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CONTENT

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THE ACCUMULATION OF GLUTEN PROTEINS IN WINTER WHEAT UNDER THE INFLUENCE OF THE USED TECHNOLOGY

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Abstract

The bread quality of wheat is one of the most important aspects targeted by crop technologies, given the great diversity of foods obtained from this crop and given the fact that bread is one of the main foods in the daily diet of many people. This paper highlights the role of mineral fertilization with nitrogen on the accumulation of gluten proteins. The study was conducted at SCDA Lovrin, in a long-term experiment with fertilizers. The Lab-on-a-Chip (LoaC) technique was used to extract gliadin and glutenin, followed by polyacrylamide gel electrophoresis. Ammonium nitrate was used for fertilization, with the following graduation: N0, N30, N60, N90 and N120. Nitrogen fertilizers significantly influence the quality of wheat crop. Thus, the percentage of protein and wet gluten increase by up to 47% and 70%, respectively. The accumulation of glutenins and glutenins at the level of molecular weight, increases exponentially with the dose of fertilizer administered to the crop, the highest values being registered at doses N90 kg / ha and N120 kg / ha, values statistically assured very significant for the probability of transgression of 0.1%. Also, the gliadin / glutenin ratio, whose value is an indicator for the bread quality of the grains, records the best value (as close as possible to 1) in the variant fertilized with the maximum dose of nitrogen.

Key words: *gliadin, glutenin, gluten, protein, nitrogen, wheat quality*

INTRODUCTION

Given the multitude of products obtained from wheat flour, wheat is arguably one of the most important crops in the world, sown on significant areas. One of the main objectives of wheat breeding programs is to improve quality [4], [16]. Therefore, the creation of ecobiotypes with high protein content is considered.
The quality of the products that reach the consumer's table is given by the quality of the gluten from the wheat flour, that vascoelastic network obtained after mixing the flour with water. The vascoelastic properties of the dough obtained are decisive for the bread quality of the wheat [2], [18].
Wheat proteins can be classified as follows: structural proteins (non-gluten) and storage proteins (gluten).
Gluten proteins are represented by prolamine, so named because of its high content of amino acids, proline and glutamine [13]. In turn, prolamins include: sulfur-rich prolamins, sulfur-poor prolamins and high molecular weight gluten (HMW) subunits. Sulfur-rich prolamins are β- and γ-gliadins, B- and C-LMW glutenins. Sulfur-poor prolamins include ω-gliadin and D-LMW-glutenins [18], [14], [15]. In general, wheat flour proteins include 45% gliadin, 45% gliadin and 10% soluble proteins.
The bread-making properties of wheat are given by storage proteins, as follows: density and extensibility are given by the gliadin monomer, and hardness and flexibility by the

glutenin polymer [6], [7], [8], [21], [22].

In addition to genetics, the technological factor, especially crop fertilization, plays an important role in achieving quality production. The quality of the dough and the bread-making properties of the wheat are strongly influenced by the mentioned factors.

Nitrogen fertilizers greatly influence both crop productivity and quality.

To identify and characterize the main components involved in determining the baking qualities of wheat and flour, an impressive number of techniques have been used over time, using the most diverse principles [1], [9], [3].

The first techniques tried to separate the protein fractions from wheat and flour, based on their differences in solubility in a number of solvents. Subsequently, a functional analysis (solubility, foaming capacity and emulsification) of some glutenin fractions, obtained after its hydrolysis with fungal proteases [17], was successful.

Another group of techniques used in the study of these components were chromatographic (adsorption, distribution chromatography, ion exchange chromatography, exclusion chromatography), electrophoretic (starch gel electrophoresis, polyacrylamide, isoelectric focusing, isotachophoresis) and spectroecopic (based on IR and Electron Spin Resonance) [11], [5], [12].

In the present study we evaluated the influence of chemical nitrogen fertilizers on the accumulation of gliadin and glutenin, the distribution of protein subunits in molecular weight, the technique used being Lab on a Chip, followed by polyacrylamide gel electrophoresis.

MATERIALS AND METHODS

The study was conducted at ARDS Lovrin, in a long-term experiment with fertilizers.

The soil on which the experimental device was placed is a typical chernozem, weakly glazed and weakly alkalized.

The annual average rainfall in the area is 520 mm. The average annual temperature is 10.8°C.

The variety that was used in this experiment is the Ciprian variety, created and approved by ARDS Lovrin.

Ammonium nitrate was used for nitrogen fertilization of the crop, with the following graduation: N0 (V_1), N30 (V_2), N60 (V_3), N90 (V_4) and N120 (V_5).

The Lab-on-a-Chip (LoaC) technique was used to extract gliadins and glutenins, a rapid technique frequently used to separate and quantify proteins. Wheat grains, obtained after harvesting the crop, were ground to obtain flour. For extraction, 30 g of flour treated with 300 μL 70% ethanol were used. 200 μL solution was used for gliadin extraction and 100 μL for glutenin extraction. Extraction of gluten-free spores took place after removal of globulins and albumin and were used.

After evaporation of the ethanol, 350 μL 2% SDS solution containing 5% β-mercaptoethanol were used for the extraction of gliadins, maintained for 5 min at 100^0C.For the extraction of glutenins, the same volume of solution was used to which 0.0625 M tris base and the same temperature conditions were added. The final solution for the extraction of gluten proteins contains 4 μL sample to which was added 2 μL Agilent sample buffer and 84 μL deionized water [10], [20], [19], [23].

The molecular weights of the proteins were determined in the range 12.5 - 230 kDa, using chip electrophoresis techniqueon Agilent 2100 Bioanalyzer with Protein 230 Plus Lab-on-a-Chip kit. After analysis, each subunit was manually integrated and their percentage was calculated from the time-corrected area. The results were statistically analyzed using analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

After harvesting the culture, a conclusive sample was taken from each experimental variant which was analyzed from a qualitative point of view. The following were determined: protein, wet gluten, starch, glassiness.

Then the quality of protein and gluten was evaluated. The aim was to accumulate gliadins, accumulate glutenins and distribute them by molecular weight.

The percentage of protein and gluten,

respectively, increase significantly under the influence of the doses of fertilizers administered to the crop, in proportion to the increase of the dose (Table 1).

Table 1. Variation of protein and wet gluten content under the action of mineral nitrogen fertilization

Experimental variant	Protein (%)	Difference and significance	Wet gluten (%)	Difference and significance
V_1	10.7	Mt	21.2	Mt
V_2	11.0	0.3	24.2	3.0
V_3	12.8	2.1*	26.2	5.0*
V_4	15.2	4.5***	34.0	12.8***
V_5	15.7	5.0***	36.1	14.9***

Protein: DL 5% - 1.66; DL 1% - 2.75; DL 0.1% - 3.16.
Wet gluten: DL 5% - 4.9; DL 1% - 6.2; DL 0.1% - 12.1.
Source: Original data.

Very significant increases in the percentage of protein are registered at the application of doses of 90 kg/ha, respectively 120 kg/ha. Wet gluten varies in the range of 21.2% - 36.1%, with the best results obtained in the variants fertilized with high doses of nitrogen - 34%, respectively 36.1%, with up to 14.9% more than in the control variant, non-fertilized. Regarding the accumulation of gluten proteins (gliadin and glutenin) and this registers important changes under the influence of the dose used.

The accumulation of gliadin, presented in Table 2 and the distribution of gliadin subunits at the level of molecular weight, changes significantly when applying chemical fertilizers with nitrogen.

Table 2. Distribution of gliadins at the molecular weight

Molecular weight (kDa)	V_1- unfertilized	V_2 – fertilized with N_{30}	V_3 – fertilized with N_{60}	V_4 – fertilized with N_{90}	V_5 – fertilized with N_{120}
	The total concentration of gliadin extracted (ng/ μl)				
	3,355.2 ng/ μl	3,772.4 ng/ μl	3,850.7 ng/ μl	3,937.1 ng/ μl	4,522.1 ng/ μl
	Molecular weight distribution (ng/ μl)				
4.5	0.0	0.0	0.0	0.0	0.0
6.1 – 13.9	34.0	83.6	79.5	78.1	77.5
14.0 -16.2	67.7	74.5	76.6	78.1	87.8
16.3 – 37.8	85.7	95.6	86.2	76.1	136.7
37.9 – 46.9	2,534.8	2,858.0	2,496.5	2,964.0	3,384.7
47.0 – 57.6	434.5	494.2	632.1	569.4	636.8
57.7 – 90.5	90.5	81.7	55.6	81.6	74.9
ω-gliadin	96.1	121.6	293.1	149.3	124.7

Source: original data.

The total concentration of extracted gliadin, expressed in ng/μl, varies between 3,355.2 ng/μl - 4,522.1 ng/μl, the increasing trend being proportional to the dose of ammonium nitrate administered, a situation reported by other specialized studies (Table 3).

Analyzing the comparison in Table 3, we can say that the accumulation of gliadin under the influence of administered nitrogen doses indicates significant increases, statistically assured, in variants 3 and 4, and in the variant fertilized with maximum dose of nitrogen the increase of gliadin compared to non-fertilized variant is statistically assured very significant for the probability of transgression of 0.1%.

Table 3. Comparison table

Variant	Gliadin (ng/ μl)	%	Difference and significance
V_1	3,355.2	100	0.00
V_2	3,772.4	112.1	407.2
V_3	3,850.7	114.8	495.5*
V_4	3,937.1	117.3	581.9*
V_5	4,522.1	134.8	1,166.9***

DL 5% - 414.99; DL 1% - 603.62; DL 0.1% - 906.43
Source: Original data.

From the point of view of the molecular weight distribution, there is an increase of the values recorded in each of the analyzed ranges, an increase due to the increase of the amount of nitrogen administered to the culture.

The electrophoregrams obtained from gliadin extraction are presented in Figure 1.

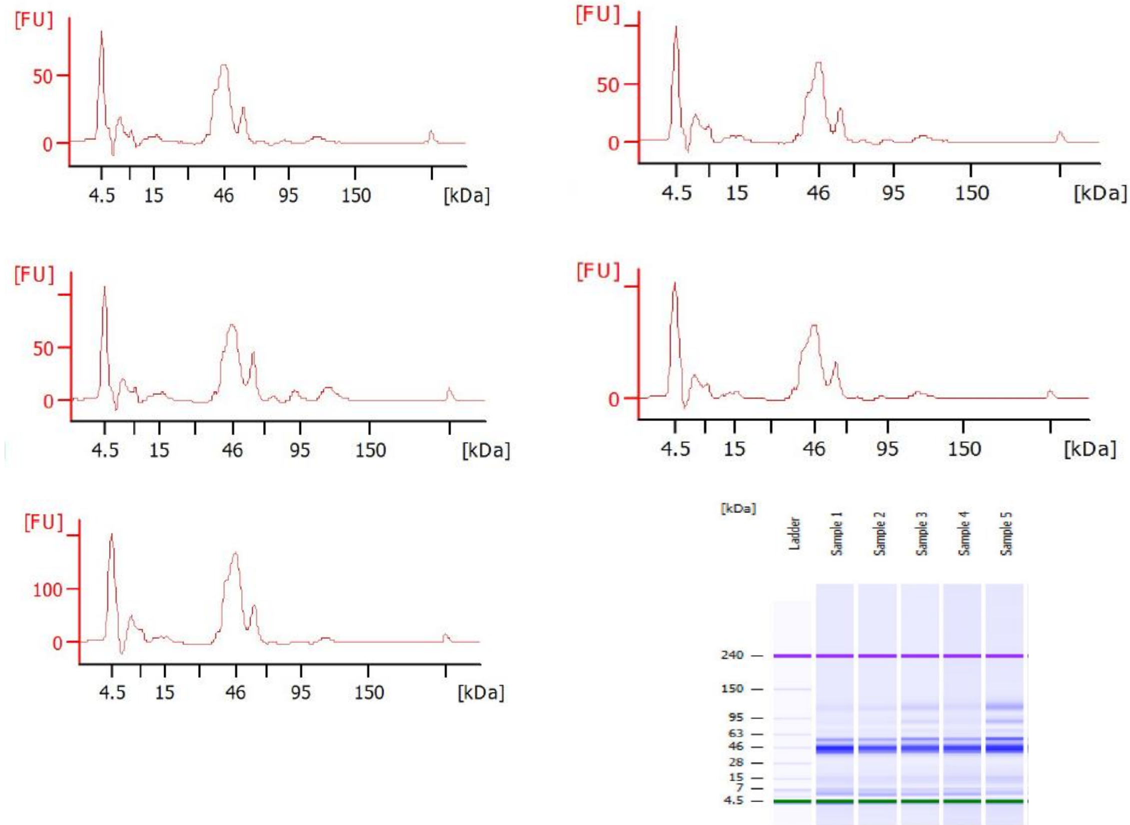


Fig. 1. The electrophoregrams of gliadin accumulation under the influence of the agrofund used
Source: Original figure.

Omega - gliadins, which are high molecular weight gliadin subunits, it accumulates in the range of 90-120 kDa. As the dose of fertilizer applied increases, the amount of omega gliadin also increases. In proportion to this the highest value accumulates when applying the nitrogen dose of 60 kg/ha - 293.1 ng/µl. Then there is a decrease of high values of fertilizer administered, up to 124.7 ng/µl, at the maximum dose of nitrogen administered.

Regarding the weight of ω - gliadin in the analyzed samples, it varies from 3.7% to 2.4%, with the highest value in the control variant, unfertilized. As the dose of nitrogen increases, so does the amount of ω - gliadin in the flour, but percentage, in the total amount determined, its share decreases by up to 1.3% (Figure 2, Figure 3).

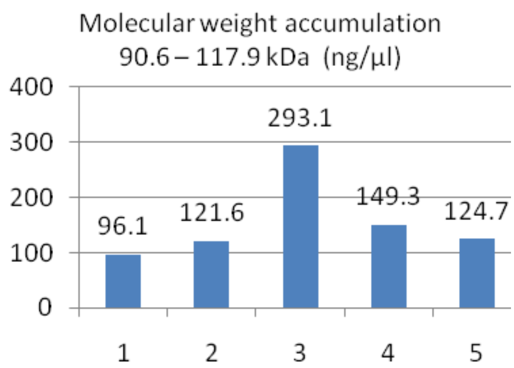


Fig. 2. Accumulation of ω - gliadin depending on the dose of nitrogen administered
Source: Original figure.

In order to highlight the correlation that is established between the amount of gliadin that accumulates in the control variant and in the variants fertilized with the four nitrogen graduations, a linear regression was used, presented in Figure 4.

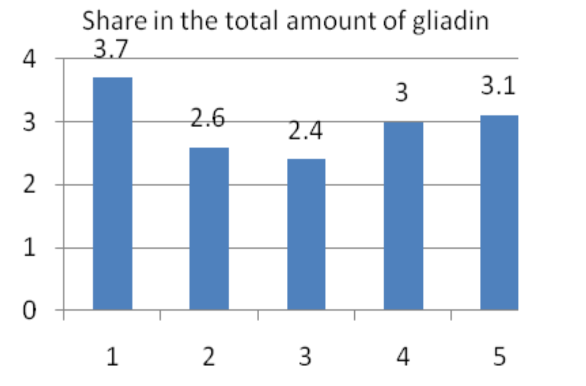


Fig. 3. The share of ω - gliadin in the total amount of protein
Source: Original figure.

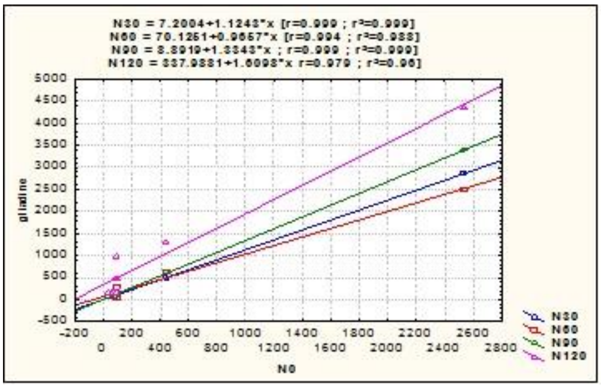


Fig. 4. The correlation between gliadin and nitrogen doses administered to the culture
Source: Original figure.

A very significant correlation is observed between the amount of gliadin belonging to the unfertilized control and the amount of gliadin accumulated at the N30, N60, N90 graduations.

The value of the correlation coefficients r = 0.999 (N30), r = 0.994 (N60), r = 0.999 (N90) indicates a very significant correlation between the amount of gliadin accumulated on the indicated agrofunds. At the maximum applied nitrogen dose - N120 kg/ha active substance, the correlation coefficient r = 0.979, indicates a distinctly significant linear correlation.

Of the two gluten proteins, gluten is the one that is associated with the bread quality of the dough, being responsible for their elasticity and viscosity.

Under the action of the agrofund administered to the crop, glutenin registers a slight decrease to low nitrogen values, followed by a significant increase when applying the doses of 90 kg/ha and 120 kg/ha, respectively.

Table 4 shows the distribution of glutenins in terms of molecular weight, under the influence of the five levels of fertilization used.

Table 4. Distribution of glutenins at the molecular weight

Molecular weight (kDa)	V_1- unfertilized	V_2 – fertilized with N_{30}	V_3 – fertilized with N_{60}	V_4 – fertilized with N_{90}	V_5 – fertilized with N_{120}
	The total concentration of glutenins extracted (ng/ μl)				
	1,396.1 ng/ μl	1,209.5 ng/ μl	1,136.6 ng/ μl	1,846.3 ng/ μl	2,348.9 ng/ μl
	Molecular weight distribution (ng/ μl)				
4.5	0.0	0.0	0.0	0.0	0.0
6.1 – 13.7	0.0	0.0	0.0	0.0	0.0
13.8 -44.2	1,051.4	1,092.3	788.1	893.1	911.5
44.3 – 57.6	273.4	117.1	265.7	417.5	506.6
57.8 – 112.7	14.5	0.0	34.1	174.1	389.6
112.8 – 173.3	41.8	0.0	25.2	176.9	355.4
173.4 – 222.7	18.0	0.0	23.5	113.1	185.9

Source: Original data.

Analyzing Table 5, which represents the table of comparisons between the five agrofunds studied, shows the influence of fertilization on glutenin accumulation. Thus, large amounts of nitrogen bring distinctly significant (N90) and very significant (N120) increases, by 32% and 68% respectively more than the control, unfertilized variant.

Table 5. The comparison table

Varianta	Glutenin (ng/ μl)	%	Difference and significance
V_1	1,396.1	100	0.00
V_2	1,209.5	86.6	-186.73
V_3	1,136.6	81.4	-259.60°
V_4	1,846.3	132.2	450.20**
V_5	2,348.9	168.2	952.80***

DL 5% - 215.00; DL 1% - 312.73; DL 0.1% - 469.09
Source: Original data.

Regarding the bread quality of the flour, the studies indicate a superior quality to the increased accumulation of high molecular weight (HMW) subunits of glutenin. HMW subunits of glutenin accumulate starting at 112.8 kDa. There is a progressive accumulation, with the highest values - 290 ng/μl and 541.3 ng/μl at the highest doses of nitrogen, very significant differences from the control variant, Figure 5.

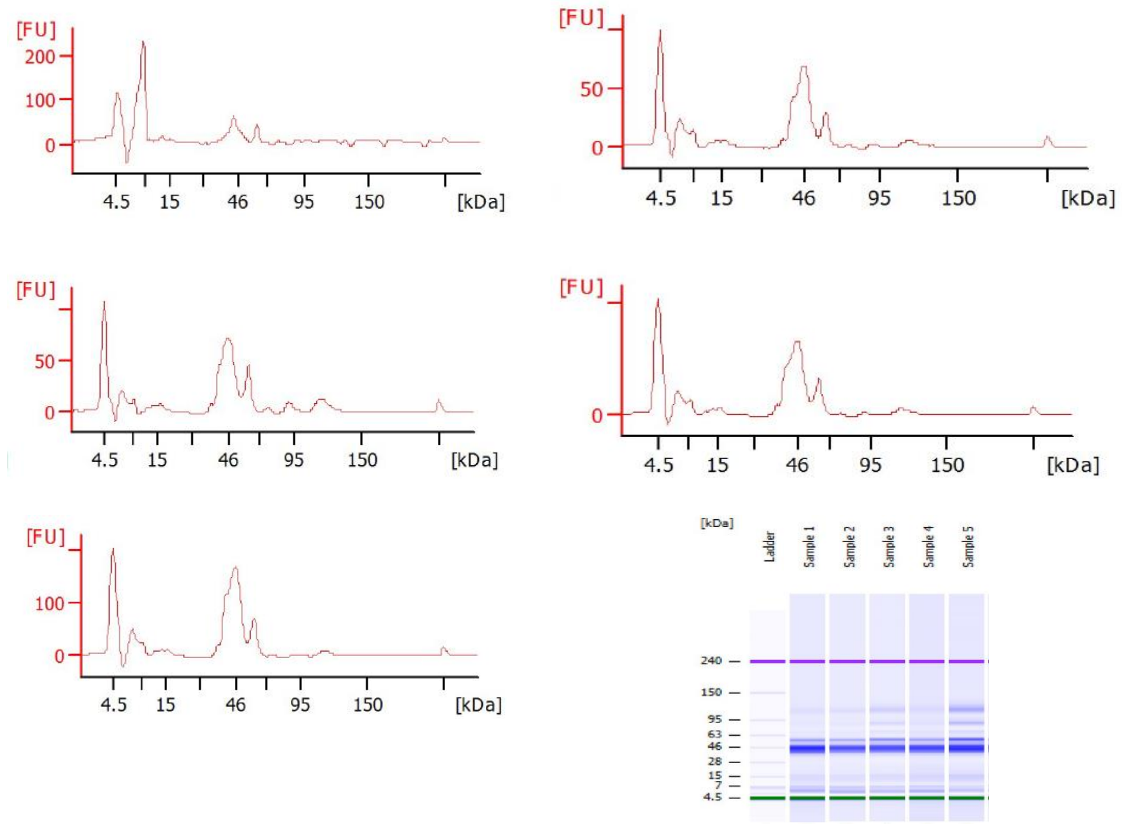
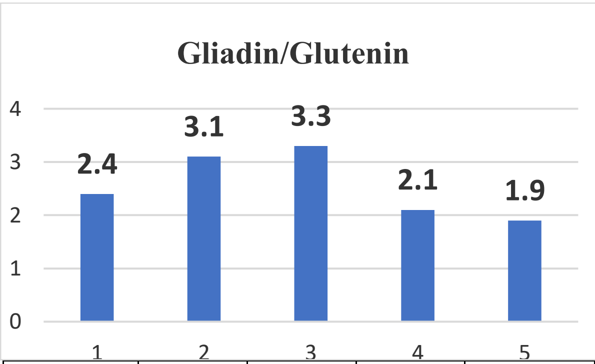


Fig. 5. The electrophoregrams of glutenin accumulation under the influence of the agrofund used
Source: original figures.



1,396.1	1,209.5	1,136.3	1,846.3	2,348.9
3,355.2	3,772.4	3,937.1	3,937.1	4,522.1

Fig. 6. The gliadin/glutenin ratio
Source: Original graph.

The gliadin/glutenin ratio is considered an indicator of grain quality.
The closer its value is to 1, the better the bread value of the flour. Under the influence of the fertilizer doses administered to the crop, this ratio has an interesting evolution, which emerges from Figure 6.
The closest value of 1 is registered in the variant fertilized with 120 kg/ha nitrogen 1.9, followed by the variant fertilized with 90 kg/ha nitrogen - 2.1. Compared to the unfertilized control, there are decreases of this quality indicator by up to 20%.

CONCLUSIONS

Nitrogen fertilizers significantly influence the quality of wheat crop. Thus, the percentage of protein and wet gluten increase by up to 47% and 70%, respectively.
At the same time, the quality of gluten, given the participation rate of gluten proteins is considerably influenced. The proportion of

gliadin in the flour increases in proportion to the dose of nitrogen applied to the wheat crop. ω-gliadin, also called anti-bread quality protein, accumulates in an amount that increases to the level of the N60 agrofund, after which there is a decrease in high values of the amount of nitrogen administered. The lowest value is recorded in the control version, unfertilized. However, the share of the total amount of protein decreases with increasing nitrogen dose, from 3.7% - value belonging to the unfertilized control to 2.4%, a value found in the version fertilized with 60 kg/ha nitrogen.

The accumulation of glutenins at the level of molecular weight, increases exponentially with the dose of fertilizer administered to the crop, the highest values being registered at the doses N90 kg/ha and N120 kg/ha.

Also, the gliadin/glutenin ratio, whose value is an indicator for the bread quality of the grains, registers the best value (as close as possible to 1) in the version fertilized with the maximum dose of nitrogen.

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THE ANALYSIS OF THE CONVERGENCE OF HORTICULTURAL SECTOR IN ROMANIA AND COMPARISONS WITH OTHER EU COUNTRIES

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Abstract

The paper aims to analyze the degree of convergence of the horticultural sector in Romania with other EU member states taking into consideration the competitiveness indicators. In order to be able to establish a causal link between the factors of competitiveness in determining the degree of convergence of the horticultural sector, certain indicators of competitiveness were considered such as the family income of the holding per annul work unit (AWU) and the net added value per unit of annual work. In addition, other indicators were calculated, such as gross value added/AWU and the total value of production. These indicators were calculated based on FADN data, covering the period 2013-2018 including for several other member states of the European Union in order to make comparisons with Romania. The results show a low level of competitiveness compared to all countries analyzed, which indicates that the horticultural sector in Romania is not yet close to achieving the economic convergence with the main EU horticultural sectors of some countries which represent Romania's competitors in the field.

Key words*: *Romanian horticultural sector, convergence, competitiveness

INTRODUCTION

The paper aims to analyze the degree of convergence of the Romanian horticultural sector by looking at several indicators of profitability and viability (family income of the holding per unit of work and the net added value per unit of annual work). In addition, other indicators were calculated, such as gross value added/AWU and the evolution of the production value. At the same time some comparisons were made with several EU countries. There are currently many concerns about assessing the competitiveness of the horticultural sector due primarily to the measures and instruments provided by the Common Agricultural Policy as it is desired to observe their impact on total production, yields and incomes of farmers and the degree of convergence. The study is also important in order to improve the domestic supply and meet consumer requirements. The instability of the vegetable market, the high volatility of prices and the weak capacity to provide the raw material needed for processing plants further accentuate the need to ensure the stability of the vegetable supply, and especially to find solutions to improve the use of factors that contribute to increasing competitiveness such as supply chain, consumption of inputs, technical progress, given the existence of a rather low level of capitalization of the sector and a domestic production that is still far from ensuring the consumer demand of the population and possibly the creation of a competitive producer status within Europe. At the same time, the poor organization of the supply chain, the small number of producer groups and organizations in the sector contribute to maintaining a low level of competitiveness of the sector. A similar analysis was undertaken for the German horticultural sector, by making a comparison of the German business environment with some other eight European countries using a scoring-model [7] and in Republic of Moldova [5].

MATERIALS AND METHODS

In this study, the convergence is analyzed by taking into consideration some competitiveness indicators [2]. Competitiveness can be studied in a national or international context through sector analyzes. The competitiveness of a sector is reflected in its profitability and ability to maintain in the domestic market and / or export markets Some authors [12] defines competitiveness using several categories of factors: 1) actual production and trade characteristics (competitiveness can be evaluated by production evolution, export and import index, the position regarding the comparative advantage, etc.) and 2) the strategic management of the firm referring to the business structure and its strategy. Also, competitiveness can be calculated by using several indicators related to profitability/viability, productivity, efficiency and costs). To date, there is no generally accepted definition of competitiveness measurement so comparative analyzes and case studies can complement a competitiveness analysis [9].

On the other hand, some scholars [6] consider that a large impact on the competitiveness of companies includes the level and intensity of education, natural resources (including the neo-factors) and environmental/business policy. In is well known that on agriculture, the factors which influence competitiveness are mainly related to the agricultural input prices and subsidies [8]. To date, there is no full agreement on the assessment of competitiveness, some researchers stressing that there is no perfect way to measure competitiveness, [10] and [11]. However, most theories point to technology and productivity as factors that influence long-term competitiveness which could contribute to increased real convergence. The convergence analysis using competitiveness indicators of the horticultural sector is performed at the European Union level for the years 2013-2018 taking into consideration 9 countries, including Romania. The analysis is based on FADN data (Farm Accountancy Data Network), EUROSTAT data (Economic Accounts of Agriculture), Tempo-online.The indicators used to assess the competitiveness of the Romanian horticultural sector in order to determine the degree of convergence with the EU can be grouped as follows:

1. Viability/profitability indicators

1.1. Farm net value added
1.2. Agricultural family income
1.3.Net value added/annual work unit (AWU) in the horticultural sector
1.4. The production values

For evaluation the competitiveness of horticultural products some authors used a score assessment (methodology presented in the annual Global Competitiveness Report) [1].

RESULTS AND DISCUSSIONS

Farm net value added

In this study it was analyzed the financial viability of the Romanian horticultural production by observing the capacity of a horticultural farm to create increased revenues and achieve superior profit margins. Accordingly, it was calculated the indicator referring to the real income of the agricultural factors per annual work unit, which is known also as the Farm Net Value Added (FNVA) reported at the cost of the agricultural factors per total annual work unit.

The indicator reveals the level of compensation of fixed production factors per labor resource used in horticultural activities and can be calculated by subtracting the operating costs from total production. The value of intermediate consumption and consumption per unit of fixed capital shall be calculated by subtracting the value of agricultural production from basic prices and adding the value of subsidies less taxed on production. The percentage change in the real income of the holding per unit of annual work is known as the agricultural income indicator, and is calculated for the period 2013-2018.

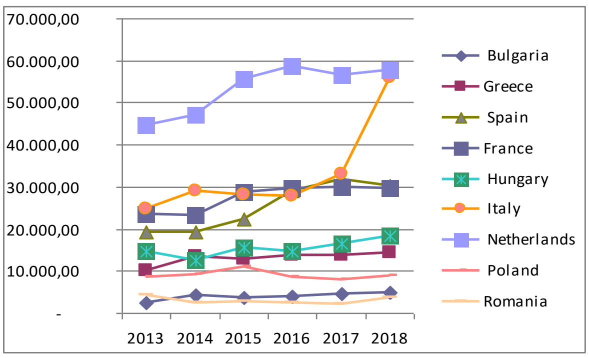

Fig. 1. Agricultural net value added per unit of annual work in the horticultural sector (euros/ha)
Source: calculations based on FADN, 2021.

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As it can be seen from Figure 1, according to the results, until 2018, the increase in agricultural income in the horticultural sector in Romania was on average lower compared to all other countries included in the analysis. There is a very high volatility of this indicator, partly due to the high volatility of yields and prices for primary horticultural products, this indicator being much lower even when compared to Bulgaria about 1.6 times in 2018. Compared to countries such as the Netherlands, France and Spain, it is extremely low, 25 times lower, and 5-6 times lower than countries such as Poland and Hungary. Over the whole period analyzed, the value of income, and therefore the value of the FNVA index, increased for all former EU member states included in the analysis, the Netherlands, France and Spain except Greece.

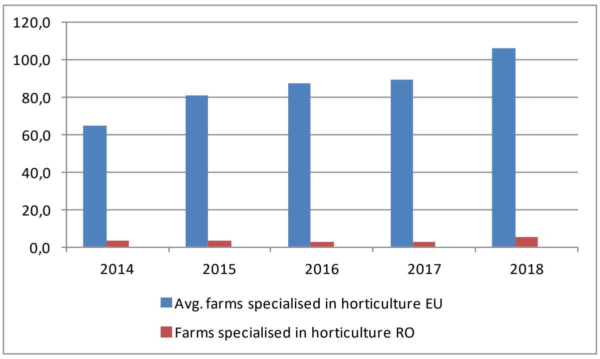

Fig. 2. Net added value of the farm (thousand euros), at the level of the EU and Romania average
Source: calculations based on FADN, 2021.

In Figure 2 one can notice the huge difference between the Romanian average horticultural net added value and the average net added value at the EU level, showing extremely poor competitiveness of the Romanian horticultural farms compared with the EU average.

Net added value per annual unit of work

The FNVA per AWU of farms specialising in horticulture is among the highest compared to other sectors.

Figure 3 shows that comparing the average net added value per annual unit of work calculated for Romania to the EU average, the labour productivity of the Romanian horticultural sector is very low. Small labour productivity reflects once more the low level of technology used on the Romanian horticultural farms.

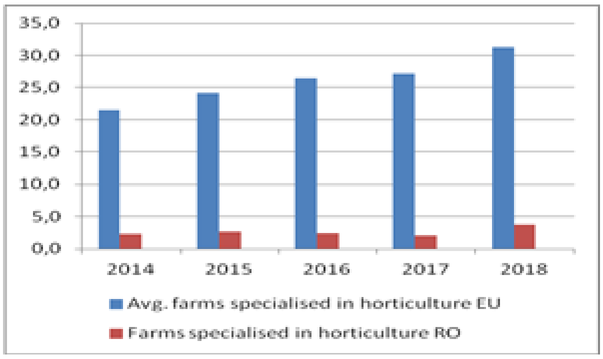

Fig. 3. Net added value per annual unit of work (thousand euros), comparison Romania - EU average
Source: calculations based on FADN, 2021.

The processing and preservation of vegetables and fruits represents a small percentage of the value added of the food sector, about 3%, below sectors such as meat and the meat processing, flour and dairy products. At the level of agriculture, the share is also relatively low, below 3%, and the FNVA/AWU of the horticultural sector is extremely low compared to EU countries (both old and new, Figure 1). The distribution of value added by supply chain is unbalanced mainly due to the lack of price transparency in the market and a low level of contracting.

Although the supply of vegetables is quite diverse, it has a rather low added value, mainly due to the poor organization of producers (about 1% degree of organization compared to 45% of the EU average). The consequence of this situation leads to insufficient marketing activities including poor collection of produce. This jeopardizes the attractiveness of local horticultural products and consumer's food safety, reflecting an underdeveloped logistics and storage system.

Agricultural family income in Romanian horticultural sector

This indicator reveals the level of family agricultural income per unit of work. This indicator takes into account differences in the remuneration of family work. Increasing the farm income is a central objective in the Common Agricultural Policy (CAP). Farm family income has been an important indicator in the CAP and this why is recorded in FADN monitoring system.

