on the length of the dry season during which there is a little transmission. In the Southern part of Nigeria, there is a 6–7 months transmission season with the highest number (50–60%) of cases occurring between April and November [14].
Malaria parasite reproduces in the blood and in the liver, and in some cases can be transferred via organ transplant or blood transfusion. In addition, malaria parasite can cross the placenta, and so can be transmitted from a mother to her unborn child, either in the womb or during childbirth. This is known as congenital malaria [19].

Malaria conditions and agricultural activities are interwoven. This stems from the fact that many farms in tropical countries serves as breeding ground for the malaria vector (mosquito). Human health and economic development are impeded by malaria. According to [27] malaria impedes economic development by reducing population growth, productivity of workers, savings and investment, and increasing absenteeism from work, mortality and medical costs. Malaria can have devastating negative effect on smallholder farmers. For instance, [14, 25] noted that when a farmer takes ill at planting season he/she may not be energetic enough to cultivate available farmlands or adopt intensive farming practices. As a coping strategy to malaria, the affected farmer may resort to planting less labour-intensive crops,

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changing cropping patterns, and cultivating crops with lower output and returns.

Farmers especially swamp rice farmers in the South-Eastern part of Nigeria are mostly exposed to mosquitoes due to the nature of their farm work. Mosquitoes are in abundance during the rainy season, when farming activities are more pronounced. Farming is done in bushes and swampy lands where mosquitoes rest and breed. Also, due to the nature of swamp rice farmers' work, they are sometimes compelled to cross rivers, streams and ponds which are breeding places for the vectors of the parasites that cause malaria [17]. An increase in malaria infection rates during rainfalls is majorly responsible for decrease in agricultural swamp rice labour supply output [31]. During critical farming periods such as planting, weeding, and harvesting, malaria often result to loss of manpower hours among infected farmers. A study by [23] reported that malaria illness caused decrease in the percentage of supplied farm labour. The study of [15] revealed that malaria contributes to both poverty and underdevelopment in Nigeria through reduced productivity/output and absenteeism from work. Consequently, recent intervention efforts have focused on effective prevention and control measures. Successive governments have attempted to eradicate malaria through anti malaria campaign, seminars and workshops and free distribution of mosquito nets. Adolescents and young adults are now dying of severe forms of the disease. Air travel has brought the threat of the disease to the doorsteps of industrialized countries, with an increasing incidence of imported cases and deaths from malaria by visitors to endemic-disease regions. A number of factors contribute to the extent to which malaria disease occurs: 1) rapid spread of resistance malaria parasites to chloroquine and the other quinolines; 2) frequent armed conflicts and civil unrest in many countries, forcing large populations to settle under difficult conditions, sometimes in areas of high malaria transmission; 3) changing rainfall patterns as well as water development projects such as dams and irrigation schemes, which create new mosquito breeding sites; 4) adverse socio-economic conditions leading to a much reduced health budget and gross inadequacy of funds for drugs; 5) high birth rates leading to a rapid increase in the susceptible population under 5 years of age; and 6) changes in the behaviour of the vectors, particularly in biting habits, from indoor to outdoor biters. Malaria affects labour mobility, mortality, investment and fertility decisions of the household, the result of which could be efficiency and productivity losses to the household [18]. There seems to be a consensus among several researchers that malaria affects the "poorest of the poor" households and it poses a considerable economic burden on the society [1, 12, 16, 18, 24].

In reality, data from health facilities are potentially useful for monitoring time trends in the number of malaria cases that can guide interventions. However, trends of routinely collected data over a prolonged period and over a wide geographical area can be useful for local programmes planning and can engender major investments in improving both access to health services and monitoring changes. The study will advocate for interventions in the form of mobilizing resources, formulating, implementing policies and programmes that will ensure effective labour supply by improving the standard of living of farmers. Farmers through this study will be guided on the appropriate and effective farming practices/technologies that can be adopted to reduce days of incapacitation and also improve their quality of life and boost food production. The broad objective of this study was to analyze the impact of malaria disease on swamp rice farm labour supply and coping strategies under incapacitation in South East, Nigeria.

The study specifically:

(i) described the socio-economic characteristics of swamp rice farmers in South-east Nigeria;

(ii) described coping strategies by farmers under incapacitation due to malaria in the study area;

(iii) determined the impact of malaria disease on labour supply to swamp rice production among farmers in in South-east Nigeria.

Hypothesis of the study

To guide the study, the following hypothesis was tested in null form

HO_1: labour supply is not influenced by health status, health information, distance to farm, drug supply, drug side effect, housing, farm income.

MATERIALS AND METHODS

Study area

The study was conducted in South-east geo-political zone of Nigeria. South-east Nigeria is made up of five states namely: Abia, Anambra, Ebonyi, Enugu and Imo. The study area is located between Latitudes $5^0 06'$N and $6^0 34'$N of the Equator and Longitudes $6^0 38'$ E and $8^0 08'$ E of the Greenwich Meridian. It covers a land area of about 109,524km^2 or 11.86% of the total land area of Nigeria. The population of the area was 16,381,729 persons, comprising of 8,306,306 males and 8,075,423 females [20].

South-East geo-political zone shares boundaries with Kogi and Benue states to the north, Edo state to the north-west, Cross River state to the east, Akwa-Ibom and Rivers States to the south, Bayelsa state and Delta state to the south-west and west respectively. The region experiences two main seasons in the year, namely: the rainy season (late march – early November) and the dry season (late November – early March). The average annual rainfall amounts to about 1,730mm in about 110 rain days. Its maximum monthly atmospheric temperature is about 32.5^{o}C and humidity is often above 80% during the rainy season. The inhabitants of this zone are predominantly farmers cultivating food crops such as cassava, yam, cocoyam, maize and rice, and cash crops such as oil palm, cocoa and cashew [22].

Sampling technique

Multi-stage random sampling technique was employed in the selection of states, local government areas (ADP blocks), circles and respondents. In the first stage, three states (Abia, Enugu and Ebonyi States) of the five states in South-East Nigeria, were selected at random. Secondly, five local government areas representing five Agricultural Development Project (ADP) blocks were selected at random from each of the states. This gave a total of 15 LGAs or ADP blocks. Deliberate efforts were taken to ensure that the chosen LGAs were spread across the agricultural zones of the states. In the third stage, three circles were randomly chosen from each of the 15 selected blocks (LGAs), summing up to 45 circles. The fourth stage involved the random selection of two (2) hospitals (primary and/or secondary health Institution) in each chosen circles to give a total of ninety (90) hospitals. Finally, a random selection of ten (10) diagnosed malaria patients (in and out) who are swamp rice farmers was made from the selected hospitals to give a total of nine hundred (900) diagnosed malaria patients.

Method of data collection

The data for this study were obtained mainly from primary sources through field survey using a well-structured pre-tested and validated questionnaire. Respondents who cannot read and write had the questionnaire administered through personal interview method. Primary data collected included those on socio-economic characteristics such as age, annual farm income, number of days of incapacitation, distance to health care facilities and coping strategies.

Analytical tools

The data collected were subjected to both descriptive and inferential analyses. Objectives (i) and (ii) were achieved using descriptive statistics tools of frequency, tables, means and percentages. Objective (iii) was achieved using ordinary least square regression model.

To determine impact of malaria disease on labour supply ordinary least square regression model was used as described by [14].

$Y= f\ (X_1,\ X_2,\ X_3,\ X_4,\ X_5,\ X_6,\ X_7,\ e)$… ....(1)

where:

Y= Labour Supply (Mandays)

X_1= Health Status (dummy variable; healthy = 1, not healthy = 0)
X_2= Health Information (access to information = 1, no access to information = 0)
X_3=Distance (Km)
X_4= Drug supply (Gram)
X_5=Drug Side Effect (dummy variable; yes=1, no=0)
X_6=Housing (₦)
X_7= Farm Income (₦)
e = error term

The multiple regression model was expressed in four functional forms (linear, semi-log, double-log and exponential forms).

RESULTS AND DISCUSSIONS

Socio-economic characteristics of the swamp rice farmers

The distribution of the rice farmers with respect to their socio-economic characteristics is shown in Table 1. As shown in the table, 30.7% of smallholder swamp rice farmers in South East, Nigeria were between the ages of 40 years and 49 years. This result suggests that smallholder rice farmers in this age range (i.e. between 20 years and 59 years) were economically active and thus carryout major swamp rice production activities in the rice farms in the study areas. The greater participation of smallholder swamp rice farmers that were between 20 years and 59 years in swamp rice production activities lead to greater exposure to mosquito's bites and malaria disease among the youth. This age bracket (20 years and 59 years) contained the hub of the youth with greater strength and energy to increase rice production, productivity and invariably welfare. The mean age of the smallholder swamp rice farmers in South-East, Nigeria was 45.5 years. This is productive age and is requisite for manual labour supply necessary for swamp rice production and farming as observed by [28]. Also, smallholder farmers within this age bracket (20 years and 59 years) are more conscious of their health and more likely to seek care on malaria ill-health [13].

Table 1 also revealed that 59.2% of the smallholder swamp rice farmers had annual farm incomes within the range of ₦60,000.0 and ₦109999.0. Mean annual farm income of the farmers was ₦133,362.2. This amount translates to average monthly farm income of ₦11,113.5 which is far below the country's monthly minimum wage of ₦30,000.00. This means that in the face of the prevailing inflation and economic crunch experienced in Nigeria, this income level may not be adequate for the farmers to cater for the needs of their households and still set some aside for meeting costs associated with malaria treatment, prevention and investment in swamp rice production. The economic cost of seeking malaria services for low income farmers can account for a large share of household income and deplete savings and investments in their farms [10]. This result lends credence to finding of [7] among farmers in South-east Nigeria.

Table 1 revealed further that 48.1% of the smallholder swamp rice farmers in South East, Nigeria had between 7 and 11 days of incapacitation. The mean number of days of incapacitation of the farmers was 10.5 days. This implies that smallholder swamp rice farmers lost valuable productive time to malaria. This is in line with the findings of [5] that malaria attacks an individual on average of four times in a year with an average of 10-14 days of incapacitation in the agrarian households. The days of incapacitation caused by malaria could cause serious consequences on agricultural production in the area. This number of days lost has implications for productivity level as the threshold productivity level may not be achieved [30].

Lastly, Table 1 showed that 62.8% of the rice farmers travelled a distance within the range of 0.50 km and 1.79km to get to health care centres. The mean distance travelled by the farmers from home to health care centres was 1.6km. Close proximity to health care facilities reduced the odds of progression from mild to severe malaria. Distance is the most important factor that influences utilization of health care facilities and closeness to health facilities could ease access to treatment. [11] was of the opinion that closeness to health care centres and facilities increase the level of awareness and orientation on the possible causes of malaria infection and measures to control its incidence.

Table 1. Socio-economic characteristics of smallholder swamp rice farmers with malaria incidence in South-East, Nigeria

Socio-Economic Characteristics	Frequency	Percentage
Age (Years)		
20-29	74	8.2
30-39	186	20.7
40-49	276	30.7
50-59	247	27.4
60 and above	117	13.0
Mean (years)	45.5	
Std dev.	11.4	
Annual Farm Income (₦)		
60,000.00-109,999.00	533	59.2
110,000.00-159,999.00	168	18.7
160,000.00-209,999.00	102	11.3
210,000.00-259,999.00	15	1.7
260,000.00 and above	82	9.1
Mean (years)	133,362.2	
Std dev.	83,120.5	
Days of Incapacitation		
2-6	202	22.4
7-11	433	48.1
12-16	146	16.2
17 and above	119	13.2
Mean (Days)	10.5	
Std dev.	4.9	
Distance to Health Care Facilities (Km)		
0.50-1.79	565	62.8
1.80 and above	335	37.2
Mean (Km)	1.6	
Std dev.	0.8	
Total	900	100.00

Source: Field Survey, 2022.
Exchange Rate (710.00 = 1.0 USD

Alternative arrangement by smallholder swamp rice farmers during incapacitation due to malaria in South East, Nigeria

The distribution of smallholder swamp rice farmers according to alternative arrangements adopted to ensure swamp rice production during incapacitation due to malaria disease is presented in Table 2. The table shows that 93.8% of the smallholder swamp rice farmers in South East hired labourers as coping strategy during incapacitation by malaria. The prevalence of malaria illness among farmers would result to momentary incapacitation and decrease in physical strength which invariably reduces their ability to engage in income earning activities, leads to irregular visits to their farms, imposes health cost and leads to decreased farm yield. [8] asserted that malaria disease leads to incapacitation of the economically active labour force, reduces capacity to work, affects the quality and quantity of available labour and decreases overall productivity. Thus productive time and income are lost as a result of malaria illness, treatment and control.

Table 2 also shows good proportion of smallholder swamp rice farmers in South-East, Nigeria (78.9%, 77.2% and 70.8%) cultivated less labour intensive crops, reduced varieties of crops cultivated and also reduced area of farm land cultivated as an alternative coping strategy during malaria disease incapacitation. Malaria illness would cause reduction in variety of crops grown in the study area [21]. Increase in poverty among swamp rice farmers in malaria endemic agrarian communities in South East may give rise to a vicious circle of decline in the variety of crops grown. Malaria-specific incapacitation therefore constitutes an important poverty dimension that causes reduction in variety of crops. The farmers may resort to planting less labour-intensive crops and also change cropping patterns, thereby raising fewer crops which give lower returns [9]. A sick farmer during the planting season may be incapacitated to cultivate a vast area of land due to the self labour loss and unable to engage in intensive farming practices which could exhaust him/her due to a high-energy requirement of such practices. This may resort to the farmers planting less labour-intensive crops like maize, okro and fluted pumpkin which give them lower returns [14]. Malaria incapacitation of swamp rice farmers results to little use of land for rice cultivation by the farmers. There are less use of effective methods of rice production and fewer efforts are put into other farming activities. This situation then culminates to less rice being harvested, climaxing in less income and, therefore less money available to pay for prevention and treatment of malaria [9].

The table further shows that 75.6% of smallholder swamp rice farmers in South East, Nigeria withdrew their savings and sold off their assets in period of incapacitation. For instance, due to costs of treatment and other expenses as well as lower incomes from loss of self labour, disease affected households usually draw on assets. After the onset of diseases, savings and financial assets are usually the first to be depleted. The cost of healthcare for sick persons and of funerals drive many households into debt, and they resort to using their savings and remittances received or even sell household and farm assets to defray the costs. In addition, households may have to sell off productive assets such as tools, draught animals, and land [29] just to cope with the devastating effect of ill-health. Swamp rice farmers may also borrow money from friends to settle treatment bills with very little improvements made to their farms, thereby decreasing their productivity very remarkably because of malaria disease. Malaria transmission usually coincides with the planting and harvesting seasons, making the illness's impact particularly damaging.

Finally, 50.0% of the smallholder swamp rice farmers in South East, Nigeria were involved in the reallocation of labour as a result of malaria induced ill-health. During the period of malaria incapacitation, a typical farmer may stop work partially or completely due to debility arising from malaria infection. Consequently labour availability and productivity may suffer a setback under severe malaria attack and self labour may not be available on the farm at all during the period of incapacitation while in a situation of mild malaria attack, the intensity of productivity of labour which is measured by work done per unit time, may be reduced. The loss of workdays as a result of malaria-specific illness had accounted for the decline in farm outputs [4, 26].

Table 2. Distribution of Smallholder Swamp Rice Farmers according to Adopted Alternatives during Malaria Disease Incapacitation in South East, Nigeria

Adopted Alternatives	*Frequency	Percentage
Reallocation of labour	450	50.0
Hiring of labour	844	93.8
Reduction in farm size	637	70.8
Withdrawal of savings/assets sales	680	75.6
Cultivating of less labour-intensive crops	710	78.9
Reduction in variety of crops planted	695	77.2

Source: Field survey, 2022.
* Multiple responses recorded

Determinants of impact of malaria disease on labour supply to swamp rice production among the swamp rice farmers in South East, Nigeria

The estimates of the Ordinary Least Square (OLS) multiple regression model used to determine factors that influenced labour supply to swamp rice farmers production induced by malaria diseases in South East, Nigeria is presented in Table 3. The F-values of all the tried functional forms of the regression model were significant at 1.0% alpha level indicating goodness of fit and implying that any of the functional forms can be used for predictive purposes. However, the exponential logarithmic functional form gave the best fit to the data having produced highest R^2 value of 0.729, F-value of 100.757 and number of significant variables. The R^2 (coefficient of multiple determination) value of 0.729 implies that 72.9% of the variation on the impact of malaria diseases on labour supply to swamp rice farmers production was explained by the joint action of the independent variables included in the model. Specifically, the coefficient of health status was positive (0.010) and statistically significant at 1.0 percent alpha level. This implies that an increase in the health status of the smallholder swamp rice farmers increased labour supply to swamp rice production. Health is wealth and represents a key ingredient of human capital. Thus, when health is endangered as a result of malaria disease, labour supply is reduced. There is greater likelihood of swamp rice farmers with good health status being relatively more productive as a result of uninterrupted labour supply with the complement of reduced level of malaria disease affecting them. Healthier farmers are thus expected to earn more. According to [6], Poor health affects agricultural production as the health status of the farmers affect their physical ability to work, efficient utilization of resources as well as ability to adopt innovations and thus impact negatively on their labour supply [9].

The coefficient of access to health information (0.002) was positive and statistically significant at 5.0% alpha level.

The implies that the more the access to health information, smallholder swamp rice farmers have, the more they are able to eradicate malaria disease and reduce the effect of malaria disease. This will increase the labour supply in their swamp rice farms. Also, health information helps in early diagnosis and treatment of malaria, reduces malaria disease, reduces days of malaria disease incapacitation, prevents deaths and contributes to reducing its transmission [30]. This is in line with *a priori* expectation.

The coefficient of distance to health facilities was negative (-0.003) and significant at 1.0 percent level. This implies that a unit increase in distance to health care facilities in which the swamp rice farmers receive treatment for malaria disease, the quality and quantity of labour supplied by the swamp rice farmers decrease. This is in line with *a priori* expectation. The implication of this finding is that the likelihood of increased malaria incidence and number of days is reduced with farmers who are closer to health facilities. Closeness to health facilities could ease access to malaria treatment. Also, it could increase the level of awareness and orientation on the possible causes of malaria disease and measures to control its incidence [11].

The coefficient of side effects (-0.789) of the malaria drugs was negative and statistically significant at 1.0% alpha level. This implies that increase in side effects of malaria drugs increases the days of incapacitation of a swamp rice farmer and thus reduced the number of labour supplied in swamp rice farm. According to [2], increase in days of incapacitation as a result of malaria reduces amount that would have been invested in rice production (hiring of labour), because the more the number of days, the greater the loss incurred during treatment, and the less the annual income. Under severe condition, labour may not be available on the farm at all during the period of incapacitation while in a situation of mild side effect of malaria drugs, the intensity and efficiency of labour supply is reduced.