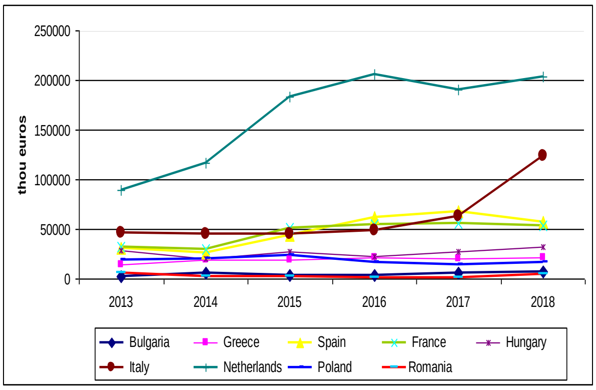

Fig. 4. Agricultural family income, thousand euros
Source: calculations based on FADN, 2020.

In this study it is used to check the degree of convergence of the Romanian horticultural farms with some other horticultural sectors from the EU. The farm income aggregates do not represent the disposable income of farm households, because the latter, in addition to their purely agricultural incomes, may also have income from other sources (non agricultural activities, salary, social remuneration, income from different assets ownership)

The viability of the farm analyzed through the agricultural family income indicator calculated as a ratio between the farm's net income and unpaid work at the Romanian farm reveals the lowest level compared to the countries considered in the analysis registering the lowest level in 2016, respectively 1,523 euros/person and a maximum level in 2018, respectively 3,603 euro/pers. It seems that the accession to the European Union did not have a major influence on the family agricultural income in the primary horticultural sector, our country occupying the last place among the compared countries. According to the results, the viability differences are huge between the primary horticultural sector in Romania compared to the other countries analyzed, the agricultural family income being over 60 times lower compared to the Netherlands, 6 times lower compared to Poland and 16 times lower compared with Hungary (Fig. 4).

Unfortunately, this situation is reflected at the whole agricultural sectors according to a study prepared by DG Agri and Rural Development. At the level of each country there are important variations regarding the incomes in the old EU Member States which are in general superior to those countries which became members after 2004.

The lowest factor income levels per full-time worker can be found in Romania, Slovenia and Croatia (all below 6,000 euros/AWU per year).

At the other end of the scale, factor income per full-time worker in the Netherlands stands at euros 59,657 or more than 3 times the EU average (euros 17,846/AWU) (Fig. 5) [3].

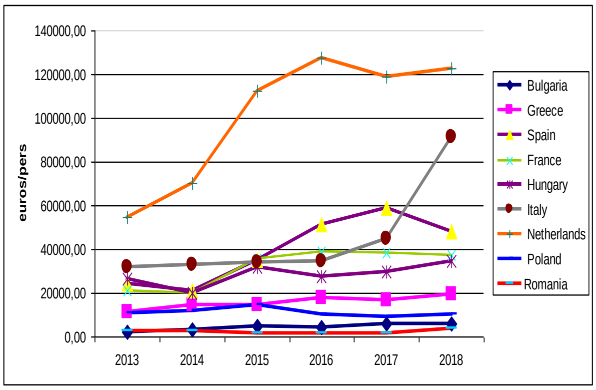

Fig. 5. Farm family income per family work unit, euros/pers
Source: calculations based on FADN, 2020.

The variability of income over time reflects the income risks faced by horticultural farmers especially in Romania.

The volatility of income reduces the well-being of risk-averse farmers and reduces farmers' motivation to produce, invest and innovate [3].

The value of horticultural production

The Romanian horticultural value production decreases in the period 2013-2018 (-2%), while in the other countries, except Poland (-6%) recorded significant increases, Bulgaria (+ 88%), Spain (+ 83%). The highest value of horticultural products is recorded in the Netherlands, followed by France and Spain (Fig. 6). A high value of production is then reflected in higher productivity levels which allow constant investments in new technologies, seeds and equipments.

Among the comparator countries Romania reveals the smallest levels regarding the production value which explains the low level of profitability indicators discussed above. Low levels of production value means insufficient cash flow for new investments especially in new technologies and also impedes a financially sustainable crop plan.

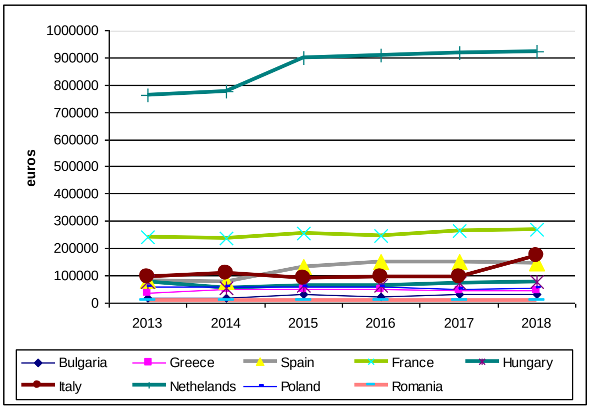

Fig. 6. Value of total production in the horticultural sector, euro
Source: calculations based on FADN, 2020.

Low levels of Romanian production value and its variability is given by the fluctuation of the prices and the volatility of the yields. Thus, Romania records 4-5 times smaller yields for cabbages and carrots and even higher yields differences in case of tomatoes when comparing with the EU average. The Romanian horticultural farmers need to generate sufficient profit from their sales to be able to cover their production costs and make new investments. With their current level of production value this still remains a key issue. One possible solution to this problem would be a more positive and proactive attitude towards creating producers groups, knowing the poor level of association within the sector at this moment.
If farmers cannot pool and sell their production, their potential profitability decreases. This highlights the danger of increasing production without a potential contract within a producer group or with a retailer. At this moment in Romania the contracting level is much reduced although it is well known that the most beneficial relationships and sustainable profits is the long-term contracting. Low level of contracting of production and the yields discrepancy when comparing with countries such as Netherlands make the profitability and convergence of this sector being far away from its competitors.

CONCLUSIONS

The calculation of the competitiveness indicators of profitability related to the Romanian horticultural sector and the comparative analysis made with some other EU competitors reveals a low level of competitiveness for the Romanian horticultural sector. The Netherlands stands out as the most competitive country, followed by countries such as Italy, France and Spain.
The value of production is smallest compared to all the other analysed countries although there is, however, an increase in yields, which is primarily due to the increase in areas grown in greenhouses and plastic tunnels that allow the use of more productive varieties and the correct application of technologies. However, average yields remain highly volatile. The Farm family income per family work unit is also smallest in regard with comparator countries a consequence of reduced production values. This triggers low attractiveness of this activity and in some cases abandonment of this activity or a decrease of the cultivated areas. The Net added value per annual unit of work records the smallest value in Romania, showing again a poor profitability amongst all comparator countries, a consequence among others of a poor infrastructure and weak level of organization. Other explanation apart from the causes already listed is found in the poor functioning of the supply chain and low level of contracting.
The increase of cultivated areas in greenhouses and plastic tunnels will allow the increase of yields per hectare by using selected seeds, with high productive potential but also the correct application of technologies including the purchase of equipment, logistics, and new storage systems.
Although the supply of horticultural products is relatively diversified, the added value of the products is small, mainly due to the lack of marketing knowledge meant to ensure attractiveness and safety in front of the consumer, the lack of technical means of sorting, packaging, labeling, storage and transport production to the market, as well as

the lack of a system for planning production and adapting it to market requirements. This situation leads many times to poor collection of produce and as a consequence a small value of production.

Although the horticulture is the EU's fastest growing agricultural sector after important European production grows in recent years, it seems that Romanian horticultural sector remains far from a close convergence with the other horticultural sector in the EU. Similar conclusion was drawn by other authors, in countries like Egypt, where the horticultural sector is at risk of remaining behind with its competitiveness with a subsequent loss in income and jobs for a great number of rural families [4].

The policy of this sector must respond to market demands by reducing price fluctuations and the imbalance between supply and demand and encouraging the consumption of fruit and vegetables, while ensuring the competitiveness of products. Supporting local production through coherent legislative measures, facilitating access to European funds, creating an organized supply chain (by supporting the formation of producer groups) could significantly contribute to the development of the horticultural sector in Romania.

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EVALUATION OF THE ORNAMENTAL ASPECT ON CROCUS BASED ON FLOWERS SIZE

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Abstract

The present study evaluated the size of crocus flowers as an element of ornamental quality, depending on the biometric parameters of the plants, against the background of different growing substrates. Two types of crocus were studied: "Queen of the Blues" crocus and "Yellow" crocus. The plants were evaluated in terms of height (Ph, cm) at the beginning of flowering (Ph B-Flo) and at the end of flowering (Ph E-Flo). The size of the flowers (Fs) was evaluated based on the diameter (Fs, cm). Three different substrates were used: sand (V1), mixture of sand and compost (V2) and soil (V3). The bulbs were planted at t1 - mid-October (a), t2 - early November (b), and t3 - mid-November (c). There were 9 experimental variants: V1a - sand at t1; V2a - sand and compost at t1; V3a - soil at t1; V1b– sand at t2; V2b - sand and compost at t2; V3b - soil at t2; V1c - sand at t3; V2c - sand and compost at t3; V3c - soil at t3. The size of the flowers (Fs) varied between 3.97 cm (V1c) and 5.07 cm (V2a) in "Queen of the Blue", respectively between 3.83 cm (V1c) and 4.07 cm (V2b) in "Yellow" crocus. 3D models and in the form of isoquants graphically represented the variation of Fs depending on the physiological parameters (Ph B-Flo and Ph E-Flo). The fs estimation safety was quantified by evaluating the degree of fit between the true values (RFs) and the predicted values (PFs). PC1 explained 79.234% of variance, and PC2 explained 19.046% of variance in the case of the "Queen of the Blues" crocus, and in the case of Yellow crocus, PC1 explained 88.851% of variance, and PC2 explained 8.8951% of variance.

Key words: *crocus, flower size, model, ornamental aspect, physiological parameter*

INTRODUCTION

The genus Crocus, Family *Iridaceae*, includes approx. 100 different plant species, throughout the world [26], many of which are found in culture, especially for pharmaceutical and medicinal purposes, but also for food industry (eg aroma, color, flavor), and in the fabric and paper coloring industry [14], [4], [1], [21], [7].

Crocus has been studied from various perspectives, such as genetic diversity and physiological specificity [3], [20], evolutionary aspects and botany, taxonomy, cytology, cultural, economic, phytopharmaceutical importance [24], [29], [13], [25].

The biology of crocus flowers has been studied in relation to various ecological factors of influence, such as thermal conditions and water regime [17], [29].

In relation to the field of interest, the quality of crocus flowers has been studied in relation to the content of bioactive compounds [27], [18].

The improvement of crocus quality has been studied for medicinal and pharmaceutical purposes, in relation to the content of active principles, under the influence of various treatments and biopreparations applied to the plants, as elements in cultivation technology [21].

The plant growth media has a significant importance on plants, in relation to soil or substrate type, and morphological, physicochemical and biological properties, respectively different factors of influence [23].

The processes of physiological growth and corm formation in crocus have been studied in relation to certain substrates in protected space conditions (greenhouse), and a significant influence of the substrate has been found [28]. The study authors reported the favorable, significant influence of manure on flower size and stigma weight, and the results as a whole confirmed the great importance of the substrate on flower formation in crocus. Corm quality and some morphological aspects of crocus were evaluated in relation to the soil and perlite substrate as plant cultivation media [11]. The authors recorded the differentiated influence of the substrate, in relation to certain parameters analyzed in plants.

Other studies have looked at fresh crocus flowers and stigmas from a production perspective in relation to bulb size and production cycle (1 to 3 years) [6].

Corm size, cultivation conditions, and stress factors (eg water stress) were elements in relation to which photosynthesis and crocus biomass production were evaluated during the vegetation period [22].

The production and quality of saffron flowers were also evaluated in relation to different systems and methods of cultivation [2] and agro-climatic conditions [15].

Various studies have been carried out for plant breeding in crocus, for ornamental purposes have followed the quality of plants, flowers in terms of color, shape, size, duration of flowering [10]. The quality of flowers in terms of color in yellow crocus species, compared to purple and white were studied in relation to UV models [16].

The present study evaluated the size of the flowers, as an element of ornamental quality in the crocus, depending on the biometric parameters of the plants, on the background of different growth substrates.

MATERIALS AND METHODS

The ornamental aspect of the crocus was evaluated based on the size of the flowers, in relation to the physiological parameters of the plants. Two types of crocus were studied: "Queen of the Blues" crocus and "Yellow" crocus, Figure 1.

Fig. 1. Aspects of crocus plants under cultivation conditions, spring 2021
Source: Original figure, authors' photo.

The plants were evaluated in terms of height (Ph, cm) at the beginning of flowering (Ph B-Flo) and at the end of flowering (E-Flo).

Flower size (Fs) was evaluated based on flower diameter (Fs, cm).

Crocus bulbs were planted on three different substrates: sand (V1), a mixture of sand and compost (V2) and soil (V3). Planting was done at three different times: t1 - mid-October (a), t2 - early November (b) and t3 - mid-November (c). From the combination of the two elements, given by the substrate and the moment of planting, resulted 9 experimental variants: V1a - sand at t1; V2a - sand and compost at t1; V3a - soil at t1; V1b– sand at t2; V2b - sand and compost at t2; V3b - soil at t2; V1c - sand at t3; V2c - sand and compost at t3; V3c - soil at t3.

Experimental data were processed statistically appropriately to assess the presence of the variance, the degree of statistical safety (p, R^2), and the differences between the variants, on each type of crocus studied. PAST software [9] and Wolfram Alpha [30] application were used.

RESULTS AND DISCUSSIONS

By planting crocus bulbs in the two types studied, "Queen of the Blues" crocus and "Yellow" crocus, on substrates and at different times, the biological material benefited from different growth conditions. In the spring, the height of the plants was determined at the beginning of flowering (Ph B-Flo) and at the end of flowering (Ph E-Flo). The size of the flowers (Fs) on each variant was also determined. The data on vegetative parameters and flower quality are presented in Table 1.

Table 1. Average values of vegetative parameters and crocus flower size

Experimental Variant	"Queen of the Blues"			"Yellow"		
	Ph		Fs	Ph		Fs
	(cm)					
	B-Flo	E-Flo	BC-Fs	B-Flo	E-Flo	YC-Fs
V1a	10.14	15.03	4.26	10.69	15.24	3.93
V2a	11.69	15.17	5.07	11.83	16.15	4.01
V3a	11.65	15.08	5.00	11.58	15.78	3.96
V1b	10.50	14.63	4.18	10.40	14.93	3.92
V2b	11.39	15.01	4.76	11.28	16.07	4.07
V3b	11.15	14.85	4.44	11.22	15.49	3.95
V1c	10.48	14.19	3.97	10.28	14.45	3.83
V2c	11.29	14.91	4.69	11.17	15.17	3.96
V3c	11.07	14.25	4.58	10.97	14.73	3.91

Source: Original data from experimental conditions.

The graphical representation of the flower size, as average values, in direct relation with Ph B-Flo and Ph E-Flo, for the two types of crocus studied, is shown in Figures 2 and 3.

Regression analysis was used to evaluate the variation of flower size (Fs) in relation to the vegetative parameters of the plants considered, respectively the height of the plants before flowering (Ph B-Flo) and the height of the plants at the end of flowering (Ph E-Flo).

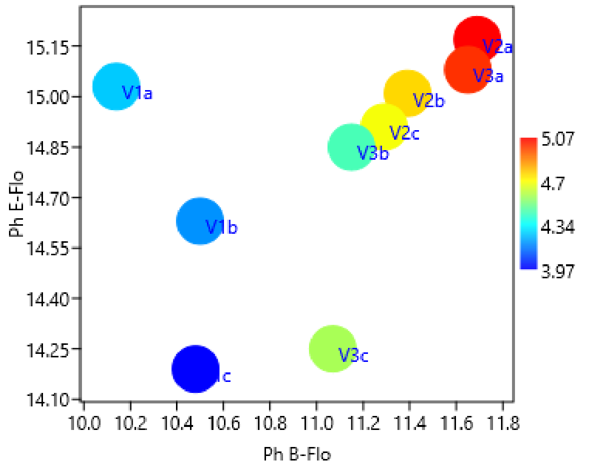

Fig. 2. Flower size of "Queen of the Blues" crocus (average values) in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis)
Source: Original figure, based on data analysis.

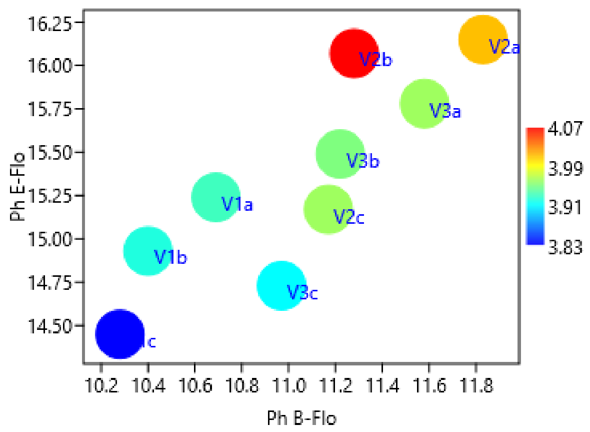

Fig. 3. Flower size of "Yellow" crocus (average values) in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis)
Source: Original figure, based on data analysis

Thus, the variation in flower size was described by equation (1) for "Queen of the Blues" crocus, and equation (2) for "Yellow" crocus, in general statistical safety conditions ($R^2 = 0.999$, $p < 0.001$).

The graphical distribution regarding the Fs variation in relation to the physiological parameters of the plants (Ph B-Flo, and Ph E-Flo) is shown in the form of 3D model and in the form of isoquants in figures 4 and 5 for "Queen of the Blues" crocus, and respectively in figures 6 and 7 for "Yellow" crocus.

$$Fs_{QB} = a\,x^2 + b\,y^2 + c\,x + d\,y + e\,xy + f \qquad (1)$$

where: Fs_{QB} - flower size of the "Queen of the Blues" crocus (cm);
x – plant height at the beginning of flowering (Ph B-Flo);
y – plant height at the end of flowering (Ph E-Flo);
a, b, c, d, e, f – coefficients of the equation (1);
a = 0.53218659
b = 0.21095152
c = -1.24302600
d = 0.95127036
e = -0.65479873
f = 0

$$Fs_{Y} = a\,x^2 + b\,y^2 + c\,x + d\,y + e\,xy + f \qquad (2)$$

where: Fs_{Y} - flower size of the "Yellow" crocus (cm);
x – plant height at the beginning of flowering (Ph B-Flo)
y – plant height at the end of flowering (Ph E-Flo);
a, b, c, d, e, f – coefficients of the equation (2);
a = 0.26431630
b = 0.20766234
c = 1.68881901
d = -0.81194304
e = -0.49207633
f = 0

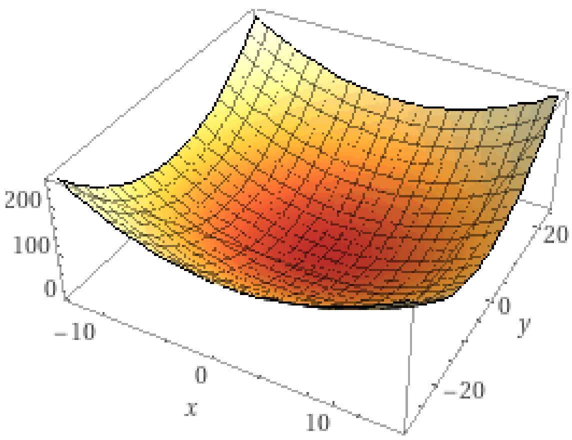

Fig. 4. 3D model of flower size variation in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis), "Queen of the Blues" crocus
Source: Original figure generated based on experimental data.

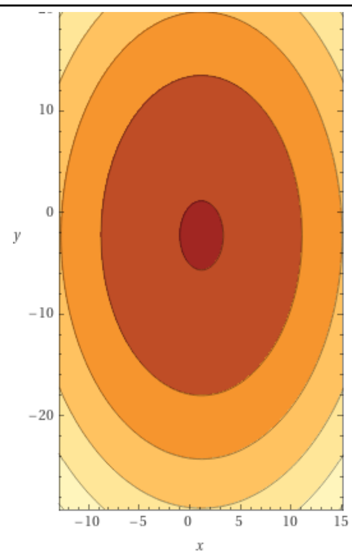

Fig. 5. Model of flower size variation, in the form of isoquants, in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis), "Queen of the Blues" crocus
Source: Original figure generated based on experimental data

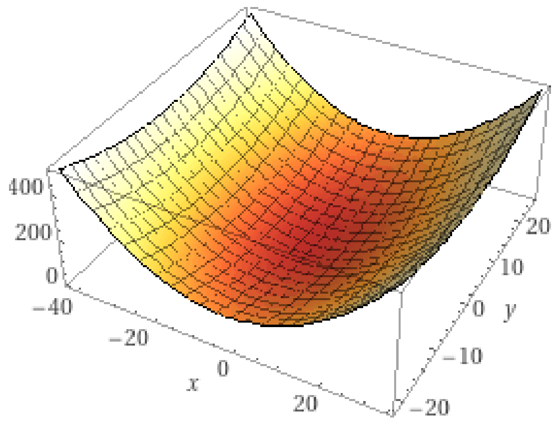

Fig. 6. 3D model of flower size variation in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis), "Yellow" crocus
Source: Original figure generated based on experimental data.

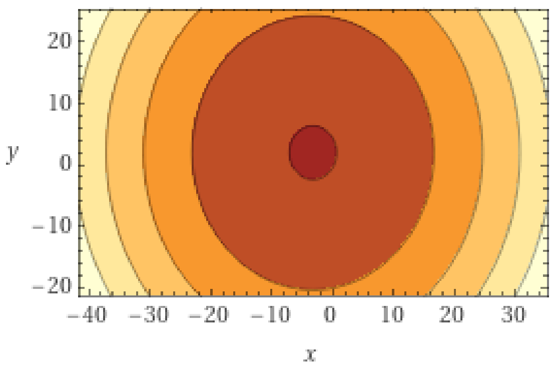

Fig. 7. Model of flower size variation, in the form of isoquants, in relation to Ph B-Flo (x-axis) and Ph E-Flo (y-axis), "Yellow" crocus
Source: Original figure generated based on experimental data.

The safety of estimating Fs was analyzed by assessing the degree of fit between the actual values (RFs) and the estimated values (PFs) for each of the two types of crocus studied.

In the case of "Queen of the Blues" crocus, the linear equation (3) described the fit between the two data series (average values), and the graphical representation is shown in Figure 8.

$$PFs = 0.9815 \cdot RFs + 0.084 \qquad (3)$$

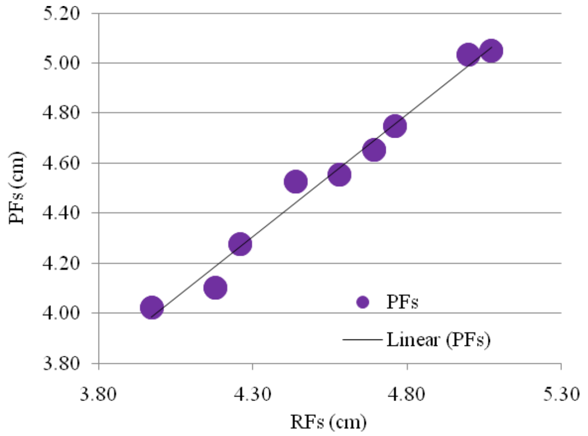

Fig. 8. The fit line between RFs and PFS in the case of the "Queen of the Blues" crocus
Source: Original figure generated based on experimental data.

In the case of "Yellow" crocus, the linear equation (4) described the fit between the two data series RFs and PFs (average values), and the graphical representation is shown in Figure 9.

$$PFs = 0.9576 \cdot RFs + 0.1674 \qquad (4)$$

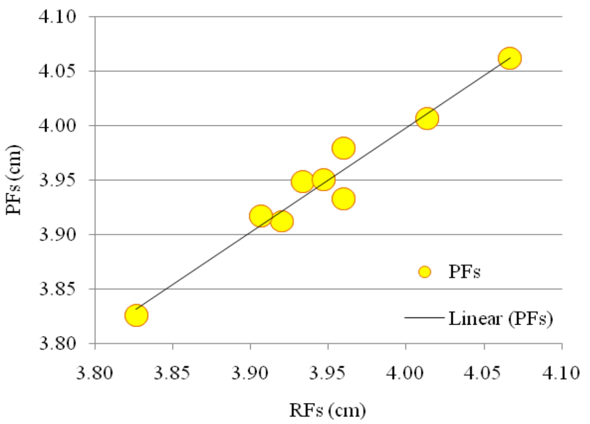

Fig. 9. The fit line between RFs and PFS in the case of the "Yellow" crocus
Source: Original figure generated based on experimental data.

The PCA led to the distribution diagrams of the variants shown in Fig. 10 for the "Queen of the Blues" crocus and in Figure 11 for the "Yellow" crocus.

In the case of the "Queen of the Blues" crocus, figure 10, PC1 explained 79.234% of variance, and PC2 explained 19.046% of variance. In the case of "Yellow" crocus, Figure 11, PC1 explained 88.851% of variance, and PC2 explained 8.8951% of variance.

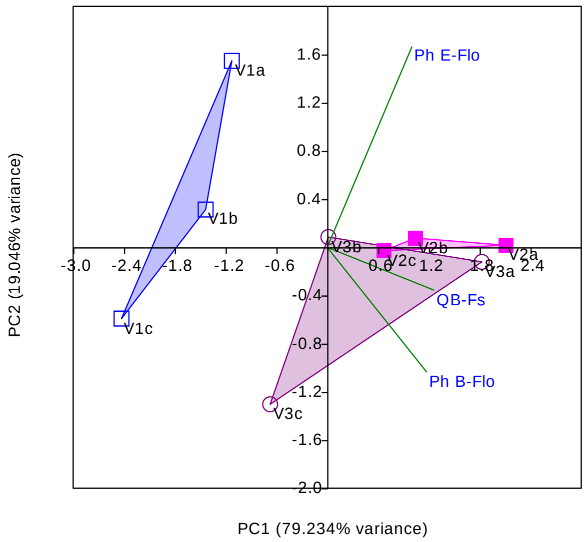

Fig. 10. PCA diagram, Correlation matrix, "Queen of the Blues" crocus in relation to physiological parameters of plants and Fs
Source: Original diagram generated based on experimental data.

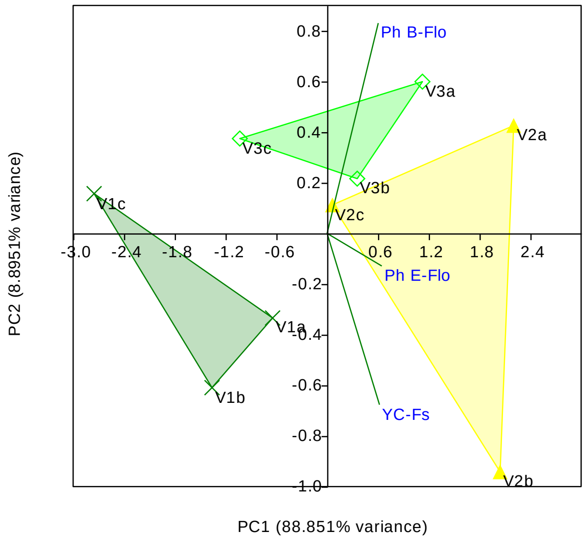

Fig. 11. PCA PCA diagram, Correlation matrix, "Yellow" crocus in relation to physiological parameters of plants and Fs
Source: Original diagram generated based on experimental data.

A comparative presentation of the average values of the flower size for the two types of crocus, under the study conditions, is represented in Figure 12.

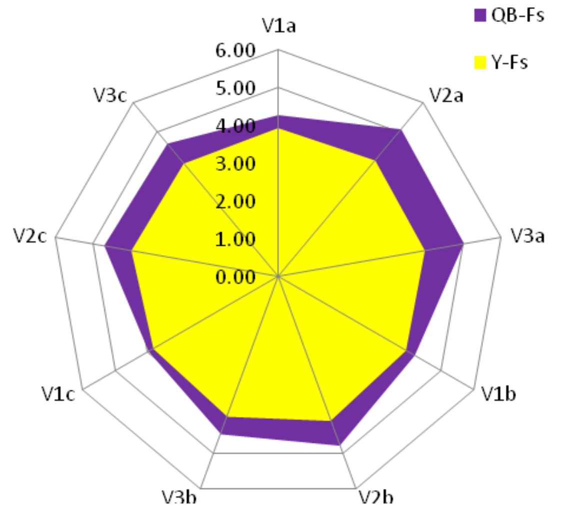

Fig. 12. Comparative graphical representation of flower size (Fs) of the two types of crocus under experimental conditions
Source: Original figure generated based on recorded data.

Comparing the Fs values recorded with the average of the experiment, for each of the two types of crocus studied, positive or negative differences were found, in relation to the experimental variants.

The graphical distribution of the calculated difference values, compared to the average value of Fs, are shown in Figure 13 for the "Queen of the Blues" crocus and in Figure 14 for the "Yellow" crocus.

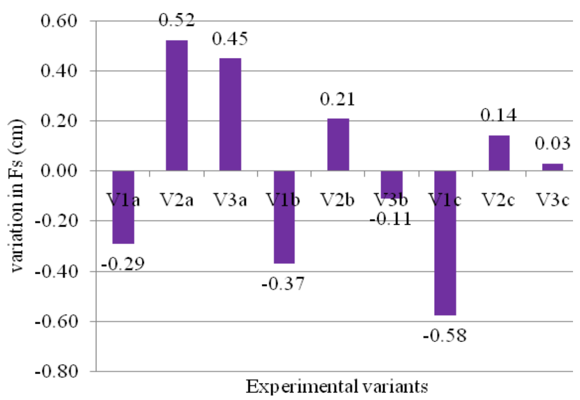

Fig. 13. Fs variation given by the experimental variants in relation to the average value of the experience, "Queen of the Blues" crocus
Source: Original figure generated based on data.

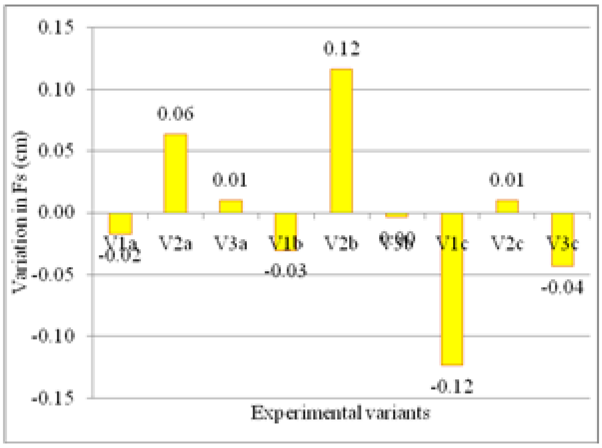

Fig. 14. Fs variation given by the experimental variants in relation to the average value of the experience, "Yellow" crocus
Source: Original figure generated based on data.

In the case of "Queen of the Blues" crocus, compared to the average value (4.55 cm) of flower size, positive values were found for V2a, V3a, V2b, V2c and V3c, and negative values for V1a, V1b , V3b and V1c.

In the case of "Yellow" crocus, compared to the average value (3.95 cm), positive values were recorded for V2a, V3a, V2b, V2c and negative values for V1a, V1b, V1c and V3c.

In both types of crocus studied, it was found that the V1 variant (sand substrate), generated lower values of flower size, regardless of the period of planting the bulbs. Although it is an affordable substrate, it does not offer the best results alone.

The size of crocus flowers is of interest and has been studied in relation to production targets for the phytopharmaceutical, food and dye industry [1], [25]. At the same time, the size of the flowers is interesting from an ornamental perspective.

Physiological indices and biometric parameters of plants express the environmental and living conditions of plants, and the relationship of plants with habitat [19], [12], [5], [26]. Some non-destructive methods, based on imaging analysis, can provide information on the health of plants, very useful methods and applicable to ornamental plants, in order not to harm plants by sampling [7].

Therefore, in the case of cultivating crocuses for ornamental purposes, by using quality biological material, and by directing plant density, substrate quality, water regime, the plants will have a better growth and thus larger flowers can be obtained, which will ensure a high quality ornamental look.

In conditions if crocus is cultivated for ornamental purposes, mixed with other early spring bulbous species (eg *Galanthus*, *Scilla*), in competition with these species for space, water and nutrients, it is possible that the size of the flowers is close to the lower limit, and the ornamental aspect will depend on the whole floral carpet and not on singular plants.

CONCLUSIONS

The size of crocus flowers (Fs) varied in close connection with the physiological parameters represented by the height of the plants at the beginning of flowering (Ph B-Flo) and at the end of flowering (Ph E-Flo) at the two types of crocus studied.

Models in the form of 3dD and isoquants, described the Fs variation in relation to the physiological parameters considered, and linear models confirmed the high degree of fit between predicted values (PFs) and real values (RFs) of flower size.

By properly managing the vegetation factors that contribute to the growth and development of crocus plants, and organizing the cultivation system (especially growth substrate), plants with variable flower sizes can be obtained, in relation to the proposed objectives, such as ornamental (simple or mixed culture), food or industrial.

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RESEARCH ON THE USE OF NDVI IN MONITORING THE WHEAT CROP VEGETATION, THE CARBON STORAGE AND THE YIELD LEVEL, ON THE CHERNOZEMIC SOILS FROM SOUTH ROMANIA

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Abstract

In the southern part of the Romanian Plain, a research was carried out over a period of 5 agricultural years (2016-2021) regarding the evaluation of wheat crops, consisting of 7 premium varieties, on a surface of 110 ha. The NDVI index was used to assess the quality of management, the influence of climate change, which are in constant variation, on wheat crops and their ability to fix atmospheric carbon in the form of CO_2. For analyzing the data obtained from the Sentinel-2 satellite, in order to make the NDVI periodically summing and, then, to establish the daily average during the vegetation period from spring to summer, the calculation of the correlations and of the complex functions in 2D were used. In the integrated amount, NDVI ranged between 110.06 in 2020, the driest year, and 124.79 in 2018, the most favorable year for wheat cultivation. Yields also fluctuated in direct proportion to NDVI values, from 2,100 to 6,700 kg of wheat/ha. The obtained results place the area in conditions of high risk to water and other climatic factors, risks that can be partially reduced by optimizing crop management.

Key words: *wheat, NDVI, Sentinel-2, yield, crop management*

INTRODUCTION

The Normalized Difference Vegetation Index (NDVI) is the most widely used indicator, the one that best describes the level of vigour, the metabolic activity of the crop, the consumption of CO_2 by photosynthesis, of water and nutrients, in order to achieve production and its quality. At the same time, NDVI serves to detect the phytosanitary status of the crop and it provides information on the necessity for interventions. Indirectly, it provides information on the quality of technological works and on the need for nutrition, especially with nitrogen [5].
NDVI is a dimensionless parameter, which describes the visible reflective difference of crops and the one in near infrared, as well as the measurement of the crop's green color intensity that it transforms and transmits in numbers, which can then be calculated and interpreted [2]. Together with NDMI (The Normalized Difference Moisture Index), which deals specifically with measuring the state of water stress of the crop, it provides us with valuable information on the effect of climate change on the evolution and productivity of crops.
The measurement of reflectance, i.e. of the light intensity reflected by the crop on certain specific bands (wavelengths), can be easily done today, using specialized sensors, mounted on drones or satellites.
For NDVI search and calculation, the following are used in light spectrum [9]:

- the red band (RED) is visible in the spectral range (600-700 nm or 0.6-0.7 μm) and is in the visible spectrum of the human eye;
- the NIR band is in infrared on the spectral width 750-1,300 nm (0.75-1.3 μm) and is not retained by the eyes, but only by sensors.

The sensors mounted on the satellites are very varied and can also record slightly wider widths, that don't affect the index calculation. With a very good working algorithm, the Sentinel-2 and Landsat 8 satellites [6, 8] accumulate data over a longer interval, usually 5 years. According to several authors

[1, 3, 7], the calculation formula of NDVI is (1):

$$NDVI = \frac{NIR - RED}{NIR + RED} \qquad (1)$$

The values of the index vary between -1 and +1, each value in this range corresponding to a different vegetative state and agronomic situation, regardless of the crop [12]. If two wheat crops of the same variety are in the same phenological phase, the lower NDVI values found in one of them indicates one of the following situations [4]:

- food stress (bad nutrition);
- phytosanitary stress, attack of weeds, diseases or pests;
- damage caused by frost or other calamities – hail, fire or major technological errors.

The greener the plants are, the closer the index is to +1, without being able to reach it because they aren't perfect colors. The more degraded, yellowed the crop is, the farther it goes from +1 to 0. Under 0 there are no crops, the ground is empty and black. The value of NIR (near infrared) increases the greener the culture is, while the opposite happens with RED [10]. The NDVI index correlates with many other parameters, which are extremely useful for agricultural specialists, in order to optimize their crop management [11].

Here are just a few:

(1)The correlation between NDVI and chlorophyll assimilation – is usually significant and very significant and serves to:

- determination of carbon absorbed in the form of CO_2 from the atmosphere and its fixation in crop and soil;
- establishing plant health, but also the climatic environment;

(2)The correlation between NDVI and LAI (leaf area index) – extremely important for determining the size of foliar surface and the efficiency of photosynthesis;

(3)The correlation between NDVI and crop level – a decisive factor in crop planning and in their management;

(4)The correlation between NDVI and NDMI – it provides special information about the state of water stress of crops, requesting interventions in the genetics of varieties.

Knowing the possible losses is also useful for sizing costs in case crop management optimizations aren't possible. These correlation vectors make NDVI one of the most important and useful index, able to describe many aspects of the relationship between crops and the natural and social environment. Otherwise, it comes in several variants, allowing to a lot of researchers and practitioners to use it extremely differently.

MATERIALS AND METHODS

Work was carried out in the research and production field of Probstdorfer Saatzucht Romania from Modelu – Calarasi county (south Romania), on a slightly leached chernozemic soil, with 26% clay and 3.1% humus. Texturally, the soil is predominantly loamy.

The field under test measured an area of 110 ha, on which 7 premium wheat varieties, with over 14.5% protein, were grown. Researches took place from the autumn of 2016, until the summer of 2021 (5 agricultural years).

The climatic conditions of the research area are presented in Table 1.

Table 1. Precipitation and temperatures in Modelu (Calarasi), September 2016 – August 2021

Month	Precipitation (mm/month)					Temperatures (°C, mean)				
	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Sept.	52	0	10	9	57	19.4	20.1	19.3	19.5	21.0
Oct.	20	0	26	39	43	11.3	12.4	13.7	14.0	15.5
Nov.	74	154	64	27	8	6.2	7.6	5.4	11.7	5.9
Dec.	0	37	47	19	114	0.0	4.8	0.5	4.9	5.4
Jan.	0	45	9	2	106	-4.3	1.8	0.5	1.9	3.3
Febr.	17	44	11	31	42	1.7	1.8	3.8	5.8	3.3
March	65	38	16	16	102	9.0	4.1	9.7	8.9	5.3
Apr.	57	0	34	11	35	11.0	15.7	11.1	12.1	10.2
May	49	20	45	75	70	16.6	19.2	18.0	17.4	17.7
June	50	121	38	105	171	22.7	22.8	23.8	22.0	20.9
July	132	109	15	18	32	23.9	23.6	24.0	24.9	24.8
Aug.	20	64	43	3	19	24.1	24.5	24.6	25.1	24.2
Total/ Mean	536	632	358	355	799	11.8	13.2	12.9	14.0	13.1

Source: Own determination.

For the measurements the Sentinel-2 satellite was used, which has the sensors and the algorithm for measuring the radiation reflected in the specific bands – NIR and RED.

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The patterns reflected by plants and captured by satellite sensors vary depending on the phenological phase of the crop, and at the level of the same phenological phase differ depending on the state of the crop (drought, nutrition, plant health, crop rotations and other climatic conditions, etc.). The sensors capture the intensity, the clarity of the light reflected by the plants in the present bands and, depending on the degree of intensity, turn the moment of capture into numbers.

This system was used, by purchasing NDVI values during the research period, but only for the spring-summer vegetation period of wheat. Specifically, it was found that this period lasts 186 days, starting with February 1, when the soil is usually cleared of snow and wheat plants resume their vegetative activity, and until the harvest of the crop.

The raw data received from Sentinel-2 came in both graphical and tabular form. Because the sky was often covered at the time of reading, there were many points of sudden decline. These figures had to be replaced by ground observations or drone recordings.

After making the corrections, the data were subjected to a correlation analysis calculation, in order to compute the annual specific curve of NDVI for wheat crop by year and its average. The correlation represented a pattern of evolution over time (during the vegetation period), transiting all wheat phenophases, from early spring to the harvest. It resulted a number of 5 annual models (curves accompanied by function and statistical assurance by the correlation coefficient) and 5-year average model, which is intended to be a zonal average characterization of the index and of the benefits resulting from its use.

RESULTS AND DISCUSSIONS

For the acquired annual data, the evolution in time of NDVI to wheat crop in each spring of the analyzed agricultural years is calculated and presented in Figures 1-5, of which we note a few aspects.

In the first agricultural year of study (2017) the NDVI curve starts with negative values, suggesting that this year the soil didn't show measurable crops by Sentinel-2. In about 50 days, due to the rains and to the right temperatures for the early phenophases, it is expected that in the last decade of March NDVI values will exceed the figure of 0.7 (70%) covered crop, to increase to 0.8 by the end of April, then 0.9 in May, i.e. during the flowering and grain filling period, and will decrease, once maturity begins, in yellow (June), returning to values of 0.2 → 0.1 at the time of wheat crops harvesting.

Throughout the vegetation period, values were registered according to the phenological phases (Fig. 1), the year being considered positive, favorable for wheat cultivation, obtaining average yields between 5,000-6,000 kg/ha.

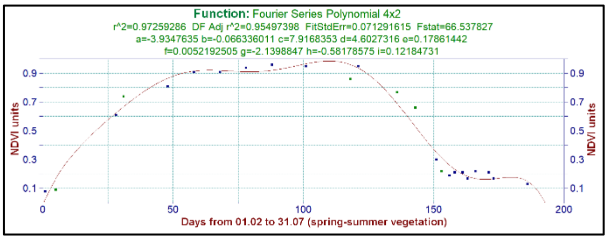

Fig. 1. NDVI values for the wheat crop, in the spring of 2017
Source: Own determination.

By performing the function integral we'll find summed the daily NDVI values from the summer vegetation period of the wheat, i.e.:

$$\sum_{x=1}^{186} NDVI = \int_{1}^{186} fx(dx) = 120.46$$

$$\text{Average NDVI} = \frac{120.46}{186} = 0.64$$

The average also shows a quality crop, but without allowing the maximum potential of the varieties to be obtained in the area.

In the second year (2018), the curve was very different (Fig. 2). First of all, the beginning is different – February has a NDVI = 0.85, i.e. 85% of the surface was covered. The climatic conditions allowed, throughout the vegetation period, up to 120 days (end of May), going through all the phenophases, the NDVI remaining at 0.85 → 0.90 (85-90%) coverage, taking us into highlights the most suitable year for wheat cultivation. Yields ranged from 6,000-7,000 kg/ha. The amount and average value of the index were:

$$\int_{1}^{186} fx(dx) = 124.79$$

$$\text{Average NDVI} = \frac{124.79}{186} = 0.67$$

Only 0.03 NDVI average points brought an additional production of about 1,000 kg/ha.

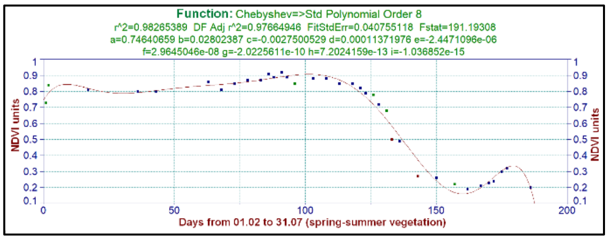

Fig. 2. NDVI values for the wheat crop, in the spring of 2018
Source: Own determination.

The third year (2019) started with quite high values of the index, but with 0.3 points below those of the previous year. As a result of the rainfall at the end of March and in April, the crop recovered, and in March - May the index increased to over 0.85, after which it suddenly decreased (Fig. 3), both due to the reduction in the amount of precipitation, as well as to an attack of diseases. The varieties reacted differently, and the yield varied in a wide range, from 4,200 to 6,500 kg/ha.

$$\int_{1}^{186} fx(dx) = 113.12$$

$$\text{Average NDVI} = \frac{113.12}{186} = 0.61$$

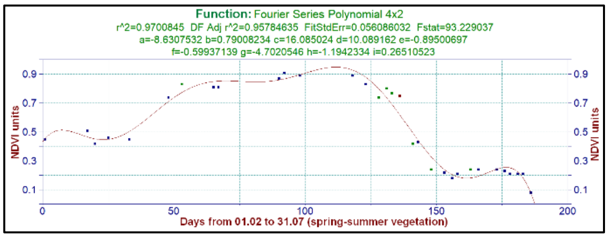

Fig. 3. NDVI values for the wheat crop, in the spring of 2019
Source: Own determination.

In the fourth year (2020), the data showed an extreme situation. Spring, although dry, finds the crop with an NDVI of almost 0.8, increases slightly to almost 0.85, then decreases continuously along the phenophases, to values of 0.2 → 0.3 during the grains filling period. Although the indicator describes the presence of the crop, the decrease of NIR values and the increase of RED values lead us to think of a yellowed culture, exhausted by drought. The determinations of the NDMI index (to be published) pointed out a high degree of dehydration, water stress of the crop, which ended with yields between 900 and 3,000 kg/ha (Fig. 4), totally unsatisfactory to cover costs.

$$\int_{1}^{186} fx(dx) = 110.06$$

$$\text{Media NDVI} = \frac{110.06}{186} = 0.59$$

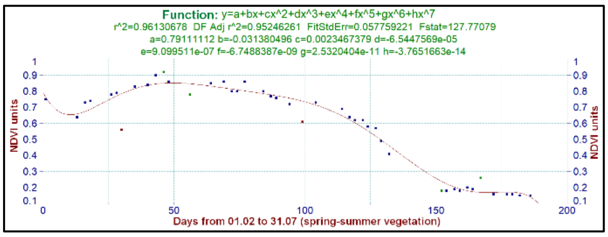

Fig. 4. NDVI values for the wheat crop, in the spring of 2020
Source: Own determination.

In the last year of research (2021), good values of NDVI in spring and high values of the index (0.85) during most phases of vegetation were founded, but there is a sudden decrease in its maturation period (Fig. 5), generated by a high disease attack, generated by heavy rains. The rains also made the harvesting more difficult. Wheat yield was between 4,800-5,500 kg/ha, with an average of 5,000 kg/ha.

$$\int_{1}^{186} fx(dx) = 116.70$$

$$\text{Average NDVI} = \frac{116.70}{186} = 0.63$$

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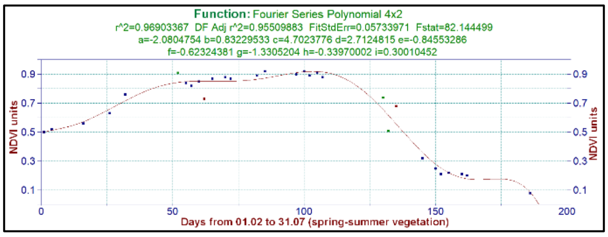

Fig. 5. NDVI values for the wheat crop, in the spring of 2021
Source: Own determination.

Due to the variability of the climatic conditions, the models of the functions and those of the curves don't resemble each other at all in the five years of study (2017-2021). As a result, it was impossible to extract a single interval along the phenophases, representing all years in the calculation of a correlation with production or biomass.

Consequently, it was calculated an average function of the NDVI evolution (Fig. 6), which characterizes quite well the area as a whole, but also mitigates the role of climate change and especially doesn't take into account the water supply of the soil. It shows, on average, crops that start growing in early spring, form good vegetation (85% coverage) in most periods of vegetation, but fall sharply during the ripening period, not giving the necessary climatic space to fill the grains, obtaining high components of production and especially the weight of 1,000 grains (MMB) and the hectoliter weight.

$$\int_{1}^{186} fx(dx) = 115.88$$

Average NDVI = $\frac{115.88}{186} = 0.623$ – for an average yield of 5,000 kg/ha, with variations from 2,000 to 8,000 kg/ha

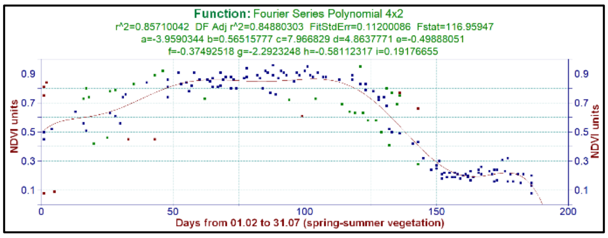

Fig. 6. NDVI values for the wheat crop, in spring, average for 2017-2021
Source: Own determination.

If the average index would increase to 0.75, then the production would be very close to the potential of the varieties, respectively 7,500-9,000 kg/ha.

It is to be mentioned that using these complex functions, were obtained very high correlation ratios ($r^2 > 0.96$). The 5-year average function, taking over the negative influence of the years, reduced the correlation ratio ($r^2 > 0.85$ - 85%).

The correlation between NDVI and wheat production is shown in Fig. 7, in which it is observed that during the experimentation period (5 years) the NDVI sum index oscillated between 110 (in 2020) and almost 125 (in 2018), i.e. the average daily NDVI = 0.59 $\rightarrow$ 0.67. During this period, the average level of wheat production ranged between 2,000 and 6,500 kg/ha.

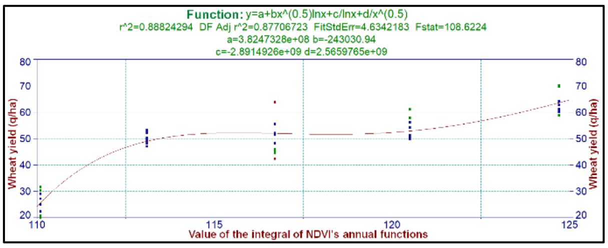

Fig. 7. Correlation between NDVI, as an integral of annual functions and wheat yield, average for 2017-2021
Source: Own determination.

The function is an exponential one, naturally logarithmic, ensured statistically by a very significant correlation ratio r^2 = 0.89, a determination of 89% and a correlation coefficient $r = \sqrt{r^2} = \sqrt{0.89} = 0.94$, also very significant. The function shows that, on the NDVI range = 0.59 $\rightarrow$ 0.62, the production values increase from 2,500 to 4,900 kg/ha, after which on the NDVI range = 0.62 $\rightarrow$ 0.65 they increase slightly to 5,100-5,300 kg/ha, so that from NDVI = 0.65 $\rightarrow$ 0.67 to reach 6,500 kg/ha. The average yield increase was $\frac{6.5-2.5}{0.67-0.59} = \frac{4.0}{0.08} = 50$ – the transformation coefficient for a NDVI unit.

If NDVI would had been equal to 0.75, then a yield of about 8,000 kg/ha could have been obtained, which would have brought the area close to about 10-15% below the potential of these valuable varieties. This isn't the case in the south of the Romanian Plain, where due to the unfavorable climatic conditions, on average for 5 years, yields of about 5,200 kg/ha can be obtained ⇒ 5,200/115.88 = 44.8. Can't be yet estimated whether the average long-term production is more than 10 years. The formula for calculating the harvest, starting from the function data and NDVI is:

$$NDVI \times 44.8 \times 186 = 0.623 \times 44.8 \times 186 = 5{,}191$$

CONCLUSIONS

NDVI is one of the most important indices that is used, along with other parameters, in the process of agricultural crops monitoring and control, in this case of wheat cultivation. It is obtained by acquiring the primary data from the Sentinel-2 satellite, correcting them with drone and ground observations in the crop, and then processing them using time functions of the length of the vegetation period of wheat crops in spring-summer, around 186 days, from February 1 to July 30.

The calculation and interpretation of NDVI showed that the agricultural area is in an extremely variable region from one year to the next in terms of climate, with NDVI ranging between 110.06 in 2020, a disastrous year for wheat cultivation, and 124.79 in 2018, which was the year with the highest yields (an average of 6,500 kg of wheat/ha). In average daily values, NDVI ranged from 0.59 to 0.67, with an amplitude of 0.08 NDVI units. Functions and graphs were statistically provided by correlation ratios $r^2 > 0.96$, i.e. determinations of over 96%.

The large variation from one year to another doesn't allow the selection of a phenological area to link it with the obtained production. Correlated with the yields obtained on the ground, the NDVI indicates an average 5-year production of about 5,200 kg of wheat/ha, i.e. more than 45% below the potential level of the tested varieties, but with large variations, from 2,100 to 6,700 kg/ha. Each hundredth of NDVI brings us a harvest of 44.8 kg/ha.

Therefore, a crop close to the varieties' potential could have been obtained with an NDVI of 0.75, which would have translated into a production of 8,000 kg of wheat/ha.

The obtained NDVI values, correlated with the yields, place the area in conditions of high risk to climatic factors, which can be partially reduced by agricultural technologies, by a better tolerance of varieties to water stress and by optimizing crop management.

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ANALYSIS OF SOME SPECIFIC FEATURES OF THE LOCAL FOOD MARKET IN ROMANIA

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Abstract

A particular importance is given to the local food products (LFP) during the last 20 years, due to the impact they could have on the public health, local economy, community and environment. Our research purpose is to determine: consumption and production, reasons, fidelity, trade mode and place. The research has been carried out: by means of two surveys, addressed to the consumers and producers in the North-East Development Region of Romania; Exploratory Factor Analysis and Cluster TwoStep Analysis. LFP consumers interact face-to-face (70.7%); they prefer the specialised shops (41.5%); have good knowledge about the production process and traceability (37.0% and 41.5%, respectively); consider LFP as being healthy (30.3%); prefer the lower price by 20% versus those in supermarkets (27.8%) and they will buy up to an increase by 30% (44.2%). The reluctance arises sometimes from the lack of quality certification (29.3%). The producers prefer the face-to-face interaction (53.5%); sell mostly on the agri-food market (31.6%); are poor informed about the production process and traceability (31.4% and 39.2%, respectively); they motivate the selling by the supply of healthy products to fellow citizens (19.9%); consider that they sell by 20% cheaper than the supermakets (46.3%), but they will give up if the prices would decrease by 20% (35.8%). The TwoStep Cluster Analysis suggests the following profiles: "elevated consumers" (49.2%) and "pragmatic consumers", "conservative producers" (61.1%) and "trader-producers".

Key words*: local food products, consumer behaviour, rural economy*

INTRODUCTION

The research regarding the local food products (LFP) is subject to numerous debates: LFP are considered healthy products; the consummers are willing to pay a higher price for these; this type of trading would offer to the farmers a high feeling of social acknowledgement; this market would encourage the social connections, it would stimulate the local economy, and, as far as the consumers are concerned, there are reasonable grounds for believing that they prefer these procesees, because these would be beneficial for environment [10].

Some products could face an impairment of their quality during transportation or due to microbial deterioration and nutritional losses. Usually, LFP benefits from short chains and, consequently, they should not be affected by these problems. However, it cannot be categorically said that the locally produced fruits and vegetables will be always of a higher nutritional quality than the non-local products, if all the processes which they are going through are unknown [9]. The origin, along with their quality, play a significant role regarding the behaviour of the LFP consumer from Izmir, Turkey. The preferences are focused on the products sustaining the local economy [1].

Gracia A. *et al.* (2012) consider that, for the analysed local food product, the consumers are willing to pay a higher price than for those which go through longer supply chains [12]. But Willis D.B. *et al.* (2016) are of the opinion that rather a part of the population, with higher income, more concerned with health and preferring ecological products, is oriented towards this type of products [23].

Some studies achieved in Ukraine indicate a revival of consummer interest for the dishes obtained from niche food, such as wild and cultivated local plants [20]. In the same area, Chemerys V. *et al.* (2019) proposed an economic model based on the setting-up of family farms specialised on food supply to the local population, which contribute to the increased employment and to the social and economic revitalization of the rural areas in Ukraine [8].

In Romania, the LFP consumption represents about 21% of the minimum value of consumption basket [18]. This products are preferred than those from national sources (65%) or from EU countries (77%) [6], and the producers are interested in trading their products to the population from the close proximity [11]. By means of tourism and on-line trade, local bee products are highly appreciated, thus stimulating the production of honey and bee products, which leads to improved quality [16].

Some studies on the local smoked cheese products from Baia Mare, Romania, highlight the correlation between the microbiological quality of cheese and the appropriate hygienic conditions of processing and storage [22]. The LFP quality is tackled also by studies concerning some products processed within the rural household. Also in this case, the processing conditions are those influencing the quality [17].

The aim of the research presented in the current paper consists in determining the main coordinates of the LFP market in the North-East Development Region of Romania, by taken into consideration: the structure of consumption and production, trade mode, place and channels, reasons of LFP purchase / sale, the consummers and producers fidelity on this market.

The North-East Development Region of Romania had, in the year 2020, a population of about 3.3 mil. inhabitants, with a monthly average income of 438 euro/inh. From the total population, 41.9% residents live in the urban area and 58.1% residents, in the rural area. The structure by gender was 49.7% women and 50.3% men, while the structure by age groups was: 34.2% (0-29 years old); 40.5% (30-59 years old); 25.4% (over 60 years old). Considering the educational background, the population in the region is characterised by: primary education level - 32.6%, secondary education level - 55.1%, university degree - 12.3% [15].

MATERIALS AND METHODS

The proposed objectives led to the accomplishment of a field research based on the conducting of two surveys: one targeted at consumers (Table 1), with 21 questions, and the other one targeted at producers who sell the products obtained within an area delimited by a radius of 100 km far away from the farm, with 20 questions (Table 2).

The questions in the survey for consumers are addressing: the determination of the subject profile; the quantification of the LFP consumption; the mode, price, place, reason, fidelity and obtained information concerning these products.

The survey for the local trader - producers is structured on: the determination of the subject profile; the quantification of the LFP sales; the mode, time consumption, price, place, reason, fidelity and provided information concerning these products. Both surveys have been drawn up based on the questions with filling-in items, selection items with text answer and multiple answers.

The order of questions is based on progressive difficulty in two stages: for the consumer survey: 1-2, 8-13, 3-7, 14-21; for the producer survey: 1-2, 6-11, 3-5, 12-20. The platform used to create and distribute the surveys was Google Forms [19]. The sampling of results has been carried out during the second trimester of the year 2021, on-line, from subjects in the North-East Development Region of Romania.

The data processing and analysis have been achieved by using Microsoft Office and IBM SPSS Statistics 23 applications, in order to set-up the main databases and, respectively, to make the validation and analysis of collected data. The validation of survey results has been done with the Exploratory Factor Analysis (EFA) from the application SPSS, because this explains the covariation from a set of measured variables and identifies the common factors which establish the structure and order among the variables [21].

The data analysis was performed with the statistical tool TwoStep Cluster Analysis from the SPSS application.

Table 1. Survey for the consumers of food products - content and form

Nr. crt.	Objective	Form	Variants of answer / content
	Subject profile		
1	Gender	multiple answers	feminine, masculine
2	Age	filling-in item	text (years)
3	Studies		studies: primary, secundary, academic
4	Residence environment	multiple answers	rural, urban
5	Income per family member	multiple answers	<2,000, 2,000-4,000, >4.000 (lei/pers.)
6	County of residence	multiple answers	Iași, Botoșani, Suceava, Vaslui, Bacău, Neamț, Vrancea
7	Health condition	multiple answers	weak, acceptable, good, very good
	LFP consumption		
8	Fresh vegetables	filling-in item	text (kg)
9	Fruits	filling-in item	text (kg)
10	Eggs	filling-in item	text (buc.)
11	Milk and mik-derived products	filling-in item	text (l/kg)
12	Honey	filling-in item	text (kg)
13	Meat and meat-derived products	filling-in item	text (kg)
	Mode, place, information, reasons		
14	Interaction form with the local producers	selection items, short text	face to face, by telefon, on-line, others
15	Place of purchase	multiple answers	agricultural market, doorstep subscription, online, agrifood shops, at farm, fairs, festivals and other events, tourist resorts, specialised shops, others
16	Knowledge on the production process	multiple answers	not at all, some, good, very good, in full
17	Knowledge on traceability	multiple answers	not at all, poor, good, very good
18	Motive of LFP purchase	selection items, short text	healthy products, non-certified ecological products, confortable purchase, lower prices than those from supermarket, lower content in chemical substances, sustaining the local producers, shpping as a relaxation mode, pleasant contact with the local producers, others
19	Motive of not purchasing LFP	filling-in item	text
20	LFP price versus in supermakets	multiple answers	-30, -20, -10, +10, +20, +30
21	Value of the increased price when giving-up arises	multiple answers	+10, +20, +30, +40, +50

Source: Own data.

Table 2. Survey for the agricultural producers – content and form

Nr. crt.	Objective	Form	Variants of answer / content
	Subject profile		
1	Gender	multiple answers	feminine, masculine
2	Age	filling-in item	text (years)
3	Studies		primary, secondary, academic
4	Residence environment	multiple answers	rural, urban
5	County of residence	multiple answers	Iași, Botoșani, Suceava, Vaslui, Bacău, Neamț, Vrancea
	LFP sales		
6	Fresh vegetables	filling-in item	text (kg)
7	Fruits	filling-in item	text (kg)
8	Eggs	filling-in item	text (buc.)
9	Milk and milk-derived products	filling-in item	text (l/kg)
10	Honey	filling-in item	text (kg)
11	Meat anf meat-derived products	filling-in item	text (kg)
	Mode, place, information, reasons		
12	Interaction form with the local producers	selection items, short text	face to face, by telefon, on-line, others
13	Sale place	multiple answers	agricultural market, doorstep subscription, on-line, agri-food shops, at farm, fairs, festivals and other events, tourist resorts, specialised shops, others
14	Information about the production process	multiple answers	not at all, some, good, very good, in full
15	Information about the knwoledge on traceability	multiple answers	not at all, poor, good, very good
16	Motive of LFP sale	selection items, short text	healthy products for local inhabitants, non-certified ecological products, confortable sale, high prices at purchaser, cost saving, sustaining the local consumers, direct sale stimulates the quality, pleasant contact with the local consumers, others
17	Motive not to sell LFP	filling-in item	text
18	LFP price versus supermarkets	multiple answers	-30, -20, -10, +10, +20, +30 (%)
19	Value of price decrease when giving-up arises	multiple answers	+10, +20, +30, +40, +50 (%)
20	Time consumption	item de completare	text (hours/week)

Source: Own data.

This tool allows the creation of natural groups (clusters) in a data set that would not otherwise be obvious in another way. This grouping is based on both categorical and continuous variables, involves the automatic selection of the number of clusters and efficiently analyzes large databases. It also uses a measure of the distance of probability that assumes that the variables in the modeled cluster are independent [4].

RESULTS AND DISCUSSIONS

After the validation of the subjects' answers to surveys, a representative distribution for the studied area has been obtained. The subjects - potential consumers (n=244) have been structured as follows: 42.2% urban and 57.8% rural; 49.5% women and 50.5% men; age: 34.0% 0-29 years old, 40.2% 30-59 years old, 25.6% over 60 years old; studies: 32.8% - primary, 54.8% - secondary, 12.4% - academic; income: 33.6% below 2,000 lei, 44.3% between 2,000 lei, 22.1% over 4,000 lei.

The subjects - potential producers (n=54) have been structured as follows: 41.8% urban and 58.2% rural; 49.6% women and 50.4% men; 34.4% with ages between 0-29 years old, 40.4% with ages between 30-59 years old and 25.2% over 60 years old; studies: 32.5% primary, 55.3% secondary, 12.2% academic.

The conduct of the Exploratory Factor Analysis has been done on 244 potential consumers and 54 potential producers from the North-East Development Region of Romania. The set of data has been appropriate for EFA, the coefficient Kaiser-Meyer-Olkin = .69, Barlett's test for sphericity, (x^2) = 151,332 $p < .001$ for the analysis of consumer's answers and respectively, Kaiser-Meyer-Olkin = .71, Barlett's test for sphericity, (x^2) = 1671,543 $p < .001$ for the analysis of producer's answers. EFA has been applied on 6 items and it has been identified a single factor, quantity of sold and purchased products, for both surveys.

The studied subjects have purchased in the last month, on average, from the local producers: 19.4 kg fresh vegetables, 10.5 kg fruits, 14.8 pieces eggs, 8.8 l/kg milk and milk-derived products, 1.7 honey and 5.6 kg meat and meat-derived products.

The LFP consumers have a general profile (Table 3) based on face-to-face interaction (70.7%). They buy mostly from specialised shops (41.5%). This characterstic has been identified also at the LFP consumers from Turkey, where the specialised shops have recorded a significant purchase frequency [13].

The subjects studied by us declared that they have good knowledge on the production process of the purchased LFP (37.0%), as well as on the traceability of these products (38.7%); they motivate the purchase of LFP through the wish to consume fresh products (30.3%); they consider the price of these products as being lower by 20% in comparison with that of the food products in supermarkets (27.8%) and they are willing to further buy LFP, even if the price would increase by 30% (44.2%). The subjects who declared that they do not consume this type of products motivate their decision by the fact that they do not benefit from a certified quality (29.3%).

Some of the claims concerning LFP, sustained in the specialized literature, have been partially confirmed by the results of our research. The main reasons of LFP buyers are the quality, the traceability and the confidence in producer, while the main dobts are caused by the low food security [7].

Regarding the use of technology, about 30.7% of consumers use the telephone and Internet in communicating with the producers. This fact is encouraging, because it facilitates and makes more efficient the sale – purchase processes. These are also those who use more a products purchase channel. Among them, 73.0% have secondary and academic studies and are more loyal to LFP consumption that the sample average, willing to continue to buy up to a price increase of 36.3%.

In turn, the LFP consumption in the studied area and for the studied population seems not to have a solid ground, because the consumers argue that they are motivated by the product quality and they have enough information about the traceability and the production process.

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Table 3. Answers of consumers and producers

Nr. crt.	Objective	Variants of answer / content
	LFP consumers	
14	Interaction form with the local producers	Face-to-face (70.7%), by telephone (22.0%), on-line (7.3%)
15	Place of purchase	Agricultural market (16.5%), doorstep subscription (3.5%), on-line (3.0%), small shops (18.0%), direct from the farm (7.0%), from fairs, festivals and other events (5.5%), from tourist resorts (5.0%), specialised shops (41.5%)
16	Knwoledge on the production process	Not at all (5.3%), some (28.4%), good (37.0%), very good (26.3%), in full (2.9%)
17	Knowledge on the traceability	Not at all (5.5%), poor (32.8%), good (38.7%), very goode (23.0%)
18	Motive of purchasing LFP	Healthy products (30.3%), ecological products, but they are not certified (9.9%), confortable purchase (9.2%), lower prices than in supermarket(14.6%), low content in chemical substances (1.9%), I sustaine the local producers (12.6%), shopping as a relaxation mode (2.7%), I like to meet the producers (7.3%), I protect the environment (11,4%)
19	Motive not to purchase LFP	Poor hygiene (21.4%), disconfort (23.2%), decentralised selling (26.1%), non-certified quality (29.3%)
20	LFP price versus supermarkets	-30 (11.1%), -20 (19.7%), -10 (27.4%), +10 (27.8%), +20 (14.1%), +30 (4.3%)
21	Value of price increase causing giving-up	+10 (25.3%), +20 (32.5%), +30 (44.2%), +40 (20.1%), +50 (35.7%)
	LFP producers	
12	Interaction form with the local consumers	Face-to-face (53.5%), by telephone (29.7%), on-line (16.8%)
13	Place of sale	Agricultural market (31.6%), doorstep subscription (5.1%), on-line (18.4%), small shopss which sell also local products (13.3%), direct from the farm (27.6%); from fairs, festivals and other events(4.1%); from tourist resorts (0.0%), specialised shops (2.0%)
14	Information about the production process	Not at all (0.0%), some (31.4%), good (29.4%), very good (15,0%)
15	Information about the traceability	Not at all (0,0%), poor (39.2%), good (31.4%), very good (29.4%)
16	Motive for selling LFP	To benefit from healthy products (19.9%), they are ecological products, but they are not certified (9.9%), the manner of selling is confortable (15.9%), the prices are lower than those from en- gros purchasing (3.3%), is more economic (13.9%), I help the local consumers (11.3%), the activity of direct selling motivates me to produce with a higher quality (14.6%), I lenjoy to meet the local consumers (11.3%)
17	Motive not to sell LFP	It produces cereals (7.4%), higher trading costs (22.9%), uneven sales (28.4%), high costs of transportation (15.1%), disorganised market (26.2%)
18	LFP price versurs supermarkets	-30 (3.7%), -20 (46.3%), -10 (7.4%), +10 (25.9%), +20 (7.4%), +30 (9.3%)
19	Value of price decrease causing giving-up	-10 (45.3%), -20 (35.8%), -30 (15.1%), -40 (0,0%), -50 (3.8%)
20	Time consumption	9.52 (ore)

Source: Own calculation.