Table 3. Pooled Data Estimate of Malaria Factors that Influenced Labour Supply to Swamp Rice Production among the Farmers in South East, Nigeria

Variables	Linear	Exponential+	Double-log	Semi-log
Constant	753.176***	1.329***	5.585***	36,992.728**
	(10.006)	(16.519)	(14.243)	(2.286)
Health Status	0.073	0.010***	0.727***	353.008*
	(0.079)	(6.294)	(3.619)	(1.652)
Access to health information	23.264**	0.002**	0.496	-10,515.298
	(2.063)	(2.537)	(1.068)	(-0.680)
Distance to health care facilities	-0.0003	-0.003***	-0.244*	-12,274.134
	(-1.442)	(-2.928)	(-1.687)	(-1.233)
Drug supply	-2.703	-0.098	0.348*	-6,327.851*
	(-0.963)	(1.026)	(1.772)	(-1.558)
Drug side effect	-8.852	-0.789***	1.406	1,585.993*
	(-0.481)	(-2.805)	(0.727)	(1.790)
Housing	-2.682*	0.392	1.361	3,402.867
	(-1.758)	(1.256)	(0.496)	(1.442)
Farm income	12.124**	-5.014E-008***	0.044	14,544.469**
	(1.975)	(-3.630)	(1.104)	(2.483)
R^2	0.300	0.729	0.595	0.480
Adjusted R^2	0.257	0.720	0.520	0.415
F-ratio	25.441***	100.757***	47.883***	39.256***

Source: Field Survey data, 2022.
*,**&*** implied Significant at 10.0%, 5.0% and 1.0%
+ = lead equation

The coefficient of farm income (-5.014E-008) was negative and significant at 1.0 percent level. This negates *a priori* expectation and implies that increase in farm income is channelled towards remediation measures and thus reduced labour supply in swamp rice farm. The result is in line with [3] who reported that direct cost of malaria treatment (which includes the out-of-pocket expenditures on treatment, and cost of transportation/round-trip associated with receiving medical care) reduced the money that would have been used for crop production. Also, [8] observed that the cost of treating and preventing malaria could lead households to reduce farm area under cultivation, planting of less labour intensive crops, changing cropping pattern, adoption of labour-scarce innovations that may be less productive.

CONCLUSIONS

The study has shown that smallholder swamp rice farmers made use of various alternatives during the period of malaria incapacitation to include hiring of labour, reduction in farm size, withdrawal of savings/assets sales, cultivating of less labour -intensive crops and reduction in variety of crops. The study further showed that health status, health information, distance to health facilities, side effect of the malaria drugs and farm income were the determinants of impact of malaria on labour supply in swamp rice farms in south-East Nigeria.

The study therefore recommends that there should be interventions by government at all levels (federal, State and local) in form of mobilizing resources, formulating and implementing policies and programmes that will promote awareness and measures that ensure effective prevention and control of the pandemic disease.

An effective health management policy strategy with emphasis on health development by the government will be a welcome idea. To this effect, health education seminars on the impact of good health on labour supply will be ideal.

There is a need for adequate preventative measures and affordable medical treatments in the study area because days lost due to malaria average more than a week, which obviously reduces labour supply and output. For farmers to receive the medical care they require, hospitals and clinics must also be quickly reachable, widely accessible, and reasonably priced. Therefore government at all levels (federal, state and local) and non-governmental organizations should invest more in building of health centers in the study areas for easy access by farmers. Medication that can reduce the days of incapacitation should be intensified and made available to farmers at affordable prices in order to improve the quality of life, labour supply and productivity of farmers..

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CHOICE BETWEEN TRADITIONAL AND MODERN MILK SUPPLY CHANNELS BY FARMERS IN PUNJAB, PAKISTAN: A LOGIT REGRESSION APPROACH

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Abstract

Considering the changing milk marketing structure in Pakistan, this study is aimed at investigating the factors influencing the farmers' choice of milk marketing channels in Punjab, Pakistan. The research has been carried by means of survey for data collection from farmers in upper and south Punjab. We interviewed 341 farmers in total, with 165 farmers from Upper Punjab and 156 farmers from South Punjab. The logit model was employed in this study to estimate the factors influencing the dairy farmers' decisions to participate in the modern and tradition milk supply channels. The empirical results indicate that the volume of milk sold, improved cattle breeds, milk prices, distance to milk collection unit and payment methods are significant factors that influence the choice of farmers between two market channels. Quantity of milk sold, and improved cattle breeds are important factors to select modern supply channels. However, milk prices, distance to the milk collection unit and long payment periods discourage farmers' participation in modern channels. The study suggests that provision of advance dairy technology, intuitional support, and investment in infrastructure could enhance farmers' capabilities of managing resources and hence could shift farmers towards commercialization.

Key words*: *choice, Logit Regression, milk, supply channels, Punjab, Pakistan

INTRODUCTION

Food production and its marketing have experienced a revolutionary change all over the world and integrated food supply channels are the fastest growing and prominent market phenomenon [9, 17]. These changes have forced the participants to adopt appropriate strategies to meet the demands of new market challenges. In dairy sector, immense changes are brought in milk marketing, in terms of value addition, product differentiation and market competition [5, 21]. Modern milk supply channels are expanding their business in developing countries since early 1990sand demand for high-value products is increasing [3, 27]. Integrated supply channels provide new opportunities to farmers in terms of price and volume stability [19]. Yet, they also pose new challenges in shape of food safety standards and continuous milk supply [2, 22, 30]. However, with the expansion of modern milk supply channels there are growing concerns that whether the small-scale fames will be able to reap the advantages of emerging opportunities or not. So, there have been apprehensions about impact of modern milk supply channels on small farmers in developing countries. These new milk supply channels brought considerable changes in milk procurement, processing, and wholesaling. Nevertheless, studies in many developing countries suggested that mainly large-scale farmers benefit from these channels while small scale farmers find it difficult to meet the quality and food safety standards. In addition to this, modern supply channels also face high transaction costs for dealing with millions of small farmers [28].

In Pakistan, from early 2000s, many new players entered processing industry and large-scale dairy farms were built in the country. This resulted in massive investment in milk processing industry and introduced advance marketing strategies. Some milk processing companies introduced modern procurement systems and contract relationship with farmers to supply dairy inputs and purchase quality milk from farmers. In Pakistan, modern integrated milk supply channels are growing at a pace of 7 to 8 per cent per year. Major players in modern milk supply channels are Nestle and Engro foods with nearly 34% share of each channel [10]. This has developed a competitive structure of milk supply in Pakistan. However, despite all these changes milk marketing structure in Pakistan is largely unorganized and dominated by informal markets. In traditional channels milk is marketed through multi-layered channels. Important player in traditional market channels is milkman/vendor, who purchase milk from small dairy holders in rural areas and sell it to its customers in urban centers. Vendors sell milk directly to consumers or to small, sweet shops, hotels, and restaurants. However, farmers also sell milk directly to consumers in village areas and small tea shops and restaurants. Market players in traditional milk markets purchase milk at farm gate while in case of modern milk supply channels farmers need to travel 1.86 km on average to sell milk. It takes lot of time and increases the transportation costs of farmers too. The other advantages of vendors are quick payments, and no quality control issues in traditional channels.

Many studies have been conducted to identify the factors influencing the participation of farmers in alternative supply chain. Misra et al. (1993) [20] analyze the factors influencing the farmers' choice of milk handlers in USA and find that price of milk is the main factor in choice of marketing channels. Abdulai and Birachi (2009) [1] examine the nature of coordination mechanism and determinants of fresh milk supply chains in Kenya. The study finds that farmers prefer written contracts and distance to markets and gender of operator are main determinants in choice of marketing channels. Staal et al. (2006)[32] address the factors influencing the choice of farmers' participation in alternative milk channels in India and find transaction costs are important determinant in choice of marketing channels. Several other studies focus on the determinants of participation in alternative milk supply chains [4, 15, 18, 30].

In Pakistan very few studies have been conducted to understand the impact of modern milk supply channels on production of farmers. Burki and Khan (2011) [7] and Sadaf and Riaz (2012) [29] studied the impact of modern supply channels on technical efficiency of farmers, [36] analyzed the competitiveness of milk marketing channels and role of government policies, and [25] investigated the profitability of different players in traditional milk marketing channels. However, no studies have been done in Pakistan to understand the factors affecting farmers' choices of milk marketing channels in this changing market structure.

The broad motivation of this study is to identify the factors that influence the farmers' participation in modern and traditional milk supply channels and to assist in formulating policies and programs to improve milk supply system in Pakistan.

The structure of the papers is as follows; reviews the structure of dairy in Pakistan, data and variables, methodology and empirical model, results and discussions, and conclusion and recommendations.

Changing Structure of Dairy in Pakistan

Dairying is an important segment of Pakistan's economy accounting for 12% to the national Gross Domestic Product (GDP) and constitutes 46% of agricultural value added while milk alone accounts for 27% of the agricultural sector [33] and 75% of the total value of livestock products [35]. Livestock sector employs half of the work force, and 35 million people earn approximately 30-40% of their income from livestock [13]. It also serves as a security to famers against crop failure. Pakistan has an annual production of 34 billion liters of milk, out of which 27 billion liters are available for human consumption [26]. Despite having plenty of milk production Pakistan cannot fulfill its growing demand of milk and is net importer of powdered milk and other dairy products.

However, Pakistan has an interesting picture of dairy sector in many ways. First, Pakistan is the fourth largest producer of milk. Secondly, per capita consumption of milk is highest in Pakistan as compared to rest of the Asian countries (159 kg per person). Third, due to low level of milk processing and high demand of milk and milk products in urban areas several new companies entered in processing of UHT milk to fill the gap after 2000, which include Engro Foods, Shakar Gunj Foods, Noon Dairy Pakistan, Nirala Dairy, Alpha Dairy, Royal Dairy and many other companies started to process milk and milk products [14].

In most of the developing countries of South Asia, Sub-Saharan Africa, and Latin, share of traditional small scale milk markets is above 80% of total milk marketed [24]. In Pakistan more than 90% of the total marketed milk is still supplied through traditional milk supply channels. Out of the total milk available for human consumption in country, nearly 40% is marketed, while the remaining 60% is consumed by rural households [35].

However, there are growing concerns about quality of milk supplied by traditional milk channels, especially, adulteration in milk with water and chemicals and poor milk handling techniques. In addition, urbanization in Pakistan has been growing at 3.1 per cent per year [11]. The demand for milk in Pakistan has been growing at 15 percent per annum [6]. In such situation traditional milk channels are unable to meet the expanding gap between supply and demand. This has created a huge potential for modern market channels to expand their business. Even though milk processing companies including multinational and local are an important component of organized milk markets in Pakistan but milk procurement through these channels is still very low. Furthermore, the distribution of supply channel networks of formal system in terms of volumes of milk handled, marketing infrastructure and installed processing facilities are mostly concentrated in some districts and provinces. Out of 21 milk processing plants in country 19 are in Punjab, 2 are in Sindh while rest of the provinces and territories have no milk processing facility [14].

Consequently, despite being the fourth largest milk producer in the world, Pakistan could not harness the maximum potential of its dairy sector. The government policies towards dairy sector did not remain so encouraging. In the first five-year Plan (1955-60) government chalked a plan to buy milk from specialized dairy farmers and vendors, pasteurize it and sell it to consumer in sealed bottles. It also suggested making cooperatives of milkmen/vendors for transportation of milk to cities. These projects came to operation in two major cities: Karachi (1965) and Lahore (1967). However, these schemes remained unsuccessful due to financial losses and lack of funding from government. The second (1960–1965) and third (1965–1970) five-year plans did not put much emphasis on the development of dairy sector.

In 1970s and early 1980s government gave incentives to private milk supply channels and encouraged investment by introduction of aseptic packaging material for ultra-high temperature (UHT) treated milk by Tetra Pak Pakistan Limited. The milk processing industry got a massive investment in Pakistan and private sector established 23 milk processing plant. Nevertheless, Pakistan was still facing lack of infrastructure, social taboos in selling milk, and little acceptance of processed milk by consumers. Most of the players could not sustain with higher cost of milk collection and low level of milk processing and sale. In early 2000s many new players entered into milk processing industry and number increased from 2 in 1990s to 21 between 2000 and 2007.

Pakistan did considerable improvement in supply channel networks from 1970s, when selling milk was considered as social taboo and now many in the country are predicting “white revolution.” However, milk collection in the country is still facing many major challenges: from serious quality problems with collected milk, to colossal drop in milk production in the summer, and access to proper marketing channels [26].

In this context, the aim of the paper was to understand the determinants of dairy farmers’ participation in formal and informal milk supply channels in Pakistan.

MATERIALS AND METHODS

This study was conducted in Punjab province of Pakistan. Punjab is the largest province of Pakistan with 56% of total population. It is also the highest milk producing province of the country with nearly 64% share in total milk production. It has the world most renowned breeds of buffalo (Neeli Ravi) and cattle (Sahiwal). Buffalo is the major milk producing animal in Punjab having 65 % share of total dairy population and 64% share in total milk production followed by cattle with 49% share of total population and 35% milk share in total milk production [16]. Besides local cattle breeds, cross bred breeds and imported cattle breeds are also gaining importance in dairy farming. In Punjab, crossbred and imported cattle breeds have 17% share in total cattle population in Punjab [12].

Punjab province has two regions based on its cultural division. Upper Punjab has 55% share in total buffalo and cattle population in Punjab and South Punjab has 45% share. In terms of milk processing Plants, Punjab has 19 milk processing plants out of 21 in the country, with 14 in Upper Punjab and 5 in South Punjab [12].

We collected the data through random sampling from 12 districts of Punjab with 6 districts from each region during February-April 2013. We interviewed 341 farmers in total, with 165 farmers from Upper Punjab and 156 farmers from South Punjab. From each district we randomly selected a Union Council (which is a small part of district that has its own local government) and collected the data from one Mauza (which is a part of Union Council that consists of few villages and has its own revenue officer) of each Union Council. Given the importance of changing milk marketing structure we focused on two major marketing channels: modern milk supply channels and traditional channels (vendors, direct sale to consumer and sweet shops). As a basic step in data collected, we checked the suitability of questionnaire through pilot test. We revised the questionnaire considering the loopholes detected in the pilot survey. During the fieldwork we faced several problems in collecting information. Most common were availability of head of household and in many cases hired labor was doing all dairy related activities and head of household has not appropriate information, like time spent on performing different dairy activities. So, we tried to collect relevant information from relevant persons. We collected the information on socioeconomic characteristics, landownership, cropping pattern, agricultural production, assets ownership, milk production and consumption, milk marketing choices, input output quantities and prices. Nevertheless, there are wide regional, social, lingual, and cultural differences in two regions of Punjab, which might have some effect on the quality of data. After accounting for missing observations from data and unavailability of alternative choices in the village we are left with 307 respondents.

Farmer's participation in marketing channels

Table 1 summarizes the distribution of farmers associated with modern and traditional marketing channels in two channels and two regions. Out of total 307 dairy farmers in data, 83 farmers (26%) sell milk to modern milk supply channels and 224 farmers (84%) sell milk to traditional channels.

Table 1. Household' Distribution: Marketing Channels wise and Region wise

Regions	Formal Supply Channels	Informal Supply Channels	Total
Upper Punjab	32	140	172
South Punjab	51	84	135
Total	83	224	307

Source: Author's Calculations.

Important characteristics of households in two regions of Punjab are presented in Table 2. It shows that average age, experience, education, household size and herd size are higher in South Punjab while milk output per day (liters), quantity of milk sold per day (liters) and percentage of crossbred and imported cows in herd are higher in North Punjab. The price of milk per liter in modern milk supply chains and traditional supply chains is higher in North Punjab.

Table 2. Household's Characteristics (Mean) in Two Regions of Punjab

Variables	Upper Punjab	South Punjab	Total
Age of HH head (years)	44.2	46.1	45
Experience of HH head (years)	16.1	16.5	16.3
Education level of HH head	1.89	2.42	2.
Household Size (number)	8.68	8.94	8.8
Herd Size	16.93	20.35	18.44
Milk Herd	5.01	5.38	5.17
Buffalo	11	8.86	10.05
Local Cattle	2.17	3.80	2.89
Crossbred	2.17	4.63	3.26
Imported Cattle	1.58	3.04	2.22
Crossbred and Imported Cattle	3.75	7.68	5.49
Percentage of Cross and Imported Cattle	19	36.26	26.6
Cow percentage in herd	33.16	56.30	43.38
Price of milk in traditional channels (Rs/ltr)	46.47	41.5	44.60
Price of milk in modern channels (Rs/ltr)	41.12	39.4	40.09

Source: Author's Calculations.

Table 3 describes the socioeconomic and farm related characteristics of farmers in formal and informal markets and an independent sample t-test is conducted to test the difference between characteristics of two marketing channels. It shows that the age of farmers in modern market channels is less, and experience is more than the farmers in traditional channels. However, age and experience of head of household does not vary significantly among different market channels. Educational level of farmers in modern market channels is significantly higher which may suggest farmers' tendency towards early adaptation of new marketing channels with higher education levels. The average family size in traditional channels (9) is statistically higher than modern market channels (8.24). Table 3 further shows that the herd size in modern milk channels (21.65) is higher than traditional channels (17.25) and is statistically different. It may suggest that large farmers tend to sell milk to modern supply channels. Number of buffalo and local cow in herd does not significantly different in both market channels. However, farmers in modern marketing channels have more crossbred and imported cattle (8.54) than farmers in traditional channels and it is statistically different.

Table 3. Household Characteristics of Farmers of based on Participation in Two Different Milk Supply Channels in Punjab with mean and standard deviation in (parenthesis)

Variables	Modern Channels	Traditional Channels
Modern Channels = 1, Traditional Channels = 0, Mean = 0.26, SD = 0.44		
Age of head of household (years)	44.84 (10.84)	45.15 (11.28)
Experience of head of HH (years)	17.13 (8.49)	16.07 (8.93)
Education level of head of HH	2.32 (1.43)	2.05 (1.38)
Household size (number)	8.24 (3.39)	9.00 (3.30)
Herd size	21.65 (12.90)	17.25 (11.48)
Milch herd	5.65 (3.39)	5.00 (3.99)
Buffalo	10.46 (8.87)	9.90 (7.94)
Local cattle	2.63 (4.73)	2.99 (5.72)
Crossbred	6.19 (8.60)	2.18 (3.68)
Imported cattle	2.34 (4.74)	2.18 (4.91)
Crossbred and imported cattle	8.54 (9.06)	4.36 (6.38)
% of Cross and imported cattle	37.11 (30.63)	22.76 (26.31)
% of cows in herd	52.27 (31.61	40.10 (28.77)
Milk output (liter/day)	54.14 (42.03)	39.45 (29.17)
Milk sold (liter/day)	45.20 (40.68)	31.21 (28.31)
Sold milk percentage	77.12 (13.85)	70.57 (17.73)
Price of milk (Rupees/liter)	40 (4.94)	44.6 (7.75)
Distance to city (km)	7.40 (2.80)	7.04 (2.78)
Distance to milk collection unit (km)	1.86 (0.93)	2.92 (1.06)
Distance to metalled Road (km)	0.35 (0.48)	0.46 (0.62)
Dairy farming land (acres)	3.30 (1.99)	2.90 (1.83)

Source: Author's Calculations.

Modern milk supply channels promote high yielding crossbred and imported cow to reduce seasonal variations in milk production which happens quite often in buffalo milk production system [30].

Moreover, dairy herd of farmers in modern milk supply consists of 52 per cent of cows while in traditional channels cows share in herd is 40 per cent.

Average milk production of farmers in modern supply channels (54.1 liters/day) is higher than traditional market channels (39.4 liters/day). Market surplus of farmers participating in modern milk supply channel is also higher. Nearly 77 percent of the total milk produced is marketed by farmers in modern channels while 70 per cent is marketed in traditional channels. Price offered by modern supply channels (Rs40) is significantly lower than traditional channels (Rs44.6).