But this information cannot be verified and is not sustained by the certification from the institutions specialised in food security. Consequently, the main reason for purchasing LFP is superficial and can disappear in time. The community- and environment-related reasons are almost non-existent. Only 12.6% of the questionned persones declared that they are motivated by the support given to the local producers, and only 11.4% consider that they are protecting the environment.

The interveiwed producers sold LFP, during the last month, on average: 3,706.1 kg fresh vegetables, 263.2 kg fruits, 395.1 pieces eggs, 743.9 l/kg milk and mik-derived products, 186.8 kg honey and 282.2 kg meat and meat-derived products. They prefer the face-to-face interaction (53.5%); they sell mostly on the agri-food market (31.6%); they poorly inform the consumers about the production process (31.4%) and about the traceability of products (39.2%); they motivate the selling on this channel by the preferrence to supply their fellow citizens with healthy products (19.9%); consider that they are selling products cheaper by 20% than in supermarkets (46.3%); they would decide to stop the consumption on this way if the price would decrease by 20% (35.8%) and they consume cca. 9.52 hours / week for this selling form. Subjects who stated that they do not sell the products to the local consumers motivate their decision especially by the uneven sales during the year (28.4%).

Regarding the distribution channel, about 33.1% of producers use other sale means than the traditional ones (direct from the farm, on the agrifood markets and the client doorstep subscriptions). This share of producers take oders online or telephone and deliver at home or at other locations, established in advance. All the subjects from this category have secondary or academic education level and they are less loyal to LFP consumption than the sample average, being willing to continue to sell up to a price decrease by 17.0%. They can represent the group of LFP producers that would stenghten the short chain and could benefit from their advantages.

The conduct of the TwoStep Cluster Analysis, on the LFP consumers on the 21 characteristics resultated from survey (Fig. 1) has allowed to set-up two clusters with a good quality of form (0.64) with the main predictors of importance: place of purchasing LFP, type of interactions with sellers and client gender. The continous variables have been the sold quantities, and the discret ones have been those referring to: subject profile, sale mode and place, received information and the purchase motivation.

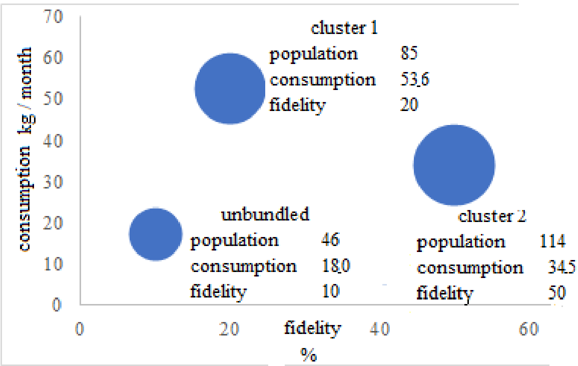

Fig. 1. Highlighting the population grouped in clusters, according the consumption and fidelity to clients
Source: Own calculation

The Cluster 1 for consumers (49.2%) has been formed by persons: with the residence address in urban area (frequency – frq. 72.0%); with ages between 30 and 60 years old (frq. 15.2%); with academic studies (frq. 50.0%); women (frq. 58.5%); who are willing to buy these products even at a price increase by 50% (frq. 52.5%); who have an income between 2,000 lei and 4,000 lei (frq. 49.1%); who declare to be very well informed on the production process (frq. 47.5%); who prefer to interact face-to-face with the producers (frq. 43.2%); who declare to have a very good health condition (frq. 36.4%); who consider that LFP are by 10% more expensive than those in supermarkets (frq. 28.0%); who buy from the agri-food market (frq. 16.1%) and motivate the purchase decision by the fact that LFP are healthy products (frq. 11.9%).

These cosumers may be named "elevated consumers", because they display a higher interest on the food impact, as they are older than those belonging to Cluster 2 for consumers, and they have a higher educational level and urban residence. They consider to have got enough information about LFP, they agree to pay a higher price than for the products in supermakets and they remain loyal even by a signficant price increase. This group has common elements with that of the Polnish LFP consumers, who usually are 30-40 years old, well educated and with a good financial status. But they are more interested by the trading with on-line tools than those belonging to this cluster [5].

This segment of consumers is partially similar to "organic meat consumers" and families with children of preschool and early school age mentioned in the study conducted by Leonidivna S.N. and Pylypivna A.O. (2017), who are focused on a healthy lifestyle, have above average income and seek high quality [14].

The Cluster 2 for consumers (50.8%) has been formed by persons from the rural area (frq. 68.0%), with secondary education (frq. 73.3%), men (frq. 88.5%); who prefer face-to-face interaction with the producers (frq. 93.4%); who declare that they are well informed about the production process (frq. 44.3%); who consider to have good health condition (frq. 41.8%); who are poorly informed about LFP traceability (frq. 41.8%); who obtain an income between 2,000 and 4,000 lei (frq. 37.7%); who consider that the prices of these products are by 10% lower than those in supermarket (frq. 32.8%); who are willing to continue to buy, even if the price would increase by 20% (frq. 32.0%); who prefer the agri-food market (frq. 23.8%); who are young people, under 30 year old (frq. 14.7%), motivating the LFP purchase by prices smaller than in supermarket and the fact that LFP do not contain harmful chemical substances (ff. 13.1%).

The consumers from this cluster may be named "pragmatic consumers", being attracted by the smaller prices of LFP in comparison with those in supermarkets. They are not very convinced about the tehnological process referring to LFP and are less loyal regarding this category of purchases. These persons, in general young, are accustomed, like the rural population, to buy a large part of products from the local agri-food market. The same perception upon the LFP impact seems to be highlighted also within other research conducted in Poland, Lithuania, Slovakia and Ukraine, where the opinions of the interviewed buyers could be noticed in the case of the following criteria: taste, price and freshness of products [2].

The conduct of TwoStep Cluster Analysis in SPSS on LFP producers on the 20 characteristics resultated from survey (Fig. 2) allowed to draw-up two clusters with a qood quality of the form (0.61), having as main predictors of importance: providing the clients clients with information on the production process, the reason and place of trading. The continuous variables were the sold quantities, while the discret variables were those concerning the subjects' profile, the sale mode and place, the provided information and the reasons to sell.

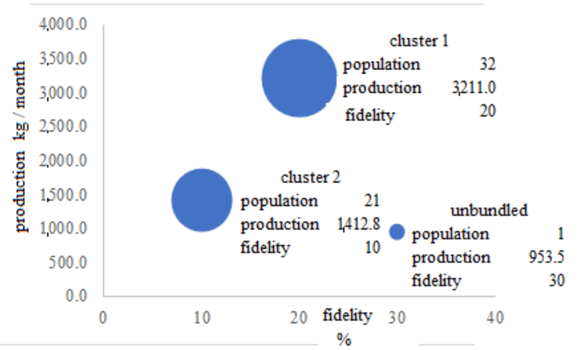

Fig. 2. Highlighting the population groupped in clusters, according to production and fidelity to clients
Source: Own calculation.

The Cluster 1 for producers (61.1%) has been formed by producers from the rural area (frq. 87.9 %), with secondary education (frq. 75.8%), men (frq. 69.7%); who interact prioritary face-to-face (frq. 57.1%); who provide the clients with poor information regarding the traceability of the food products they produce (frq. 57.1%); who appreciate that their products are cheaper by up to 20% (frq. 51.4%); who are willing to accept a price decrease by up to 20% (frq. 48.6%); who moderate inform their clients about the production processes of the food they produce (frq. 45.7%); who are accustomed to sell directly from the farm (frq. 34.3%); who have for this a time consumption of cca. 3 hours (frq. 31.4%) and apply this type of trade because they consider that this mode of selling is confortable (frq. 22.9%).

The producers form the Cluster 1 can be generic named “conservative producers”, because they have a stronger profile of producer than of seller, though they consume less time for selling and they prefer to sell rather from the farm, without making significant efforts to inform about the traceability and production processes. The preferred interaction form derives from the nature of sale, but it does not seem to represent a client fidelisation tool. They appreciate the prices as lower than those of the products in supermarkets by a share of 20%, value considered resonable for price reduction. Practically, they are not open to accept the non-favourable situations when they have to step back, in order to keep the consumers' interest.

The Cluster 2 for producers (38.9%) has been formed by producers from the rural area (frq. 52.4%), with secondary education (frq. 71.4%), women (frq. 63.2%); who inform very well the consumers about the production processes of the products they sell (frq. 78.9%); who carry on a mixed interaction: face-to-face, by phone and on-line (frq. 63.2%); who are open to sell up to a price decrease by maximum 10% (frq. 63.2 %); who inform very well the clients regarding the traceability of their products (frq. 47.37%); who consider that they have a price lower by 20% than the price of the agri-food products in supermarkets (frq. 36.8%); who sell their products on the agri-food market, by oders via Internet and delivery at home or in the residence zone (frq. 36.8%); who motivate this type of trading by declaring that they wish for their clients to benefit from healthy products; the direct selling activity motivates them to produce with higher quality; they enjoy to meet the consumers (frq. 31.6%) and they consume for this cca. 5 hours per week (frq. 26.3%).

The Cluster 2 of producers can be named generic “trader - producers”, because they undertook the role of seller more proeminent than the Cluster 1. Include in majority women concerned with the clients' information, who provide a more complete communication and are motivated by this communication. They consider that it is ethically to provide quality products to the people in the neighbourhood. At least they declare this fact. Probably, this profile is more efficient taking into account the smaller consumption of time for the post-production activities, but also the higher quantity of sold LFP. This type of local producer seems to be like the Ukranian local producers studied by Babych M. (2018), who promotes the social interaction, community and relations development, increase of social cohesion and access to healthy products, among others [3]. We consider that the producers characterised by this cluster can represent vectors for the development of the local product markets in Romania. This producers correlate the consumers' requirements with the production processes and undertake with responsability the role of traders.

The population not included in clusters is characterised by a signficant diversity determined by: aspect of the demographic profile, interaction type, forms of purchasing / selling, perception on prices and trading process. From here is possible to imerge innovative forms of networks for the production-trading of LFP. The limits of our reseach rely precisely in the difficulties to determine such profile with an early stage of development, but which could be highlighted within some broader research studies.

CONCLUSIONS

The LFP consumers interact face-to-face with the sellers (70.7%); they buy especially from specialised shops (41.5%); they have good knowledge about the production process (37.0%) and, also, about the traceability of products (38.7%); they buy LFP because these are healthy (30.3%); they consider the price as being lower by 20% in comparison with that from supermakets (27.8%) and they will further buy up to a price increase by 30% (44.2%). The reluctance regarding LFP is caused by the lack of quality certification (29.3%).

A share of 30.7% consumers use phone and Internet in communicating with the producers, thus facilitating and increasing the efficiency of the purchasing - selling processes. They use more than one channel to purchase products. In turn, the main reasons may dissapear in time. The opinions about the higher quality of LFP and the information concerning the traceability or the production process can not be verified.

The reasons with community and environmental character are present by 12.6% and 11.4%, respectively.

The producers prefer the face-to-face interaction (53.5%); they sell mostly on the agri-food market (31.6%); they poorly inform the consumers about the production process and traceability of products (31.4% and 39.2%, respectively); they motivate the selling by the supply of healthy products to their fellow citizens (19.9%); they consider that they sell cheaper by 20% than in supermakets (46.3%), but they will give up if the price would decrease by 20% (35.8%).

The producers using other modalities of selling than the traditional ones (33.1%), who have secondary or academic education, may represent the actors who would strengthen the short chains of food products and who could benefit from their advantages.

The TwoStep Cluster Analysis suggests the profiles: “elevated consumers” and “pragmatic consumers”, “conservative producers” and “trader - producers”.

The Cluster 1 for consumers, “elevated consumers” (49.2%), is characterised by the residence in urban area (frq. 72.0%); they have academic studies (frq. 50.0%), they are women (frq. 58.5%) and have an income between 2,000 lei and 4,000 lei (frq. 49.1%); they are very good informed about the production process (frq. 47.5%); they interact face-to-face with the producers (frq. 43.2%); they appreciate the prices as being by 10% more expensive than in supermarkets (frq.

28.0%) and they motivate their purchase decision by the fact that LFP are healthy products (frq. 11.9%).

The Cluster 2 for consumers include the “pragmatic consumers” (50.8%), who are persons from rural area (frq. 68.0%), with secondary education (frq. 73.3%), men (frq. 88.5%); who prefer the face-to-face interaction with the producers (frq. 93.4%); who declare that they are well informed about the production process (frq. 44.3%); who consider that they have a good health condition (frq. 41.8%) and they are poorly informed about the LFP traceability (frq. 41.8%). These are the followers of the customs originating in the communist period, marked by shortcomings, or even before it.

The Cluster 1 for producers, including the “conservative producers” (61.1%), has been formed by persons from the rural area (frq. 87.9 %) with secondary education (frq. 75.8%), men (frq. 69.7%); who interact prioritary face-to-face (frq. 57.1%); who provide the clients with poor information regarding the traceability (frq. 57.1%) and who appreciate that their products are cheaper by up to 20% (frq. 51.4%). They are not open to make efforts to strenghten this chain.

The Cluster 2 for producers, the “trader - producers” (38.9%), are characterised by the residence in the rural area (frq. 52.4%), secondary education (frq. 71.4%), women (frq. 63.2%); they inform very well the consumers about the production processes related to the products they sell (frq. 78.9%); they carry on a mixed interaction: face-to-face, by phone and on-line (frq. 63.2%) and they are open to sell up to a price decrease by maximum 10% (frq. 63.2 %). These undertake the responsibility for the role of seller and they correlate the consumers' requirements with the production processes.

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ANALYSIS OF GLOBAL TRENDS IN GM MAIZE APPROVALS IN THE PERIOD 2014-2018

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Abstract

GM maize events are developed for the benefit of the global population but their approval in each country varies according to consumer acceptance, needs and commercial interests. This study analyzed the number of global approvals (by country and type of approval) for GM maize in the period 2014-2018, based on statistical data collected from the ISAAA-GM Approval Database. Descriptive statistics, regression equations and coefficient of determination were used to identify the trends for these indicators. The results showed that a total of 691 applications were approved in 28 countries. In 2016 was registered the highest number of food, feed and cultivation approvals. South Korea, Argentina, Brazil and Taiwan were the top four countries with the most food approvals, Brazil, South Korea, Argentina and Japan were the top four countries with the most feed approvals, and Argentina, Brazil, Japan and Canada were the top four countries that issued the most cultivation approvals. In developing country the rate of acceptance for GM maize was higher compared to developed countries. Europe issued a total of 26 approvals only for food and feed, with most approvals being issued in 2016.

Key words: *cultivation approvals, feed approvals, food approvals, events*

INTRODUCTION

The first genetically modified (GM) crops were established in China (1992) for tobacco and cucumber, but officially China started cultivating GM crops in 1996. The first approval for commercial sale of a food product from a GM crop was in the USA, in 1994 for FlavrSavr™ tomato (delayed ripening) developed by Calgene Company. The first approval for the commercialization of GM maize was in the United States in 1995, namely for *Bt* maize with insect resistance developed by Ciba-Geigy Company [14].

In 1996, only six countries (USA, China, Canada Argentina, Australia and Mexico) cultivated GM crops on 1.7 million hectares, and in 2018, it reached to 29 cultivating countries and an area of 191.7 million hectares. In 2018, the top five GM crops cultivating countries were the USA, Brazil, Argentina, Canada and Paraguay, and the main commercially GM crops were soybean, maize, cotton and canola. GM maize occupied the second position (after soybean) with of cultivated area of 33.14 million hectares [5, 13].

Genetically modified crops offer many benefits to farmers, representing an important part of global agriculture [5]. Increasing the number of GM events, crops and traits leads to increased benefits for the global population but their approval for cultivation, food or feed in each country according on demand, needs and trade interest [1].

Farmers have adopted GM crops rapidly since its first commercialization in 1996. The expansion of these areas is due to the approval and marketing of new events that have improved traits to increase food production and mitigate problems related to unfavorable environmental factors (climate change, new diseases and pests).

According to [7], in 2018 the global economic benefits obtained by farmers have been of US$225 billion, and 53.8% of these income gains were for developing country farmers.

A transformation event (shortened to „event”) is the insertion of a piece of foreign DNA into the genome of an organism. To harmonize their regulatory approach for GM events, countries' efforts are coordinated by multilateral fora such as the Codex Alimentarius Commission, Cartagena Protocol on Biosafety (a supplementary agreement to the Convention of Biological Diversity) and Codex Alimentarius [16].

In 2018, maize (*Zea mays* L.) ranked as the first cereal crop globally in terms of grain yield. Of the global area of 197.2 million hectares, 30% (58.9 million hectares) were cultivated with GM maize [10, 13].

Maize is used as a raw material for industry or as direct human food, as well as feed. Also, maize is an important source of profit farms with export potential [18, 19, 20, 21].

The continuous increase of the human population and implicitly of the consumption of food of animal origin leads to the increase of the maize demand. The climatic changes and various other biotic and abiotic stresses limit the increase of maize yield and its quality. In order to overcome these challenges, it was necessary to use genetic engineering for the genetic improvement of this crop [23]. GM maize events incorporate not only abiotic stress tolerance, but and high yield and improved nutritional quality.

Currently, there is the possibility of developing new traits using transformation combined with genomics and genome editing, technologies that will have a major influence on the dynamics of global agriculture ushering in a new era of molecular breeding and varietal development [15].

In this context, the present paper analyzed the trends of GM maize events and approvals in the period 2014-2018.

MATERIALS AND METHODS

This study is based on statistical data collected from the International Service for the Acquisition of Agri-biotech Applications: GM approval Database in the period 2014-2018, in terms of the GM maize events and approvals in the world. In this paper food, feed and cultivation approvals are treated individually (approvals expired or under renewal are not included).

The indicators analyzed were: number of events, number of approvals for food; number of approvals for feed, number of approvals for cultivation, number of countries that issued approvals for food, number of countries that issued approvals for feed, and number of countries that issued approvals for cultivation.

The number and share of dominant transgenic traits in GM maize events were also analyzed.

On the other hand, the number of GM maize events and approvals for Europe (EU-28 as 1 country) was detailed. The methods used were: descriptive statistics (mean, standard deviation, coefficient of variation, minimum and maximum values); trend line, regression equations (Y=bX+a) and coefficient of determination (R^2). The data were statistically processed using Microsoft Excel, and presented in Tables and illustrated in Figures.

RESULTS AND DISCUSSIONS

Global trends in GM maize approvals

In the 5-year period (2014-2018), 28 countries (EU-28 counted as 1) imported and cultivated a total of 92 GM maize events and approved a total of 691 applications (Table 1 and 3).

In addition to these commercialized events, there are other events that have been developed, tested and then abandoned for commercial purposes [1]. Brazil, Argentina, Japan and South Korea were the top four countries by total number of approvals food, feed and cultivation). It was noticed that South Korea did not cultivate GM maize in the studied period. For use as food there were approved 320 applications in 26 countries with the top four countries being South Korea, Argentina, Brazil and Taiwan (Table 1). A total of 249 applications were approved in 23 countries for use as feed, the top four countries being Brazil, South Korea, Argentina and Japan. Also, a total of 122 approvals were approved in 12 countries for cultivation, the top four countries being Argentina, Brazil, Japan and Canada (Table 1). Of the total approving countries, 17 (65.3%) were developing countries that issued food approvals, 17 (73.9%) were developing countries that issued feed approvals, and 9 (75%) were developing countries that issued cultivation approvals, which indicates a higher acceptance rate in these countries compared to developed countries (Table 1).

Table 1. Number of GM maize events and approvals: by country and by type of approval (2014-2018)

Country	No. approvals as:							
	Total	Rank	Food	Rank	Feed	Rank	Cultivation	Rank
Argentina*	82	2	29	2	24	3	29	1
Australia	6	21	6	17	0		0	
Brazil*	84	1	29	3	29	1	26	2
Canada	33	5	11	12	11	9	11	4
China*	10	19	5	19	5	17	0	
Colombia*	29	8	21	5	6	16	2	11
Costa Rica*	1	28	0		0		1	12
European Union	26	10	13	10	13	6	0	
Honduras*	2	27	1	25	1	22	0	
Indonesia*	4	26	3	23	1	23	0	
Iran*	5	25	5	20	0		0	
Japan	62	3	20	7	20	4	22	3
Malaysia*	24	13	12	11	12	7	0	
Mexico*	33	6	21	6	12	8	0	
New Zealand	6	22	6	18	0		0	
Nigeria*	19	15	10	14	9	12	0	
Pakistan*	12	18	4	22	4	20	4	7
Paraguay*	26	11	8	15	8	14	10	5
Philippines*	26	12	11	13	11	10	4	8
Russia*	6	23	3	24	3	21	0	
Singapore	24	14	15	8	9	13	0	
South Africa*	19	16	8	16	8	15	3	10
South Korea	59	4	31	1	28	2	0	
Taiwan	28	9	28	4	0		0	
Turkey*	10	20	0		10	11	0	
United States	16	17	5	21	5	18	6	6
Vietnam*	32	7	14	9	14	5	4	9
Zambia*	6	24	1	26	5	19	0	
TOTAL	691		320		249		122	

* Developing countries
Source: Own calculation based on the data from [11].

In the studied period, the evolution of the number of all types of approvals (food, feed or cultivation) registered decreasing trends with peaks and lows (Figure 1).

The number of food approvals reached its peak at 84 approvals in 2016 and declined to 57 in 2015, to 53 in 2017 and to 58 in 2018. The number of feed approvals reached its peak in 2016 at 61 approvals and declined to 45 in 2017 and to 40 in 2018. Also, the number of cultivation approvals reached its peak in 2016 at 28 approvals and declined to 20 in 2017 and 2018. The coefficients of determination showed that 9.2%, 24.6% and 67.6%, respectively, of the variation of the number of food, feed or cultivation approvals is caused by year's variation (Figure 1).

The declining trends for the number of events and approvals were determined probably due to the trend in more developing countries to adopt other GM crops, such as rice and potato and also due to the low international price of maize in 2017 [12].

The global trends of approving countries presented in Figure 2 showed decreases during the studied period. The number of countries that issued food approvals reached its peak in 2016 at 18 countries then declined to 15 in 2015 and 2017 and to 14 in 2018. The number of countries that issued feed approvals stagnated at 13 in 2015, 2016 and 2017, and declined to 11 in 2018. Also, the number of countries that issued cultivation approvals registered a decline significantly from 10 countries in 2014 to 5 countries in 2017 and 2018.

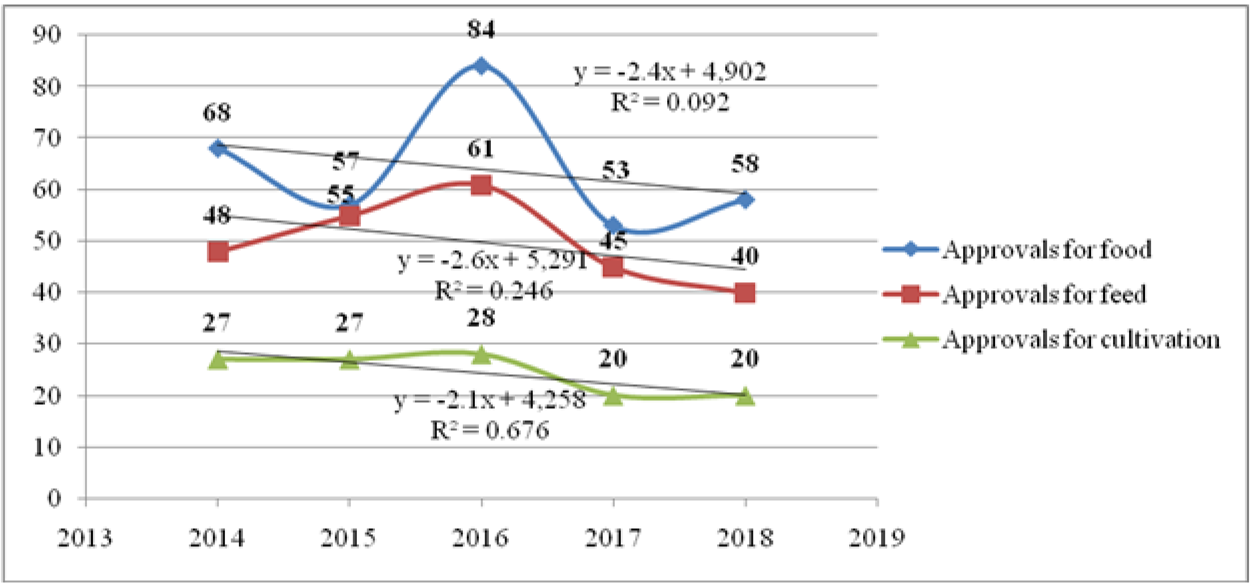

Fig. 1. Global trends in number of GM maize approvals for food, feed or cultivation (2014-2018)
Source: Own design and calculation based on the data from [11].

The coefficients of determination showed that 17.3%, 50% and 70.3%, respectively, of the variation in the number of countries that issued food, feed or cultivation approvals is determined by variation of the years.

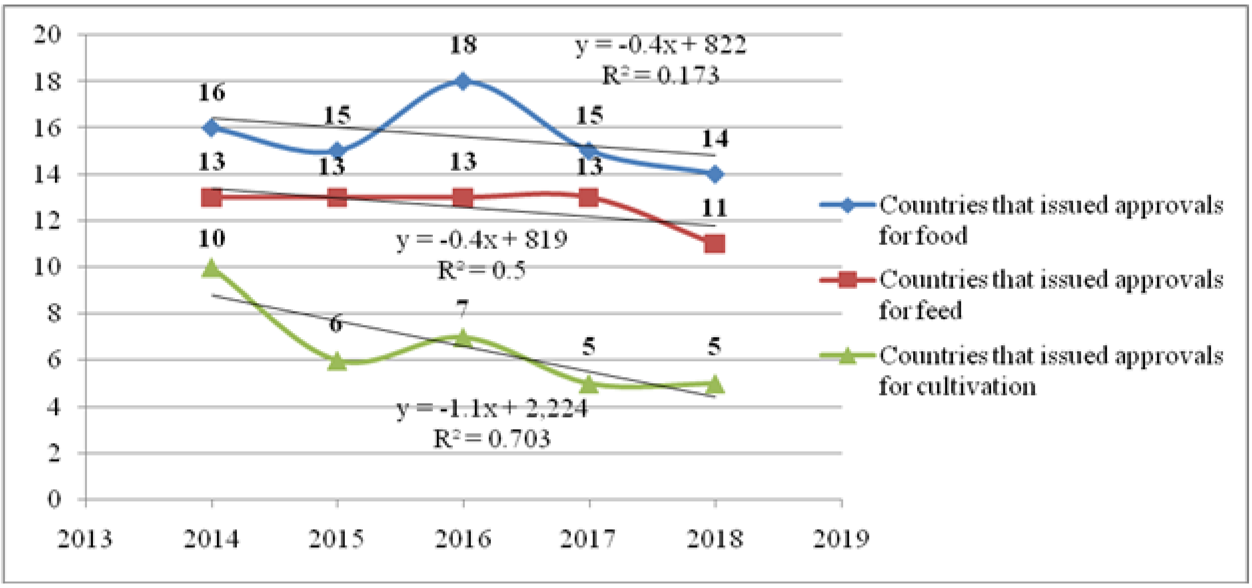

Fig. 2. Global trends in number of countries that issued GM maize approvals (for food, feed or cultivation) in the period 2014-2018
Source: Own design and calculation based on the data from [11].

In the 5-year period, the average of the total number of approvals was of 138.2 with a minimum level of 118 in 2017 and 2018, and a maximum level of 173 in 2016 (Table 2).
In term of type of approval (for food, feed or cultivation) the minimum level was of 53 (2017), 40 (2018) and 20 (2017, 2018), respectively, and the maximum level was of 84 (2016), 61 (2016) and 28 (2016), respectively.
In the case of the number of approving countries that have issued approvals for food, feed or cultivation, the minimum level was of 14 (2018), 11 (2018) and 5 (2017, 2018), respectively, and the maximum level was of 18 (2016), 13 (2014, 2015, 2016, 2017) and 10 (2014), respectively.

The values of the coefficients of variation varied from a studied indicator to another. In the case of the number of total approvals, food approvals, feed approvals and cultivation approvals, the values of the variation coefficients ranged between the limits of 10% and 20% reflecting that the these data are relatively homogenous. In the case of countries that issued approvals for food and for feed, the values of the variation coefficients were lower than the 10% limit, showing that these two indicators did not varied too much and remained relatively homogeneous over years, but in the case of countries that issued approvals for cultivation, the coefficient of variation was higher than the 30 % limit, reflecting a very large variation in the data (Table 2).

Table 2. Statistics calculated for the studied indicators in global context (2014-2018)

Indicator	Average	St. dev.	Variation coefficient (CV %)	Minimum	Maximum
Total approvals	138.2	22.6	16.3	118	173
Approvals for food	64.0	12.5	19.5	53	84
Approvals for feed	49.8	8.3	16.6	40	61
Approvals for cultivation	24.4	4.0	16.6	20	28
Countries that issued approvals for food	15.6	1.5	9.6	14	18
Countries that issued approvals for feed	12.6	0.9	7.1	11	13
Countries that issued approvals for cultivation	6.6	2.1	31.8	5	10

Source: Own calculations based on the data from [11].

GM maize events approved in the studied period were improved for 6 commercial traits (single or stacked): herbicide tolerance, insect resistance, modified product quality; altered growth/yield, abiotic stress tolerance and pollination control (Table 3).

Table 3. GM maize events approved in world: by commercial traits (2014-2018)

Rank	Commercial traits	Events	
		No.	%
1	HT +IR	59	64.1
2	HT	12	13.0
3	IR	10	10.8
4	HT + IR + MPQ	3	3.3
5	HT +IR + AST	2	2.2
6	AG/Y	1	1.1
7	AST	1	1.1
8	MPQ	1	1.1
9	HT + AST	1	1.1
10	IR + AST	1	1.1
11	PC	1	1.1
	TOTAL	92	100

HT-Herbicide tolerance; IR-Insect resistance, MPQ -Modified product quality, AG/Y-Altered growth /yield; AST -Abiotic stress tolerance; PC-Pollination control
Source: Own calculations based on the data from [11].

The top three GM maize events with the highest number of approvals in world were events with HT+IR stacked traits included in 59 events or 64.1% of the total number of events, followed by events with HT trait included in 12 events (13%), and events with IR trait included in 10 events (10.8%) (Table 3).

GM maize approvals in EU

In the studied period, the European Union approved 13 GM maize events. 9 events (69.2%) of them have a combination of herbicide tolerance and insect resistance, 2 (15.4%) events have only herbicide tolerance, 1 (7.7%) has insect resistance, and 1 (7.7%) has abiotic stress tolerance (Table 4).

In 2014, the EU did not issue any approvals, and since 2015 it has issued approvals only for food and feed. In 2016, most approvals were issued.

A total of 26 approvals were issued: 13 food approvals and 13 feed approvals (without cultivation approvals (Table 5)

According to [2] the authorization process of applications for the events crops in the EU is considered as one of the strictest in the world, each new event has to undergo a risk analysis before a committee of the member states can vote on its approval.

Table 4. GM maize events approved in EU: by commercial traits (2014-2018)

Rank	Commercial traits	Events	
		No.	%
1	HT +IR	9	69.2
2	HT	2	15.4
3	IR	1	7.7
4	AST	1	7.7
	TOTAL	13	100

HT-Herbicide tolerance; IR-Insect resistance, AST - Abiotic stress tolerance
Source: Own calculations based on the data from [11].

Table 5. Indicators studied for EU (2014-2018)

Indicators	2014	2015	2016	2017	2018
Total approvals	0	4	14	4	4
Approvals for food	0	2	7	2	2
Approvals for feed	0	2	7	2	2

Source: Own calculation based on the data from [11].

MON810 event with the inserted *cry1A(b)* gene which confers protection against certain lepidopteran insect was the only maize event approved for cultivation in EU, but this event was first authorized in 1998 (for 10 years) for use as food and feed and also, for cultivation. In 2007, Bayer applied for the renewal of the MON10 authorization, receiving a favorable opinion in 2009 only from EFSA. To date, the cultivation authorization for the MON 810 is considered „no expiration date as long as the renewal application is pending". For use as food and feed, the European Commission adopted the renewal of the authorization in 2017 [9]. In 2014 and 2015, 5 member states (Spain, Portugal, Czech Republic, Romania and Slovakia) cultivated MON810 maize, and in 2016 only 4 (Spain, Portugal, Czech Republic and Slovakia). Although the benefits of cultivating MON810 have been reported in numerous studies [3, 4, 6, 8, 22], Romania has not cultivated GM maize since 2016, probably for variety reasons, such as strict requirements for reporting on cultivation of GM crops and non-preference of farms for this GM crop.

According to EU Decision 2016/321, since 2016 a number of 21 member states announced that they restrict the cultivation of GM maize [17], and only two countries (Spain and Portugal) continued to cultivate this crop in the period 2016-2018 [13].

CONCLUSIONS

In the studied period (2014-2018), a total of 28 countries (with EU-28 as one) have approved a total of 691 applications (for food, feed and cultivation).

The commercialization and cultivation of GM maize approvals showed that since 2014, when 143 total approvals were issued, the number decreased in 2017 and 2018 to 118 total approvals.

On the other hand, in 2016 was registered the highest number of food, feed and cultivation approvals, and the highest number of countries that issued approvals for food.

South Korea, Argentina, Brazil and Taiwan were the top four countries with the most food approvals.

Brazil, South Korea, Argentina and Japan were the top four countries with the most feed approvals, and also, the top four countries that issued the most cultivation approvals were Argentina, Brazil, Japan and Canada.

Globally, the top three maize event with the highest number of approvals were events that combined herbicide tolerance with insect resistance traits (64.1% of total events), followed by events with herbicide tolerance (13%) and events with insect resistance (10.8%).

EU-28 (as 1 country) issued a total of 26 approvals, only for use as food and feed, with most approvals being issued in 2016.