Average distance to milk collect unit is statistically different and higher in case of traditional marketing channel (2.92 km) than modern channels (1.86 km). Distance to metaled road is found statistically lower in modern marketing channels (0.35 km) than traditional marketing channels (0.46 km). Land use for dairy farming is lower in case of farmers participating in modern milk channels (2.46) than traditional ones (2.90 acres). It could portray better use of resources by farmers participating in modern supply channels.

Econometric Model

The logit model developed by Cox (1958)[8] and Walker and Duncan (1967)[34] is used in this study to estimate the factors influencing the dairy farmers' decisions to participate in the modern and tradition milk supply channels. In binary logit model the dependent variable (milk marketing channel) is a dichotomous variable (yes=1; no=0) and independent variables are qualitative and quantitative, the probability of adoption can be expressed as follows:

Probability of adoption

$$P_{(y=1)} = \frac{e\beta_o + \beta_1 X_i}{1 + e\beta_o + \beta_1 X_i} \qquad \text{equation (1)}$$

The logit transformation of the probability of adoption P(y=1) can be expressed as follows:

$$ln\left[\frac{p_{(y=1)}}{(1-p_{(y=1)})}\right] = \beta_o + \beta_1 X_i \qquad \text{equation (2)}$$

where: p represents the probability of farmers participating in modern milk supply channels and β_{is} are the regression coefficients estimated by maximum likelihood method. Equation (2) represents the logarithm of the odds of choice of milk marketing channels conditional on the independent variables that are included in the model.

The interpretation of logit regression coefficients is less straightforward than ordinary least square model. The coefficients of logit regression represent the likelihood of an outcome depending on the increase or decrease in independent variables. A positive coefficient of independent variables increases the probability and vice versa. However, the marginal effects of independent variables on the probabilities are not equal to the coefficients. The marginal effects of each variable are computed by using following equation:

$$\frac{\delta p(Y)}{\delta X_i} = \frac{\beta X_i * \exp[Z]}{[1+\exp(z)]^2} \qquad \text{equation (3)}$$

where Z is the sum of coefficients, multiplied by the means of respective variables plus the constant term. The binary logit model does not assume the linearity between explanatory and explained variables. It does not require homoskedasticity assumption and does not assume normally distributed variables.

Since the logit regression is non-linear model, the normal R^2 measure for the goodness of fit is not valid. To measure the percentage of correct predictions, the predicted probability of adoption is calculated for each farm and is compared to the actual adoption decisions. The predicted probabilities of logit model lie between 0 and 1. The model predicts adoption if the predicted probability is higher than 0.5 and assumes non-adoption otherwise. The binary logit model used in this study is specified as follows:

$Y_i = f(\beta;\chi_i) = f$ (milk sold, cross and imported cattle, dairy farmland, milk price, distance, payment, education, region)

where:
Yi is dichotomous variable (modern channels = 1, traditional channels = 0) and X_i are the independent variables.
Here, milk sold (liters) is the quantity of milk sold per day, cross and imported cattle are the number of these cattle in herd, dairy farm land (acres) is the total land used for cultivation and shed, milk price is price of milk per liter in Rupees paid by different channels, distance is the distance in km from milk collection unit, payment is the payment period (fortnight or less = 1, more = 0), education is the levels of education (no education = 0, primary = 1, middle = 2, higher secondary = 3, bachelor = 4, master of higher = 5) and region is based on the political and cultural division of Punjab (North Punjab = 1, South Punjab = 0).

RESULTS AND DISCUSSIONS

Traditional market channel is considered as base category in logit model. The results of logit regression are presented in Table 4. It shows that the volume of milk sold, number of cross and imported cows in the herd and regional dummy has significant positive effect on the farmers' likelihood to participate in the modern supply channels. Volume of milk sold increases the likelihood of farmers' participation in modern milk supply channels by 0.2%. This may suggest that farmers with large quantities of milk are inclined towards modern milk supply channels for smooth supply of milk and modern milk supply channels have less price fluctuations in peak season. Moreover, modern milk supply channels also offer relatively higher prices to large farmers too. These findings are also consistent with the study of [31] who find that the farmers who sale large volumes of milk prefer to participate in modern channels which can absorb the huge amounts of milk.
Farmers having higher share of cross and imported cattle are more likely to sell milk to modern milk supply channels that could explain that they are technologically more advance and try to avoid seasonal drop of milk which happens in case of buffalos' production. Another possible explanation could be that the farmers who are largely cow milk producers are also more likely to join modern milk supply channels because of less preference of cow milk by consumers due to low fat contents. However, the marginal effect of cross and imported cattle on farmers' participation in modern milk supply channel is quite small (0.6%).
Regional dummy has also significant positive effect on likelihood of participation of farmers in modern supply channels. The rationale here is that the modern milk supply channels are more concentrated in North Punjab and farmers have better access to modern supply channels and competition among different supply channels ensures better prices and incentives to farmers to participate in modern supply channels. Marginal effect of regional dummy is high which show that farmers in Upper Punjab are 12% more likely to participate in modern supply channels.
Negative coefficient of price of milk implies that increase in milk price reduces the likelihood of participation of farmers in modern milk supply channels. The possible interpretation of this is price is basic driving force in selection of marketing channels by small and medium farmers. Lower prices of milk offered by modern marketing channels in comparison to vendors and consumers, reduces the likelihood of farmers towards modern milk supply channels.
However, its marginal effect on non-participation of farmers in modern supply channel is quite low (0. 9%). It could also elucidate that the farmers with higher volumes of milk are more likely to sell milk to modern supply channels to ensure smooth delivery of milk. However, these findings are inconsistent with the study of [30] who suggests that farmers are more likely towards modern milk supply channels irrespective of lower prices offered by these channels. They find that modern channels have price stability as compared to traditional ones that increases the likelihood of farmers towards these channels.

Table 4. Logit model estimates of milk marketing channels

Independent Variables	Regression coefficients		Marginal effects	
	Coefficients	Standard Error	Coefficients	Standard Error
Constant	4.636***	1.33	-	-
Milk sold (ltrs)	0.017**	0.00	0.002**	0.00
Cross and imported cow	0.048**	0.02	0.006**	0.00
Dairy farmland	-0.263**	0.13	-0.032**	0.01
Milk price (Rs/ltr)	-0.074***	0.02	-0.009***	0.00
Distance to MCU (km)	-1.009***	0.19	-0.126***	0.01
Payment method	-2.097***	0.38	-0.262***	0.03
Education	0.158	0.11	0.019	0.01
Region	1.032***	0.40	0.129***	0.04
Number of observations	307			
Log likelihood	-120.58			
Pseudo R^2	0.32			

Source: Author's Calculations.

Distance to milk collection unit lowers the likelihood for the choice of modern supply channels. It has higher negative marginal effect (12%) on the participation of farmers in modern supply channels. This suggests that with increase in distance, small and medium farmers do not supply milk to modern market channels because of increasing transport costs and time required to transport milk. However, large farmers may find it difficult to transport large quantity of milk at greater distance and it increases their transportation cost too. So, increase in distance discourages both small and large farmers to participate in modern supply channels. These results are consistent with the findings of [30] and [23] who find that the channels associated with long distance have higher transport costs and are not preferred as these reduces farmers' gross margins.

Payment procedure reduces the likelihood of participation of farmers in modern supply channels. It has strong negative marginal effect (26%) on the modern milk supply channels. Farmers are less likely to participate in the modern supply channels because they make payments monthly and through banks. This creates difficulty for small and medium farmers in meeting their day-to-day expenses. Farmers are also not so familiar with banks and are usually hesitant to deal with banks. Moreover, monthly income from milk sale is not so high that they keep it in banks. However, vendors and consumers make them weekly payments and give them early payments in case of emergency. For small and medium farmers, it is easy to sell milk to traditional milk supply channels. These findings are consistent with study of [31] who find that the farmers prefer to sell milk to market channels who make them immediate cash payments as it is necessary to fulfill farmers' daily financial needs. However, these findings are inconsistent with the study of [32] who find that the farmers are less likely to sell milk to those channels who make cash payments.

Size of land used for dairy farming, reduces the likelihood of farmers' participation in modern milk supply channel by 3.2%. This needs a careful interpretation. The possible rationale behind is that the farmers who use more land for cultivation of fodder and dairy activities are relatively less efficient in use of resources and are traditional ones. Besides this, farmers with large share of buffalos who have more fodder requirements than cows might use more land for cultivation.

To the best of our knowledge, farmers having buffalos are more inclined towards traditional channels because of high demand of fresh milk of buffalo due to its high fat contents. Such farmers have less likelihood for participation in modern milk supply channels.

Table 5 shows that the logit model correctly predicts 86% of the overall observed values, with 63% correct predictions for participation in modern supply channels and 95% correct predictions for traditional market channels.

Table 5. Classification of predicted outcomes of logit model

Predicted			
Classified	Modern = 1	Traditional = 0	Total
Modern = 1	52	12	83
Traditional = 0	31	214	224
Total	83	224	307
Percentage correctly predicted	62.6%	94.6%	85.8%

Source: Author's Calculations.

CONCLUSIONS

Although modern milk supply channels are expanding their base, but traditional milk markets still have major share in milk markets in Pakistan. Major hurdles in modern supply channels are small and scattered milk producers that increase the milk collection costs of modern milk channels. Traditional milk markets are effective in terms of access to small farmers and urban consumers. However, growing concerns in consumers about quality of milk and hygiene related issues with traditional milk channels are increasing the demand for processed milk. Urbanization has been growing in Pakistan with huge pace that has increased the demand for fresh milk in urban centers and traditional channels are unable to fill the gap. These factors have created enormous space for modern milk supply channels in Pakistan.

In this study we analyze the factor influencing the choice between modern and traditional milk marketing channels by using the survey data of dairy farmers in Punjab, Pakistan. We have found significant difference in terms of herd size, cross and imported cattle in herd, milk sale volume, milk output volume, price, and educational levels of farmers in modern and traditional milk channels. Volume of milk sold and high-quality breeds in herd have significant effect on farmers' participation in modern supply channel. This shows that technologically advance and large farmers opt for modern supply channels. Furthermore, with the commercialization of dairy sector and increasing demand of quality milk the participation in modern supply chains will increase.

However, milk prices, distance to milk collection unit and payment procedure, negatively affect the farmers' participation in modern supply channels. This suggests that farmers with small quantity of milk sale are inclined towards those market channels that offer higher prices and collect milk at farm gate that reduces their transport cost. Furthermore, traditional milk supply channels make early payments and sometimes make advance payments that encourage farmers to sell milk to these channels. The growth of modern milk supply channels by and large depends on the development of milk collection infrastructure, competitive prices and rapid system of payments.

Considering the findings of this study, if farmers are provided with advance dairy technology and are given intuitional support, it could enhance milk production and farmers' capabilities of managing resources and hence could shift farmers towards commercialization. Easy access to market by improved market infrastructure needs investment in infrastructure and is necessary step for enhancing milk supply. Moreover, milk prices and payment methods are important factors in choice of market channels and selling milk and hence can be used as a policy instrument in enhancing farmers' level of commercialization.

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PROBLEM ISSUES IN THE IMPLEMENTATION OF INNOVATIONS AND DIGITAL TECHNOLOGIES IN AGRICULTURAL PRODUCTION IN THE CONDITIONS OF NBIC CONVERGENCE

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Abstract

Currently, in the agro-industrial complex, the problem of import substitution of key technological solutions, innovative resources and digital technologies is becoming increasingly important for increasing agricultural production. The aim of the article is to study the prerequisites for accelerating the introduction of innovative and digital products in the agro-industrial complex based on NBIC convergence in the context of digital transformation and improving methods for stimulating demand for them. The article clarifies aspects of the phenomenon of NBIC convergence and its impact on the technological structure of economies. The analysis of indicators characterizing the dynamics of the volumes of innovative goods and services in the context of industries was carried out. An assessment is given of indicators of the digital economy in 2021. It is substantiated that at present the nature of the implementation of NBIC technologies is of a point nature, mainly in the leading agricultural holdings. According to the results of expert surveys, points in growth in terms of the development of digital transformation conditions have been identified. Directions for the development of strategic priorities are proposed in terms of optimizing the cost of introducing digital technologies, increasing digital literacy and competencies of employees, creating mechanisms to subsidize the development of domestic innovative and digital products, as well as stimulating demand for them. The practical significance of the results of the study lies in the possibility of their use in the development of a strategy for the scientific and technological development of Russia.

Key words: *agro-industrial complex, innovations, digital technologies, NBIC convergence, indicators, growth points, digital literacy, strategic development*

INTRODUCTION

The current stage of scientific and technological development and the transition to the sixth major cycle of N. Kondratiev is associated with the process of NBIC convergence, which applies to all sectors of the national economy, including the agricultural sector. The process of convergence is distinguished by the blurring of boundaries between individual technologies and an interdisciplinary approach to the development and obtaining of relevant results. In the research environment, information technologies, biotechnologies, nanotechnologies and cognitive science can interact and merge into a single scientific and technological program. Theoretical and methodological aspects of the implementation of NBIC technologies are represented by numerous works in the world and domestic literature. The NBIC convergence paradigm was substantiated by foreign researchers Michael Rocko and William Bainbridge. In the work Converging Technologies for Improving Human Performance, prepared at the World Technology Assessment Center (WTEC), the features of NBIC convergence, stages of evolution, essence and significance in the development of world civilization were studied [23].

Among the works of domestic scientists, it should be noted the works of Yatsishin E.B. [15], Gokhberg L.M. [1]. Emelina V.A. [10] [30].Implementation of NBIC technologies in the context of the digital transformation of Industry 4.0. leads to the development of productive forces and is a new technological order [9].

The main infrastructure link of Industry 4.0, based on the use of fundamentally new digital technologies and digital platforms, is represented by the industrial Internet, through which all participants in the value creation process interact effectively. The emergence of nanochips, biochips and quantum computers served as the basis for the creation of intelligent computers and robots that are widely used in industrial activities [16].

The creation of a fundamentally new scientific and technological base makes it possible to control processes at the atomic and molecular level. In agriculture, artificial neural networks can be used both at the micro and macro levels to predict trends and patterns of development, although it remains quite problematic to choose the most optimal neural network format. A large role is given to innovative computer recognition systems, which significantly increase the efficiency of the use of agricultural machinery. In the research environment, information technologies, biotechnologies, nanotechnologies and cognitive science can interact and merge into a single scientific and technological program, which is a prerequisite for the transition of the agro-food system to an inclusive development model [7].

Currently, digital technologies are becoming increasingly important in the agri-food sector. As a result of the evolution of IT systems, a large number of participants were involved in the integration process. A number of foreign researchers note the need for a new paradigm of digital innovation. In particular, Sjaak Wolferta,*, Cor Verdouwb, Lan van Wassenaera, Wilfred Dolfsmac, Laurens Klerkxd substantiated the theoretical and methodological issues of the analysis and formation of sustainable digital innovation ecosystems in the agri-food sector.

The issues of the implementation of large public-private innovation projects in a number of European countries for the period from 2011 to 2021 were studied. The project participants were engaged in the development of various options for digital solutions, on the basis of which the authors formed the basic principles for the functioning of the digital innovation ecosystems in the agro-food sector and substantiated recommendations for improving the mechanisms for managing digitalization processes [29].

In recent years, the process of digitalization in the agri-food sector has been characterized by an increase in the number of participants, which can be represented by the “digital transformation ladder”. On the left side of the ladder, digitalization extends from production and supply chain to food systems [20].

The right side characterizes the expansion of the scope of IT systems from individual applications of farm information systems to data platforms (Ge and Bogaardt, 2015) [12] as well as the data space (Nagel and Lycklama, 202; [5, 21]. The number of new actors is changing towards complex business ecosystems (Wolfert et al., 2021). [28].

Thus, digital transformation reflects significant social and technical and economic changes in the main business operations that affect both production processes and management concepts [4] [19]. The initial stage of digitalization was characterized by the automation of production processes, then the creation of management information systems for farmers took place [17].

Authors such as Fountas, Sørensen [11] analyzed the stages of development, testing and demonstration of digital innovations; the use of such types of digital technologies as the Internet of Things, cloud and mobile computing in the agro-food systems of European countries.

The use of extensive information is a prerequisite for efficient and sustainable food production, as well as raising consumer awareness. It should be noted that the new generation of information systems is characterized by an increase in the number of external users, which complicates

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theaggregation of relevant functions for various stakeholders.
A significant role in increasing the efficiency of production and optimizing the structure of sown areas is assigned to the use of genetic algorithms [26].
At the same time, institutional heterogeneity in the use of digital technologies should be noted; due to the high purchase price, they are used mainly by large agricultural organizations of the holding type. In addition, in some industries there is a lack of digital competencies and digital literacy, low susceptibility to innovative and digital technologies.

MATERIALS AND METHODS

The purpose of the article is to study the prerequisites for accelerating the introduction of innovative and digital products in the agro-industrial complex based on NBIC convergence in the context of digital transformation and improving methods for stimulating demand for them.
The methodological basis of the research is legal, legislative acts, works of foreign and Russian authors on the subject of innovative development of the agro-food complex. In the process of research, monographic, abstract-logical, analytical, research methods were used. Regulatory and legislative acts, information from OECD, INSEAD, Global Innovation Index, Rosstat, National Research University Higher School of Economics were used as the information base of the study.

RESULTS AND DISCUSSIONS

One of the most important indicators of the innovativeness of the economy and its industries is the export of technology. In 2021, the export of ICT goods (information and communication technologies) in the whole Russian economy amounted to 2686 million US dollars, an increase of 47.2% compared to 2020, and the export of ICT services over the same period increased by 21.8 % [2].
Russia's positions in the global food market have noticeably improved: in 2022, agricultural exports amounted to 41.6 billion US dollars, an increase of 5 times compared to 2010 [24].
For certain types of economic activity, there is a positive trend in relation to the volume of innovative goods, works and services introduced or undergoing significant technological changes (Table 1).

Table 1. Dynamics of innovative goods, works, services introduced or covered by significant technological changes, million rubles

	Years					2021 by 2017, %
	2017	2018	2019	2020	2021	
Total innovative goods, works, services	3,014,435.1	3,006,565.0	3,156,522.8	2, 925, 556.9	3, 389, 581.3	112.4
of which by type of economic activity: growingannualcrops	9, 446.0	8, 152.6	20, 743.8	21, 714.1	9, 242.1	97.8
animalhusbandry	10, 430.5	16, 211.2	27, 587.1	15, 482.5	25, 319.6	242.7
manufacturingindustries	2, 140, 102.3	2, 077, 459.1	2, 070, 895.3	1, 940, 743.3	2, 346, 795.3	109.7
of whichfoodproduction	240, 423.8	223, 993.3	203, 739.0	190. 758.9	220, 406.3	91.7

Source: Own calculations based on [3].

For the period 2017-2021 The highest rates of growth in the introduction of innovative products were achieved in animal husbandry (242.7%), outpacing the average for the economy as a whole.
However, it should be noted the insufficient

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use of domestic innovative developments in the agricultural sector in recent years.

Currently, the trend is improving and more and more domestic products are being introduced into agricultural production. In the Russian agro-industrial complex, about 500 new types of scientific and technical products are annually produced and transferred for the purpose of development.

According to the results of expert assessments, the technologies of no-tillage farming, loose keeping of livestock, as well as biofuel production technologies are recognized as the most in demand in medium-sized agricultural organizations. On the contrary, technologies of precision agriculture, computerization and automation have a low potential for implementation [18].

The use of individual innovative technologies in farms of various categories is shown in Figure 1.

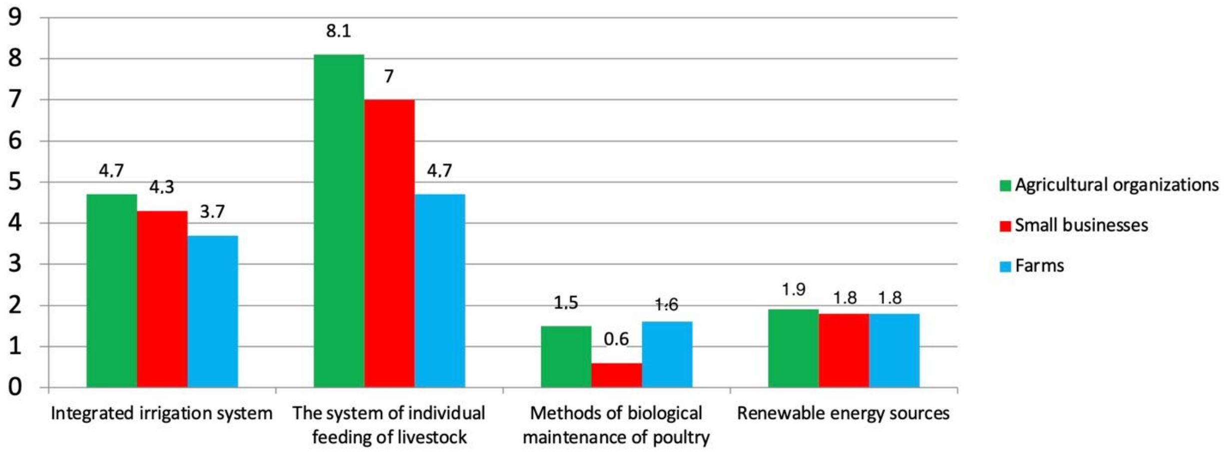

Fig. 1. Share of organizations that used innovative technologies in agriculture
Source: Own calculations based on data [14].

The national platform "Digital Agriculture", which is currently being created by the Ministry of Agriculture of Russia, contains all the necessary information on an industry scale.

Table 2. The main indicators of the digital economy of Russia in 2016-2021

	2016	2017	2018	2019	2020	2021	2021 by 2016,%
Domestic costs for the development of the digital economy from all sources as a percentage of GDP, %	1.7	1.9	1.9	2.2	2.1	2.12	124.7
Number of patent applications for inventions in the field of ICT, units	1977	2270	2063	2702	2457	2684	135.7
Percentageofglobalpatentapplications in the field of ICT,%.	0.33	0.35	0.30	0.36	0.30	0.30	90.9
The share of innovative goods, works, services in the total volume goods shipped, works performed, ICT sector services, %	6.4	6.6	8.0	8.0	7.6	9.4	146.9
Gross value added of the information and advisory services sector as a percentage of GDP	2.9	2.9	2.8	2.9	3.3	3.2	110.3
Share of Russia in the global number of patent applications and inventions in the field of information and consulting services	0.33	0.35	0.3	0.36	0.3	0,32	97.0
Gross domestic costs for the development of the digital economy, billion rubles	3289	3324	3795	4094	4063	4848	147,4
In % of GDP	3.6	3.6	3.6	3.7	3.8	3.7	102.8

Source: Own calculations based on [3].

Currently, according to the National Research University Higher School of Economics [2,3] in Table 2 shows the sector of information and communication technologies in the economy as a whole occupies 3.2% of GDP, demonstrating upward growth trends.

So, in 2010-2021. exports of goods and services related to ICT amounted to 9918 million US dollars, an increase of 2.7 times. In 2017-2021 gross domestic spending on the development of the digital economy increased by 45.8%, and domestic spending on the creation, dissemination and use of digital technologies, as well as related products and services, increased by almost 70%.

The number of patent applications for inventions in the field of ICT, filed by Russian applicants, has increased over 2016-2020. by 24.3%, although the share of Russia in the global number of patent applications for inventions in the field of ICT in the period under review remained practically unchanged.

The number of technology export agreements in 2021 amounted to 6,783, an increase of 61.7% from 2019.

Technology export revenues reached $4,662.7 million. Studies by Russian scientists have shown that the "Knowledge of ICT" indicator has the greatest value on the value of the digital competitiveness index, and the "Conditions for the development of technologies" indicator has the smallest value. The share of agriculture in Russia's GDP is 4.5%, the level of introduction of advanced technologies (especially digital) in the agro-industrial complex is still not high enough compared to other sectors of the economy.

It is also substantiated that the sufficiency of consumption of basic foodstuffs largely depends on the increase in domestic production [6].

The share of agriculture in Russia's GDP is 4.5%, the level of introduction of advanced technologies (especially digital) in the agro-industrial complex is still not high enough compared to other sectors of the economy.

In recent years, there has been an improvement in the use of digital technologies in agriculture, as evidenced by an increase in the number of agrotech start-ups in 2020–2021 by 30% [13].

The use of certain types of digital technologies is presented in Table 3.

Table 3. Use of digital technologies in organizations of certain types of economic activity (% of the total number of organizations)

	Cloudservices		Collection technologies, processing and data analysis		Digital platforms		Industrial robots / automatedlines	
	2020	2021	2020	2021	2020	2020	2020	2021
Total	25.7	27.1	22.4	25.8	14.7	17.2	4.3	4.4
Manufacturing industry	27.1	28.9	26.5	29.9	14.5	16.0	4.1	5.3
Agriculture	17.8	21.5	17.2	23.3	10.2	9.8	4.2	2.9

Source: Own calculations based on [3].

Digital technologies provide ample opportunities to meet the requirements of the neo-industrial economy. The experts assessed the role of digital agriculture in the process of socio-economic transformation in terms of the following parameters:

- production of agricultural products in the digital environment "from field to counter"; -
- - minimization of intermediaries and trade margins;
- increasing the level of control over the condition and use of agricultural land;
- improving the efficiency of industry management;
- improving the quality of life in rural areas [8].

Growth of profitability of production is achieved due to point optimization of costs. In crop production, technologies for compiling digital maps and planning yields are quite relevant; technologies for differentiated application of fertilizers.

Of great importance is monitoring the condition of crops and monitoring the quality of the crop. For livestock production, monitoring the health of the herd is important; monitoring the quality of livestock products.

It should be noted that in agriculture, the share of organizations using various digital technologies is much lower. Precision farming and innovative technologies in animal husbandry are mainly used by large enterprises and agricultural holdings.

Agricultural organizations are more actively using parallel driving systems, GIS technologies and industrial robots. In 2021, industrial robots were used by 5.3% of all agricultural organizations, which exceeded the values for the economy as a whole and manufacturing enterprises (4.4% and 2.9%), respectively. The use of robots in dairy cattle breeding can increase profitability by about 15%, and in the case of widespread introduction of robotization, selection and informatization in agriculture, the total economic effect from the use of the above technologies in Russian agriculture will reach 10 trillion rubles.

On the contrary, cloud services, digital platforms and artificial intelligence technologies turned out to be less in demand in agriculture: in 2021 they were used by 21.5%, 9.8% and 2.9% of all enterprises, respectively.

The biggest demand for new technologies comes from large Russian agricultural holdings; the possibilities of digital technologies for small enterprises are significantly limited. Only a few digital products are used by small and medium-sized businesses.

A significant obstacle to the mass introduction of new technologies and products is the lack of IT specialists and the insufficiently high level of digital literacy in agriculture [14].

The most important condition for the multifunctional development of rural space is the activation of investment policy [22].

Stimulation of innovative development is possible on the basis of expanding the forms and methods of interaction between investment policy, science and agribusiness [27].

State support for the digitalization process should be aimed at stimulating end-to-end digital solutions based on appropriate platforms for creating life cycle chains for the production and sale of agricultural products.

The Strategy for the Digital Transformation of Agriculture defines the stages of introducing digital technologies and the algorithm of state support. If at the first stage (2021-2024) it is planned to pilot the stimulation of the introduction of digital technologies by agricultural producers, then at the second stage (2025-2027) the mass application of proven technologies is expected, supported by appropriate measures of targeted state support for enterprises implementing processes and digitalization technologies. At the second stage, intelligent decision support subsystems will also be tested.

At the third stage (2028–2030), an end-to-end system of information support in the field of agriculture will be created. Measures to create digital twins and create digital production in crop and livestock production guarantee a reduction in cost and increase the availability of products by reducing the number of intermediaries in the sale of agricultural products.

The active support of the state will consist in the creation of favorable tax and regulatory regimes; creation of digital infrastructure [25].

To improve the efficiency of innovative and digital potential, the Strategy for Digital Transformation of the Agro-Industrial and Fishery Complexes identifies the following priorities:

-introduction and large-scale dissemination of digital technologies in the main industries and sectors of the agro-industrial complex, including electronic document management systems, artificial intelligence technologies, the Internet of things;

-organizing the production of Russian analogues of imported electronic equipment and software with the provision of the necessary state support;

-creating conditions for expanding the marketing of agricultural products through the introduction of traceability systems for grain and livestock products, accounting for agricultural land, providing access to digital platforms, including small forms of farming;
-increasing digital literacy and developing digital competencies of employees through the creation of new and improvement of existing training and advanced training programs. digital transformation strategy
Improving the opportunities for the introduction of digital technologies by agricultural producers depends both on the level of state support for the digital transformation of the agricultural sector in the form of subsidizing relevant developments and programs, and on the degree of interaction between actors in value chains in the process of generating demand for innovation.

CONCLUSIONS

The article studies the prerequisites for accelerating the introduction of innovative and digital products in the agro-industrial complex based on NBIC convergence, presents the evolution of views on digital transformation issues both in the economy as a whole and in the agro-industrial complex.
Theoretical and methodological aspects of the introduction of domestic innovative products and technologies in the agro-industrial complex are developed and methods for stimulating demand for them are developed.
The analysis of indicators characterizing the volumes of innovative goods and services in the context of industries was carried out. An assessment is given of the indicators of the digital economy in 2021, as well as the dynamics of the use of digital technologies in organizations of certain types of economic activity.
Based on the results of expert surveys, growth points were identified in terms of the development of digital transformation conditions. Directions for the development of strategic priorities in terms of building up digital competencies and stimulating demand for domestic innovative products and digital technologies are proposed.

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THE RESPONSE OF THE MEDIUM FIBER COTTON VARIETY PIDOZERSKY 4 TO THE SEEDING RATE AND ROW WIDTH UNDER DIFFERENT CONDITIONS OF SOIL MOISTURE IN THE SOUTHERN STEPPE OF UKRAINE

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Abstract

The article presents the results of studying the reaction of the early maturing medium-fiber cotton variety Pidozerskyi 4 to the sowing rate and row width under different conditions of moisture supply in the Southern Steppe of Ukraine. The scheme of the experiment included soil moisture conditions: natural moisture and watering at 70% of the lowest moisture content (LM); row width 30, 60, 90 cm; sowing rate of 250, 300 and 350 thousand pieces/ha. Studies have shown that the formation of the number of pods on a plant that opened before harvesting was significantly influenced by the rate of seed sowing, with an increase in which the indicators of the number of pods decreased on average by 43.9% in the experiment, and regardless of the conditions of soil moisture and width row spacing. The variability of the effective signs of the mass formation of the boll of pre-freeze raw cotton depended by 25.0% on the humidification conditions, by 15.0% - on the width of the rows, and by 16.0% - on the seeding rate; yield of domestic raw cotton - by 66.0% from the conditions of wet supply, by 3.0% - from the width of the rows and by 9.0% - from the sowing rate. The significant influence of irrigation on the yield formation of frozen raw cotton was determined. The increase in yield on irrigated plots at the seeding rate of 300,000 units/ha was: for row widths of 30 cm – 17%, for 60 cm – 18%, for 90 cm – 22%, compared to non-irrigated options. Raw cotton production is highly effective, the profitability level is 63-69%.

Key words: *precocious, medium-fiber, cotton variety, seeding rate, row width, moisture supply conditions*

INTRODUCTION

Cotton is widely cultivated in more than 80 countries worldwide due to its great socio-economic benefits and is the most important industrial fiber crop [9, 26, 36].

The shortage of water resources poses serious threats to the sustainable development of agriculture and causes the need for water-saving technologies. One of the potential strategies to overcome reduced irrigation opportunities is to plant crops such as cotton (*Gossypium hirsutum* L.) or sorghum (*Sorghum bicolor* L.), which are characterized by drought resistance [7].

Since this plant is able to withstand drought well, undemanding to growing conditions, it can become an alternative to traditional crops in the area of risky agriculture [41].

Climate change towards warming creates favorable conditions for crop cultivation in the Southern Steppe of Ukraine [39, 47]. Therefore, the greatest achievement of the Ukrainian breeders of the Institute of Irrigated Agriculture of the NAAS (now the Institute of Climate-Smart Agriculture of the NAAS) was the creation of two precocious, medium-fiber cotton varieties of a new generation for this zone.

For effective, scientifically based cotton production, the question arises of the need to improve its varietal agrotechnics of growing. The study of the reaction of the production features of cotton varieties with the optimization of the main parameters of technological elements is relevant and important. Solving this problem will contribute to the increase of high yields of raw cotton and the effective implementation of the culture in production in the conditions of the Southern Steppe of Ukraine.

Scientists from all over the world paid attention to the issue of improving cotton growing technology [11, 19, 20, 27].

In the conditions of climate change, agriculture is the key to human survival, and water is an indispensable factor for ensuring crop production. Approximately 70% of the world's water consumption is used for crop production [46], 60–80% – for irrigation [1, 15].

It has been proven that even crops which are not very picky about moisture - also need water during critical periods of development. The greatest need for vegetation irrigation of cotton arises during the flowering of plants and the formation of bolls, which in the conditions of the Kherson region take place in July.

Studies have shown that a water deficit during the flowering of this crop can lead to a significant reduction in yield [33, 35, 16].

A number of scientists emphasize the need for conducting field studies to assess the response of cotton under different soil moisture conditions [5, 12, 37]. Water use varies greatly depending on location, climate, irrigation method, and cotton variety [6].

The study of the cotton irrigation regime in Bulgaria (Chirpan) at the Institute of Cotton and Durum Wheat showed that the optimal irrigation regime is watering at the irrigation rate 1,130 m^3/ha and one rational watering with rate 418 m^3/ha, which ensured a 64.4% yield increase [31].

When studying the regime of cotton irrigation in the south of Ukraine Shtoyko D.A. recommends applying irrigation with an irrigation rate of 2,000 m^3 to obtain a cotton crop of 2.0 t/ha [34]. To obtain high yields of cotton in Uzbekistan, Azerbaijan and the former republics of Central Asia, it is necessary to carry out from 3 - 4 to 8 - 10 irrigations, depending on the type of soil [45].

However, cotton can withstand severe droughts. It forms a crop without irrigation in areas with an annual amount of precipitation up to 350 mm. At the same time, the main importance is not the total amount of precipitation, but its distribution. Heavy rains harm cotton, if there is a lack of light and a drop in temperature. The amount of precipitation in the cotton regions of southern Ukraine is much lower than in South America, and the annual amount of heat is lower than in the republics of Central Asia, located in the dry zone, where cotton culture is possible only with irrigation [24]. In this regard, a number of authors recommend reducing the use of water on cotton crops to 25% of the recommended irrigation rate [29, 30].

The results of research carried out by scientists of the Institute of Irrigated Agriculture proved that the optimal irrigation rate of Dniprovskyi 5 cotton variety in the conditions of the Southern Steppe of Ukraine should be considered 1,250 m^3/ha at 70% of the LM [31].

Plant density is an important abiotic factor affecting cotton production [44], optimal indicators of which increase crop yield [2, 3, 13, 21, 38, 43].

When the plant density of 15,000, 33,000, 51,000, 69,000, 87,000 and 105,000 per hectare was studied in the Henan province of China, it was established that cotton grown at a lower density formed taller plants and a large number of leaves on them, while at a high one, a larger the number of branches, fruit nodes and a large number of pods per unit of sown area. The highest yield of raw cotton 4.55 t/ha and fiber 1.68 t/ha was obtained at a density of 87,000 plants per hectare [24]. Other authors also followed this opinion [12, 22].

Increasing the density from 10 to 15 plants per m^2 led to an extension of the cotton vegetation period.

It has been proven that raw cotton yields increase with plant density up to a certain value, which is called optimal, while low yields are obtained at very high or very low planting densities. Cotton plants react especially sharply to increased plant density during flowering [8].

It has been established that the optimal plant density depends on many factors, such as

climate, genotype, irrigation method, and type of ground cover. Therefore, to determine the optimal density of cotton plants, in order to obtain the maximum yield, it is important to conduct research in each geographical area [10, 23, 24, 28]. With the introduction of modern varieties of cotton, interest in its narrow-row production has revived, primarily due to the reduction of weed control problems. Narrow-row spacing proved to be a viable agronomic practice for cotton production compared to traditional crop cultivation [18]. To determine the effect of row spacing on precocity, three row spacings of 60, 75 and 90 cm were studied in Pakistan. It was found that precocity index was highest (50.9%) with 60 cm row spacing, productivity index (55.9 g/day) - with a row spacing of 90 cm, and the yield of raw cotton is the highest (2.6 t/ha) - with a row spacing of 75 cm [32].
For machine cultivation of cotton, a number of scientists recommend an optimal row spacing of 76 cm [17, 25]. Thus, an important issue in the technology of growing new varieties of cotton is their reaction to the area of plant nutrition depending on the width of the rows and the density of the stand under different conditions of moisture supply. Optimizing the feeding area and moisture supply is important for the maximum use of natural factors and the formation of high yields of raw cotton. The study of these parameters is also necessary to determine the technological requirements for the purchase or creation of new equipment. The purpose of our research was to determine the reaction of the early ripening medium-fiber cotton variety Pidozerskyi 4 to the density and width of sowing under different conditions of soil moisture in the Southern Steppe of Ukraine.

MATERIALS AND METHODS

Determining the method of seeding and the density of plants under different conditions of moisture supply was carried out by conducting a field experiment. Factor A – soil moisture conditions: natural moisture and watering at 70% of the LM; Factor B – row width 30, 60, 90 cm; Factor C - seeding rate of 250, 300 and 350 thousand units/ha.
Experiments on the study of the method of seeding in conditions of moisture supply and on crops of the early ripening cotton variety Pidozerskyi 4 were carried out on the fields of the Institute of Irrigated Agriculture of the NAAS during 2012-2013, 2018 according to the Methodology of field and laboratory research on irrigated lands [40]. Soils are typical for the southern part of Ukraine - dark chestnut, medium loamy, medium saline. The depth of the humus horizon is 30-45 cm. The content of humus in the soil layer is 0-25 cm - 2.15%. The reaction of the soil solution in the upper horizons is close to neutral (PH = 7.0). The object of research is the cotton culture, the subject is the irrigation regime, the new variety is Pidozersky 4. The predecessor is winter wheat. Plowing was carried out to a depth of 25-26 cm, the experimental plot was marked with a RPL-6 seeder to a width of 0.7 m. Cotton is a heat-loving crop and is very responsive to soil temperature conditions. Cotton seeding was carried out when the soil temperature at the depth of seed wrapping reached 13-14°C using a nest method with a manual seeder on May 5-8, equipped with a brush seeding mechanism with different hole diameters. Seeds were sown exposed to concentrated sulfuric acid. Laboratory seed germination was 92.0% in 2012, 91.5% in 2013, and 92.1% in 2018. After seeding, the herbicide "Stomp" was used at the rate of 5-6 l/ha for harrowing. The plot, depending on the size of the row spacing, had 12 rows (row spacing 30 cm), 6 rows (row spacing 60 cm) and 4 rows (row spacing 90 cm). In the variant with a row spacing of 30 cm, 8 rows were counted, with a row spacing of 60 cm – 4 rows, and with a row spacing of 90 cm – 3 rows. The registered area was 24 m^2. The direction of seeding is south-north. The recurrence is five times, the placement of plots is five-tiered by the method of randomization of plots of the third order.
During the growing season, two inter-row treatments were carried out with a cultivator KRN-4.2, chemical stamping of plants - with the retardant Pix at the rate of 1 l/ha in the

first decade of August. Fertilizers were applied manually, watered with a DDA100MA sprinkler.
Research methods - field, laboratory, statistical.