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EFFECTS OF AGRICULTURAL EXPORTS ON ECONOMIC GROWTH IN NIGERIA: A CO -INTEGRATION ANALYSIS (1980-2019)

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Abstract

The study analysed the nexus between agricultural exports and economic growth in Nigeria. Time series data covering the period between 1980 and 2018 were utilized by the study. Data were analysed using descriptive statistics, Augmented Dickey-Fuller statistics, Johansen's co-integration method, and vector error correction mechanism (VECM). The results of the time series analysis revealed that the first difference of the variables is stationary and co-integrated. Descriptive analysis results reveal a fluctuating trend in the volume of agricultural exports and economic growth with an average of 351.99 tonnes and $24,200,000 respectively. The contribution of agricultural exports to economic growth declined progressively, with an average of 7.09 percent. VECM results reveal that agricultural exports volume and ratio of average world price to producer price of agricultural export commodities negatively affects economic growth. While exchange rate affects economic growth positively. The study concluded that agricultural exports, exchange rate, and the ratio of average world price to producer price of agricultural export commodities are significant determinants of economic growth in Nigeria. Thus, embarking on agricultural policy interventions that will stimulate increased agricultural export supply, stable producer prices of agricultural export commodities and a friendly macro-economic environment for agricultural exports would promote economic growth.

Key words: *agricultural export commodities, agricultural policy interventions, error correction mechanism*

INTRODUCTION

Agriculture has been the pivot of the Nigerian economy at independence in the 1960s. The sector through agricultural exports contributed significantly to the total Gross Domestic Product (GDP) of Nigeria. The sector is the largest employer of labour in Nigeria, providing employment more than 36% of the total labour force [8] and [13].

The agricultural exports sub-sector was the highest foreign exchange earner in the Nigerian economy in 1960s; contributing over 60 percent of the GDP through the exports of agricultural commodities such as Cocoa, Palm oil, Cotton, Rubber and Ground nuts [5].

However, the advent of oil exploration and subsequent production in commercial quantities in the early 1970s led to serious neglect of the agricultural export sector by the government for the quick income generating crude oil sector; a phenomenon known as "Dutch Disease" [3].

Although, the oil boom era in the 1970s led to significant changes in the Nigerian economy such as increase in government revenue, rapid development of infrastructural facilities and improvement in GDP, the agricultural export sector continues to suffer serious decline in output because little or no attention was given to the sector by the government [11].

Consequently, the neglect of the agricultural sector resulted into serious food and economic problems, especially food insecurity and balance of payment deficit as food importation bills continue to surge [4].

The contribution of agriculture to Nigeria's total export earnings is small relative to crude oil exports. For instance in 2019, agriculture contributed less than 2% of total exports, while the crude oil sub-sector contributed 76.5%. Agricultural exports declined by about 11% from ₦302.2 billion in 2018 to ₦269.8 billion in 2019 [13].

According to [7], [12], [2], and [17] as cited by [15], in emerging economies, the role of agricultural exports in the growth and development of the economy is a serious policy issue. Growth in real exports is expected to cause improvement in real GDP and product. This can be attributed to the fact foreign exchange earnings from exports will help in the acquisition of industrial and capital goods, and technological advancement in production.

The hypothesis of Adam Smith and Ricardian export-led growth (ELG) which postulates that export is a significant factor in economic growth and development has been subjected to empirical analysis by a number of studies and its role in economic growth and development is a significant policy matter in under-developed and emerging economies [6] and [9].

Serious arguments have erupted in the literature on the link between economic growth and agricultural exports. It has been established by a number of empirical studies that a significant relationship exists between agricultural exports and economic growth in the first, second, and third world countries.

Some of these studies ([5]; [11]; [1]; [16]; [10]; [14] and [9]) argued that foreign exchange earnings from agricultural exports are used to procure imported capital goods, which will result in a long-run expansion of the productive capacity of the less developed countries with comparative disadvantage in the manufacture of capital goods.

From the foregoing, the study analysed the influence of agricultural exports on economic growth in the economy of Nigeria from 1980 to 2019. Specifically, the study examined trends in agricultural exports volume, GDP growth, agricultural exports contribution to GDP, and the relationship between agricultural exports and growth in the economy of Nigeria over the study period.

MATERIALS AND METHODS

Time series data for the period between 1980 and 2018 were employed in the study. The data were obtained from reputable sources such as publications of Central Bank of Nigeria (CBN), National Bureau Statistics (NBS) and Food and Agriculture Organisation Statistical Database (FAOSTAT). Data were analysed with trend analysis model, Augmented Dickey Fullers tests, Johansen co-integration model and error correction analysis

The implicit model used in this study is specified as follows:

$$\Delta lnX_{1t} = \alpha_1 + \alpha_2\Delta lnX_{1t-1} + \alpha_3\Delta lnX_{2t-1} + \alpha_4\Delta lnX_{3t-1} + \alpha_5\Delta lnX_{4t-1} + \alpha_6\Delta lnX_{5t-1} + \alpha_7\Delta lnX_{6t-1} + \lambda_1 ECT_{t-1} + u_{t1} \ldots\ldots (1)$$

$$\Delta lnX_{2t} = \beta_1 + \beta_2\Delta lnX_{1t-1} + \beta_3\Delta lnX_{2t-1} + \beta_4\Delta lnX_{3t-1} + \beta_5\Delta lnX_{4t-1} + \beta_6\Delta lnX_{5t-1} + \beta_7\Delta lnX_{6t-1} + \lambda_2 ECTt_{-1} + u_{t2} \ldots\ldots (2)$$

$$\Delta lnX_{3t} = \theta_1 + \theta_2\Delta lnX_{1t-1} + \theta_3\Delta lnX_{2t-1} + \theta_4\Delta lnX_{3t-1} + \theta_5\Delta lnX_{4t-1} + \theta_6\Delta lnX_{5t-1} + \theta_7\Delta lnX_{6t-1} + \lambda_3 ECT_{t-1} + u_{t3} \ldots\ldots (3)$$

$$\Delta lnX_{4t} = \rho_1 + \rho_2\Delta lnX_{1t-1} + \rho_3\Delta lnX_{2t-1} + \rho_4\Delta lnX_{3t-1} + \rho_5\Delta lnX_{4t-1} + \rho_6\Delta lnX_{5t-1} + \rho_7\Delta lnX_{6t-1} + \lambda 4\ ECT_{t-1} + u_{t4} \ldots\ldots (4)$$

$$\Delta lnX_{5t} = \phi_1 + \phi_2\Delta lnX_{1t-1} + \phi_3\Delta lnX_{2t-1} + \phi_4\Delta lnX_{3t-1} + \phi_5\Delta lnX_{4t-1} + \phi_6\Delta lnX_{5t-1} + \phi_7\Delta lnX_{6t-1} + \lambda_5 ECT_{t-1} + u_{t5} \ldots\ldots (5)$$

$$\Delta lnX_{5t} = €_1 + €_2\Delta lnX_{1t-1} + €_3\Delta lnX_{2t-1} + €_4\Delta lnX_{3t-1} + €_5\Delta lnX_{4t-1} + €_6\Delta lnX_{5t-1} + €_7\Delta lnX_{6t-1} + \lambda_6 ECT_{t-1} + u_{t6} \ldots\ldots (6)$$

Where:
X_1 is economic growth represented by gross domestic product (GDP) in $billions;
X_2 is volume of agricultural exports in tonnes;
X_3 is exchange rate measured as amount of ₦ exchanged per $;
X_4 is interest rate in the economy measured in percentage;

X_5 is inflation rate in the economy measured in percentage;
X_6 is the ratio of average world price to producer price of agricultural export commodities;
Δ is the difference operator;
$_{t-1}$ is the lagged values of variables;
ECTt is the error correction term;
U_{ts} are stochastic random errors;
α, β, θ, ρ, ϕ, λ and € are parameters to be estimated.

RESULTS AND DISCUSSIONS

Trends in the volume of agricultural exports (tonnes) (1980-2019)

Table 1 and Figure 1 present the trend in agricultural exports volume during the period under study. Data in the Table reveals a fluctuating trend in agricultural exports volume rising from 252.30 tonnes recorded during the 1980-1989 period to 407.36 tonnes in 2010-2019. The highest and lowest values of agricultural exports volume were 252.30 tonnes and 407.36 tonnes respectively, occurring in the 1980-1989 and 2010-2019 sub-periods respectively. The overall average agricultural exports volume for the entire period of the study stands at 351.99 tonnes. degree of instability over the study period.

Table 1. Trends in volume of agricultural exports (tonnes) in Nigeria (1980-2019)

Sub-period	Average volume ('000 tonnes) per annum	Annual percentage change	Coefficient of variation
1980-89	252.30	+0.18	44.75
1990-99	353.33	-13.35	38.92
2000-09	405.98	-6.71	33.01
2010-19	407.36	+38.34	9.41
All periods	**351.99**	**-3.00**	**36.48**

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

The intra sub-period percentage change per year in agricultural exports volume shows that the average positive annual growth rate was recorded during the 1980-1989 and 2010-2019 sub-periods, while a negative annual growth rate was recorded in the 1990-1999 and 2000 and 2009 sub-periods. The average annual growth rate of agricultural exports volume was a negative of -3.00 percent for the duration of the study. Trends in the coefficients of variation show a high degree of instability in the agricultural exports volume, ranging between 9.41 percent and 44.75 percent, and averaging 36.48 percent over the study period. Generally, agricultural exports volume reflects a high.

Fig. 1. Trends in volume of agricultural exports (tonnes) in Nigeria (1980-2019)
Source: Authors' computation, 2021.

Trend in economic growth represented by gross domestic product (GDP) in Nigeria (1980-2019)

Table 2 and Figure 2 show the trend in economic growth (proxied by GDP) in Nigeria between 1980 and 2019. The trend in the GDP shows a stagnation between 1980 and 1994, thereafter, it increases sharply between 1995 and 2019, with increasing averages across the sub-periods. It increases from $190,558.60 in the 1980-1989 sub-period to $83,907,233.00 in the2010-2019 sub-period. Average GDP during the study period is in the range of $190,558.60 in the 1980-1989 sub-period and $83,907,233.00 in the 2010-2019 sub-period, averaging $24,200,000.00 for the period covered by the study. The trend in the intra sub-period annual percentage growth rate in GDP shows a positive growth rate of 4.37 percent in the 2010-2019 sub-period. However, a negative annual percentage growth rate of -18.67 percent, -32.99 percent, and -22.74 percent in GDP were recorded in the 1980-1989, 1990-1999, and 2000-2009 sub-periods, with an average of -3.00 percent growth rate for the entire period of the study. The coefficients of variation ranged from 56.63 percent to 21.50 percent, with an average of 138.43 percent over the study period, indicating that GDP was not stable during the period covered by the study.

Table 2. Trend in economic growth represented by GDP in Nigeria (1980-2019)

Sub-periods	Average economic growth (GDP) (USD)	Annual Percent change	Coefficients of variation
1980-89	190,558.60	+18.67	56.63
1990-99	2,752,327.00	-32.99	69.91
2000-09	22,747,393.00	-22.74	55.83
2010-19	83,907,233.00	+4.37	21.50
All Periods	24,200,000.00	-18.66	138.43

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

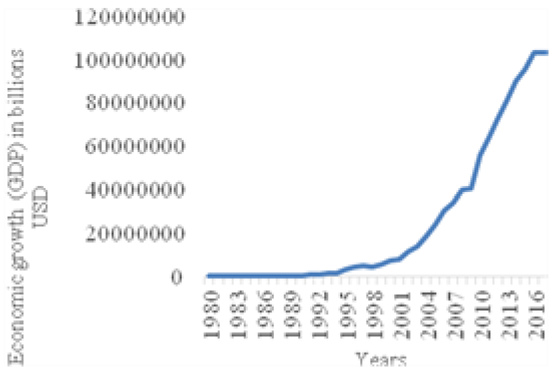

Fig. 2. Trend in economic growth (GDP) ($ billions) in Nigeria (1980-2019)
Source: Authors' computation, 2021.

Trend in the contribution of the agricultural exports to economic growth (GDP)

The trend in the contribution of agricultural exports to economic growth (GDP) in Nigeria is presented in Table 3 and Figure 3. The Table and Figure reveal that contribution of agricultural exports to economic growth (GDP) in Nigeria continuously decline over the study period, decreasing progressively from 13.24 percent in the 1980-1989 sub-period to 0.49 percent in the 2010-2019 sub-period. The lowest average contribution of agricultural exports to economic growth occurred in the 2010-2019 sub-period, and the highest average contribution of agricultural exports to economic growth is recorded in the 1980-1989 sub-period. Agricultural exports was responsible for 7.09 percent of the growth in the Nigerian economy during the period under study.

In summary, there is a steady decline in the contribution of agricultural exports to economic growth during the study period.

Table 3. Trend in the contribution of the agricultural exports to the economic growth (GDP) in Nigeria (1980-2019)

Sub-periods	Average value of export ('000 USD)	Average GDP ('000 USD)	Contribution to economic growth (Percentage)
1980-89	252.38	1,905.59	13.24
1990-99	358.33	2,752.33	12.84
2000-09	405.98	22,747.39	1.79
2010-19	407.36	83,907.23	0.49
All Periods	356.01	27,578.14	7.09

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

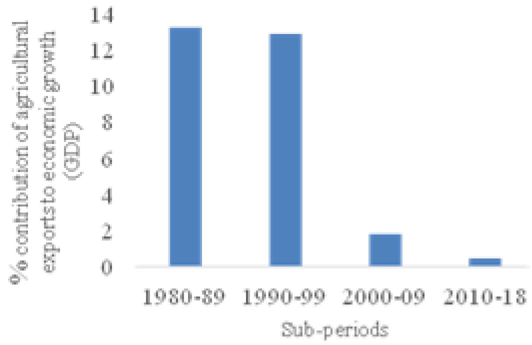

Fig. 3. Trend in percentage contribution of agricultural exports to economic growth (GDP) (1980-2019)
Source: Authors' computation, 2021.

Short run equations

Economic growth (GDP) equation

X_{1t} = -0.04 (-0.00) + 0.635 (4.99)* X_{1t-1} – 14120.72 (-3.30)* X_{2t-1} + 33010.65 (0.87) X_{3t-1} – 1.30e07 (-1.05) X_{4t-1} – 4089.45 (-0.14) X_{5t-1} – 79736.63 (-0.92) X_{6t-1} – 0.01(-1.99) **ECT_{t-1} R^2 = 0.73

Volume of agricultural exports equation

X_{2t} = 78.19 (1.98) ** - 7.60e-07 (-0.13)* X_{1t-1} – 0.17 (-0.86) X_{2t-1} – 1.28 (-0.71) X_{3t-1} + 433.07 (0.74) X_{4t-1} – 1.76 (-1.24) X_{5t-1} + 8.63 (2.11)* X_{6t-1} + 6.27e-07(2.61)*ECT_{t-1} R^2 = 0.56

Exchange rate equation

X_{3t} = -2.77 (-0.73) + 3.30e07 (0.57) X_{1t-1} – 0.028 (-1.47) X_{2t-1} + 0.50 (2.95)* X_{3t-1} – 30.42 (-0.54) X_{4t-1} + 0.04 (0.33) X_{5t-1} – 0.41 (-1.05) X_{6t-1} – 5.83e-08(-2.55)*ECT_{t-1} R^2 = 0.48

Interest rate equation

X_{4t} = 0.02 (1.65) - 1.74e-10 (-0.09) X_{1t-1} + 0.00 (1.27) X_{2t-1} – 0.00 (-0.19) X_{3t-1} – 0.03 (-0.17) X_{4t-1} – 0.00 (-1.27) X_{5t-1} + 0.00 (1.24) X_{6t-1} + 9.35e-11(1.25) $ECTt_{-1}$ R^2 = 0.15

Inflation rate equation

X_{5t} = -8.20 (-2.00) * - 2.68e-07 (-0.43) X_{1t-1} – 0.17 (-0.86) X_{2t-1} + 0.13 (0.70) X_{3t-1} + 26.59 (0.44) X_{4t-1} – 0.28 (-1.85) X_{5t-1} + 0.17 (0.17) X_{6t-1} – 7.53e08 (-3.03)*ECT_{t-1} R^2 = 0.45

Ratio of average world price to producer price of agricultural export commodities equation

X_{6t} = 3.30 (1.46) + 2.10e-07 (0.61) X_{1t-1} + 0.02 (1.37) X_{2t-1} – 0.14 (-1.38) X_{3t-1} + 27.94 (0.84) X_{4t-1} + 0.12 (1.53) X_{5t-1} + 0.15 (0.67) X_{6t-1} + 2.85e-08(2.08)*ECT_{t-1} R^2 = 0.35

Long run equation

ECT = 1.00X_{1t-1} – 1234898 (-10.00)* X_{2t-1} + 3899326 (8.07)* X_{3t-1} – 9.3e08 (-4.74) X_{4t-1} + 4197355 (5.00) X_{5t-1} – 1.62e07 (-10.50)* X_{6t-1} + 9.67e08

In the economic growth (GDP) short-run equation, the coefficients of agricultural exports volume have a negative sign, and are significant statistically at a 1% level, implying a short-run negative impact of agricultural exports volume and economic growth (GDP).

In the same way, in the agricultural exports volume equation, economic growth (GDP) is negatively signed and is significant statistically at the 1% level. These results imply that economic growth (GDP) is inversely related to agricultural exports volume, and the ratio of world price to producer price of agricultural export commodities is directly rated to agricultural exports volume during the study period.

Long-run equation reveals that agricultural exports volume and the ratio of world price to producer price of agricultural export commodities have a positive impact on the gross domestic product, while the exchange rate has a negative impact on the gross domestic product. The coefficients are significant statistically at the 5% level.

The adjustment term (0.01) is statistically significant at a 5% level, suggesting that last year's error or deviation from long-run equilibrium are rectified for within the current year at a convergence speed of 10%.

In summary, from the estimated ECM equations, the error correction factor coefficient is negative as expected and is significant, statistically at a 1 percent level. The coefficients of agricultural exports volume and world price to producer price of agricultural export commodities ratio lagged by one year is negatively signed and is significant, statistically at 1 percent. The exchange rate coefficient lagged by one year is has a positive sign and is significant statistically at 1 percent.

CONCLUSIONS

From the empirical findings from this study, it is concluded that agricultural exports, exchange rate, and the ratio of average world price to producer price of agricultural export commodities has a significant influence on economic growth. Thus, embarking on agricultural export policies interventions that will improve production and agricultural export supply, stabilise producer prices of agricultural export commodities, and a friendly macro-economic environment for agricultural exports would promote economic growth.

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EFFECTS OF MACRO-ECONOMIC VARIABLES ON FISHERIES SUPPLY IN NIGERIA (1980-2019)

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Abstract

Fish is an important source of animal protein in Nigeria. The per capita consumption of fish in Nigeria has suffered a serious decline in the recent years due to declining production. The study investigated the macro-economic determinants of fisheries supply in Nigeria between 1980 and 2019. Secondary data spanning 39 years (1980 – 2019) were sourced from reputable organizations. Food and Agricultural Organization database (FAOSTAT) Nigeria Bureau of Statistics (NBS) and Central Bank of Nigeria (CBN) Data were analyzed using mean, percentages coefficient of variation, Augmented Dickey-Fuller statistics, Johansen Co-integration and vector error correction model (VECM) result of statistical analysis revealed that variable of the model was stationary after first difference with co-integration among the variable Descriptive results shows the fluctuation in the agriculture capture fisheries and total fisheries supply over the study period with a mean of 88,890.48 tonnes, 453,278.80 tonnes and 547,043.50 tonnes respectively average annual growth rate of agriculture capture fishery and total fishery production were 502.42 percent, 187.98 percent, and 298.59 percent respectively. VECM results revealed that population has an asymmetric effect on total fishery supply in the short and long run. However, exchange, interest, and inflation rate negatively influence fishery supply, the study concludes that population, exchange, interest, and inflation rate significantly influence total fisheries supply in the study area. Thus, it is recommended that there is a need for significant improvement in aquaculture production and reduction in fish importation to cushion the effect of exchange, inflation, and interest rate on the economy.

Key words: *domestic fish supply, domestic fish demand, exchange and inflation rates, error correction mechanism*

INTRODUCTION

Fish is very important to nutrition among Africa populace [5]. Maintaining the required levels of animal-sourced protein is an important factor in fighting malnutrition among the populace, especially children in Africa [10]. Africa generally as a continent is confronted with acute food shortage and malnutrition problems [2], and fish is one of the most sourced animal protein across the African continent [6]. The situation is not different in Nigeria where there is a high prevalence of malnutrition and fish is of the most sourced animal protein food sources. [12], [16] and [13]. As in other developing coastal nations, especially in West Africa, Nigeria recorded a high prevalence of micro-nutrients deficiencies among children, in spite of the fact that 20% of the current fish catches can supplement children's nutrient requirements [11] and [3].

The fishing industry in Nigeria comprises of three major sub-sectors; artisanal, industrial, and aquaculture which has the full potential of augmenting significantly, the domestic fish production and supply in the country [1].

The amount of fish or other aquatic organisms consumed as food that consumers in Nigeria are willing and are able to buy annually at a particular price is known as the demand for fish in Nigeria. The amount of fish or other aquatic organisms consumed as food that is produced and made available for consumption and utilization domestically is known as fish supply [15]. Fish supply in

Nigeria currently comes through two major sources; the capture fishery (capture) and aquaculture fishery (aquaculture) [7], [8] and [15]. The total amount of fisheries resources that are harvested by the state from all available extensive sources as the aggregate of all fishing effort in terms of manpower, time, gears, and trawlers directed into harvesting fresh water and marine fisheries over a one year period is known as fish capture. Fish capture is therefore independent of harvested fishery resources from aquaculture sources. Aquaculture fishery is made up of fish that are cultivated or farmed in controlled, enclosed, and or confined freshwater or brackish ponds, and they are harvested for consumption or for income generation at maturity [17].

The difference between the demand for fish and fish supply is fish demand-supply gap, which can be a surplus, when supply is higher than demand or a deficit, when demand is higher than supply) [15].

According to the [14]. In 2014, Nigeria population is estimated at 180 million people, demand for fish is estimated at 3.32 metric tonnes, domestic fish production and supply from aquaculture, artisanal and industrial fisheries us estimated at 1.12 metric tonnes, creating a demand-supply gap of 2.20 metric tonnes which is met through fish importation. Also in 2014, the contributions of fisheries to Agriculture Gross Domestic Product (Ag GDP) were 0.48% and 20.24% respectively.

Furthermore, the [8] and [9] reported that Nigeria currently produces about a 0.8million metric tonnes of fish annually, with domestic annual demand estimated at 2.7 million tonnes, resulting in a deficit of 1.9 million metrics tonnes of fish, which is supplemented through annual importation of $1.2 billion worth of fish into the country. Currently, Nigeria is the fourth leading importer of fish in the world, behind China, Japan, and the United States [3]. This incessant importation of fish signifies an enormous loss of foreign exchange earnings to Nigeria which is detrimental to economic growth and development [17 and [15].

Nigeria is blessed with a vast amount of inland water bodies and gasoline estimated at 800 km and providing means of livelihood to about 1.5 million people who are engaged in fish-based livelihoods [9], [19] and [2]. The output of Nigeria's fisheries is estimated at one million tonnes of fish per annum, with capture fisheries supplying over 750,000 tonnes and about 310,000 tonnes are produced from aquaculture fisheries. [19] and [3]. Despite being blessed with a coastline of Atlantic Ocean measuring about 853 kilometres, and other water resources such as freshwater bodies, mangrove swamps, coastal rivers, creeks, onshore and offshore, waters, bays, and estuaries, it is not clearly understood why Nigeria still supplemented her domestic fish demand through fish importation. Eight out of thirty-six Nigerian states, with 25% of the total population of Nigeria are surrounded by the coastline of the Atlantic Ocean; a major fishing resource of the world. Yet, domestic demand for fish is more than domestic production and supply,, resulting in a huge supply-demand deficit.

In view of the above, the study investigated the effects of macro-economic variables on fisheries supply in Nigeria over the study period (1980 – 2019). The study examined trends in aquaculture production, capture fisheries production, total fisheries production, and the influence of macro-economic variables on fisheries supply in Nigeria during the study period (1980 – 2019).

MATERIALS AND METHODS

The research was conducted in Nigeria. With about 186 million people in 2014, Nigeria is the country with highest population in Africa [4], [19] and [3], and it continues to grow steadily each year. From 2010 to 2016, Nigeria's population grew an average of 17% annually [18]. The data for this research were in annual time series. The data set was obtained from secondary sources. These sources included publications of the Central Bank of Nigeria (CBN), the National Bureau of Statistics (NBS), and Food and Agriculture Organization (FAO) Statistics (FAOSTAT). Data were collected specifically on capture fisheries supply, aquaculture supply, total fisheries supply, gross domestic product

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(GDP), population, interest rates, inflation rates, and exchange rate. Data analysis covers the period between 1980 and 2019.

This study took advantage of a number of analytical methods based on the previously stated objectives of the study. These include; means, standard deviation, coefficients of variation, percentages, and average growth rate. These statistical tools were used to describe trends in aquaculture supply, capture fisheries supply, and total fisheries supply.

The Augmented Dickey-Fuller statistics were used to examine the stationary of time series data. The Johansen's method was employed in verifying co-integration among the variables of the model. The vector error correction model (VECM) was employed as a tool to investigate the macro-economic determinants of fisheries supply over the study period. The implicit model employed in this study is specified as follows:

$$\Delta LnY_t = \alpha_1 + \alpha_2 \Delta lnY_{t-1} + \alpha_3 \Delta lnX_{2t-1} + \alpha_4 \Delta lnX_{3t-1} + \alpha_5 \Delta lnX_{4t-1} + \alpha_6 \Delta lnX_{5t-1} + \lambda_1 ECT_{t-1} + u_{t1} \ldots\ldots (1)$$

where:

Y is the total fisheries supply in thousands metric tonnes;

X_1 is the GDP valued in USD;

X_2 is the population in millions people;

X_3 is the exchange rate measured as amount of Naira exchanged for USD;

X_4 is the interest rate in the economy measured in percentage;

X_5 is the inflation rate in the economy measured in percentage;

ECMt is the error correction factor.

Δ is the difference operator;

$_{t-1}$ is the lagged values of variables;

Ln is the logarithm operator;

U_{ts} are stochastic random errors;

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6,$ and λ_1 are parameters to be estimated.

RESULTS AND DISCUSSIONS

Trend in aquaculture production in Nigeria (1980-2019)

Table 1 and Figure 1 present the trend in aquaculture production in Nigeria between 1980 and 2019. From the table, aquaculture production fluctuated over the study period. Average aquaculture production ranged from 8,805.20 tonnes in the 1980-1989 sub-period and 2,615,641.60 tonnes in the 2010-2019 sub-period, showing an increasing trend in aquaculture production during the study period. The average aquaculture production over the study period was 88,890.48 tonnes. However, the highest average annual growth rate (328.61%) in aquaculture was recorded in the 1980-1989 sub-period and the lowest annual growth rate (54.03%) in the 2010-2019 sub-period. The intra sub-periods coefficients of variation ranged from 14.16 percent in the 2000-2009 sub-period and highest of 37.82 percent in the 1990-1999 sub-period, with an average of 129.22% over the period of the study, showing a high degree of instability.

Table 1. Trends in aquaculture production (tonnes) in Nigeria

Sub-period	**Annual percent growth rate**	**Annual percentage change**	**Coefficient of variation**
1980-89	259,703.00	7.58	250.07
1990-99	336,130.90	47.46	42.37
2000-09	512,049.50	35.53	11.83
2010-19	705,232.00	19.15	6.81
All periods (1980-2019)	453,278.80	187.98	40.13

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

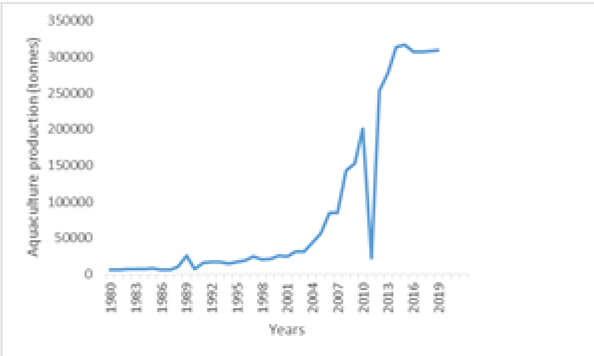

Fig. 1. Trends in aquaculture production (tonnes) in Nigeria (1980-2019)
Source: Authors' computation, 2021.

Trend in capture fisheries production (tonnes) in Nigeria (1980-2019)

Table 2 and Figure 2 present the trend in capture fisheries production in Nigeria between 1980 and 2019. From the table, average capture fisheries production increased progressively across the sub-periods, ranging from 259,703.00 tonnes in the 1980-1989 sub-period to 705,232.00 tonnes in the 2010-2019 sub-period, with a mean of 453,278.80 tonnes over the study period. The average annual growth rate of capture fisheries production alternately decreases and increases during the entire study period, with an all-period mean of 187.98 percent. The intra sub-periods coefficients of variation ranged from 6.81 percent in the 2010-2019 sub-period to 250.87% in the 1980-1989 sub-period, with an average of 40.13 percent over the period of the study, reflecting a high degree of instability in capture fisheries production.

Table 2. Trend in capture fisheries (tonnes) in Nigeria (1980-2019)

Sub-periods	Mean	Annual percent growth rate	Coefficients of variation
1980-89	8,805.20	328.6066	14.29
1990-99	17,452.20	195.86	37.82
2000-09	67,742.90	494.12	14.16
2010-19	2,615,641.60	54.03	28.54
All Periods	88,890.48	502.42	129.22

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

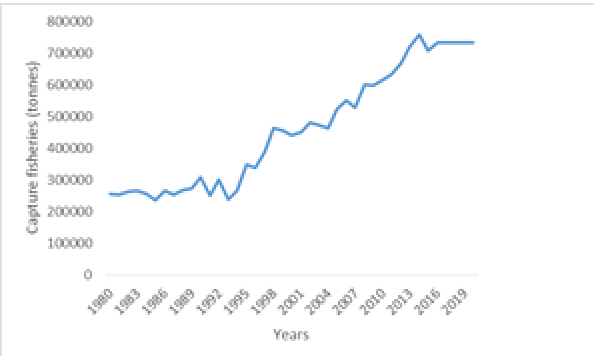

Fig. 2. Trend in capture fisheries production (tonnes) in Nigeria (1980-2019)
Source: Authors' computation, 2021.

Trend in total fisheries production (tonnes) in Nigeria (1980-2019)

The total fisheries production trend in Nigeria over the study period (1980 – 2019) is shown in Table 3 and Figure 3. The table reveals an increasing trend in the average total fisheries production in Nigeria, with the lowest value of 268,514.20 tonnes recorded in the 1980 - 1989 sub-period, and the highest value of 986,284.20 tonnes in the 2010 -2019 sub-period. The overall average total fisheries production during the period of the study is 547,043.50 tonnes. The average growth rate per annum of total fisheries production fluctuated over the study period varying from 14.99% in the 1980 to 1989 sub-period to 6.078 in 2000 to 2009 sub-period with an overall mean of 298.59%, showing that the total fisheries supply increase enormously over the study period The coefficients of variation reflected a high instability in the total fisheries production in Nigeria over the study period varying from 43.07% in 1990-1999 sub-period to 184.75% in the 1980 to 1989 sub-period, with overall of 53.86% during the study period.

Table 3. Trend in total fisheries production (tonnes) in Nigeria (1980-2019)

Sub-periods	Mean	Annual percent growth rate	Coefficients of variation
1980-89	268,514.20	14.99	184.75
1990-99	353,583.10	50.91	43.07
2000-09	579,792.40	60.78	55.16
2010-19	986,284.20	27.40	111.14
All Period	547,043.50	298.59	53.36

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2021.

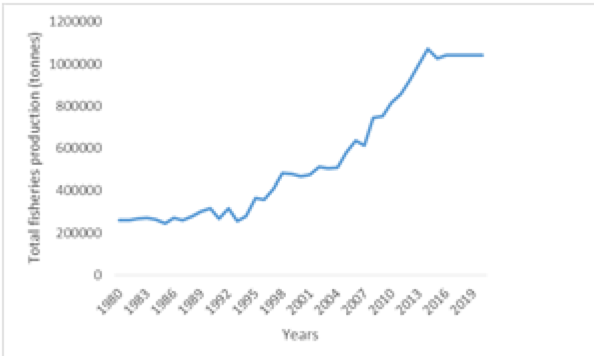

Fig. 3. Trend in total fisheries production (tonnes) in Nigeria (1980-2019)
Source: Authors' computation, 2021.

Results of time series analysis

Unit root test

In time series analysis, it is necessary to consider whether the series contains a unit root or not. In other words, it must be asserted if a time series data is stationary or not. This is because using a non-stationary time series for regression analysis will give false or spurious results which cannot be used for statistical inference.

It is therefore imperative that time-series data must be stationary before it can be used in regression analysis for the results to be suitable for statistical inference and policy formulation. Results of unit root test of the variables of the model using the Augmented Dickey-Fuller (ADF) test in Table 4 reveals the presence of unit root (non-stationary) in the original values of the model, since the ADF statistics are lesser in value than the critical values at 1%, 5% and10% respectively; hence the null hypothesis of no unit root is rejected. Therefore, the series cannot be used for regression analysis in their original values, because the results will be spurious. The model first difference variables ADF unit root test results are presented in Table 5. Data in reveals that the value of ADF statistics is higher than all the critical values at 1%, 5%, and 10% significant levels, implying the acceptance of the null hypothesis of no presence of unit root in the series.

Table 4. Results of ADF unit root test for variables (original values)

Variables	ADF value	Mackinnon critical values			Decision
		1%	5%	10%	
lnY	-3.02	-3.67	-2.97	-2.62	Non-stationary
$\ln X_1$	-1.84	-3.67	-2.97	-2.62	Non-stationary
$\ln X_2$	-2.30	-3.75	-3.00	-2.63	Non-stationary
$\ln X_3$	-2.11	-3.75	-3.00	-2.63	Non-stationary
$\ln X_4$	-3.13	-3.75	-3.00	-2.63	Non-stationary
$\ln X_5$	-3.47	-3.75	-3.00	-2.63	Non-stationary

Source: Authors' computation, 2021.