RESULTS AND DISCUSSIONS

Determining the date of onset of phases of growth and development of cotton plants allowed to calculate the duration of its interphase periods [42]. The results of the observations showed that this indicator was influenced by hydrothermal conditions, soil moisture, and plant density. Depending on the specified factors, the vegetation period of cotton plants lasted from 110 to 122 days (Table 1).

Table 1. Duration of phases of growth and development of cotton plants (average for 2012-2013, 2018), days

Soil moisture conditions, Factor A	Row width, cm Factor B	Seeding rate, thousand units/ha Factor C	Growth and development phases		
			"seeding - seedling"	"seedling- blooming phase"	"seedling phase - full maturity" (on the date of collecting the boxes)
Without irrigation	30	250	14	49	116
		350	14	49	114
		450	14	48	114
	60	250	14	51	114
		350	14	50	110
		450	14	50	112
	90	250	14	51	116
		350	14	50	113
		450	14	48	114
Irrigation at 70% of the LM	30	250	14	51	122
		350	14	50	120
		450	14	49	119
	60	250	14	51	118
		350	14	52	115
		450	14	49	114
	90	250	14	54	121
		350	14	52	119
		450	14	52	118
LSD_{05} Partial differences	Factor A				6.6
	Factor B				1.9
	Factor C				3.3
LSD_{05} The average (main) effects	Factor A				2.2
	Factor B				0.8
	Factor C				0.8

Source: Own calculation.

The results of the observations showed that the duration of the "seeding-seedling" period was the same for all variants of the experiment and amounted to 14 days on average over the years of research.
One of the most important indicators of the rate of growth and development of plants is the duration of the "seedling-blooming" period. In this period, slight differences were observed between the options of irrigation and natural soil moistening, which was 1–3 days.

The duration of the "seedlings-full maturity" phase was characterized by lower indicators in the variants without irrigation – 110 - 116 days, than in the case of watering, where the vegetation period was extended by 3.6 - 5.2% and was within 114 - 122 days. It should be noted that, regardless of moisture conditions and plant density, the vegetation period in the variants of the experiment with a row spacing of 30 cm was somewhat shorter – by 1 - 2 days, compared to the width of the row spacing of 60 and 90 cm (Fig. 1).

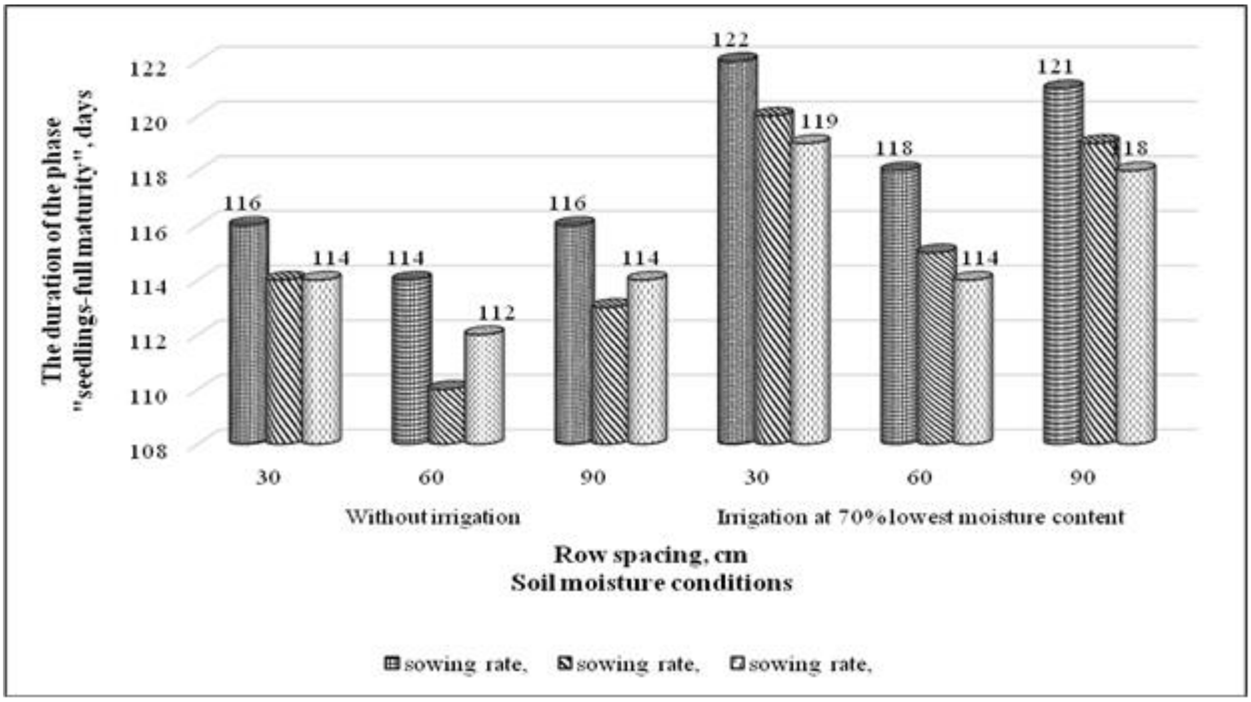

Fig. 1. The reaction of cotton plants of the Pidozerskyi 4 variety to duration of growth and development phases depending on the width of the rows and sowing rates under different conditions of moisture supply, days (average for 2012-2013, 2018)
Source: Own calculation.

As can be seen from Figure 2, the variability of the duration of the growing season depended significantly on soil moisture conditions (36.0%): with irrigation, the ripening period of the pods was extended by 4-6 days.

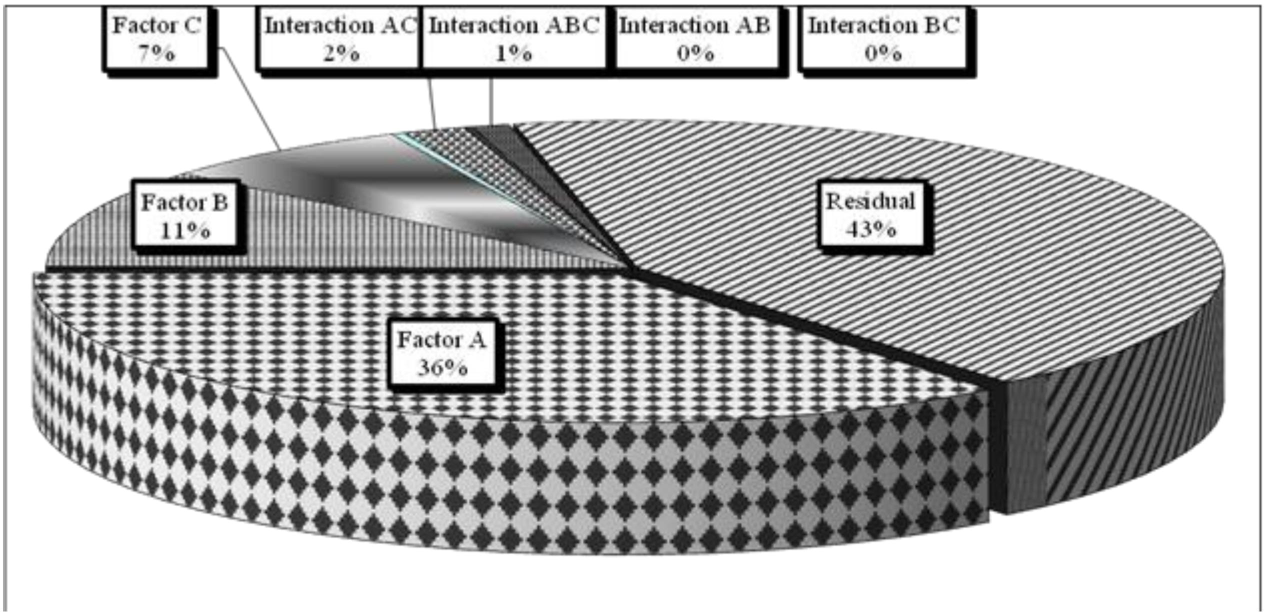

Fig. 2. Variability of the effective signs of the duration of the phases of growth and development of cotton plants of the Pidozerskyi 4 variety depending on the width of the rows and sowing rates under different conditions of moisture supply, days (average for 2012-2013, 2018)
Source: Own calculation.

Somewhat smaller variability of the vegetation period was observed depending on the width of the rows (11.0%) and even smaller - on the sowing rate (7.0%).

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The main task in selecting a system of agrotechnical techniques for growing cotton varieties is to create such conditions that would best comply the requirements of the plants. In order to justify agrotechnical recommendations for growing high cotton yields, the dynamics of linear plant growth and their biometric parameters were studied in the conducted research. Biometric measurements on 10 medium plants from each plot were carried out in the phases of budding, blooming and full maturity on the date of collection of pods. As a result, the dynamic response of the Pidozerskii 4 cotton variety to soil moisture conditions, row spacing and sowing rates was determined based on the characteristics of "plant height" and "height of attachment of the first sympodial branch".

The height of the plants, depending on the investigated factors, varied from 52 to 72 cm. In the budding phase, according to this feature, the difference of these indicators by variants was insignificant. During the blooming phase in the areas with natural moisture, the height of the plants, depending on the studied row spacing and density, ranged from 52 to 62 cm (Fig. 3).

The highest values of 62 cm for this feature were observed with a row spacing of 90 cm and a seeding rate of 250,000 units/ha. Depending on these factors of influence, the most intensive growth of plants in height occurred before the flowering phase and reached its maximum in the phase of full maturity – 56 - 62 cm.

The lowest value of the indicator was observed at the seeding rate of 350,000 units/ha, regardless of the width of the rows.

In the irrigated areas during the blooming period, the height of the plants, depending on the studied row width and density, ranged from 62 to 72 cm, which was 10 cm higher than the variants with natural soil moisture and was the highest at 72 cm with a row width of 90 cm and sowing rates 250 thousand units/ha.

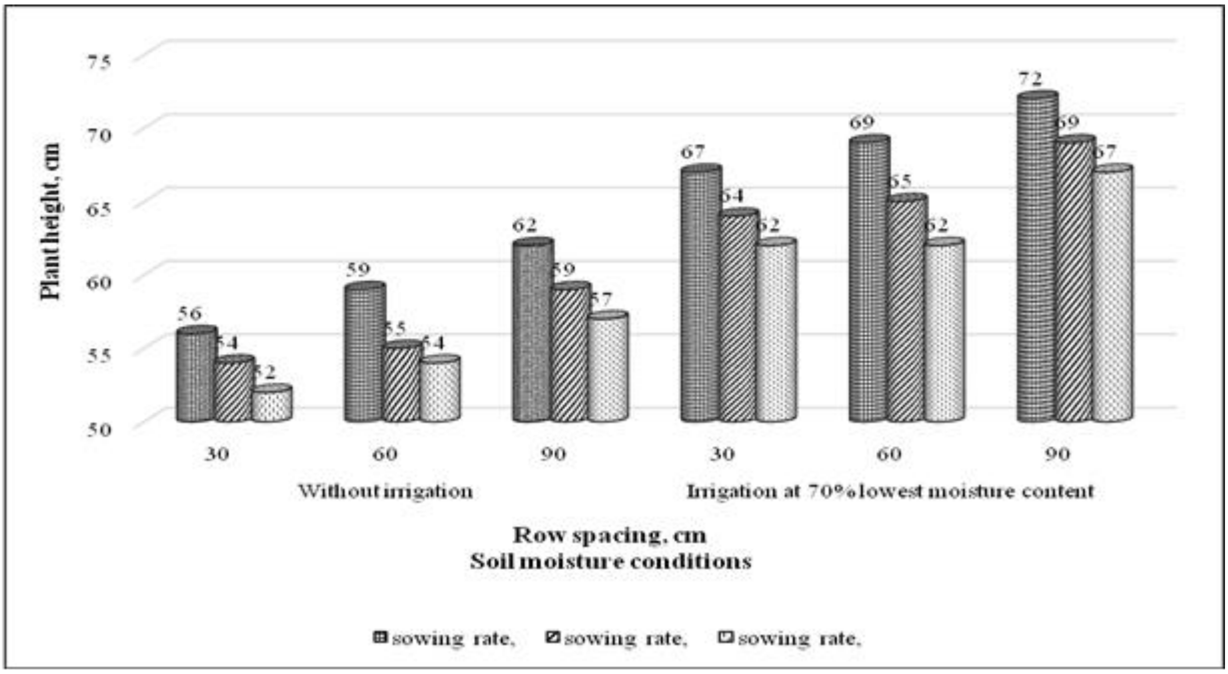

Fig. 3. The reaction of cotton plants of the Pidozerskyi 4 variety to duration of growth and development phases depending on the width of the rows and sowing rates under different conditions of moisture supply, days (average for 2012-2013, 2018)
Source: Own calculation.

A similar dependence was observed in the phase of full ripeness. Fluctuations of indicators for the "plant height" feature were within 52-72 cm. Research results show that irrigation turned out to be a significant factor influencing the height of cotton plants, therefore, higher values of indicators for this feature were obtained on these variants, compared to non-irrigated areas.

Variability of the formation of plant height depending on irrigation was 53.0%, the width of the rows and the density of plant stands – 10.0% each (Fig. 4).

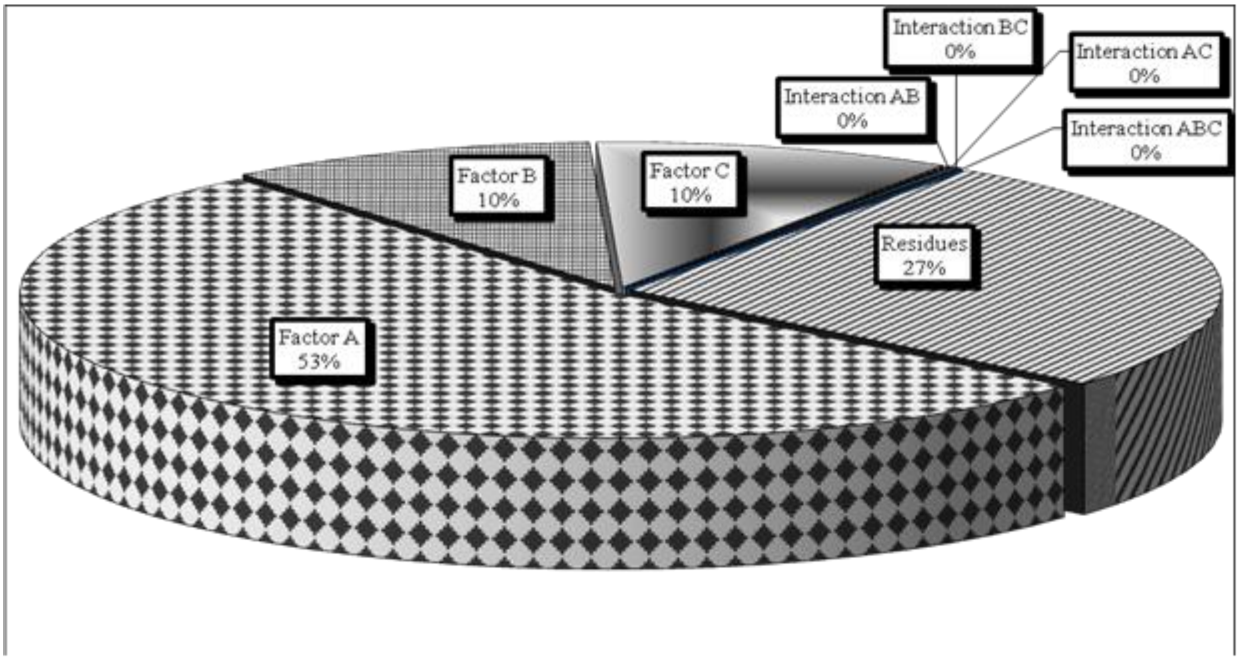

Fig. 4. Variability of the effective signs of the formation of the height of cotton plants of the Pidozerskyi 4 variety under different conditions of soil moisture, row width and sowing rate, cm (average for 2012–2013, 2018)
Source: Own calculation.

Determining the height of the first sympodia of the studied cotton variety Pidozerskyi 4 is important, as it determines its suitability for mechanized harvesting.

The height of attachment of the first sympodia of cotton plants on average over the years of research was affected by soil moisture conditions, row spacing and sowing rates.

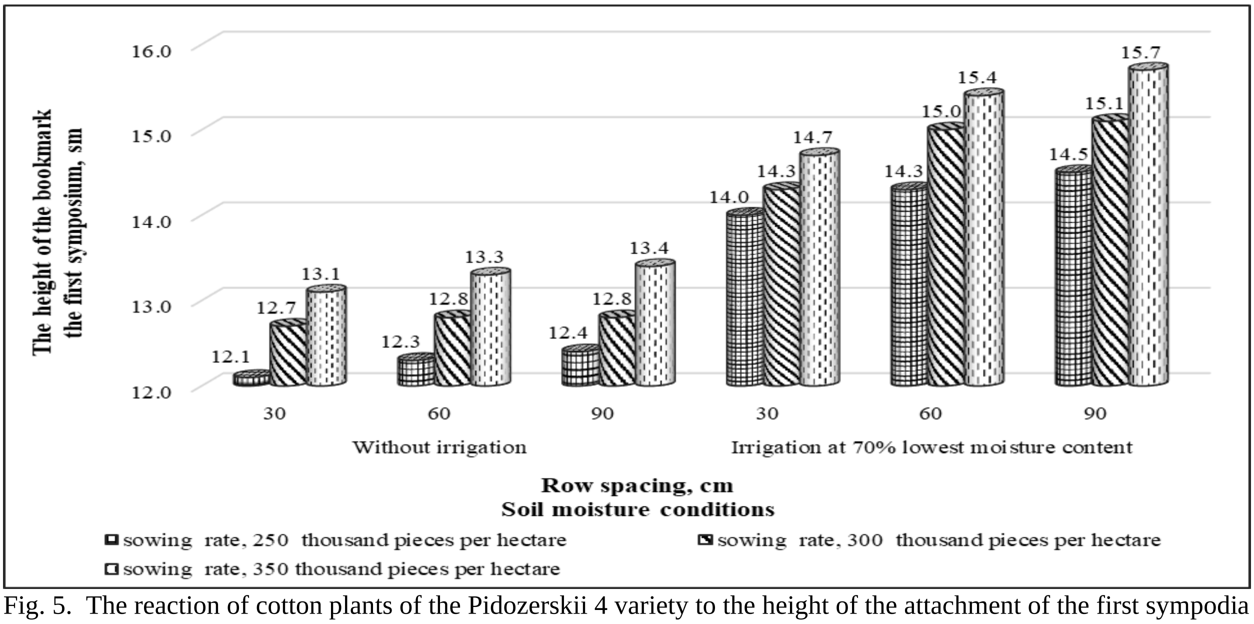

Fig. 5. The reaction of cotton plants of the Pidozerskii 4 variety to the height of the attachment of the first sympodia depending on the conditions of soil moisture, the width of the rows and the rate of sowing, cm (average for 2012-2013, 2018)
Source: Own calculation.

Depending on the investigated factors, for cultivation without irrigation, this indicator varied between 10.5 and 13.4 cm, and was the highest at 13.4 cm for the row width of 30 cm and the seeding rate of 350 thousand units/ha (Fig. 5).

When growing cotton under irrigation, the indicators of the height of attachment of the first sympodia were significantly higher – by 6.0 - 8.0% or by 0.8 cm (according to LSD_{05} = 0.1), compared to the options without irrigation, and ranged within 11.3 – 14.2 cm. The variant with a row width of 30 cm and a plant density of 350,000 units/ha stood out for the maximum height of the attachment of the first sympodia of 14.2 cm, as well as in non-irrigated conditions.

Therefore, the variability of the effective signs of attachment of the first sympodia depended to a large extent on the irrigation conditions and amounted to 62.0% (Fig. 6). A very small percentage of the influence on the formation of the height of attachment of the lower bean was exerted by the width of the interrows of 2.0% and the density of the plants standing at 8.0%.

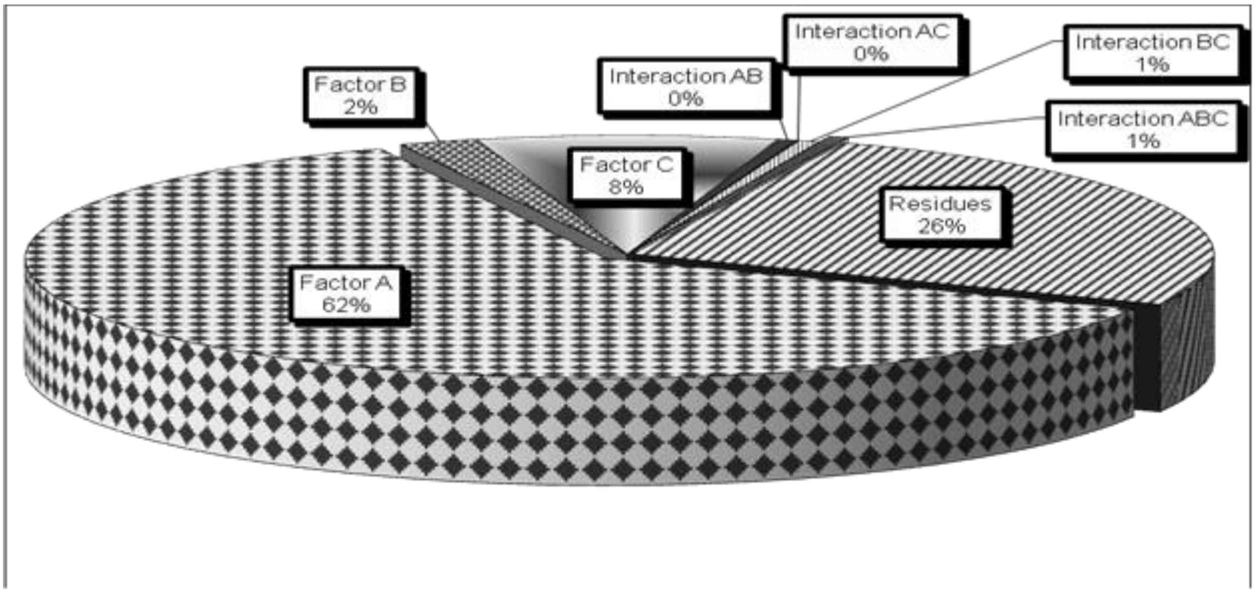

Fig. 6. Variability of the effective signs of the attachment of the first sympodia under different conditions of soil moisture, row width and sowing rate in cotton plants of the Pidozersky 4 variety, cm (average for 2012–2013, 2018)
Source: Own calculation.

For specific soil and climatic conditions, the optimal seeding rate for each variety is the one that ensures the formation of the maximum yield of raw cotton [14]. The calculation of plant stand density depending on the seeding rates indicated in the studies shows that this indicator in the phase of full maturity on the date of harvesting the pods decreased by 1.35-1.93 times, compared to the number of sown seeds, depending on the conditions of moisture and width row spacing. The death of plants before the harvest period can be explained by the fact that in the initial period of growth, before the appearance of the first 2 true leaves, cotton plants have a very delicate structure, as a result of which they are easily damaged under the influence of various external factors, including during mechanical processing crops. Thus, the average density of standing cotton plants at a seeding rate of 250 thousand units/ha was 96 thousand units/ha, at a seeding rate of 300 thousand units/ha – 168, and at 350 thousand units/ha – 240 thousand units/ha of plants, respectively (Table 2).

The data in Table 2 show that the density of cotton plants decreased with an increase in the width of the rows both in non-irrigated options and under irrigation conditions. For example, with a row width of 30 cm, the density of plants in the areas without irrigation was 112, 182, and 260 thousand units/ha, and at 90 cm – 88, 156, 218 thousand units/ha; on irrigated areas, respectively – 112, 182, 262 thousand units/ha and 83, 156 and 218 thousand units/ha.

Table 2. The reaction of cotton of the Pidozerskyi 4 variety to the density of plant stands depending on the width of the rows and sowing rates under different conditions of moisture supply, thousand units/ha (average for 2012 - 2013, 2018)

Soil moisture conditions (factor A)	Row spacing, cm (factor B)	Density of standing plants in the phase of "full maturity", thousand per ha (factor C)			The average factor of A, thousand pieces per hectare	The average factor of B, thousand pieces per hectare
		sowing rate, 150 thousand pieces per hectare	sowing rate, 300 thousand pieces per hectare	sowing rate, 450 thousand pieces per hectare		
Without irrigation	30	112	182	260	168.2	185.0
	60	90	172	236		166.0
	90	88	156	218		153.2
Irrigation at 70% lowest moisture content	30	112	182	262	167.9	
	60	92	166	240		
	90	83	156	218		
The average factor of C, thousand pieces per hectare		96.2	169.0	239.0		

Source: Own calculation.

As a result of the research, it was established that the rate of seed sowing had a significant influence on the formation of the number of pods on the plant that opened before harvesting [4], as it increased, the indicators of the number of boxes decreased, and regardless of the conditions of soil moisture and the width of the rows. The reduction of these indicators occurred, on average, by 43.9% (Fig. 7).

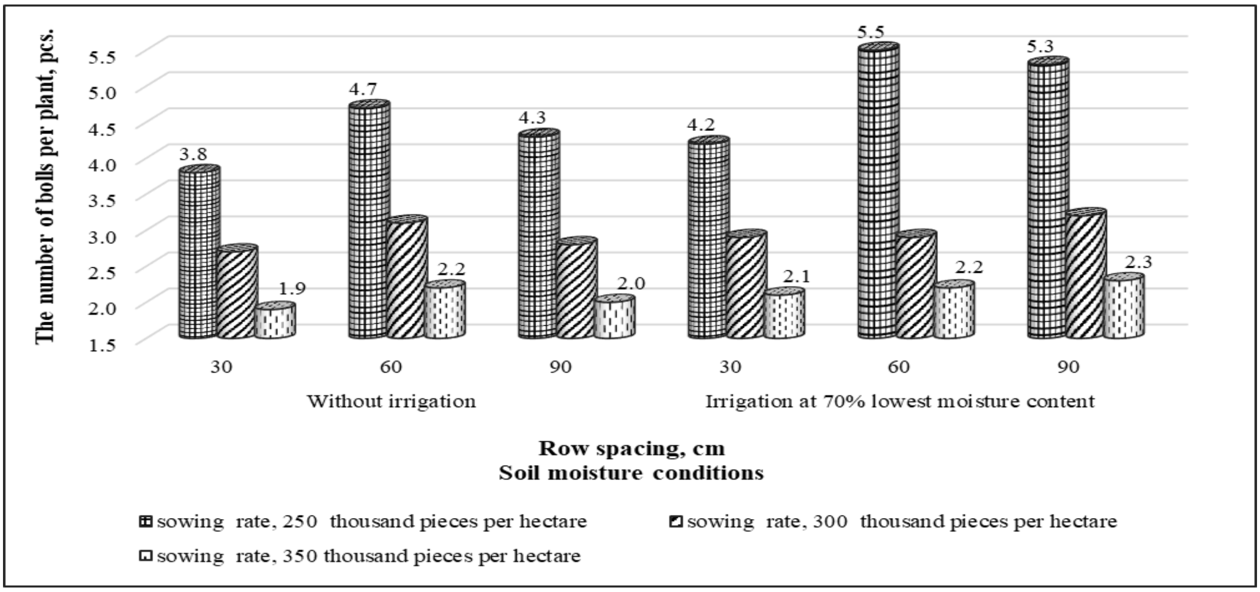

Fig. 7. The reaction of cotton of the Pidozerskiy 4 variety to the formation of the number of bolls per plant depending on the conditions of soil moisture, the width of the rows and the rate of sowing, pcs. (average for 2012-2013, 2018)
Source: Own calculation.

The variability of the effective signs of the formation of the number of bolls per plant in cotton of the Pidozerskyi 4 variety depended most, by 86.0%, on the seeding rate.

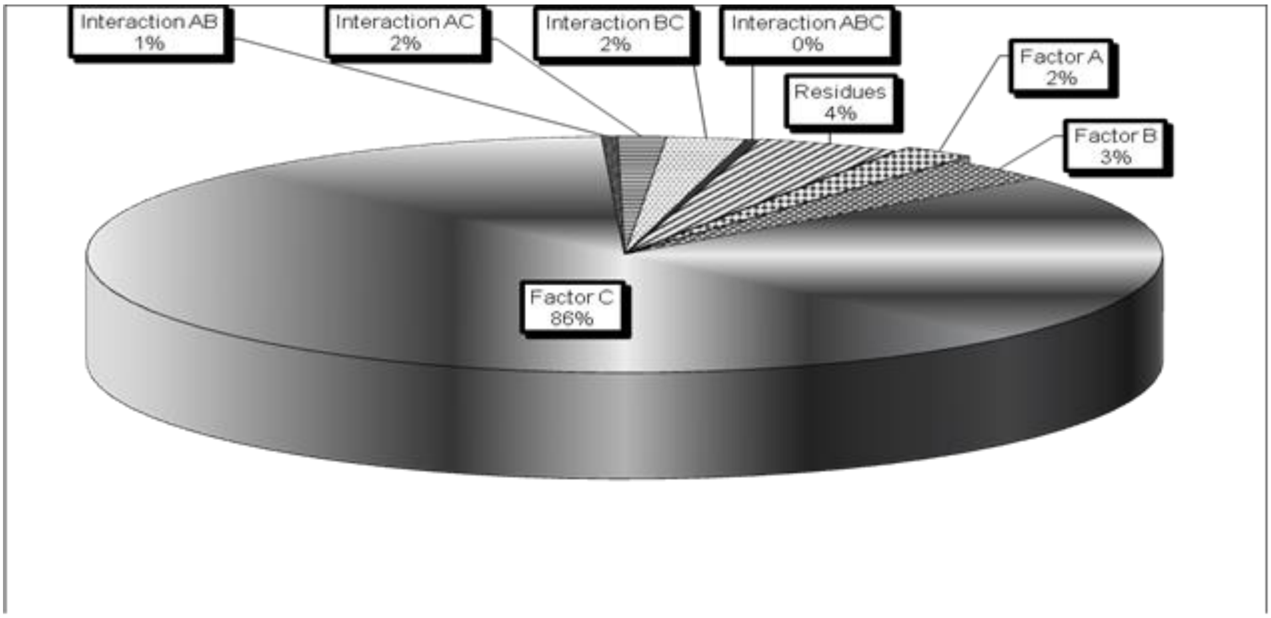

Fig. 8. Variability of the effective signs on the formation of the number of bolls per plant in cotton of the Pidozerskyi 4 variety depending on the conditions of soil moisture, the width of the rows and the rate of sowing, pcs. (average for 2012-2013, 2018)
Source: Own calculation.

A completely different pattern was observed in relation to the reaction of cotton plants to the formation of boll mass, depending on the studied Factors: larger bolls were observed in areas with a lower density of plant stands. Also, the formation of the mass of the box was influenced by the conditions of wet provision of sowing and the width of the rows (Fig. 9).

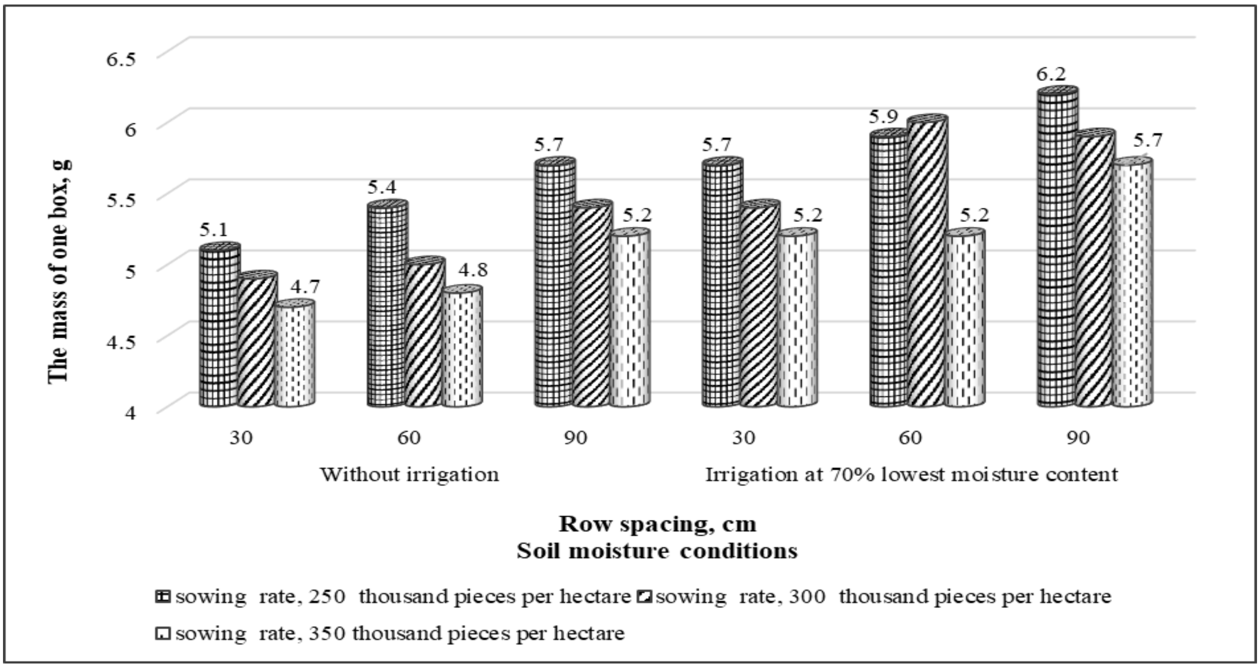

Fig. 9. Reaction of cotton of the Pidozersky 4 variety to the formation of the mass of one box depending on the conditions of soil moisture, the width of the rows and the rate of sowing, g (average for 2012-2013, 2018)
Source: Own calculation.

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If in the variants without irrigation, the parameters of the mass of the box were in the range of 4.7 - 5.7 g, then in the irrigated areas - 5.2 - 6.2 g. The maximum value of the weight of the box of 5.6 g was observed in the areas with natural soil moisture in variants with a row spacing of 60 cm and a seeding rate of 300 thousand units/ha and 5.7 g with a row spacing of 90 cm and a sowing rate of 250 thousand units/ha and 6.0 and 6.1 thousand units/ha, respectively, on areas with irrigation. An increase in the width of the rows and the rate of sowing or a decrease, in relation to the above parameters, led to a decrease in the weight of the box.

Variability of the effective signs of boll mass formation of pre-freezing raw cotton depended by 25.0% on the conditions of wet supply, by 15.0% - on the width of the rows, and by 16.0% - on the seeding rate.

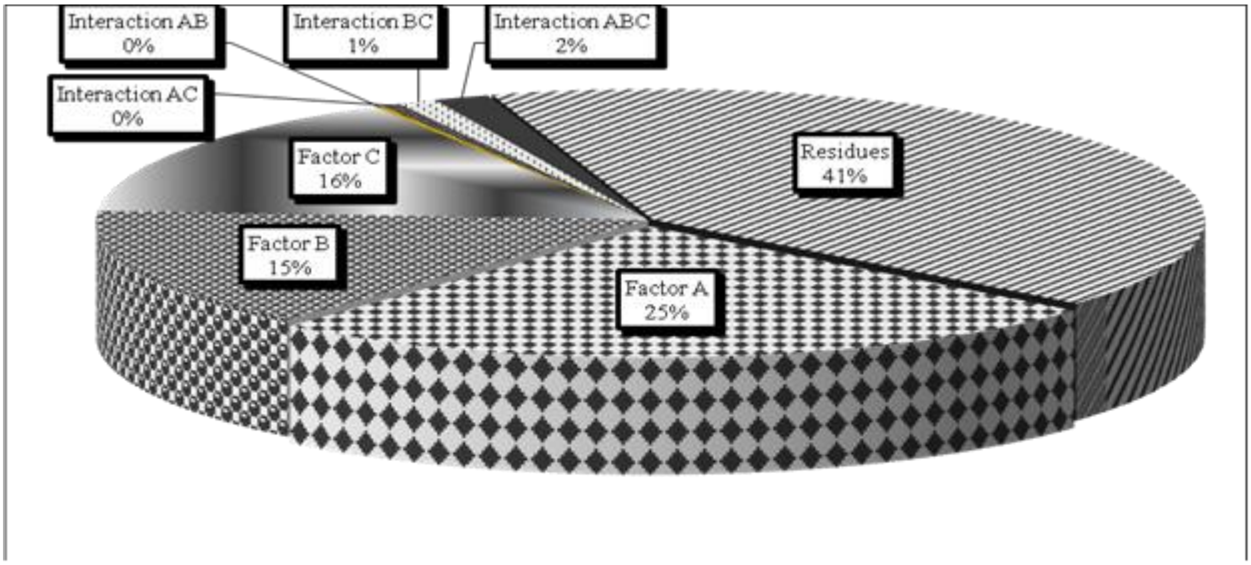

Fig. 10. Variability of the effective signs of the formation of the mass of one boll in cotton of the Pidozersky 4 variety depending on the conditions of soil moisture, the width of the rows and the rate of sowing, g (average for 2012-2013, 2018)
Source: Own calculation.

The competition of plants for material growth factors regulated by different conditions of soil moisture, the method and seeding rate - had a significant impact on the formation of the yield of cotton plants.

Based on the results of the research, it was established that the maximum indicators of yield to frost raw were obtained with a row width of 60 cm, regardless of the moisture conditions: 2.56 t/ha with natural soil moisture and 3.02 t/ha on irrigated plots (Fig. 11).