Table 5. Result of ADF unit root test for variables (first difference values)

Variables	ADF value	Mackinnon critical values			Decision
		1%	5%	10%	
dlnY	-7.63	-3.68	-2.97	-2.62	I(1)
$d\ln X_1$	-5.03	-3.68	-2.97	-2.62	I(1)
$d\ln X_2$	-4.45	-3.68	-2.97	-2.62	I(1)
$d\ln X_3$	-5.02	-3.68	-2.97	-2.62	I(1)
$d\ln X_4$	-6.10	-3.68	-2.97	-2.62	I(1)
$d\ln X_5$	-4.62	-3.68	-2.97	-2.62	I(1)

Source: Authors' computation, 2021.

Co-integration test

Johansen's co-integration test result for all variables in the model is shown in Table 6. The results of the analysis reveal 4 co-integrating equations for the variables of the model, showing that a long-run relationship exists among variables of the model, satisfying the condition for analysis with Vector Error Correction Model (VECM).

Table 6. Results of Johansen tests for co-integration

Maximum rank	Parms	LL	Eigen value	Trace statistics	5% critical value
0	114	-1,008.17	-	177.90	94.15
1	125	-972.31	0.87	106.18	68.52
2	134	-946.87	0.77	55.31	47.21
3	141	-931.11	0.57	25.39*	29.68
4	146	-921.77	0.44	5.12	15.41
5	149	-919.58	0.12	0.74	3.76
6.	150	-919.22	0.02		

Source: Authors' computation, 2021

Results of vector error correction model (VECM)

Results of short-run vector error correction model (VECM) regression analysis

Table 7 shows the results of short and long-run VECM regression analysis. From the table, the value of R^2 is 0.550 and is statistically significant at 1%, confirming that the model has a good fit. In the short run, the coefficient of the population (X^2) is negative and statistically significant at a 1% level, showing an inverse relationship between the variable and fisheries supply in the study area.

Table 7. Short run vector error correction model regression analysis results

Variables	Coefficients	Standard error	z-value	p-value
Ce_1	-0.472	0.139	-3.40	0.000*
Total fisheries supply (Y)	0.306	0.344	0.89	0.373
GDP valued in United State dollars (X_1)	0.319	0.264	1.21	0.228
Population in million people (X_2)	-91.515	33.602	-2.72	0.006**
Exchange rate (X_3)	731.073	826.386	0.890	0.376
Interest rate (X_4)	2,767.552	1,952.532	1.42	0.156
Inflation rate (X_5)	41.271	349.730	0.20	0.906
Constant	-1,780.984	27,061.740	-0.07	0.948
R^2	0.556			
Chi-square	35.501*			
p-value	0.000			
AIC	77.425			

* mean significant at 1% level
** mean significant at 5% level
Source: Authors' computation, 2021.

Results of long-run vector error correction model (VECM) regression analysis

VECM long-run results are shown in Table 5. The sign of the coefficient of the population (X_2) is positive and is significant statistically in the long run at a 1% level, implying a direct relationship between this variable and fisheries supply. However, the coefficients of the exchange rate(X_3), interest rate (X_4), and inflation rate (X_5) are negative and statistically significant at a 1% level. This reveals an inverse relationship between these variables and fisheries sup ly in the study area.

Table 8. Long run vector error correction model regression analysis results

Variables	Coefficients	Standard error	z-value	p-value
Total fisheries supply (Y)	1	-	-	-
GDP valued in United State dollars (X_1)	-0.032	0.096	-0.340	0.736
Population in million people (X_2)	17.631	2.800	6.300	0.000*
Exchange rate (X_3)	-2,007.249	402.252	-4.99	0.000*
Interest rate (X_4)	-10,605.920	2,181.254	-4.86	0.000*
Inflation rate (X_5)	1,335.253	415.939	3.21	0.001*
Constant	618,541.60	-	-	-

*mean significant at 1% level
Source: Authors' Computation 2021.

CONCLUSIONS

Based on findings from the study, it is concluded that population, exchange rate, interest rate and inflation rate are significant factors influencing fisheries supply in Nigeria over the study period. In the light of the study findings, there should be improved aquaculture production to reduce the wide supply-demand gap of fisheries supply as a result of population surge. Also, measures should be taken to reduce fish importation significantly to conserve foreign exchange earnings and cushion the economy against the effects of high inflation and interest rates.

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ORGANIC NICHE AGRICULTURE IN THE SUSTAINABLE DEVELOPMENT OF RURAL AREAS

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Abstract

The purpose of the study is to determine the possibilities of creating conditions for the development of organic agriculture as an effective direction of its greening and niche direction of further development of this branch as a resource basis for sustainable development of rural areas of Ukraine. The research methodology is formed on the basis of a dialectical approach to the study of economic phenomena and includes such methods as the method of analytical generalizations, induction and deduction, scientific abstraction, comparison and monographic description. The results of the study show that organic agriculture in Ukraine has the necessary natural conditions for its development, but its rate is much lower than in European countries. This is evidenced by the low share of organic crops, the extremely negative situation in organic livestock and low levels of consumption of organic products. The development of organic agriculture in Ukraine requires the creation of conditions to increase access to credit for small producers, adapt foreign experience in the industry, to promote the development of certification of products and producers, to develop cooperation and information and advisory services, to promote the consumption of organic food, as well as increasing of government support within the framework of the implementation of the National Economic Strategy of Ukraine for the period up to 2030.

Key words*: *agriculture, organic production, niche direction, ecologization, sustainable development, rural areas.

INTRODUCTION

The sustainable development of rural areas should objectively be the main way of forming their perspective due to its content, which is the optimal combination of development of social, economic and environmental spheres of rural life. There is every reason to agree with that social development cannot be fully possible without simultaneous economic and ecological development, economic – without social and natural, ecological – without social and economic [26]. Naturally, the defining sphere in this triad is economic, which is represented mainly by agriculture as the dominant sphere of economic activity of rural residents. Assessing the situation, it can be affirmed, that agriculture was, is and in the foreseeable future remains the basis for the sustainable development of villages and rural areas as a set of economic, social and environmental spheres of life of the rural population, and hence – a determining factor in their development. Under conditions of aggravation of social and ecological problems of the present as a consequence of deterioration of an economic condition of the village diversification of directions of economic, including directly agricultural activities can objectively play an important role in their solution.

One of the real and effective ways of this diversification under the existing conditions is niche agricultural production, especially organic, the importance of which is growing in the context of the need to implement the concept of sustainable development of rural areas. At the same time, the development of niche organic agriculture is a real way to its greening. It should not be overlooked, that the period of problems less connections between humanity and its activities and the environment has long passed and seems irreversible, so the question of the relationship between society and nature and the use of natural resources are becoming increasingly important. Famous V. Vernadskyy warned mankind, that humanity, social systems, the structure of scientific knowledge, engineering and technology are in unity with the environment. Changes in any component will sooner or later affect the state of the whole system [44]. So, the development of organic agriculture is also one of the most practical ways of the economy ecologization, because, given that agriculture is a branch, in which contact with the environment, comparing to other sectors of the economy, is the closest, as natural resources are the basis of this branch, we can say that agriculture creates the most intense specific negative impact on environment. It is also logical to conclude, that the ecologization of agriculture is one of real ways to resolve the contradictions between the needs of intensifying the use of natural resources and ever increasing human needs meeting.

Apart of that, organic products provide real benefits for the environment and the health of consumers, who prefer to use organic production methods. In addition, there is virtually unlimited demand for organic products in European countries, although their markets require very high quality products. So, the general market for organic products is constantly growing, but the analysis shows, that the rate of this growth could be much higher.

The results of research of economic aspects of the general problem of sustainable development or rural areas are contained in the works of such well-known scientists as V.Ambrosov, D.Dobryak, P.Makarenko, P.Sabluk, M.Khvesyk, V.Shebanin, O.Tsarenko, N.Zinovchuk and others. Regarding the niche crops growing economy and niche products, producing from agricultural raw materials, especially when it is talking about organic farming, it can be argued, that the problems of development of this agricultural sector in Ukraine are also in the spotlight of agricultural economists, analysts and practitioners, including V.Aristov, R.Bezus, V.Bolokhovskyy, A.Gubin, V.Harmashov, Ye.Havaza, G.Humeniuk M.Zhybak, O.Kardash, O.Khodakivska, Yu. Kernasyuk, M.Kobets, O.Maslak, V. Medvedyuk, E. Milovanov, N.Prokopchuk, V.Tereshchenko, V. Shcherban, Yu.Voskobiynyk and others. Important results of the research of the problem are contained in the works of agrarian scientists from other countries such as M.Altieri, G.Beddington, C.Burghelea, K.Ditrtova, C. M.Ene, J.Golaś, B.Grujic, B.Huber, B.Klepatskyy, M. Klodzinsky, E.Krajenbrink, M.Rotkiewich, S.Roljevic, K.Shor, D.Topor, C.Uzlău, P.Vukovic, H.Wheeler, V.Zientara and others. In particular, O. Khodakivska points on the development of organic production as one of the main strategic objectives of agricultural production ecologization [25].

“Organic farming represents a system of safe food in accordance with environmental protection, maintaining soil fertility, ecosystem and human health” [38, p.241].

It is impossible to speak of a high level of well-being of rural residents, if their livelihood, albeit economically and socially efficient, takes place in conditions of low quality of the natural environment. “Organic production in agriculture is definitely fulfilling the idea of sustainable development.” [20, p.165].

«Organic agricultural production enables the production of controlled, certified, safe, and high-quality food, and at the same time it provides high economic and ecological profit and preserves a healthy environment» [21, p.125].

The existent low level of rural social-economic development and low general standard of living in the Ukrainian countryside, especially in terms of its environmental friendliness, indicate the need to continue and to deepen of research on this issue in accordance with today's conditions and needs, especially regarding Ukraine's course to prepare for European integration. Therefore, taking into account the above and assessing the situation with organic agriculture in Ukraine, the aim of the study is to evaluate the condition and to identify main ways of further development of the agricultural sector of the Ukrainian economy as a resource basis for sustainable development of rural areas and diversification of its areas, in particular - through the development of organic niche agriculture.

MATERIALS AND METHODS

Under conditions of the limited official statistical information on the niche organic sector of agriculture as the main sources of information for conducted research were used the results of the authors' own observations and processing of available scientific and practical publications and data on the research topic, as well as data from: AgroPolit.com; Bakertilly; Ecobusiness Group; Ecoindustry.pro; EUR-Lex; Federation of Organic Movement of Ukraine; FiBL Statistics; International Federation of Organic Agriculture Movements (IFOAM); Landlord; Latifundist.com; Organic.info; Organic Standard; Research Institute of Organic Agriculture FiBL; SSSU State Statistics Service of Ukraine.

The general approach to the scientific search for solutions to the problem was based on the use of a dialectical method of cognition of economic phenomena. The study used general scientific research methods, in particular, analytical generalizations - to present the results of systematization and generalization of modern views on niche organic agricultural production as a way of ecologization of the branch in the context of its impact on the sustainable development of rural areas; inductions and deduction - to analyze the state of organic niche agriculture and its impact on the quality of food security of the country; comparison - to compare the efficiency of individual niche crops growing; monographic description - to present some good practices of niche organic production. Statistical analysis of numerical data was carried out using methods of analysis of dynamic series, comparison, calculation and indexes. The main indicators used in the conducted research: number of farms in organic agriculture, cultivated surface in organic agriculture, number of animals in organic farming, organic production volumes.

RESULTS AND DISCUSSIONS

According to FiBL, organic agricultural land in the world in 2019 increased by 1.1 million hectares (1.6%) and amounted to 72.3 million hectares (1.5% of total area of agricultural land) (against 11 million hectares in 1999), and sales of organic products continued to grow, so the market for organic products in the world reached € 106.4 bln (against € 15.1 bln in 2000), incl. € 44.7 - in USA, as it evidenced by data from 187 countries, engaged in organic production The leader in terms of organic market turnover in the United States is following by Germany - € 12 billion and France - € 11.3 billion [18, p.19].The analysis shows high growth rates of organic agriculture and that, the increase in the area of organic farmland in the world is slower than the growth of demand for organic products. The number of producers of organic products in the world in 2019 became 3.1 million [18, p. 55].

In Europe the area of organic farming has reached about 16.5 million hectares in 2019 (EU-14.6 million hectares) and its share is 3.3% of the total agricultural area (EU: 8.1%) [18, p. 228] what is largely due to the International Federation of Agricultural Organic Movement (IFOAM). Over the past 10 years in EU, market of organic food volume has more than doubled - from about € 18 billion in 2010 to over € 41 billion in 2019 (€ 41 billion totally in Europe). So, organic market grew faster (by 8%) than the organic area (by 6 %) [18 p.228].

Ukraine's agricultural sector generates more than 10% of the country's GDP and creates about 40% of total export revenue. According to official data from the State Statistics Service of Ukraine, 41.4 million hectares of land in Ukraine are used in agriculture. Of these, 32.7 million hectares are arable land, what forms one of the largest indicators in the world of plowed land - almost 79% (54% of the country area) [42]. Agricultural producers in Ukraine have been consciously engaged in organic production since 1997. That is, comparing to the developed countries of the world, the historical development of the organic sector of agriculture in Ukraine dates back 15-20 years and its evolution can be divided into three main stages:

- 1991-2001 - the emergence of organic agriculture in Ukraine - its legal framework lays down, the first international agreements on cooperation are concluding and the first export deliveries of organic products are realizing;

- 2002-2012 - formation of the organic market in Ukraine - creation of the Association of participants of organic production "BIOLan Ukraine", of the Federation of Organic Movement of Ukraine, expanding of the range of organic products, adoption of the Law "On Organic Production", which defined legal, economic, social and organizational bases of organic agriculture;
- approximately since 2013 - a jump in the size of organic areas (by 44.2%) and the number of organic producers, the adoption of the Law "On basic principles and requirements for organic production, circulation and labeling of organic products" (came into force on August 2, 2019 p.).

In Ukraine, the total area of agricultural land with organic status and certified according to the standard equivalent to the EU Regulation on organic production in 2019 is 467980 hectares (1.1% of the total area of agricultural land), including the area of agricultural land with organic status (Table 1).

Table 1. Dynamics of the main indicators of development of organic agriculture in Ukraine

	Years					
	2010	2015	2017	2018	2019	2019 in % to 2010
Area of land certified for organic production, thousand hectares	270.2	410.5	420.0	429.1	468.0	173.2
Number of certified organic farms	142	210	375	510	597	4.2 times
Average farm size, ha	1,903	1,952	1,120	841	788	41.4
Volume of the market of organic products in Ukraine, € million	2.4	17.0	29.4	33.0	36.0	15 times

Source: Constructed by authors according to IFOAM and Organic Standard [14], [18], [19], [36].

The results of the calculations presented in Table 1 showed, that in Ukraine in 2010-2019 the size of the market for organic products increased 15 times, while the area under organic crops increased by only 73.2%, and the average farm size decreased by 58.6%. The latter indicates a gradual transition of organic production to smaller farms due to the specifics of organic production. According to calculations, in Ukraine, about 4 million hectares of land can additionally be used for organic production [40]. That is, currently only 11.7% of the possible area is used for growing organic products. According to other estimates, large areas of ecologically clean land - over 7 million hectares - remain unused for the production of organic products [8, p.37)]. Studies show, that "the development of organic production in Ukraine can be carried out not less than on 19% of the total area of agricultural land, which are suitable for the implementation of organic farming" [24, p. 21]. At the same time, Ukraine occupies the first place in the Eastern European region in the certified area of organic arable land, specializing mainly in the production of cereals, legumes and oilseeds [15]. Ukraine currently ranks 20-th place out of 175 countries in terms of the area of all organic agricultural lands [18, p.39-40] (against 23-rd place from 191 countries in 2018) [17, p. 39-40], but unfortunately it was not and is not included into group of 16 countries, where the share of organic agricultural land in their total area is at least 10% [18, p.42] and in the overall ranking of this indicator ranks as much as 68-th with a rate of 1,1% [18, p.43], against 80th with a rate of 0.7% in 2018 (17, p.43]. That is, progress is clearly visible. In 2019, Ukraine entered the group of 10 countries with the highest rates of growth of organic space and ranked 5th there after India, the United States, France and Bolivia with 158,880 hectares per year [18, p. 47].

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In Europe, Ukraine ranks 12th in the area of organic land (after Poland) [18, p. 232].

IFOAM and Organic Standard data confirm, that for 2010-2019, the number of producers of agricultural organic products in Ukraine increased 4.2 times and in 2019 there were already 597 organic farms (Table 1), certified according to standards equivalent to EU and US organic legislation (NOP), what indicates the interest of Ukrainian producers in organic production [18].

But the share of producers of organic products in Ukraine is only 0.01% of the total in the world [18, p.63].

The largest Ukrainian organic producers are presented in Table.2.

Table 2. Top 10 companies of Ukraine by organic area, 2019

No	The company name	thousand hectares
1	Arnica Group	15.0
2	Galex-Agro Group	13.4
3	Agricultural Production Cooperative “Rodyna”	10.0
4	Private Enterprise "Agroecology"	6.9
5	All in foody Group	6.7
6	Agricultural Cooperative after Lenin	6.3
7	Sviatovit-Eco LLC	5.8
8	Agroinvest-Natural Products LLC	5.3
9	Biocore Organic LLC	5.1
10	Ros Agro LLC	4.9

Source: Constructed by authors according to [1, p.21].

Ukrainian certified organic enterprises vary in size from a few hectares, as in most European countries, to several thousand hectares of agricultural land.

The specialization of small organic enterprises focuses primarily on the cultivation of fruits, vegetables and berries. The larger is the enterprise, the more it deals with organic cereals, and legumes (Table 3).

According to FiBL and IFOAM studies, 16 types of organic products have been certified in Ukraine: cereals and legumes, oilseeds, vegetables, watermelons, melons, pumpkins, fruits, berries, grapes, essential oils, meat, milk, mushrooms, nuts and honey. Certified processed products include: grains, cereals, jams, syrups, juices, butter, flour, dairy and meat products, cereals, eggs, flour, pasta, vegetable oils, beverages (fruit/vegetable/ berry and birch juices, herbal teas), dark and white chocolate, spices, canned foods (berry pastes, syrups, jams, vegetables), semi-finished products, snacks (corn sticks, energy bars) etc. [37]. According to Organic Standard, only 154 producers of organic berries, 39 producers of vegetables and 31 producers of fruit are certified in Ukraine. The area of organic gardens is about 2,500 hectares - only 7% of the total area of garden plantings [8, p.37].

Table 3. Examples of diversification of organic agricultural companies in Ukraine

Name	Area, ha	Direction (type of product)	Countries - importers	Specifics
Agricultural firm "Field", Cherkasy region	9,000	millet, pasta cereals, barley, soybeans, rye, chickpeas, lentils, peas, mustard, sunflower, flax	Netherlands, Germany, Austria, Great Britain, Italy, Belgium, Australia, Malaysia, Poland, Czech Republic, France	Quality control - own certified laboratory and European laboratories. There is an organic elevator complex of 5,000 tons for organic millet. The company has two offices in the Czech Republic and Poland.
Arnica Organic, Poltava region	9,460	green lentils, chickpeas, wheat, soybeans, corn, industrial hemp, oil flax, oil sunflower	Switzerland, Germany, Netherlands, Austria and New Zealand	The largest in Ukraine exporter of organic products to Switzerland. Monitoring compliance with organic standards with GPS-monitoring, barcodes. Elevator for 20.5 thousand tons, terminals for road and rail transport, container transportation.
"Danube Agrarian", Odessa region	2,000	watermelon, chickpeas, canola, wheat, peas, barley, millet, peach, lentils, sunflower	Austria, Germany, Romania, Great Britain	The only enterprise in Ukraine that produces certified organic watermelon.
Small Fruit, Kyiv region	300	raspberries, blackberries, strawberries	Germany, France, Denmark, Poland, Switzerland, Norway, USA and Japan	2014 - on the basis of the company established a service cooperative "Kyiv" of farmers of organic farming. Since 2016, Small Fruit distributes the first in Europe and the only franchise in Ukraine for growing organic raspberries
Farmberry, Zaporozhye region	14	dogwood		The only industrial dogwood producer in Ukraine, it has the largest dogwood garden in Europe. Own processing of berries: jams, pastilles, dried fruits, sauces, fruit juices, fresh-frozen berries.

Source: constructed by authors according to [6].

In 2020, Ukraine produced 2,945 tons of organic vegetable products, almost 50% of which are pumpkins, zucchini and other melons. 24% of organic vegetables are the so-called borscht set: potatoes, carrots, beets and other roots. About 10% are onions and garlic (twice as much by 2019). All other vegetables and greens together make up less than 15%. In Ukraine, there are just over 10 companies engaged in the production of organic vegetables indoors. Most of them are small farms, mostly with an area of up to 0.1 ha under organic cucumbers and tomatoes and provide 25% of their production in Ukraine [39].

Of the 485 Ukrainian entrepreneurs which received an organic certificate, only 15 entrepreneurs or 3% of their total number produce livestock products [36]. In this sector, organic production is carried out in meat and dairy cattle and poultry breeding. Organic eggs are not yet in the TOP-5 of organic products in terms of consumption in Ukraine, but in Switzerland it is organic eggs that rank first in terms of consumption. But in 2018-2020, the number of large producers of organic eggs in Ukraine increased from 2 to 5. [35]. It is planned to put into operation two more large poultry complexes, what generally stimulates the demand for appropriate feed.

The production and consumption of organic livestock products is of particular importance, as it provides saturation of the people diet with essential animal proteins, unsaturated fatty acids and trace elements, which has a positive effect on improving health and intellectual potential of the nation, what, combined with the accumulation of added value, forms a solid synergistic effect. The small scale of development of organic livestock deprives the country of this effect.

The unsatisfactory situation with organic animals husbandry is not unique to Ukraine. IFOAM's information shows similar disappointing statistics in this area. In Europe, the share of organic animals in total production is as follows: bovine animals - 4.0% (in EU – 6.0%; in Ukraine - about 1%), sheep - 3.5% (in EU – 5.3%; in Ukraine no subject is certified), pigs - 0.9% (in EU – 1.1%; in Ukraine - less than 1%), poultry – 2.5% (in EU – 4.2%; in Ukraine - less than 1%); milk production in EU – 3.4% (in Ukraine - about 1%) [18, p. 243-244; 28, p.79]. That is, in European countries the share of organic livestock is higher than in Ukraine, but as for Europe it is also very low.

In the EU, high quality of livestock products are also associated with "Protected Designation of Origin" (PDO) and "Protected Geographical Indication" (PGI) products. Of the 565 registered in EU PDOs, almost 70% are designations of origin for livestock products [27, p.56], [28, p.79]. The first Ukrainian products with a geographical indication, recognized in the EU, in 2020 were Hutsul cow and sheep bryndzia, which are completely authentic products and are not produced anywhere else in the world. Such registration of a geographical indication mark will help to expand markets, and consumers will receive products of guaranteed high quality.

According to OrganicInfo.ua., in Ukrainian market in 2020, according to estimates, it has been sold 7,850 tons organic products worth 709 million UAH (equivalent to $25.1 million) [34]. Dairy products make up almost 65% of the total consumption of organic products in Ukraine. The greatest demand is for milk and butter. Second place in terms of consumption (18%) is occupied by cereals and grains, flour and seeds. The greatest demand in this category is for cereals and cereals. In 2020, the consumption of organic eggs and oilseeds increased significantly. Instead, consumption of vegetables and fruits, canned food and ice cream decreased. Despite some market growth, Ukraine's per capita consumption of organic products remains the lowest in Europe at around €1 [18, p.266]. Although every European, according to FiBL and IFOAM, spends about €55.8 (in EU - €84.2) on average per year for organic products [18, p.252] the annual consumption of organic products per capita varies considerably between states-members from € 344 (in Denmark) to € 1 (Slovakia) [13]. This differentiation can be explained by differences in the purchasing power of the population as well as insufficient consumer knowledge of the logo and the benefits of organic production.

In terms of the volume of the domestic market of organic products, Ukraine ranks only 25th in Europe. For every hectare of organic farmland in Ukraine, only €50 enters the domestic market. The "return" of the European organic hectare is 47 times higher - in European countries there is an average of € 2,345 of domestic "pure" market per 1 hectare [29].

The export orientation of organic producers in Ukraine remains a fact. Exporters of organic products from Ukraine enjoy the benefits of the Association Agreement signed in June 2014 between the EU and Ukraine. Since January 2016, the EU and Ukraine have been applying the Deep and Comprehensive Free Trade Area, which is part of the Association Agreement [11].

In general, about 85-95% of all Ukrainian organic products are exported, and the rest remains for processing and domestic consumption [41].Total exports of Ukrainian organic products in 2020 are estimated at $ 204 million [32]. In 2019, Ukraine ranked first in Europe in terms of exports of organic products and second in the world out of 123 countries, rising two places compared to the previous year. During 2019, 3.24 million tons of organic agri-food products were imported into the EU, more than 10% of which were Ukrainian. At the same time, Ukrainian imports to the EU increased by 27%: from 265.8 thousand tons in 2018 to 337.9 thousand tons in 2019, what is $189 million [10]. According to the Organic Standard, the main organic products exported by Ukrainian producers directly from agricultural production are cereals, oilseeds, soybeans, fruits, and millet. Ukraine is the largest exporter of organic cake, fruit juices and vegetables. Top 3 in Ukrainian agricultural export - corn, wheat, soybeans [2]. Moreover, the structure of exported organic Ukrainian products is changing dynamically - if 10 years ago in the structure of export of organic products up to 100% were occupied by cereals, today - wheat - 28.5%, soybeans - 5%. Also, the share of fresh and dried fruits in the supply is 5%, cereals and flour - 1.5% [30] According to Organic Standard, Ukrainian organic products are bought mainly by EU-countries - Netherlands, Switzerland, USA, Germany, Lithuania, Italy, Austria, Georgia. France, Great Britain, Poland, Denmark [3] in total, more than 200 foreign companies import organic products from Ukraine [33, p.2].

The main problems of organic agriculture in different countries are quite similar and well described in the economic literature [for example [9, p.74]. However, in Ukraine there are certain specifics of the reasons for the low rate of development of this sector of the branch, which lie in the shortcomings of organic production itself, compared to conventional, and in not very appropriate for the development of organic production institutional and organizational environment. In particular, Ukraine's incomplete accession to the OECD Variety Certification Schemes has a negative impact - organic products without proper certification do not even have the right to be called organic in Ukraine, where GMO products are actually outlawed, even ordinary soybeans grown without GMO-technologies are rare. Generally solving the problem of certification of organic production and products in Ukraine is still quite slow. EU Regulation №1235 / 2008 lists 18 certification bodies for Ukraine: 17 foreign and 1 Ukrainian. The only Ukrainian certification body is Organic Standard LLC; all others are foreign or their local offices. However, on a positive note, most certification bodies in Ukraine are members of the European Council of Organic Certification Bodies (EOCC).

There is also no necessary level of some of niche organic products consumption culture. For example, food, made from frogs, snakes or snails is quite unusual for Ukrainians, although abroad these products have become almost traditional, as they are well understood there for their usefulness and safety.

Organic products are still sold at a relatively high price, because from an economic point of view, organic production is very expensive. Organic products should not be used with pesticides and yield-enhancing chemicals, so its volume may be 50-70% of traditional agriculture. Organic animal husbandry has clear requirements for the number of animals on farms per unit area, restrictions on animal husbandry, feeding and treatment, the use of antibiotics and growth hormones, the need for more humane treatment of animals, which ultimately affects pricing. I addition, the high cost of organic livestock products is forming by the high price of organic feed and by its shortage. Organic raw materials proceeding products have a shorter shelf life, which increases the cost of logistics. Pricing is also affected by the cost of annual organic certification [31]. And high prices negatively affect sales volumes. According to scientists from the NSC "Institute of Agrarian Economics", the difference in retail prices for traditional and organic agricultural products is 50-200%. Thus, organic chicken eggs are 60% more expensive than their counterparts from the traditional sector, lard - 50%, milk - 2.2 times, pork (tenderloin) - 2.8 times, chicken - 3.3 times, honey - 2.1 times [22, p.133]. Only 2-5% of respondents in Ukraine are ready to overpay more than 80% of value added (for organic meat - 5% of respondents, for organic sour-milk products - 4%, for eggs - 3%) [7, p. 235-236]. Ye. Gavaza and Yu. Voskobijnyk obtained similar data - in Ukraine at a margin of 75% and above to buy organic meat and meat products to completely replace them with traditional products are ready only 5% of consumers, milk and cheese -7%, eggs -8% [23].

There is reason to expect that after increasing the number of producers of organic products and expanding the range of organic raw materials, this price will be normalized and will not be higher than, according to foreign experience, by 10-30% over the same traditional. In Poland, according to surveys, a third of citizens are willing to pay at least from time to time for organic products 2-3 times more than for its traditional counterparts, so the growth rate of the market for organic agricultural products is at 20-30% per year [39]. This is largely due to the implementation of an intensive policy of reasoned persuasion of the population about the usefulness of organic food and care for the environment protection, because it is organic agriculture that should promote it.

The specifics of the technology of organic production determine the higher level of time capacity and labor capacity of organic products, which accordingly also affects the pricing. Therefore, this direction is economically advantageous mainly in smaller farms - smaller volumes of production require less manual labor. And the look of such products is mostly not as bright as conventional.

It is also characteristic of Ukrainian organic agriculture that, according to foreign experts, in Ukraine there is a low level of competition among producers in the organic sector, and sometimes even its complete absence in most product lines. This fact, together with a narrow range of organic products, regional dispersion of organic producers and ever-increasing demand, has the consequence that the organic market in Ukraine is a seller's market [12, p.8].

In contrast to traditional farming, there is a transition period in organic production, which is 24 months for annual crops before sowing. That is, the products may receive organic status not earlier than three years from the beginning of such activities. In addition, during the transition period, yields and profits are usually significantly reduced. Therefore, the start of organic production is usually associated with long-term planning and investment, which is difficult to do on leased land. In addition, until organic products are certified, they cannot be branded and sold as organic. Therefore, it is very important for the state to support organic agriculture, especially in such transition periods. European farmers have the possibility to develop the organic direction and reduce the cost of organic products, because the state provides them with sufficient financial support, the average amount of which is 200-300 €/ha. [4]. Until recently, this practice was underdeveloped in Ukraine.

Requirements for organic production include the creation of mandatory buffer zones. Therefore, producers depend on landlords who can sell their land, which is located inside the organic farm. In addition, the new EU Regulation 2018/848, which comes into force on January 1, 2022, shifts all responsibility even for accidental contamination of organic crops entirely to the producer [41].

Only in Lviv and Poltava oblasts there are programs of compensation of the costs of organic farms certification and also some support at the local budget level is in action. State support directly for organic producers in Ukraine was introduced for the first time in 2021. It is planned to help first of all family business at the rate of 5 thousand UAH on 1 hectare (near $200). First of all, we are talking about family farms, which, according to the law, have a maximum size to 20 hectares [43]. In 2021, the government allocated UAH 50 million for state support of producers of organic agricultural products, which will be used in following way (Table 4).

Table 4. State support for producers of organic agricultural products in Ukraine in 2021

Kind of support	Support size
Budget subsidy per unit of arable land (1 hectare)	In the amount of 5 thousand UAH, but not more than 100 thousand UAH. per one operator (total amount UAH 30 million)
Budget subsidy for keeping cattle identified and registered in accordance with the legislation as of August 1 of the current year	In the amount of 5 thousand UAH per 1 head of cattle (total amount UAH 15 million)
Partial reimbursement of the cost of certification of organic products	In the amount of 30% (excluding value added tax), but not more than UAH 20,000 per business entity (total amount of UAH 5 million).

Source: constructed by authors according to [5],[16].

This is not a very significant amount comparing to what farmers in the EU have from the state, but for small producers in Ukraine it is also significant.

According to the National Economic Strategy of Ukraine until 2030, approved by the Cabinet of Ministers in March 2021, 3% of the total area of agricultural land in Ukraine should be used in organic production (about 1.3 million hectares). Ukraine's Second Nationally Defined Contribution (NDC2) also identifies organic production as one of its priorities for reducing the greenhouse gas emissions, regarding which Ukraine is taking obligation to do and will require € 2.3 billion in investment by 2030 [41]. In addition, Ukraine continues to adapt to EU legislation in the framework of the Association Agreement (AA), where many issues are related to improving legislation in the field of environmental protection and agricultural production. If the AA is seen mainly as an opportunity for the development and expansion of sale markets, the Nationally Defined Contribution, together with the changes required for its implementation, are perceived by both farmers and politicians with restraint.

CONCLUSIONS

A real way to solve the problem of ecologization of agriculture as a way to rationalize the use of natural resources and create favorable conditions for the implementation of the concept of sustainable development of rural areas is the reorientation of agricultural producers to niche organic production and on this basis - to social and environmental problems of the village solving.

The study shows that Ukraine, having significant potential for production of organic agricultural products, for exports, for consumption in the domestic market, in recent years has achieved some results in this direction, showing a stable positive growth of agricultural land areas under certified organic production and of the number of organic market operators, as well as of the level of organic products consumption in Ukraine, what is facilitated by the trend of active filling of the domestic market with its own organic products through the gradual establishment of processing of organic raw materials. However, compared to the European Union and the world, the development of organic agriculture in Ukraine is much slower, because the culture of consumption of such products in Ukraine is still underdeveloped, prices for such products are objectively much higher than conventional counterparts, and processing of such products as of raw materials is underdeveloped. The share of organic products in the domestic market of Ukraine does not exceed 0.1%. Only a bit more than 1% of the agricultural land in the country is certified for the production of organic agricultural products, 80% of Ukrainian organic agricultural products are exporting. Organic animal husbandry has special difficulties in Ukraine.

The situation is a consequence of the lack of necessary state support for organic agriculture, especially in transition periods, of lack of necessary experience and qualifications, underdeveloped certification system and its high cost, lack of cooperation and information and advisory services. Organic directions of agriculture are characterized mainly by lower levels of crops yield and productivity of animals, higher costs for sowing and tillage, higher labor intensity of the unit, lack of reliable markets for its products. Ukraine still lacks niche organic products of high export quality to form its wholesale batches. The development of the industry requires the creation of conditions for increasing the level of access to credit for small producers, adaptation of foreign experience in the industry, promoting the development of certification of products and farms, development of cooperation and information and advisory services and state support increasing.