Further narrowing of the row spacing to 30 cm at the sowing rate of 300 thousand units/ha led to a decrease in pre-freeze raw material collection by 0.2 t/ha [4].

Despite the drought resistance of cotton plants, a significant influence of irrigation on the formation of the yield of raw cotton was determined. The increase in yield on irrigated plots at the seeding rate of 300,000 units/ha was: for row widths of 30 cm – 17%, for 60 cm – 18%, for 90 cm – 22%, compared to non-irrigated options.

Correlation-regression analysis of the obtained data of the research results shows that there is a direct relationship between the formation of the crop and the number and weight of the box under natural moisture supply (Fig. 12).

The correlation coefficient is 0.623 – 0.644, respectively.

The mathematical model has the form

$y=23.248x^2-112.45x+138.78$,

where y - productivity ratio;

x – number of boxes on the plant;

and

$y=3.5209x^2-17.977x+27.863$,

where y - productivity ratio;

x – the weight of one box.

The variability of the effective signs of yield formation of pre-frost raw cotton depended by 66.0% on the conditions of moisture supply, by 3.0% - on the width of the rows, and by 9.0% - on the seeding rate (Fig. 13).

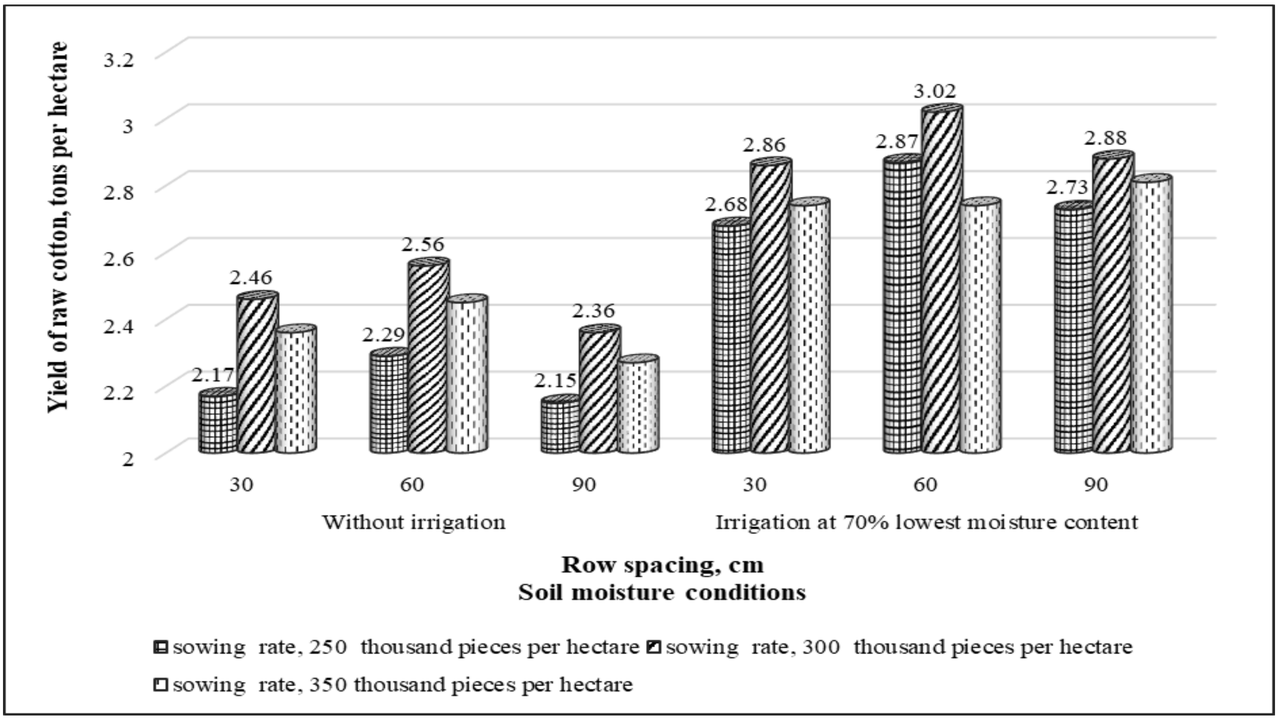

Fig. 11. Yield of pre-freeze raw cotton in the Pidozerskyi 4 variety depending on soil moisture conditions, row width and sowing rate, t/ha
Source: Own calculation.

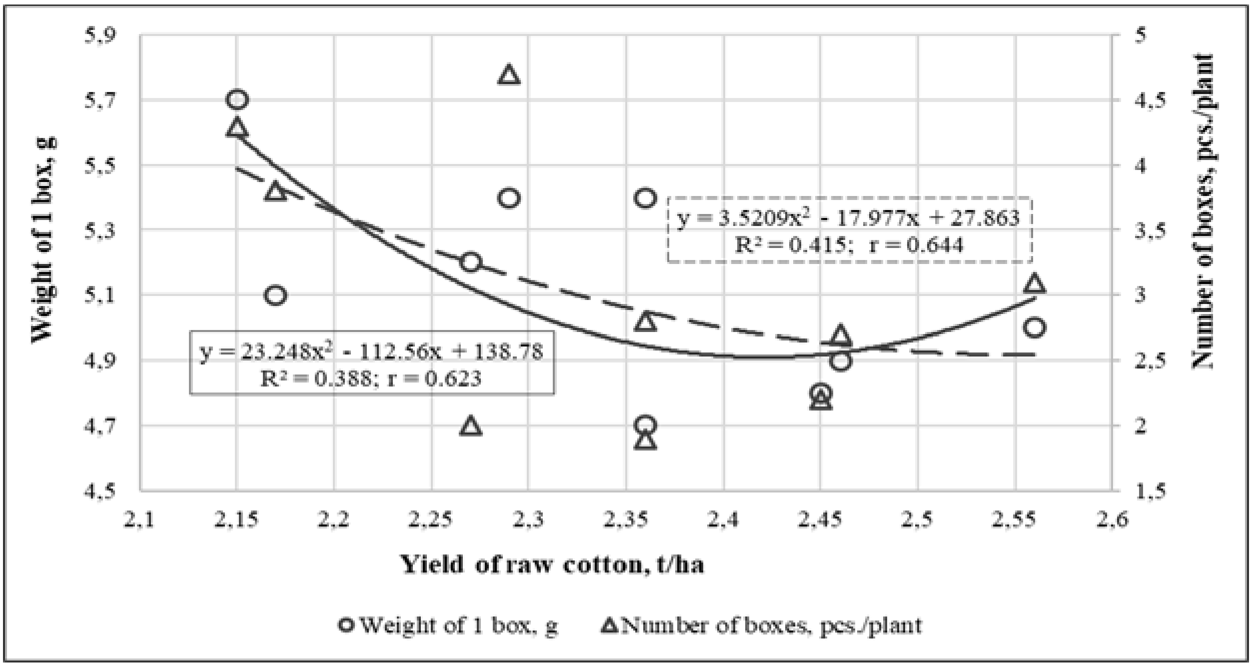

Fig. 12. Correlation-regression model of yield formation depending on the number and weight of the box under the conditions of natural moisture supply (average for 2012-2013, 2018)
Source: Own calculation.

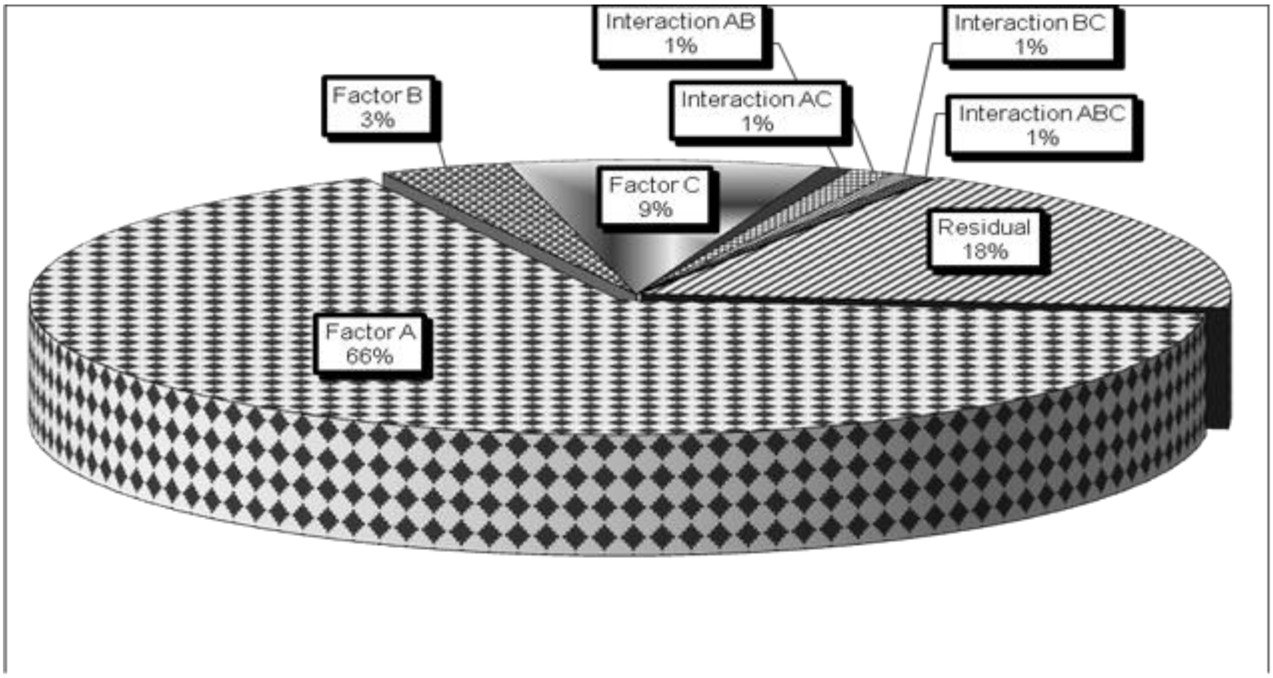

Fig. 13. Variability of the effective signs of the formation of the yield of pre-freeze raw cotton in the Pidozerskyi 4 cotton variety depending on the conditions of soil moisture, the width of the rows and seeding rate, t/ha (average for 2012-2013, 2018)
Source: Own calculation.

Table 3. Economic efficiency of raw cotton growing depending on technological support (average for 2012-2013, 2018)

Soil moisture conditions Factor A	The width of the row, cm Factor B	Sowing rate, thousand pcs/ha Factor C	Yield, t/ha	Conditionally net profit, USD/ha	Cost, USD/t	Profitability level, %
Without irrigaring	30	250	2.27	1,239	306	64.00
		300	2.52	1,447	277	68.00
		350	2.38	1,327	294	66.00
	60	250	2.33	1,289	298	65.00
		300	2.65	1,558	264	69.00
		350	2.48	1,412	282	67.00
	90	250	2.18	1,161	319	63.00
		300	2.40	1,345	291	66.00
		350	2.31	1,268	303	65.00
Irrigation at 70% of the LM	30	250	2.72	1,480	307	64.00
		300	2.82	1,562	297	65.00
		350	2.77	1,518	303	65.00
	60	250	2.90	1,634	289	67.00
		300	3.07	1,775	273	68.00
		350	2.77	1,518	303	65.00
	90	250	2.84	1,582	292	66.00
		300	2.91	1,639	288	67.00
		350	2.90	1,629	290	66.00

Source: Own calculation.

According to calculations, the production of raw cotton is quite efficient and profitable. In all presented areas, it provided high indicators of net profit and profitability. Conditionally net profit was 1,239-1,775 USD/ha, and the level of profitability was 63-69%.

For the width of the rows of 60 cm, in areas with irrigation where the highest yield of raw cotton was formed – 3.07 t/ha, the maximum conditionally net profit of 1,775 USD/ha was obtained (Table 3).

And although the maximum yield was obtained under irrigation conditions, the highest profitability of 69.00% and the lowest cost of funds per hectare of 264 USD/ha were observed on the plots without irrigation.

So, the results of the research show that for irrigation on a plot with a row width of 60 cm. a high yield of 3.07 t/ha of raw cotton of the early ripening medium-fiber cotton variety Pidozerskyi 4 is ensured at the lowest cost of 273 USD/ha and the highest profitability of 68.00%. On non-irrigated areas. the maximum yield of 2.65 t/ha was obtained at an even lower cost of 264 USD/ha than on irrigation. and at the highest profitability of 69.00% in the conditions of the Southern Steppe of Ukraine. which makes it possible to use this agrotechnical technique as on non-irrigated areas as well as on irrigated lands.

CONCLUSIONS

The formation of the number of pods on the plant that opened before harvesting was significantly influenced by the rate of seed sowing. with an increase in which the indicators of the number of pods decreased by 43.9% on average in the experiment. regardless of the conditions of soil moisture and the width of the rows.

The variability of the effective signs of the mass formation of the boll of pre-freeze raw cotton depended by 25.0% on the conditions of moisture supply. by 15.0% - on the width of the rows. and by 16.0% - on the seeding rate; the yield of domestic raw cotton depended by 66.0% on the conditions of moisture supply. by 3.0% - on the width of the rows. and by 9.0% - on the seeding rate.

The significant impact of irrigation on the formation of the yield of frozen raw cotton was determined. The increase in yield on irrigated plots at the seeding rate of 300 thousand units/ha was: for row widths of 30 cm – 17%. for 60 cm – 18%. for 90 cm – 22%. compared to non-irrigated options.

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ANALYSIS OF THE SOCIO-ECONOMIC DETERMINANTS OF GOVERNMENT-SUBSIDIZED CERTIFIED SEED USE: A CROSS-SECTIONAL STUDY ON TURKISH POTATO FARMING

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Abstract

Potato is one of the important agricultural products in the fight against malnutrition and poverty. It is also very important for the economy of countries with its contribution to employment and foreign exchange earnings in the production process. The use of certified seeds increases yield in potato production. Potato production costs are decreased due to increased yield. For this reason, certified potato seed use is encouraged by the government in Türkiye since 2005. This study, it was aimed to analyze the socio-economic determinants of government-subsidized certified seed use. To achieve this aim, the socioeconomic and technical characteristics of the farmers using certified seed and farm-saved seeds were compared. This study was conducted with 80 potato farmers. According to the research findings, it was determined that both the farm size, the potato production area and the potato yield of the farmers using certified seeds were higher than the farmers using farm-saved seeds. It is determined that the factors that farmers give importance to when purchasing potato seeds are the seed is cheap, resistant to diseases, and high yielding, respectively. The most common problem faced by farmers in the use of seeds is that the seed is expensive for farmers using certified seeds; It has been revealed that there are diseases and pests in farmers using farm-saved seeds. Considering that certified seeds use is one of the main factors that increase the potatoes yield supporting the use of certified seeds is important for the continuity of potato production and profitability.

Key words: *potato farming, certified seed use, farm-saved seed, seed subsidy policies, Türkiye*

INTRODUCTION

The agricultural sector is the main sector that provides nutrition to people and fights hunger by increasing food production. In addition, it has an important role in the economy of countries with the formation of GDP, foreign exchange earnings, raw material supply to food industry, reducing poverty, and contributing to employment [25]. Potatoes, one of the important crops, constitutes one of the four crops (rice, wheat, corn) that meet 50% of the world's food needs [11]. For this reason, it is an important product to be considered within the scope of combating malnutrition and malnutrition [32]. The International Year of Potatoes was declared in 2008 by the United Nations due to its contribution to food security and poverty eradication, as it is the most important non-grain food in the World [10, 18]. In addition, it takes its place among the crops preferred by the farmers due to the large amount of product obtained from the unit area, the possibility of storage, the short product life cycle, and the ability to be converted into a cash source in the short term [16]. In addition, it is a low-fat and energy-giving food, rich in carbohydrates and vitamin C [6, 15]. According to 2020 production data in the world, in a total area of 16,494,810 hectares, 359,071,403 tons of potatoes were produced. The first five countries that are important in production are respectively: China (21.77%), India (14.29%), Ukraine (5.80%), Russia (5.46%), and the USA (United States) (5.23%). These countries meet 52.56% of the total potato production in the world. Türkiye accounts for 1.45% of world production with 5,200,000 tons of potato production and ranks 16th [12].

Considering the climatic conditions, ecology, and soil structure of Türkiye, potato production can be done in almost every region of the country [34]. When Türkiye's 2000-2020 potato production period is examined, although there is an increase in potato yield over the years, there are fluctuations in the production area and amount. This is because; increases in potato prices in the market; increase the potato cropping areas in the next year, and the decrease in prices may cause a decrease in cropping areas [34]. This situation is expressed as the Cobweb Theorem in economics. Seed has a very special place in the agricultural production [23]. The importance of using seeds in potato production is more than other crops [16]. Farm-saved seeds and certified seeds are used as potato seeds in the potato production. Farm-saved seeds can be produced on the farm or market, neighbour, etc. can be purchased anywhere. Certified seeds are seeds purchased from specialist breeders through a seed certification program whose seed quality is usually formally established by government agencies. In some studies, it has been stated that farm-saved seeds, which are used informally, cause the spread of diseases and lead to low yields [8, 13, 18, 27]. The use of certified seeds in crop production provides an increase of about 20-30% in yield, depending on other production conditions. The use of certified seeds in crop production reduces the unit cost with high yield. Therefore, the use of certified seeds in crop production provides important gains both for agricultural management and for the economy of the region and the country [1, 20, 33].

The establishment of the necessary organizations related to seed certification in the world started in the early 1900s [3]. In Türkiye, the entry into force of Law No. 308 on "Registration, Control and Certification of Seeds" in 1963 is one of the important steps taken on certified seeds. Since 2005, Certified Seed Use Support has been given to farmers by the Turkish government to encourage the use of certified seeds [5]. With the support given, the use of certified seeds has increased. Potato seed sector in Türkiye mostly works in the form of marketing the imported rootstock stage seed once in the country. In case of insufficient certified seed production, farmers use potato tubers as seeds, which they compulsorily separate from their own crops or obtain from others. The use of farm-saved seeds causes the spread of many disease factors, as well as low yield, and causes the sustainability of our potato production to become threatening. While the rate of certified seed usage is 95-100% in developed countries where potato farming is carried out, this rate is around 25-30% in Türkiye [24].

In order to increase certified potato seeds production and use in Türkiye, disease-free and high-yielding certified production of certified potato seeds and the use of certified potato seeds are supported by the government. With the potato seed policy implemented by the government, in order to ensure the development of the seed sector in accordance with international competition, in species where domestic seed production is insufficient, a support payment per kg is made to authorized seed organizations that produce/produce and certify certified seed domestically and sell them domestically. Certified seed usage support is paid to farmers who use domestically produced and certified seeds and who crop on lands registered in the Farmer Registration System in the relevant year. With an increase of 18 TRY in 2005 and 11.1 times in 2022, the amount of support has reached 200 TRY [2]. This study, it was aimed to examine the socio-economic determinants of the use of government-supported certified seeds in Ödemiş District of İzmir province. In order to achieve this goal, the socio-economic and technical characteristics of farmers using certified seeds and farm-saved seeds were compared. In addition, the problems faced by the farmers in the potato production process were determined.

MATERIALS AND METHODS

The study was carried out in the Ödemiş district of İzmir province, which has an important share in potato production in

Türkiye. The data of the study; ranks first in potato production in Ödemiş district of İzmir province with a share of 83.3%; The original quality data obtained by the survey method with potato farmers in Kazanlı, Karakova, Günlüce, Cumhuriyet, Tekke, Çaylı, Gereli, Kaymakçı, Birgi, Anafartalar, Atatürk, Balabanlı, Büyük Avulcuk, and Kurucuova neighbourhoods. As a result of the negotiations with the Ödemiş District Directorate of Agriculture and Forestry, it was determined that there were 1,700 potato farmers in the Ödemiş district of İzmir province in the production period of 2018.The formula "Simple Random Probability Sampling Based on Population Ratios: Finite Population" was used to determine the sample size [22]. As a result of the calculations, the sample size was found to be 80 (n=80.11) with a 9% part of the error in the 90% confidence interval. The surveyed farmers were determined randomly and 80 farmers were interviewed in the study area. In the selection of sample neighbourhoods, criteria that can represent the district in terms of socio-economic terms were taken into consideration.

$$n = \frac{Np\,(1-p)}{(N-1)\sigma^2 + p(1-p)} \quad \text{..................................(1)}$$

In the formula presented above:
n = Sample size
N = Population size (1,700)
p = Estimation rate (0.05 for sample size)
σ^2 = Population variance.
The data obtained from the farmers as a result of the survey were analyzed in the statistical program (SPSS Statistics) and the socio-demographic and technical characteristics of the farmers and farms were determined. In addition, related variables between farm-saved and certified seed selected among potato farmers were revealed by the chi-square test. Also, simple average, the absolute and relative distributions were calculated in the analysis of the data. The obtained findings were interpreted with tables.

RESULTS AND DISCUSSIONS

Farmers plant potato in January and February in Ödemiş district. The harvest date is between May and June. Potatoes are planted as a second or third crop in August and harvested in November-December. While the early potato production in the research area is made as table, the second or third product potato is produced as seed. In addition, some farmers sow forage crops within two-three months after the early potato harvest and turn them into silage. Then they crop the third crop, seed potatoes [14].
Information on the socio-demographic and technical characteristics of potato farmers and farms is given in Table 1. 25% of the surveyed farmers use certified seeds. The age range of farm owners using farm-saved seeds in potato production ranges from 29 to 70 years, with an average age of 51.4 years. The age range of farm owners using certified seeds varies between 28 and 77 years, with an average age of 55.1 years. It was concluded that farm owners using certified seeds are older than farm owners using farm-saved seeds. The average education level of farm owners using farm-saved seeds and certified seeds was determined as 5.9 years and 6.1 years, respectively. Türkiye's average education level in 2018 was 7.7 years, according to a United Nations Development Program report [29]. In this study, it was determined that the average education level of farm owners is below the average in Türkiye. In farms using farm-saved seeds, agricultural production experience was determined as 28.8 years and potato production experience as 22.0 years. In farms using certified seeds, the average experience of agricultural production is 30.6 years, and the average experience of potato production is 21.3 years. In another study, it was determined that potato farmers had an average of 23.3 years of agricultural production experience [4]. Daniel et al. [7] determined that the agricultural production experience of the farmers was 14 years. A study in Kenya found that potato farmers have an average of 14 years of experience in production [18]. The average land size was calculated as 4.3 hectares, the average potato land size was 2.0 hectares in the farms using

farm-saved seeds, the average land size was 7.8 hectares and the average potato land size was 4.9 hectares in the farms using certified seeds. It was determined that the farms using certified seeds were larger in terms of average land size and average potato land size (Table 1). In another study, the average land size was found to be 2.5 ha [7]. Tolno et al. [28] determined the size of the farm as 1.5 ha and the potato cultivation area as 0.9 ha. Potato yield; It was determined as 32,250 kg/ha on average in farms using farm-saved seeds, and 36,725 kg/ha on average in farms using certified seeds. Seed use per hectare was calculated as 3,333.3 kg in farms using farm-saved seeds, and as 3,622.5 kg in farms using certified seeds (Table 1). In a study, it was determined that the used of seeds and yield in potato production were 3,377.8 kg/ha and 36,580 kg/ha, respectively [17]. In another study, it was figured out that the farmers used 1,592.10 kg/ha of seeds and 10,730.5 kg/ha yield [7]. For farms using farm-saved seeds, the average fallow area was 0.03 hectares, the average irrigated land was 4.3 hectares, and the average dry land was 0.02 hectares. The average irrigated land area was calculated as 7.8 hectares in the farms using certified seeds, and it was revealed that there was no fallow land and dry land area in these farms. It was determined that the farmers did not have agricultural adviser in the farm using farm-saved seeds, and 10% of the farms using certified seeds had agricultural adviser. It was realized that 1.7% of the farms using farm-saved seeds while 5.0% of the farms using certified seeds had agricultural insurance. It was found out that 46.7% of the farms using farm-saved seeds had non-agricultural income, 66.7% benefited from agricultural supports, and 5% received training in potato farming. It was determined that 30.0% of the farms using certified seeds had non-agricultural income, 80.0% benefited from agricultural supports, and 15% received training in potato farming (Table 1). In another study, it was stated that less than 40% of potato farmers were aware of the existence of training and research institutes to improve their production activities [21].

Table 1. General characteristics of the farms and farmers

Characteristics	*Farm-saved seed* used farms *(N=60)* Min	*Farm-saved seed* used farms *(N=60)* Max	*Farm-saved seed* used farms *(N=60)* Mean	Std. Dev.	Certified seed used farms *(N=20)* Min	Certified seed used farms *(N=20)* Max	Certified seed used farms *(N=20)* Mean	Std. Dev.
Age (years)	29.0	70.0	51.4	10.7	28.0	77.0	55.1	11.9
Education level of farmers (years)	5.0	12.0	5.9	2.2	5.0	12.0	6.1	2.6
Population (person/family)	2.0	5.0	3.6	0.8	3.0	6.0	4.2	1.0
Experience in farming (years)	8.0	50.0	28.8	11.0	4.0	50.0	30.6	12.3
Experience in potato production (years)	8.0	35.0	22.0	7.1	4.0	35.0	21.3	7.6
Farm size area (hectare)	0.5	27.0	4.3	4.5	1.5	21.0	7.8	4.9
Potato area (hectare)	0.5	9.0	2.0	1.7	1.0	18.0	4.9	4.1
Other crops production area (hectare)	0.0	24.5	2.2	4.2	0.0	12.5	2.9	3.6
Potato yield (kg/ha)	25,000.0	36,000.0	32,250.0	2,919.1	30,000.0	40,000.0	36,725.0	2,844.5
The use of seed (kg/ha)	2,500.0	4,000.0	3,333.3	366.7	3,000.0	4,000.0	3,622.5	249.5
Number of parcels	1.0	16.0	4.7	3.8	1.0	24.0	5.9	6.4
Fallow land (hectare)	0.0	2.0	0.0	0.3	0.0	0.0	0.0	0.0
Irrigated land (hectare)	0.5	27.0	4.3	4.5	1.5	21.0	7.8	4.9
Dryland (hectare)	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.0
Own property land (hectare)	0.0	27.0	2.7	3.8	0.0	16.0	3.8	3.8
Rent land (hectare)	0.0	10.0	1.6	2.2	0.0	15.0	3.9	4.0
Agricultural consultancy of farmers (%)	-	-	0.0	-	-	-	10.0	-
Farmers taking out agricultural insurance (%)	-	-	1.7	-	-	-	5.0	-
Non-agricultural income (%)	-	-	46.7	-	-	-	30.0	-
Benefiting from agricultural support (%)	-	-	66.7	-	-	-	80.0	-
Training about potato farming (%)	-	-	5.0	-	-	-	15.0	-

Source: Authors' own calculations based on survey data.

It was determined that the average farm land size was between 1-2.5 hectares in 41.2% of the farms, between 2.6-5.0 hectares in 22.5%, and 5.1 hectares and above in 36.3%. In terms of farm land size, the difference between farms using farm-saved seeds and those using certified seeds was found to be statistically significant ($p<0.01$).It was determined that the average potato planted land size was between 1.0-2.0 hectares in 58.7% of the farms, between 2.1-4.0 hectares in 22.5%, and 4.1 hectares and above in 18.8%. The difference between the farms using farm-saved seeds and those using certified seeds in terms of potato planted land size was found to be statistically significant ($p<0.01$). In a study conducted in Kenya, it was found that farmers have an average of 1.7 hectares of farm size and potatoes production on an average of 1.3 hectares [18]. In addition, it was noticed that the size of the land did not have important as statistical on the use of certified seeds. In a study conducted in Türkiye's Afyonkarahisar province, it was determined that the average potato land size of the farms was 10.5 hectares [16].

It has been determined that 56.3% of the farmers do not have a membership in any agricultural cooperative. A statistically significant difference was found between the farms using farm-saved seeds and those using certified seeds in terms of agricultural cooperative membership ($p<0.05$). In another study, the rate of potato farmers being a member of any cooperative was stated as 25% [26]. Daniel et al. [7] stated in their studies that 42% of the farmers are members of any producer association, while Kadakoğlu [17] stated that 63.3% of the farmers are members of agricultural cooperatives. It was determined that 21.3% of the farms used agricultural credit. In terms of agricultural credit use, a statistically significant difference was found between farms using farm-saved seeds and enterprises using certified seeds($p<0.05$). In another study, it was stated that only 35% of farmers had access to agricultural credit [7]. Tolno et al. [28] determined the rate of farmers who have access to credit as 54% in their interviews with farmers. It was determined that 7.5% of the farms were engaged in contract farming. .The difference between farms using farm-saved seeds and farms using certified seeds was statistically significant ($p<0.01$).In another study, it is stated that only farmers who are financially stable and who can take the risk of loss make contract production, while farmers with less stability in terms of income stay away from contract production by making subsistence production [30]. It was determined that 70% of the farms benefited from the agricultural supports given by the Ministry of Agriculture and Forestry in Türkiye for potato production. Kadakoğlu [17] found that 67.1% of potato farmers benefited from agricultural supports. In addition, 38.0% of potato farmers benefiting from agricultural supports stated that they received certified potato seed use support. Bağcı and Yılmaz [3] also stated that support for the use of certified seeds increased the rate of use of these seeds. The percentage of farmers that state that it is important to be cheap when purchasing potato seeds is 85.0%. The percentage of farmers that state that it is important to be resistant to diseases is 43.8%. The rate of farmers that state that it is important to have high yield is 15%. The difference between the farms using farm-saved seeds and the farms using certified seeds was found to be statistically significant in terms of cheapness and high yield when purchasing seeds ($p<0.05$). In addition, the difference between farms using farm-saved seeds and farms using certified seeds was found to be statistically significant in terms of the resistance of potato seeds to diseases ($p<0.01$). In a study, it was determined that the production type, cooking method, resistance to diseases, and yield characteristics were effective in determining the seed selection preferences of the farmers [19]. In another study, the factors affecting the selection of seed potatoes by farmers are respectively; yield level, price, and ease of sale after production, germination power, resistance to diseases and pests, being an early variety, and physical characteristics of the seed [14]. It was determined that 50% of the farmers had irrigation problems in potato farming. The difference between the farms using farm-saved seeds and the farms using certified seeds was found to be statistically significant in terms of experiencing irrigation problems ($p<0.05$).

Table 2. Chi-square analysis results of the relationship between seed use type and selected socio-economic characteristics

Characteristics	Farm-saved seed used farms *(N=60)*		Certified seed used farms *(N=20)*		**Total** *(N=80)*	
	N	**%**	**N**	**%**	**N**	**%**
Size of farmland area (ha)						
1-2.5	31	51.7	2	10.0	33	41.3
2.6-5.0	13	21.7	5	25.0	18	22.5
5.1+	16	26.7	13	65.0	29	36.3
Total	60	100.0	20	100.0	80	100.0
χ^2=12.468, p=0.002***						
Size of potato production area (ha)						
1-2.0	42	70.0	5	25.0	47	58.8
2.1-4.0	12	20.0	6	30.0	18	22.5
4.1+	6	10.0	9	45.0	15	18.8
Total	60	100.0	20	100.0	80	100.0
χ^2=15.637, p=0.000***						
Education						
Primary and Middle school	54	90.0	17	85.0	71	88.8
High school or university	6	10.0	3	15.0	9	11.3
Total	60	100.0	20	100.0	80	100.0
χ^2=0.376, p= 0.540						
Farming experience (years)						
1-30	36	60.0	10	50.0	46	57.5
31+	24	40.0	10	50.0	34	42.5
Total	60	100.0	20	100.0	80	100.0
χ^2= 0.614, p=0.433						
Potato production experience (years)						
1-25	40	66.7	14	70.0	54	67.5
26+	20	33.3	6	30.0	26	32.5
Total	60	100.0	20	100.0	80	100.0
χ^2= 0.076, p=0.783						
Cooperative membership of farmers						
Yes	22	36.7	13	65.0	35	43.8
No	38	63.3	7	35.0	45	56.3
Total	60	100.0	20	100.0	80	100.0
χ^2= 4.893, p = 0.026**						
Use of agricultural credit						
Yes	9	15.0	8	40.0	17	21.3
No	51	85.0	12	60.0	63	78.8
Total	60	100.0	20	100.0	80	100.0
χ^2= 5.602, p= 0.018**						
Contract farming						
Yes	1	1.7	5	25.0	6	7.5
No	59	98.3	15	75.0	74	92.5
Total	60	100.0	20	100.0	80	100.0
χ^2= 11.772, p= 0.003**						
Number of irrigations						
1-7	37	61.7	12	60.0	49	61.3
8+	23	38.3	8	40.0	31	38.8
Total	60	100.0	20	100.0	80	100.0
χ^2= 1.113, p= 0.573						
Benefiting from agricultural supports						
Yes	40	66.7	16	80.0	56	70.0
No	20	33.3	4	20.0	24	30.0
Total	60	100.0	20	100.0	80	100.0
χ^2= 1.270, p= 0.260						
Using the same seed every year						
Yes	36	60.0	7	35.0	43	53.8
No	24	40.0	13	65.0	37	46.3
Total	60	100.0	20	100.0	80	100.0
χ^2= 3.771, p= 0.046**						
I buy cheap seeds						
Yes	48	80.0	20	100.0	68	85.0
No	12	20.0	0	0.0	12	15.0
Total	60	100.0	20	100.0	80	100.0
χ^2= 4.706, p= 0.030**						
I buy disease-resistant seeds						
Yes	34	56.7	1	5.0	35	43.8
No	26	43.3	19	95.0	45	56.3
Total	60	100.0	20	100.0	80	100.0
χ^2= 16.271, p= 0.000***						
I buy high-yielding seeds						
Yes	12	20.0	0	0.0	12	15.0
No	48	80.0	20	100.0	68	85.0
Total	60	100.0	20	100.0	80	100.0
χ^2= 4.706, p= 0.030**						
I'm having a problem irrigation						
Yes	26	43.3	14	70.0	40	50.0
No	34	56.7	6	30.0	40	50.0
Total	60	100.0	20	100.0	80	100.0
χ^2= 4.267, p= 0.035**						

**$p \leq 0.05$, *** $p \leq 0.01$

Source: Authors' own calculations based on survey data.

The problems faced by the farmers in potato production at the examined farms are given in Table 3. The biggest problem experienced by farmers using certified seeds was; while the seed was expensive (70%), the farmers using farm-saved seeds stated that they had problems with disease (60%) and low yield (36.7%) (Table 3). Wasilewska-Nascimento et al. [31] determined the most important problems faced by potato farmers in tropical and subtropical regions; they stated that the farm-saved seed potatoes are of insufficient quality, the availability of certified seed is insufficient, and the cost is high. It has been determined that the rate of encountering diseases and pests is quite high for farmers using both certified and farm-saved potato seeds in the research region. The most common disease is *Phytophthora infestans*; the most common pests are *Macrosiphum euphorbiae* and *Agrotis spp.* (Table 3). In a study conducted in Vietnam, the reason for the large yield losses in potatoes is *Phytophthora infestans, Liriomyza spp.*,and *Ralstonia solanacearum* [21]. Erdevil and Erkılıç [9] stated that the use of certified seeds and soil drainage should be given importance in order to reduce the incidence of *Rhizoctonia solani* disease, which is common in potatoes. It has been revealed that farmers using certified seeds have more irrigation problems (70%), These problems include insufficient irrigation water (40%) and high energy prices used in irrigation (40%). It was noticed that farmers using farm-saved seeds (73.3%) experienced more marketing problems than farmers using certified seeds (50%). Input costs were found to be high for farmers using both certified (70%) and farm-saved seeds (61.7%) (Table 3). Other studies [16, 34] found that seed costs were the most expensive factor in potato production.

Table 3. Problems in potato production

	Farm-saved seed used farms *(N=60)*		**Certified seed used farms *(N=20)***	
	N	**%**	**N**	**%**
Seed*				
To be expensive	3	5	14	70.0
Disease	36	60	1	5.0
Low yield	22	36.7	0	0
Seed supply	2	3.3	1	5.0
Disease*				
Phytophthora infestans	59	98.3	19	95.0
Ralstonia solanacearum	17	28.3	2	10.0
Erwinia carotovora	8	13.3	4	20.0
Streptomyces scabies	21	35.0	4	20.0
Synchytrium endobioticum	8	13.33	3	15.0
Pests*				
Phthorimaea operculella	21	35.0	10	50.0
Macrosiphum euphorbiae	48	80.0	14	70.0
Leptinotarsa decemlineata Say	20	33.3	3	15.0
Agrotis spp.	47	78.3	14	70.0
Gryllotalpa gryllotalpa	11	18.3	2	10.0
Irrigation*	26	43.3	14	70.0
Insufficient irrigation water	10	16.7	8	40.0
High irrigation fee (High energy prices used in irrigation)	16	26.7	8	40.0
Infrastructure	7	11.7	3	15.0
Marketing	44	73.3	10	50.0
Input Costs	37	61.7	14	70.0
Harvest (Lack of labor)	17	28.3	7	35.0
Storage (Loss of crop)	3	5.0	1	5.0

*More than one option marked.
Source: Authors' own calculations based on survey data.

CONCLUSIONS

Potato is an important food product in human nutrition. In addition to supplying raw materials to countries, it provides foreign exchange earnings, a contribution to employment, and a competitive advantage in the fight against poverty. This study was conducted with 80 potato farmers in the Ödemiş district of İzmir province, which is an important production region for potato production. In this study, it was aimed to examine the socio-economic determinants of the use of seeds certified by the Turkish government. To achieve this goal, the socio-economic and technical characteristics of farmers using certified and farm-saved potato seeds were compared.

According to the results of the research, it was determined that both the land size and the potato production area of the farms using certified seeds with government support were higher than those of the farmers using farm-saved seeds. At the same time, it was revealed that the farmers using state-supported certified seeds had higher potato yields than the farmers using farm-saved seeds. It has been determined that farmers using state-supported certified seeds participate in agricultural extension activities related to potato production more than those using farm-saved seeds.

The factors that farmers pay attention to when buying seed potatoes are, respectively; that they are cheap, resistant to diseases, and provide a high yield.

The most common problems faced by farmers in potato production are; it was ascertained that the seeds were expensive for farmers using certified seeds, and diseases and pests were found in those using farm-saved seeds. In addition, it was determined that the input costs were high for farmers using both certified and farm-saved seeds.

One of the most important factors increasing the yield in potato production is the use of certified seeds. Increasing the use and support of certified seed production is important for the sustainability of potato production. In addition, agricultural extension activities should be carried out on the benefits and importance of using certified seeds. In addition, bureaucratic and technical barriers should be reduced so that farmers can benefit more from certified seed use support.

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