To promote the use of organic food and to acquaint potential consumers with their benefits requires extensive use of all types of media. Building consumer confidence in certified organic products will increase demand for it. Another important point is the creation of an extensive sales network in domestic and foreign markets. Given the European orientation of Ukraine, there is an urgent need to develop and adopt the "State Program for the Development of Organic Production" as an ecologically, socially and economically feasible area of production, which would take into account the provisions of the Main Directions of Ukraine's policy in environmental protection, natural resources use and ecological security, as well as the Concept of sustainable development of agro-ecosystems of Ukraine in the framework of the National Economic Strategy of Ukraine until 2030.

Despite the fact that Ukraine has significant problems hindering the development of organic production, this sector of the economy is very promising due to the presence of fertile chernozem soils in Ukraine, strong agricultural traditions and the desire of major market players to create the necessary institutional and legal conditions. The development of organic agriculture will contribute to the improvement of the economic, social and environmental situation in Ukraine, to the sustainable development of rural areas and to the improvement of public health.

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STUDIES REGARDING THE POSTHARVEST QUALITY MANAGEMENT OF STRAWBERRIES

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Abstract

The present study shows the main factors that influence the post-harvest quality management of strawberries. The study was carried out on 4 varieties of strawberries: Albion, Marmolada, Elsanta and Gorella, cultivated in the area of Vidra, Ilfov county, Romania. The fruits were harvested when about 90-95% of the surface of the fruit had the characteristic color of the variety. The storage period under modified atmosphere conditions was 14 days. A minimum of 7% soluble dry matter is recommended for strawberries and 10% would be excellent, as far as the consumer's expectation is concerned. The total losses, determined at the end of storage, showed values between 10.4% for the Gorella variety and 13% for the Marmolada variety. The depreciation due to rot was caused by the pathogens Botrytis cinerea and Penicillium italicum and showed values between 2.6% for the Marmolada variety and 5.1% for the Elsanta variety.

***Key words**: post – harvest, modified atmosphere, weight losses, loss due to rot*

INTRODUCTION

Temperature and rapid marketing are the two main factors that assure the quality of strawberries. While fresh strawberries are one of the most popular fruits for consumers, they are also one of the most perishable among fresh commodities [1].

The berries are very fragile and prone to mechanical injury as their thin skin suffers rapid loss of water in low humidity environments. Also, strawberries have one of the highest respiration rates of all fresh products.

Because of this, it is essential to establish a successful quality assurance program in order to have a profitable marketing program for strawberries [2, 10].

As a result, quality assurance should result in money saving. Grey mold was the major cause of loss at the wholesale and retail levels and it was associated with bruising and soft or leaky berries [4].

Quality assurance can really pay for itself and also improve product quality to the consumer.

In this context, the purpose of the paper aimed to analyze the main factors that influence the post-harvest quality management of strawberries.

MATERIALS AND METHODS

The research was carried out with four varieties of strawberries: Albion, Marmolada, Elsanta and Gorella, which are cultivated in the area of Vidra, Ilfov County, Romania.

The fruits were harvested at the stage where about 90-95% of the surface of the fruit had the color characteristic of the variety. After harvesting, the fruit were placed in plastic casseroles with a capacity of 1 kg each, and then packed in a 15 micron thick, semi-permeable LDPE film for gas and water vapor. A modified atmosphere was created inside the package, the storage temperature being 1-20 C, and the relative humidity of the air, 85-90%. The conditions were provided by the cold room in which the fruits were stored.

Each strawberry variety, represented by 6 kg of fruit, was divided into 3 repetitions.

The mesurement and analysis made after harvesting and at the end of the storage period tracked the following:

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-the evolution of the main physico-chemical characteristics of the fruits (soluble dry matter, total titratable acidity, ascorbic acid and sugar/acidity ratio). The content of the soluble dry matter was determinated by using the Atago electronic refractometer. The total titratable acidity was analysed by titration with NaOH 0,1N solutions. The content of ascorbic acid was determined by using the iodometric method;
- establishing the weight losses and rotten losses, by quantity and percentage;
-determining the temperature and relative air humidity into the strawberry package, using the Hanhart thermo-hygrometer.

The first part of the study presents the main aspects and factors that influence the postharvest quality management of strawberries.

Strawberries kept under modified atmosphere conditions were stored for 14 days, until they were of commercial value and could be sold.

RESULTS AND DISCUSSIONS

The main factors that influence the quality of strawberries

The most important factors for strawberry quality include:
-Ripeness level, generally assessed by percentage of pink or red colour;
-Gloss;
-Indication of freshness and absence of water loss;
-Absence of flaws such as decay, bruising and shrivelling;
-Flavour, influenced by sugars, acidity and flavour volatiles (Table 1);
-Berry size and uniformity;
-Firmness, absence of soft, overripe or leaky berries;
-Price and availability.

The quality specifications determination

When setting up a quality assurance program the first step is to determine the company's criteria for quality for the product. It is important to know your customers wants and needs and whether they are more concerned with price and availability than quality. At the same time you should know if ripeness and flavour are important for them or if the appearance is what matters the most. Different types of customers have different preferences and requirements for quality factors. As soon as the critical quality factors are determined, objective means have to be developed in order to measure those quality factors [3].

Keeping records of quality – related factors is what allows the evaluation of company performance and what can assist in management decisions regarding quality assurance [5].

Table 1. The strawberry flavour according the main quality parameters

Sugar	Acid	Flavour quality
high	high	good
high	low	bland
low	high	tart
low	low	tasteless

Source: Own determination.

The fruit ripeness at the harvest period

Quality assurance for strawberries begins in the field with variety selections.

The variables when it comes to strawberry varieties are as follows: berry firmness when ripe, sugar and acid content, disease susceptibility, and yield. The selection of the varieties to grow can have a tremendous impact on potential fruit quality. Fruits with better flavour may have lower yields or less disease resistance.

Management must decide which varieties are to be grown and the stage of ripeness at which the fruits will be harvested in order to best meet their specific goals for fruit quality [6].

As a consequence, riper fruit will have a higher sugar content and better flavour quality. Studies have shown that a percentage of customers will pay more for riper fruits with higher sugar content (soluble solids content). In order to supply consistent flavor quality to these customers, soluble solids content (SSC) should be monitored so that a minimum SSC is reached. A minimum of 7% SSC is recommended for strawberries and 10% would be excellent [8].The level of ripeness should be monitored in harvested trays to cheek picker performance.

Quality is influenced by agricultural practices

Agricultural practices and pre harvest disease control can have an immense influence on postharvest quality and storage life. Taking into consideration that postharvest fungicides are not used on strawberries, pre harvest disease control is very important. Low light intensity has been directly correlated with lower levels of ascorbic acid, red color and SSC, while high nitrogen fertilization has been associated with softer fruit, lower SSC and less flavor.

Preventing the strawberries fruit diseases and injury

It is essential to handle berries carefully during harvest and to avoid placing injured or diseased berries in the tray. Training and supervision are also critical. Harvesters should be prompted and incentivized to harvest with care. Overall harvesting quality can be improved by monitoring the harvesting trays for the presence of defects, which provides critical information to crew supervisors.

The importance of rapid cooling and adequate marketing

After harvest, the most critical factors to monitor for strawberry quality maintenance are pulp temperatures and time delays in the system. Fruit quality and shelf life are directly influenced by how fast the fruits are cooled and how close to 0^0C the pulp temperature is maintained [7].

As the time between harvest and cooling of the berries is critical for quality and shelf life, it is important for the time elapsed from harvest to cooling to be recorded along with fruit pulp temperatures. Management should decide what the acceptable time from harvest to cooling is. The delay should be no longer than one hour to avoid losses in strawberry quality and postharvest life [9]. More frequent trips to the cooler can be ensured by making an investment in additional small trucks.

The strawberries fruit cooling

Upon arrival at the cooling facility, pallets should be transported immediately to the forced – air cooler. Cooler temperature should be maintained at -1^0C to 0^0C and 90 to 95% relative humidity. The fruits should first be cooled at 0 to 1^0C and only then moved to the cold storage room. More efficient cooling can be ensured by making use of a separate cooler and cold storage rooms. In the case in which the refrigeration system cannot keep cooler air temperature near 0^0C, an additional refrigeration capability may be necessary, requiring a capital investment in quality.

Cooler air temperature and pulp temperatures of the warmest berries upon removal from the cooler should be monitored regularly. Cold storage air temperatures should also be monitored and records should be maintained for it (Table 2).

Table 2. The optimal parameters for strawberries storage

Precooling temperature	2……..3° C
Storage temperature	-1…..0° C
Transport temperature	0…….1° C
Relative humidity	90……95%

Source: International Institute of Refrigeration.

Delivery of the strawberries fruit

It is essential to pay careful attention to the transport vehicle when the product is loaded.

Trucks should be cooled to near 0°C prior to product loading. Each load should be checked for the condition of the insulation, doors, cooling system and air delivery. Strawberries should be well secured and loaded in the center so as to prevent warming or freezing of product during transit. Provided that the truck conditions fail to meet the criteria established to maintain fruit quality during shipment, the buyer should be notified that the seller cannot guarantee the arrival condition of the fruit due to truck conditions.

The assurance of quality during the commercialization process

Pulp temperature should be checked and inspected for incoming products right without delay. If berries are warmer than 4°C, fruit quality could benefit from forced – air cooling. For the strawberries that have become warm during transport a small, portable forced – air cooler can be used in the cold room to cool the fruits. Alternatively, rapid cooling can also be facilitated by spreading pallets or trays in the room. Cooler temperature should be maintained at 0°C with 90 to 95% relative humidity. The condition of the transport vehicle should be checked as well as the incoming air temperature. If MA pallet bags are present, their arrival condition should be checked and then removed to allow for product cooling. After the product has been transferred to the cooler, an inspection of berry condition should be conducted, including color, firmness, gloss, shrivel and decay. If decay is discovered, trays should be repacked as possible avoiding excessive warming of the fruit during this period.

Handling of the inferior quality product

One of most important quality assurance that management must make is to determine the minimum level of quality at which the product will continue to be marketed. A firm commitment to quality requires that difficult decisions be made – namely to discard inferior quality product, especially when additional product is unavailable and demand is high. It is advisable to record the causes of product loss, as this information can be useful for management decisions to improve product quality. At the retail level, strawberries should be kept in refrigerated cases in the cold storage room at night. If relative humidity in the above mentioned is lower than 85% what may help reduce water loss is placing clean, plastic film over the strawberry trays, as it creates a humid environment around them.

The behavior of the strawberries under modified atmosphere

During the evolution towards fruit ripening, the main physico-chemical characteristics underwent changes, so that, at harvest, they presented the values mentioned in Table 3. Thus, the soluble dry matter content ranged between 6.72% for the Albion variety and 8.16% for the Elsanta variety. The total titratable acidity was very similar for all varieties. The lowest value, of 1.62%, was measured for the Albion variety, and the highest, for the Marmolada variety, respectively 1.88%. The ascorbic acid content had the lowest value in the Marmolada variety (68.14 mg/100 g), while the highest value was determined in the Gorella variety (82.34 mg/ 100 g).

The measurements performed at the end of the 14 days of storage in the modified atmosphere, showed lower values for all the analyzed parameters, compared to the results obtained immediately after harvest. We mention only the sugar/acidity ratio, which had values between 4.19 for the Albion variety and 4.77 for the Elsanta variety.

Table 3. The main physic-chemical parameters of strawberries

Variety	Analysis time	Soluble dry matter -%-	Total titratable acidity -%-citric acid	Ascorbic acid -mg/100 g-	Sugar/acidity ratio
ALBION	At harvest	6.72	1.62	72.24	4.15
	End of storage	6.54	1.56	68.72	4.19
MARMOLADA	At harvest	7.86	1.88	68.14	4.18
	End of storage	6.94	1.62	63,62	4.28
ELSANTA	At harvest	8.16	1.72	80.18	4.75
	End of storage	7.44	1.56	74.26	4.77
GORELLA	At harvest	7.46	1.68	82.34	4.44
	End of storage	6.82	1.60	77.26	4.26

Source: Own determination.

The behavior of the strawberry varieties during storage was different, regarding weight losses, rotten losses and physiological disorders, as it results from the data presented in Table 4.

Thus, the weight losses ranged between 6.2% for Elsanta variety being significantly negative and 10.4% for the Marmolada variety, the differences from the average being distinctly significantly positive.

The rotten losses measured at the end of storage under modified conditions had values between 2.6% for the Marmolada variety and 5.1% for the Elsanta variety. The main pathogens involved in fruit depreciation were *Botrytis cinerea* and *Penicillium italicum.*

The total losses, represented by the sum of the losses due to rot, had values between 10.4% for the Gorella variety (significantly negative differences) and 13% for the Marmolada variety (distinctly significant differences).

The physiological disorders manifested mainly by changes in taste and flavor, or color changes, recorded relatively small values, ranging between 2.1% for the Albion variety and 3.7% for the Marmolada variety.

Table 4. Total and qualitative losses of strawberries at the end of storage

Variety	Weight losses		Rotten losses -%-	Total losses		Physiological disorders %
	%	Signification grade		%	Signification grade	
ALBION	6.9	°	4.6	11.5	-	2.1
MARMOLADA	10.4	**	2.6	13.0	**	3.7
ELSANTA	6.2	°	5.1	11.3	-	2.4
GORELLA	6.3	°	4.1	10.4	°	2.8
AVERAGE VALUE	7.4	-	4.1	11.5	-	2.7

Source: Own determination

Legend: ** = distinctively significantly positive;
* = significantly positive;
°° = distinctly significantly negative;
° = significantly negative;
- = insignificant

CONCLUSIONS

The main characteristics that define the quality of strawberries at harvest are: the colour, taste and aroma of the fruit.

Strawberry fruits do not continue to ripen after harvest and will not increase in sugar content; therefore, riper fruit will have higher sugar content and better flavour quality.

As far as the consumer's expectations are concerned, a minimum of 7% soluble dry matter is recommended for strawberries and 10% would be even more desirable.

Agricultural practices and controlling pre-harvest diseases have an important influence on postharvest quality and storage life, due to the fact that postharvest chemical treatments are not allowed on strawberries.

As strawberries are very perishable, it is recommended to harvest the fruit directly in the transport and storage packaging, in order to reduce the number of handling sessions and depreciation of the fruit. After harvesting, the faster the fruits are cooled and the closer the pulp temperature is maintained to 0 to 1°C, the higher the fruit quality and the longer the shelf life.

A critical element for the quality and shelf life of strawberries is the time period between harvesting and the cooling storage of the fruits.

The optimal duration of storage in conditions of modified atmosphere of the fruits of the 4 studied strawberry varieties, was 14 days.

At the end of storage, the soluble dry matter content was between 6.54% for the Albion variety and 7.44% for the Elsanta variety, and the total titratable acidity varied between 1.56% for the Albion and Elsanta varieties, respectively 1, 62% for the Marmolada variety.

Weight loss during storage ranged from 6.2% for Elsanta to 10.4% for Marmolada, and depreciation due to rot ranged from 2.6% for Marmolada to 5.1% for Elsanta.

The losses due to rot were mainly caused by the pathogens *Botrytis cinerea* and *Penicilium italicum.*

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RESEARCH REGARDING THE INFLUENCE OF THE HARVESTING PERIOD UPON THE QUALITY AND STORAGE CAPACITY OF SOME APPLE VARIETIES

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Abstract

The research studies were carried out during the 2019 – 2021 period with 4 apple varieties, harvested at 3 degrees of maturity. After 190 days of storage, the overall losses, consisting of weight decreases and losses through rotting, presented lower values in the case of Sirius apples harvested at moment I (8.6%) and Golden Orange (11.7%) respectively., Ciprian (11.4%) and Fuji (8.9%), harvested at time 3. The apples of the Ciprian and Fuji varieties harvested earlier (moment I) saw a loss in quality of 63.2 – 86.5%, due to the occurrence of the scald. For cold storage, it is recommended that Sirius fruit be harvested 140 days after blossoming. The Golden Orange variety must be harvested about 145 days after blossoming and the Ciprian and Fuji varieties after 150 days after blossoming.

Key words: *losses, cold storage, storage capacity, harvesting period*

INTRODUCTION

Fruit quality is the essential factor that determines their commercial value, the storage behavior as well as the economic efficiency of their valorisation.
The research carried out so far has shown the influence of various factors on fruit quality such as: pedoclimatic, agrotechnical, the degree of maturation at harvest, etc.[2] and [4].
Global research has highlighted the particular importance of the ripeness of apples in storage, their quality and behaviour in storage [1], [3] and [7].
The storage of apples with an appropriate degree of ripeness leads to significant quality depreciation, and the storage process becomes uneconomical [5] and [6].
As a result, the practice of storage requires prior knowledge of the capacity and shelf life of apples according to their degree of ripeness, in order to ensure their valorisation by instalments [8].
In this context, the purpose of the paper was to study the influence of harvesting period on the quality and storage capacity of some apple varieties in Romania.

MATERIALS AND METHODS

The study used apples from the Sirius, Golden Orange, Ciprian and Fuji varieties, from the 2019, 2020 and 2021 harvests from a private plantation located in the Voinesti - Dambovița area, Romania.
The apples were harvested at 3 stages of ripening:
1. – 130 days after blooming when a sum of temperature degrees of about 2,100°C was reached, and starch was present on 95% of the surface of the cross section of Sirius apples, on 97% of the surface of the Golden Orange variety and on 98% of the surface for Ciprian and Fuji varieties.
2. - 140 days after blooming when a sum of temperature degrees of about 2,300°C was reached and the fruits of the Sirius variety had the starch present on 75% of the surface of the cross section, Golden Orange on 80%, Ciprian on 85% and Fuji on 87% of the section area.
3. - 150 days after blooming, when a sum of 2,400°C temperature degrees has been

reached, the starch being present on 50% of the cross-sectional area of Sirius apples, on 60% of the Golden Orange apples section, 70% of Ciprian apples section and 75% of the cross section of Fuji apples.

Each experimental variant consisted of about 150 kg of apples, divided into 3 repetitions.

The fruits were stored in the cold storage room of a private company in the Voinești - Dambovița area, at an average temperature of 2-3°C and a relative humidity of 85-90%.

The measurements and analysis made after harvesting and at the end of the storage period tracked the following:

-the evolution of the main physic-chemical characteristics of the fruits (starch index, dry soluble matter, total sugar, total titratable acidity and the content of ascorbic acid). The starch index was determined by using the test of Iodine into Potassium iodine solution. The content of the soluble dry matter was measured using the Atago electronic refractometer. The total sugar content was measured by iodometric method-Schoorl variant. The total titratable acidity was measured by titration with a NaOH 0.1N solution. The content or ascorbic acid was measured using the iodometric method.

-establishing the weight losses and quality depreciation, by quantity and percentage;

-determining the temperature and relative air humidity in the environment in which the apples were stored, using the Hanhart thermo hygrometer.

RESULTS AND DISCUSSIONS

The delay in harvesting the fruits and as a result keeping them on the trees under the influence of environmental conditions favored the evolution of the ripening process.

The biochemical processes that take place in the fruits during their maturation, determine the modification of the chemical composition and the realization of the characteristic properties of the fruits (Table 1).

Table 1. The main physic - chemical parameters of apple fruits, harvested at different harvesting period

Variety	Harvesting period	Analyses time	Soluble dry matter %	Total sugar %	Total titratable acidity (acid malic) %	Ascorbic acid mg/100 g	Sugar/acidity ratio
SIRIUS	1	at harvest	12.30	9.15	0.72	10.15	12.71
	1	end of storage	12.55	10.05	0.40	4.50	25.12
	2	at harvest	13.50	10.30	0.70	9.82	14.71
	2	end of storage	13.00	10.20	0.35	3.60	29.14
	3	at harvest	13.70	10.70	0.70	7.85	15.28
	3	end of storage	13.25	10.10	0.35	3.50	28.85
GOLDEN ORANGE	1	at harvest	12.10	9.25	0.47	12.40	19.68
	1	end of storage	12.30	9.30	0.15	5.15	62.00
	2	at harvest	13.70	10.35	0.50	13.10	20.70
	2	end of storage	13.85	10.30	0.20	6.40	51.50
	3	at harvest	14.25	11.80	0.45	12.05	26.22
	3	end of storage	14.95	10.90	0.15	6.80	72.66
CIPRIAN	1	at harvest	11.00	7.25	0.30	5.42	24.16
	1	end of storage	13.50	10.20	0.25	5.30	40.80
	2	at harvest	12.10	9.70	0.30	6.45	32.33
	2	end of storage	14.70	9.80	0.15	4.30	65.33
	3	at harvest	12.65	9.45	0.25	6.35	37.80
	3	end of storage	15.40	11.50	0.20	2.40	57.50
FUJI	1	at harvest	11.15	8.50	0.25	7.30	34.00
	1	end of storage	13.20	9.90	0.18	1.70	55.00
	2	at harvest	11.90	9.90	0.25	5.80	39.60
	2	end of storage	14.10	10.00	0.15	1.95	66.66
	3	at harvest	12.55	9.60	0.20	4.55	48.00
	3	end of storage	13.30	10.25	0.17	1.45	60.29

Source: Own determination.

Thus, for the fruits harvested later (moment 3), the following were found, compared to those harvested earlier (moment 1):
- the increase in the total carbohydrate content for the 4 varieties studied, on average 1.21 times;
-the decrease in titratable acidity, on average 1.04 times and of the ascorbic acid 1.14 times;
-increasing the sugar/acidity ratio by 1.31 times.

The physiological state of the fruits during storage, as well as their chemical composition had an influence on the storage behaviour.

The weight losses (Table 2) determined by experimental variants ranged from 5.4% to 11.9%.

Applying the analysis of variance to the results obtained, the following degrees of significance were established, compared to the average value of weight loss:
-In the case of the apples from Ciprian and Fuji varieties, the values of weight loss, at the 3 moments of harvest, were lower compared to the average value, the differences being significant;
- The Golden Orange apples, harvested at time 1, had significantly higher weight losses, compared to the average value, and those harvested at times 2 and 3 were significantly higher;
- The Sirius apples, harvested at time 1, had a weight loss value close to the average values and, as a result, the differences are insignificant. Variants harvested at times 2 and 3 had significantly lower losses.

According to the presented results, the highest weight losses were found in the earlier harvested variants, respectively the 1st harvest time (6.5% - 11.9%), and the lowest, in the later harvested variants, respectively the 3rd harvest time (5.4% -9.2%).

Also, the Golden Orange variety, kept at 85% - 90% relative air humidity, had the highest weight loss, which had repercussions on the appearance of the fruit, and the apples of the varieties Ciprian and Fuji had the lowest weight loss compared to other options.

The rot losses showed similar values in the case of the 3 harvest moments, for the Golden Orange, Ciprian and Fuji varieties.

However, for the Sirius variety, large differences were found between the 3 harvest variants. Thus, the fruits harvested at time 1 showed 1.3% rotten fruit, compared to those harvested at time 3, which had 9.0% rotten fruit.

The total losses made up of weight loss and loss because of rotting showed values between 8.6% and 15.5%. For the 4 varieties studied, the situation was as follows:
-the fruits of the Sirius variety, harvested at time 3, had the highest total losses, the differences from the average being highly significant. The higher value of the total losses, in this case, is due to the internal decomposition, which determined the total depreciation of 6% of the stored fruits. Compared to the average value of total losses, the fruits harvested at time 2 had significantly lower losses, and those harvested at time 1, distinctly significantly lower.
-the fruits of the Golden Orange variety had the highest total losses in the case of earlier harvesting. Thus, at the 1st harvesting time, distinctively significantly higher values were found, and for those harvested at the 2nd and 3rd, the values were significantly higher compared to the average value of the total losses.
- for the Ciprian variety, the fruits from the 3 variants showed significantly lower values, compared to the average of the total losses.
- the apples from the Fuji variety harvested at time 1 had total losses equal to the average value. At the time of harvest 2 the total losses were significantly lower, and at time 3 they were significantly lower compared to the average.

Of these, the lowest total losses in the case of the Sirius variety harvested at time 1 and the Golden Orange, Ciprian and Fuji varieties harvested at time 3 are the lowest.

During storage, the fruits were also affected by some physiological disorders that caused their depreciation. In this regard, mention should be made of the scald, which was manifested by the browning of the fruits' epidermis, thus affecting their commercial value.

Table 2. Total and qualitative losses of the apple fruits harvested at different harvesting periods, after 190 days of storage

Variety	Harvest period	Weight losses		Rotten losses %	Total losses		Physiological disorders %
		%	Signification grade		%	Signification grade	
SIRIUS	1	7.3	-	1.3	8.6	°°	1.8
	2	6.7	°	3.6	10.3	°	0.7
	3	6.5	°	9.0	15.5	**	-
GOLDEN ORANGE	1	11.9	**	2.4	14.3	**	-
	2	10.1	*	2.8	12.9	*	-
	3	9.2	*	2.5	11.7	*	-
CIPRIAN	1	6.5	°	4.7	11.2	°	63.2
	2	6.2	°	4.8	11.0	°	8.7
	3	5.8	°	5.6	11.4	°	2.9
FUJI	1	6.9	°	4.5	11.4	-	86.5
	2	6.7	°	4.1	10.8	°	19.7
	3	5.4	°	3.5	8.9	°°	14.5
Average value		7.4	-	4.1	11.5	-	16.5

Source: Own determination.
Legend: ** = distinctively significantly positive;
* = significantly positive;
°° = distinctly significantly negative;
° = significantly negative;
- = insignificant

This physiological disorder did not manifest itself in the fruits of the Golden Orange variety, and in the Sirius variety it had a small extension (0.7% - 1.8%).
However, the Ciprian and Fuji varieties showed a high percentage of fruits affected by this physiological disorder. The variants harvested at time 1 showed 63.2% and 86.5% affected fruits, respectively, while the variants harvested later showed only 2.9% and 14.5% affected fruits.
During the storage period, the ripening processes of the fruit continue with the hydrolysis of the polyglucides and the accumulation of the resulting monoglycosides, the decrease of the titratable acidity and of the ascorbic acid.
The fruits harvested at time 1, after 190 days of storage, showed an increase in total carbohydrates by an average of 1.15 times, compared to the value determined at storage. In the variants harvested at time 3, the increase in the value of total carbohydrates is only 1.03 times, as a result of the fact that during storage the starch content of the fruit was lower.
For the varieties with a shorter maturation period (Sirius and Golden Orange), in which the starch in the fruit has been hydrolyzed to a greater extent, at the time of storage, the total carbohydrates show a decrease at the end of the storage period.
The titratable acidity of the fruit decreased during the storage period 1.71 times on average for the fruit harvested at time 1 and 1.77 times for those harvested at time 3. The ascorbic acid decreased 2.39 times and 2.16 times, respectively.
The sugar / fruit ratio was on average 45.6 for the variants harvested at time 1, respectively 46.8 at time 2 and 54.8 at time 3 of harvesting.
The level of the main chemical characteristics as well as the appearance of the fruits influenced their commercial value. Thus, the determination of sensory properties at the end of the storage period led to different results, as shown in Table 3.
The fruits harvested at time 1 had inadequate sensory properties (Table 3), being marked with the lowest score (11.3 points out of max. 20 points).

Table 3. The commercial value of apple fruits after 190 days of storage

Variety	Harvesting period 1 -points-	Harvesting period 2 -points-	Harvesting period 3 -points-
SIRIUS	13.2	17.9	17.9
GOLDEN ORANGE	11.1	17.2	17.3
CIPRIAN	10.7	15.5	18.4
FUJI	10.4	14.4	16.7
Average value	11.3	16.2	17.6

Source: Own determination.

The apples in these variants showed an advanced degree of dehydration, acid taste, unbalanced, green background color and a very little developed complementary color. The physiological disorder also affected 63.2% - 86.5% of the fruits of the Ciprian and Fuji varieties.

The highest score was obtained for the variants harvested at time 3 (17.6 points).

Out of the 4 varieties studied, only 2 (Ciprian and Fuji) had an appropriate degree of maturation. The Sirius and Golden Orange varieties were overripe, which was characterized by low firmness, intense yellow background color and low acidity.

Correlating the results regarding storage losses, sensory properties and changes in major chemical components, it can be concluded that for proper storage, with minimal losses, apple harvesting should be sequenced as follows:

-the Sirius variety 140 days after blooming, the starch being present on approximately 75% of the surface of the cross section;

-the Gold Orange variety 145 days after blooming, when the starch is present on about 80% of the cross-sectional area;

-the Ciprian and Fuji varieties 150 days after blooming, when the starch is present on about 75% of the surface of the cross section of the fruit.

CONCLUSIONS

After 190 days of storage, the highest weight losses were found in the fruits harvested earlier, respectively the 1st time of harvesting (6.5% - 11.9%), and the lowest in the variants harvested later, respectively the 3rd time of harvesting (5.4% - 9.2%).

The total losses including weight losses and losses through rotting were lower for Sirius harvested at time 1 (8.6%) and Golden Orange, Ciprian and Fuji harvested at time 3 (11.7%, 11.4% and 8.9% respectively).

The Ciprian and Fuji apples, harvested earlier (harvest period 1), saw a loss in quality by 63.2% - 86.5%, due to the manifestation of a physiological disorder (scald).

After 190 days of storage, the best sensory properties were highlighted in the fruits of the harvesting variant 3 (on average 17.6 points).

As a result of the study, it is recommended that the fruits of the Sirius variety, intended for storage, be harvested 140 days after blooming, when the starch is present on approximately 75% of the surface of the cross section of the fruit. The Golden Orange variety should be harvested approximately 145 days after blooming, when the starch is present on approx. 80% of the surface of the section, and the varieties Ciprian and Fuji after 150 days from blooming, when the starch is present on approx. 75% of the cross-sectional area of the fruit.

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TYPOLOGY OF THE ROMANIAN RURAL AREA BASED ON THE MODERNIZATION AND RURAL SOCIO-ECONOMIC DEVELOPMENT PERSPECTIVES

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Abstract

The main purpose of this paper is to create a typology of the Romanian rural area according to the socio-economic modernization-development perspectives. The starting point consisted in the development of three indices to measure the analysed processes, namely the rural modernization index, the rural development index and the rural household modernization index. To create the typology, the author proposed a method that takes into consideration both the value of indices and the trend of these indices in the period 2007-2018. From the resulting typology, a general trend was noticed, namely that the Romanian rural area has a different behaviour depending on the proximity of large urban centers (see the counties Timiș, Ilfov, Cluj, Sibiu, Constanța, Brașov), the rural households in the proximity of cities have easier access to utilities and more attractive jobs, the population is younger and more educated.

Key words*: *rural area, rural development, rural modernization

INTRODUCTION

The main hypothesis of the paper was that modernization is different from development. Development is the final stage of modernization, in which transformations are profound and long lasting, and involve changes in all respects: in economic, social, political, technological and cultural terms. The modernization-development process in Romania has not been a constant/continuous process, being directly linked to the historical evolution – political influence (change of political regime) [13].
According to Parsons, the society functions as a system of four subsystems: social, economic, political and cultural. The changes produced at the level of any subsystem trigger effects in all the other subsystems [7]. This phenomenon can be also transposed in the case of rural space and actors (rural household) to which the ecological subsystem could be added. The modernization-development of rural areas has not been achieved uniformly at national level, there ae different particularities that trigger significant gaps between counties, between rural areas.

The necessary elements for modernization in the rural area are the presence of entrepreneurship, a modern infrastructure, existence of modern attitudes and values. The presence of these elements does not imply the loss of rural specificity (of traditions and customs); ideally, these should be valorized. The modernization of rural households has been achieved in a differentiated manner, depending on the intensity of exposure to innovative elements, and this has facilitated their acceptance in the current lifestyle [2].
Romania’s accession to the European Union has triggered a new modernization – development process of rural areas. This was quite a complex phenomenon, acting in several directions: modernization of road and technical infrastructure, of communications, etc.; the free access to the European labour market, which resulted in the migration of young population; population’s access to continuous vocational training; modernization of institutions and institutional relations, with the possibility of advanced endowment and technological upgrade; modernization of the agro-processing process, raising quality standards; modernization of farms through access to technical endowment with tractors,

machinery and high-performance equipment; encouraging the diversification of rural economy.

Financing the investments in rural areas was achieved both through direct payments under the single area payment scheme (Pillar 1), and through rural development measures (Pillar 2), and mainly targeted agricultural activity, food industry, non-agricultural activities, rural infrastructure as well as other activities [11]. In addition to these EU funding sources through European Agriculture Guarantee Fund (EAGF) and European agricultural Fund for Rural Development (EAFRD) exclusively dedicated to rural areas, there is also funding from national sources and other European funds (operational programs).

Starting from the multi-dimensional character of the Romanian rural area, of rural development and of its regional, county and local specifications, a set of relevant indicators was proposed for measuring the modernization – socio-economic development processes in the Romanian countryside. Following the consultation of recent literature on the use of theoretical and applicative modelling in measuring rural development, a theoretical model was developed to measure the degree of modernization and socio-economic development of the Romanian rural area, on the one hand, and the degree of rural household modernization, on the other hand.

MATERIALS AND METHODS

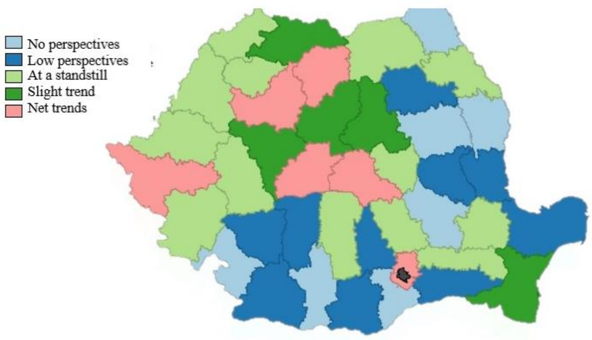
On the basis of the aggregation methods from the national and international literature, the generally accepted stages of building the composite indices were established, even though the aggregation methods have certain particularities related to the selection and aggregation of primary indicators [4].

Development of theoretical models of analysis

The great diversity of the Romanian rural area is the main element that generates differences in terms of development/modernization in the rural area, situation that is also reflected in the socio-economic behaviour of rural households. The rural area diversity (through the relief differences; natural potential of the area; accessibility – distance from city, accessibility in transport infrastructure; road infrastructure, technical infrastructure, healthcare infrastructure; cultural specificity) can argument the difference in modernization/development between the territorial units, which is quite difficult because there are some less quantifiable aspects. One of the points of interest in the research is the identification of some direct or indirect links between different social and economic factors and the development/modernization level of the rural area, without omitting the ecological nature of activities in the rural area. The main objective of the research is to establish the causal relationship between modernization and socio-economic development, on the one hand, and the rural household modernization, on the other hand. In reaching this objective, the first step was to construct the theoretical model – establish the size and selection of indicators depending on relevance and availability of data. The main source of data was the National Institute of Statistics – tempo online. The indicators were introduced into the SPSS software for aggregation, data analysis and presentation of results. Indices were calculated at country, macro-region, development region and county level, and the investigated period was the post-accession period (2007-2018). The classification of counties by the favourability of investigated phenomena implied the following stages: 1. Establishing the indices taken into consideration: RDI, RMI, RHMI, RDI trend, RMI trend, RHMI trend; 2. The next step was to establish the limits of each index (minimum and maximum); 3. Dividing the interval for each index into 5 equal groups, each group receiving a rating score from 1 (the weakest) to 5 (the best); 4. Each county was assigned a partial score from 1 to 5 according to the level reached for each index; 5. The final score for each county was calculated by summing up the partial scores.

RESULTS AND DISCUSSIONS

The typology of counties established according to the score obtained is the following: E) counties with net modernization – socio-economic development trends of the rural area and rural household modernization trends (Bistrița-Năsăud, Sibiu, Brașov, Cluj, Ilfov, Timiș) – 14.63%; D) counties with slight modernization – socio-economic development trend of the rural area and rural household modernization trend (Alba, Constanța, Harghita, Maramureș, Mureș) – 12.21%; C) counties at a standstill in terms of modernization – socio-economic development of the rural area and rural household modernization (Bihor, Brăila, Caraș-Severin, Prahova, Hunedoara, Ialomița, Iași, Arad, Argeș, Covasna, Sălaj, Satu Mare, Suceava) – 31.70%; B) counties with low perspectives of modernization – socio-economic development of the rural area and rural household modernization (Gorj, Neamț, Călărași, Dâmbovița, Tulcea, Vâlcea, Vrancea, Dolj, Galați, Teleorman) – 24.39%; A) counties with no perspective of modernization – socio-economic development of the rural area and rural household modernization (Buzău, Bacău, Giurgiu, Botoșani, Mehedinți, Olt, Vaslui) – 17.07%.



Map 1. Typology of counties by the modernization – socio-economic development of the rural area and rural household modernization trend, 2018
Source: author's own calculations based on NIS data, [9] and [8].

The structure of counties by the modernization and development trend of rural area and of rural household implicitly reveals a concentration of counties that fall in the medium interval (31.70%) and lower interval (41.46%). The counties with net and slight modernization – development trends are the only ones where RDI and RMI indices increased. The RHMI index decreased in all the categories, the lowest decrease being found in the case of counties with net modernization and development trends.

Analysis of the main indicators by categories of counties according to the modernization and development perspectives of the rural area.

The demographic indicators declined significantly in the investigated period, except for the group of counties with net modernization-development perspectives, which points to the need for demographic policies meant to prevent existing structural problems. Even if certain indicators, such as the dependency ratio, have had a positive evolution, in recent years a decrease has been noticed, from 56.82% to 50.82% (in the entire national rural area). If only the evolution of the dependency ratio were considered, the situation would be encouraging, but if we look at the evolution by age groups, the situation generates a series of problems: the diminution is determined by the decrease in the share of young dependent persons – under 15 years of age (from 17.91% in 2007 to 15.89% in 2018). Over time, the elderly population will disappear and will be replaced by a numerous population from the present population group aged 15-64 years, the 15-64 year olds will benefit from a low contribution of young population, which will lead to a high demographic dependency ratio. If the declining rate of young population is maintained and there is no intervention through demographic, economic and social policies to encourage the birth rate, the situation will continue to generate major imbalances in the age structure of the population.

As demographic indicators that have a direct relationship with the typology of counties by the modernization – development perspectives of the rural area, we mention the natural population balance (+0.763**) and the migration balance (+0.419**); as demographic indicators with an inverse relationship we mention the degree of aging (-0.426**) and the dependency ratio (-0.362*).

The demographic evolution, in the case of rural population in Romania – the demographic decline, is influenced by two processes, namely the natural movement of the population (population renewal capacity) and the migratory movement, mainly of the young population.

The natural increase values indicate a demographic crisis in the rural area, which is severe (in the case of categories A (-8.31) and B (-6.94) and acute (categories C (-4.91) and D (-2.84). Category E has positive values of this indicator, yet not in all counties.

Migration balance was favourable in the period 2007-2018, yet decreasing, from plus 927 persons in 2007 for the rural area to plus 467persons in 2018, except for the category E, where the number of persons coming to the rural area increased (from plus 1,240 persons in 2007 to plus 1,886 persons in 2018). It is worth noting that the positive migratory balance in the rural area is found only in adult and elderly people, while in the case of young people it is negative [1].

Migration is based on changing the perspective of life in the community with sustainable social and economic effects, having at its basis "a perspective of the sustainable relationship between the assumed goals and means" [12].

Migration has consequences for the rural household by changing its demographic structure, social needs and economic competitiveness. Unfortunately, the rural household becomes once again a means of survival for the population, of ensuring its subsistence. The urban area is losing population in favour of the rural area. But the phenomenon is not based on solid principles in economic terms, the rural area does not provide sufficient security or welfare for the population, the village being a refuge due to the inability to cope with the requirements of the urban area.

The aging rate in the rural area – in the investigated period – increased from 106.75% in 2007 to 111.90% in 2018, which indicates a strong aging process; the counties from category E are an exception, with the decrease of the aging rate, in the conditions in which the aging rate in this category has the lowest value anyway. Rural population aging will generate increasing financial pressure on pensions and healthcare in the next period, a situation that is mainly caused by the increase of life expectancy [3].

In terms of social dimension there is a strong direct or indirect link between the resulting typology and certain social indicators: there is a direct link with the fertility rate (+0.701**) and the average lifespan (+0.367*) and an indirect link with the infant death rate (-0.341*). There are weak links with the other social indicators (number of pupils/teachers +0.142, pupils' access to PC +0.021).

The fertility rate in dynamics is specific to a space facing difficulties in the process of demographic renewal. The involution in the value of this indicator is clear in the rural area: the decline from 44.53 live births/1,000 fertile women to 37.37 live births/1,000 fertile women. The decline is stronger is the counties with no modernization – socio-economic development perspective as against the counties with net perspectives, where there is a slight decline (from 45.35 live births/1,000 fertile women to 44.08 live births/1,000 fertile women).

Fertility rate is higher in the rural area than in in the urban, where this indicator slightly increased (from 31.9 live births/1,000 fertile women in 2007 to 36.3 live births/1,000 fertile women in 2018).

At rural household level, fertility decrease is caused both by demographic factors (population aging, high death rates) and by economic factors (pressure of financial sources from agriculture – 64.20% of total incomes are agricultural incomes; precarious investments). In the year 2018, the size of rural household was 2.8 persons and 64.29% of households were run by persons aged 50 years and over.

The average lifespan increased significantly in the period 2007-2018 (from 71.64 years in 2007 to 74.24 years in 2018), indicating positive changes in the quality of rural life, even though there is a significant gap between the urban (77.12 years) and rural (74.24 years) areas. Lifespan is reflected in food quality, living conditions, education access and quality, healthcare access and quality, environment quality, quality of family/social relations, etc. [5].

Infant death rate, indicator with high significance in the analysis of the degree of modernization at community and rural household level, significantly decreased, yet maintaining quite high values (from 13.90‰ in 2007 to 7.98‰ in 2018). In terms of the typology by modernization and socio-economic development perspectives of the rural area and household, significant differences can be noticed, when the perspectives are higher, the infant death rate decreases.

The spatial analysis of this indicator identified, at county level, rural areas where: the demographic and social vulnerability is revealed by the values of indicators that continue to be high: Botoșani 17‰, Tulcea 15,2‰, Sălaj 14,4‰, Călărași 13,5%; the demographic and social stability is described by the low values of this indicator: Hunedoara 1.3‰, Ilfov 2.8‰, Dâmbovița 2.9%.

At the level of rural household, the high infant death rate is the result of the low access to healthcare infrastructure, mothers' low level of training-educational level and the significantly low economic level.

At the level of economic indicators there is a strong direct or indirect relationship between the resulting typology and certain economic indicators: there is a direct relationship with the share of animal production +0.337*, number of employees in 1,000 inhabitants +0.633**, UAA per agricultural household +0.503** and an indirect link with labour force renewal rate (-0.645**). There are weak links with the other economic indicators (LLU per household +0.306, share of employed population in agriculture +0.250, agricultural area per person employed in agriculture +0.268 and number of tractors in 100 ha).

The share of animal production is an indicator that decreased in the analyzed period, in the conditions of increased orientation towards crop production that also generates a low, highly volatile value added (caused by the evolution of climate factors, variation of prices).

Within the typology by the modernization – development trend of the rural area and household, the share of animal production decreased in all the categories of counties, by 25.94% on the average. The greatest decreases were noticed in the category A – counties with no perspective (by 42.47%), in the category B – counties with low perspectives (by 40.86%) and C – counties at a standstill (by 20.66%). The decrease of the share of animal production in the case of category D (-1.74%) – of counties with slight perspectives – is smaller than in category E (-5.89%) – of counties with net perspectives, but category E remains the category with the highest share of animal production.

The indicator *Number of employees in 1,000 inhabitants* increased in all categories of counties. There is a strong direct link between the modernization – development trend of the Romanian rural area and rural household and the number of employees in 1,000 inhabitants. Category E (counties with net trends) stands out. The proximity of large cities is a great economic opportunity for the rural areas: on the one hand, various non-agricultural activities develop here (warehouses, agro-processing, industrial activities, etc.), and on the other hand, urban areas attract rural labour, increasing the purchasing power of the rural population.

There are two indicators *Agricultural area per person employed in agriculture and UAA per agricultural household* that had contrary evolutions in the period 2007-2018. Thus, the indicator Agricultural area per person employed in agriculture has a clear increasing trend in the conditions in which the share of the population employed in agriculture decreases and the agricultural area remains the same (in the case of this indicator the total agricultural area is taken into consideration). Taken separately, this indicator can be considered favourable, but it does not take into consideration other aspects: decline of the population and labour force, land left fallow, land concentration in the case of large agricultural holdings.

The increase of average agricultural land per person employed in agriculture does not result in the increase of average size of individual agricultural holding, but it is based on other processes of demographic nature, decline of population and employment in agriculture. This adds to the fact that part of the land is left uncultivated (either by the rural land owners or by the new owners who do not live in the countryside); this is also reflected in the decrease of utilized agricultural area, in the period 2007-2016, from 8,966,308.55 ha to 6,926,256.09 ha (FSS-NIS). At rural household level, no land consolidation can be noticed; on the contrary, the agricultural area used by an individual agricultural holding decreased from 2.29 ha in 2007 to 2.09 ha in 2016 [13]. A better situation can be noticed in the case of counties with a slight modernization-development trend of rural area and rural household (from 2.88 ha/household in 2007 to 3.31 ha/household in 2016) and in the case of counties with net modernization-development trends (from 2.86 ha/household in 2007 to 2.92 ha/household in 2016), while a decline was noticed in all the other categories.

The indicator *Labour force renewal rate* (The ratio of young population aged 25-29 years to the population in the age group 15-24 years) measures the ability to sustain the economic activities. From 2007 to 2018, the decreasing trend of the labour force renewal rate from 1.90 to 1.77 – a level in which the economic and occupational multiplication was still taking place in relatively normal conditions, is not valid for the entire rural area. For the analysis of the labour force renewal rate at territorial level the following classification will be taken into consideration [6]: I. Territorial units with values over 2, the labour force renewal process will take place in favourable conditions for occupational diversification and economic development; II. Territorial units with values larger than one ranging from 1.5 to 2, the labour force renewal process will take place in normal conditions; III. Territorial units with values larger than one ranging from 1 to 1.5, the labour force renewal process will experience certain difficulties; IV. Territorial units with values ranging from 0.5 to 1, the labour force renewal process will be very difficult.

In the typology by modernization-development rends, the values of indicator fall in the second category, ranging from 1.58 in the category of counties with net trends to 1.94 in the category of counties with no perspectives. By counties, most counties are in the category of territorial units where the labour renewal process will take place in normal conditions.

At the level of indicators regarding the housing dimensions, there is a strong direct or indirect relationship between the resulting typology and all the indicators related to this dimension; thus, there is a direct relationship with the average living area per person (+0.376*), share of new dwellings (+0.622*), quantity of natural gas supplied to the population (+0.541**), quantity of drinking water (+0.345*).

The *living area per person* had a spectacular evolution, from 15.19 m²/inhabitant to 19.78 m² /inhabitant, which can be explained by two contradictory phenomena, namely the diminution of population and of the number of members in a household, on the one hand and expanding the new housing stock through the investments of families who have worked abroad and townspeople returning to the countryside. This is a fact also confirmed in the hierarchy of counties by the average living area, the counties with net modernization – development perspectives being at the top of the list: Ilfov 28.45 m²/inhabitant, Cluj 25.06 m² /inhabitant, Timiș 24.11 m²/inhabitant; the counties with no perspectives or with low perspectives rank last: Vaslui 16.86 m² /inhabitant, Botoșani 17.17 m²/inhabitant, Călărași 17.24 m²/inhabitant.

The analysis of the housing conditions specific to rural households reveals the following characteristics: the individual house is the farmer’s fundamental choice: in the year 2007 the share of those who had a private individual house was 94.9%, while in 2018 this percentage increased to 97.4%; the quality of housing conditions has increased: the share of rural households with problems in the house (poor light; lack of proper heating; leaks through roofs or walls; dampness in walls, floors, foundations; damaged window frames, walls or floors) was down from 49.3% to 17.5% in the period 2007 – 2018. However, a worsening of problems can be noticed related to “dampness” – increase from 42.3% in 2007 to 51.9% in 2018 and to “carpentry/masonry” (deteriorated frames, walls, floors) – which increased in percentage from 61.2% in 2007 to 65% in 2018.

The number of living rooms in the rural household had significant evolutions for all types (1-2 rooms; 3-5 rooms; 6 rooms and over); in the same statistical period, 2007-2018, an increase from 59.5% to 68.2% was noticed in the case of rural households with dwellings consisting of 3 – 5 rooms; from 2.9% to 3.5% for the rural dwellings consisting of 6 rooms or over and a decrease from 37.6% to 28.3% for the dwellings with 1-2 rooms [10]. The share of rural dwellings by household utilities and endowments significantly increased in the period 2007-2018, with a narrowing of the rural-urban gap, yet differences are still significant.

The share of new dwellings is an indicator that captures modernization by the housing stock renewal. In the case of this indicator, the counties with net modernization – development perspectives stand out with the highest share of new dwellings, which increased from 12.53 % in 2007 to 15.38% in 2018; all the other categories of counties had small declining values, ranging from 2.84% for the counties with no perspectives to 4.64% for the counties at a standstill.

It is worth noting that there are rural localities in the proximity of urban centers that attract the retired population of cities who want to settle in the countryside, as well as the young population for whom the rural area is a refuge for the weekend. This phenomenon can contribute to the increase of the number of new dwellings. The indicators *Quantity of natural gas supplied to the population* and *Quantity of drinking water supplied to the population* are relevant for measuring the modernization of rural areas by increasing the level of comfort, the degree of health security of the rural people (ensuring minimum hygiene conditions), for carrying out economic activities (thus the existence of these networks increase the chances of attracting investors), as well as in terms of environmental protection. In rural Romania, the rural households have low access to drinking water supply networks and sewerage networks. Even though there are drinking water supply and sewerage networks operating at rural locality level, the households cannot use them, as they do not have equipped kitchen and bathrooms and they have no possibility to make investments for the modernization of dwellings to have access to these utilities. At rural household level, only 8% of the population benefit from the sewerage network.

At the level of ecological indicators there is not a strong link between the resulting typology and certain ecological indicators; we note only a weak direct link with the amount of organic fertilizers/100 ha (+0.297).

The counties with slight trends have almost 100% increase in the case of organic fertilizers and only 14.30% increase in the case of chemical fertilizers. In the other categories of counties, the amount of chemical fertilizers applied increased significantly (by about 85%), while the organic fertilizers increased slightly to moderately (from 5% to 31%). The agro-environmental measures applied in the period 2007-2013 mainly aimed to maintaining a high environmental value of agricultural land by providing compensation to farmers who voluntarily practice environmental friendly extensive farming. This has created the opportunity to benefit from an increase in incomes for farmers who have an eco-friendly behaviour and work in areas eligible for these measures, with limited natural resources. The ranking of localities in the category of eligible areas – less-favoured mountain areas eligible for M211 and less favoured areas (other than mountain areas) eligible for M212 can be considered a modernization – development opportunity for the population in these less favoured areas to benefit from an increase of incomes by maintaining traditional farming practices. To a certain extent, there is a significant link between the typology of counties (with the exception of counties with net modernization-development trends) and the share of areas eligible for Measure 211.

CONCLUSIONS

From the typology of counties by the modernization – development perspectives of the rural area it can be noticed as a general trend that the Romanian countryside behaves differently depending on the proximity of large urban centers (see Timiș, Ilfov, Cluj, Sibiu, Constanța and Brașov counties), and the rural households in the vicinity of cities have easier access to utilities and more attractive jobs, accessible to a younger and more educated population.

The counties with a net modernization – development trend of the rural area stand out by the most favourable demographic situation. The most populated communes can be found here, with the lowest degree of aging, the lowest dependency ratio, the highest degree of demographic renewal, the only one with a positive natural increase, the highest migration balance.

In economic terms, the counties in this category have the highest degree of diversification of economic activities, the indicator Share of population employed in agriculture having the lowest value. Another argument of the diversification of non-agricultural activities in the counties with net modernization – development trend are the values of the following indicators: the lowest number of agricultural households, the lowest number of days worked on the household, the highest number of employees in 1,000 inhabitants.

This category also stands out by the best living conditions: the largest living area per person, the highest share of new dwellings, the largest amounts of natural gas and drinking water supplied to the population.

At the opposite pole we have the counties with no modernization – socio-economic development perspective of rural area and household, with a strong demographic decline, continuous degradation of social infrastructure, with no employment opportunities, etc.

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CHARCOAL ROT OF THE SUNFLOWER ROOTS AND STEMS (*MACROPHOMINA PHASEOLINA* (TASSI) GOID.) - AN OVERVIEW

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Abstract

Charcoal rot of the sunflower roots and stems is present worldwide in all the areas with arid climate where is determining major loses. The etiologic agent of this disease is the fungus Macrophomina phaseolina considered as invasive due to its great range of host plants (over 500 species) and the very high harvest loses of the cultivated crops, mostly sunflower. The present climate changes are favouring the spread of the disease in areas where it wasn't present before. The climatic simulations realised until now in Europe shows the adaptation trend of the fungus in areas from Central and Southern Europe. The survival of the pathogen Macrophomina phaseolina in soil for long time periods makes its control almost impossible. In this work it was brought to attention the state of the art of the researches regarding the symptomatology, pathogeny, epidemiology and the control of this pathogen in conjunction with the climate change. The control strategies should highlight the prevention methods and the biological ones and less attention to be addressed to the chemical ones. The fungal and bacterial agents can be in future a viable alternative for the control of the pathogen M. phaseolina.

Key words*: *Macrophomina phaseolina, Rhizoctonia bataticola, sunflower, charcoal rot, climate change

INTRODUCTION

The fungus *Macrophomina phaseolina* (Tassi) Goidanich is framed from taxonomic point of view in the family *Botryosphaeriaceae*, genus *Macrophomina*, species *phaseolina.* Even the teleomorph form of the fungus isn't known, Crous *et al.* [21] have demonstrated that *Macrophomina phaseolina* belongs to the family *Botryosphaeriaceae*. The microsclerotial form of the fungus is *Rhizoctonia bataticola* (Taubenhaus) E. J. Butler. The microsclerotia are forming on host plants stems and inside the stem [27][46][22].
Macrophomina phaseolina is a polyphagous fungus able to infect more than 500 cultivated and wild plants species [26][27][30][28][35]. The great number of host plants shows that it is a non-specific pathogen [35]. Due to the great number of hosts and the great capacity of producing yield loses, sometimes even 100 % loss, the pathogen is considered by the specialists as being "invasive" [26][24].
In sunflower *M. phaseolina* is a very important pathogen, able to produce great yield damages and even to compromise entire crop. The economic importance of this pathogen for sunflower is given by the severe symptoms produced as flower heads with reduced diameter, low seed weight, low oil quality and even the death of the plants in case of the massive infections [27][46][8].
The pathogen is extremely dangerous in the arid areas of the world (mainly the tropical and subtropical ones) where constantly produces damages in crops [26][32][49]. Farr and Rossman [31] show that the appearance of the fungus in different species of plants increases constantly at worldwide level.

According with other researchers, yield loses due to the charcoal rot can reach even to 60% [53]. Others have reported sunflower yield loses comprised between 20 and 36 % [35] [10]. In the years with favourable conditions for the pathogeny of this fungus there were reported total harvest loses of the sunflower crops [35][36].

The charcoal rot has been reported in numerous countries as are: Hungary, Romania, Spain, Serbia, Italy, Bulgaria, Portugal, Russia, U.S.A., Czech Republic, Turkey and Slovakia [23].

In Romania are few studies regarding the presence of the pathogen in the sunflower crops. In the year 1982 Comes *et al*. [19] doesn't describe this pathogen in the book "*Phytopathology*" even during 1981-1983 period this had created problems in numerous European countries [55]. Bontea [14][15] describes later the pathogen in the book "*Ciuperci parazite și saprofite din România*" (*En. Parasyte and Saprophyte Fungi from Romania*). In 1990, Docea *et* Severin [27] describe charcoal rot in three crops (maize, sunflower and soybean) in the book"*Ghid practic pentru recunoașterea și combaterea bolilor plantelor agricole*" (*En. Practical Guide for the Recognition and Control of the Crop Diseases*). An interesting study was published in 1996 by Ioniță *et al.* [36] regarding the presence of this pathogen in different agricultural crops from Romania (soybean, sunflower, sugar beet, bean and colza). In this study the authors have reported high attack frequencies of the fungus *Macrophomina phaseolina* in sunflower during 1992-1994, they being comprised between 46.5 % and 92.7 %. In the year 2021, the pathogen has been reported in several sunflower crops from Western Romania where it has produced great yield loses, some crops being compromised in totality [20].

The present climatic changes (mainly the increase of the temperatures) could influence positively the pathological - system *Macrophomina phaseolina* (Tassi) Goid. - *Helianthus annus* L. in the areas with moderate climate. In the countries with temperate climate *Macrophomina phaseolina* produces infections only in the years when there are registered high temperature and dryness. These types of situations have been reported during 1981 – 1983 period in almost all European countries, less in Poland [55]. Coakley *et al.* [17], claim that climate changes can have direct impact on the pathogens from sunflower crop, favouring the infections. The warm and dry weather is stimulating the pathogen *Macrophomina phaseolina*. According with Sarova *et al*. [50], the warm and dry weather with temperatures comprised between 28 – 30 ºC and the deficit of the water from soil are favouring the infection with this fungus.

In general, the fungi that are resisting in soil as sclerotia for long time periods could tolerate easier the unfavourable climatic conditions (e.g. drought). The absence of water in soil could predispose the sunflower plants to the attack of the systemic pathogens that are destroying and blocking the transport tissue [57][25].

In Romania, the fungus *Macrophomina phaseolina* could be present every year from now in sunflower crops, on the background of the climatic changes, respectively the increase of the temperatures over the multiannual averages. This isn't a good perspective having in view that the fungus is difficult to control. To the climate conditions can be added the soil conditions, improper rooting of the plants, boron deficiency, being known that the pathogen is infecting easier the plants affected by physiological disorders [46].

Nowadays climate change is an important global issue threatening plants health, particularly by unfavourable temperatures and precipitations leading more and more to food insecurity worldwide. However, climate change is challenging scientists to look for new methods to cope with negative impact of climate change on crops, breeding for more tolerant varieties to abiotic stresses, improving cropping technologies and controlling biotic constrainers (pests, diseases and weeds) [11][12][13][42][45][54].

The present work is an overview over the fungus *Macrophomina phaseolina* that is spreading in new areas where was present only sporadically, on the background of the climate change. The present climatic changes could bring this pathogen in actuality in many areas with moderate climate, threatening the sunflower crops in future. The formulation of some conclusions on the background of new researched from this field is necessary.

MATERIALS AND METHODS

This work is an overview on the present state of the art of the researches regarding the fungus *Macrophomina phaseolina* in sunflower crop and the spreading capacity in new areas due to the climate change.

For the achievement of this overview there were used several approaches (methods) specific for the realisation of such article: systematic, semi-systematic, bibliometric and integrative. In this way there were identified with careful attention the most relevant articles, reports and scientific works from the field for the chosen topic. These were analysed, compared, synthesised and integrated in this overview paper. The semi-systematic review highlights usually the progress achieved in the researches from the analysed field [61][52]. At the methods used is added a simple technique of text analysis (*text mining*) to identify the best scientific contributions in the field [52].

The review papers are recognized in general as research method more and more relevant, because identifies the eventual lacks and synthesizes the relevant published literature for a certain topic, thus coming to help the young researchers too [48][52].

RESULTS AND DISCUSSIONS

Symptomatology

In sunflower, the fungus *M. phaseolina* infects the plants during the first development stages. With all of these, the symptoms appear only near to the end of flowering stage [27]. The fact that the first symptoms appear at the plant maturity stage indicates a latent infection. Often, the plants that apparently show a good development evolution in the first vegetation stages will develop severe symptoms at the maturity. The plants will maturate early due to the infection and they will have smaller flower heads, sometimes deformed, and a low number of achenes. In the central part of the flower head many flowers are aborted [28]. Near to the end of flowering stage of the sunflower there appear the first symptoms produced by the pathogen on stems and roots. The stems are usually affected in the basal area in their inferior third part [27][46]. On the attacked stem surface appear as greyish discolouring, sometimes with silvery reflections, characteristic for this pathogen (Figure 4a). The fungus will form numerous black microsclerotia in the attacked tissues, that confer a grey-black colour, compared by some authors with a fine charcoal powder. The pith from the inferior part of the stem becomes blackish due to the microsclerotia [60][39][38] (Figure 6a). Sometimes in the affected part the stem it is without pith and in other cases the pith isn't totally destroyed, being separated in disk-like segments parallelly disposed as" *tiered plates*" [27][46] (Photo 1).

Photo 1. Sunflower stem pith attacked with "*tiered plates*" like symptom; the microsclerotia are visible (in Timiş County, Romania).
Source: Original photo by Cotuna O. (2021) [20].

The diseased epiderma is detaching easily from the stem. On the surface of the affected epiderma, and below the surface are forming from abundance black microsclerotia that are determining the charcoal-like aspect [39] (Photo 4b and Photo 5a). According with Csüllög *et al*. [24] the attacked stems have charred aspect and the epiderma is detaching.

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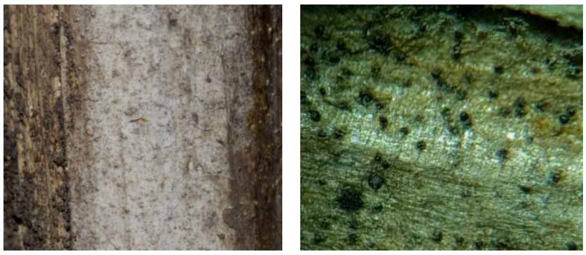
In the same time with the existence of the microsclerotia the fungus can produce pycnidia on the stems, but this happens more rarely in natural conditions. The same authors show that in the first infection stage the sunflower plants are manifesting fading symptoms, then appear the yellowing and senescence of the leaves that are remaining attached to the stems [51].

Photo 2. Fallen of the sunflower crop affected by charcoal rot attack (in Timiș County, Romania).
Source: Original photo by Cotuna O. (2021) [20].

Photo 3. Fallen sunflower plants due to the charcoal rot attack (in Timiș County, Romania).
Source: Original photo by Cotuna O. (2021) [20].

In the same way are infected the roots too. The fungus enters in the secondary and tertiary roots and after that will reach the primary root. In this way the fungus infects the fibro-vascular system of the roots and the basal internodes blocking the transport of the water and of the nutrients. Due to the destroyed root system the diseased plants can be easily uprooted from the soil and they die lastly (Photo 2 and Photo 3). On the diseased roots are forming black microsclerotia [3][27] (Photo 5b and Photo 6b).

Plant fading can start in the flowering stage and continues till to they get mature. In such situations the yield loses can be very high [40] [47].



a b

Photo 4. a) Greyish discolouring with silvery reflexions on sunflower stem; b) microsclerotia on the sunflower stem epiderma surface.
Source: Original photo by Cotuna O. (2021) [20].

a b

Photo 5. a) microsclerotia below the sunflower stem epiderma; b) microsclerotia on sunflower diseased root.
Source: Original photo by Cotuna O. (2021) [20].

a b

Photo 6. a) Microsclerotia in sunflower stem pith; b) sunflower root totally browned.
Source: Original photo by Cotuna O. (2021) [20].

Pathogeny and epidemiology

The charcoal rot fungus can resist as microsclerotia in soil on the litter but also it can resist on the seed mass [28][23][46][4]. There are researches that show positive correlations between the level of the inoculum source from the seed mass and infection severity [4][38]. The microsclerotia can survive in soil from two to 15 years [9][3] [23].

The microsclerotia of the charcoal rot fungus can have spherical, oval or elongate form. The colour differs depending by the age of the microsclerotia (Photo 7). In the first development stages they are light brown and they become black once they are getting mature [43]. According with Docea *et* Severin (1990) the microsclerotia are usually ovoid shaped and have a diameter comprised between 50 - 300 μm.

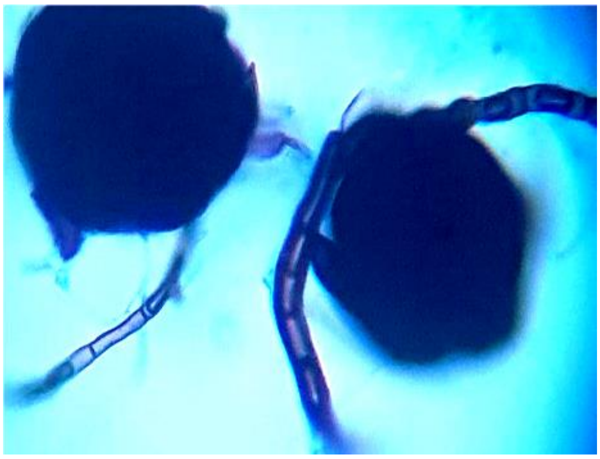


Photo 7. Microsclerotia of *Macrophomina phaseolina* sampled from diseased sunflower plant (microscope photo x40).
Source: Original photo by Cotuna O. (2021) [20].

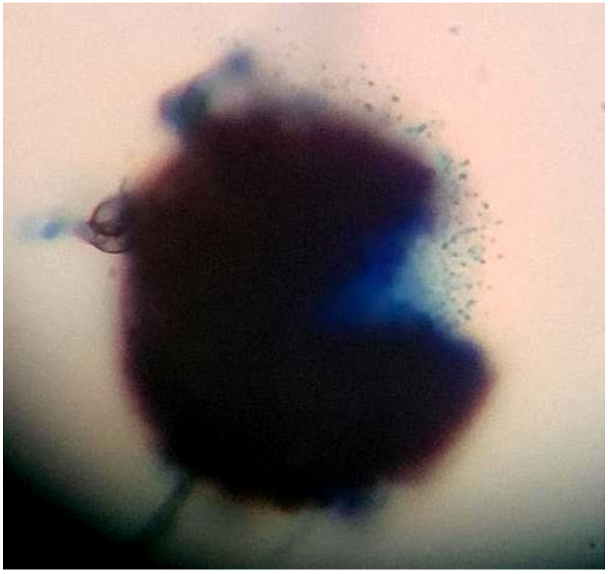


Photo 8. *Macrophomina phaseolina* pycnidia sampled from diseased sunflower stems from western Romania (Timiș County) (microscope photo x40).
Source: Original photo by Cotuna O. (2021) [20].

The fungus pycnidia are forming rarely in nature, they have greater sizes compared with the microsclerotia and have the colour from brown to black (Photo 8). According with Lakhran *et al.* [41] the pycnidia can be globulous or with irregular shape and are presenting an ostiole. The pycniospores can be oval - prolonged or cylindrical, colourless and unicellular. The size of the pycniospores is comprised between 14 - 32 x 5 - 11 μm [27].

The importance of the pycnidia in the epidemiology of the fungus *M. phaseolina* depends in a great measure by the host plant, but also depends by the fungal isolate [2][6].

The fungus attacks plants mostly during the drought periods associated with high temperatures. The temperature, air humidity and the available water are very important for the realisation of the infection with charcoal rot fungus. The microsclerotia are germinating at temperatures comprised between 30 – 35 ºC [43]. The attack of the fungus is mainly influenced by the soil temperatures that has to be greater than 28 ºC and by the rainfalls [28].

In the first development stages of the plants the fungus has the capacity to infest the host in 24 – 48 hours in conditions of low temperature and high humidity. In this phenophase usually the symptoms aren't visible and the fungus is developing slow in the attacked plants until to the development of the achenes. The symptoms characteristic for the disease are becoming visible when the humidity is low and the temperature is high during the seed formation stage [5][38].

In recent studies is shown that the fungus *Macrophomina phaseolina* produces high amounts of toxins and enzymes that are destroying the cell walls. With the help of the hydrolytic enzymes the fungus degrades the polyzaharides from the cell walls and the lignin. The pathogen produces enzymes for the hydrolysis of the cellulose (exocellobiohydrolases, endoglucanases and β-glucosidases) and for the lignin degradation (lignin peroxidases, laccases, galactose oxidases, chloroperoxidases, haloperoxidases and heme peroxidases). The toxins and enzymes produced by the pathogen are

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favouring the infections leading to the appearance of the first symptoms and finally to the host death [37][43].

According with Popescu [46] the fungus usually infects the plants with physiological disorders, when the growth of the main root is stopped and the secondary roots start to grow old. In such plants the root system will be colonized by *Fusarium sp*. and by other fungi that are preparing in this way the root tissues for the infection with *Macrophomina phaseolina*. The mechanical lesions, high plants density and pests attack are factors that are favouring the infection with the charcoal rot [51][4].

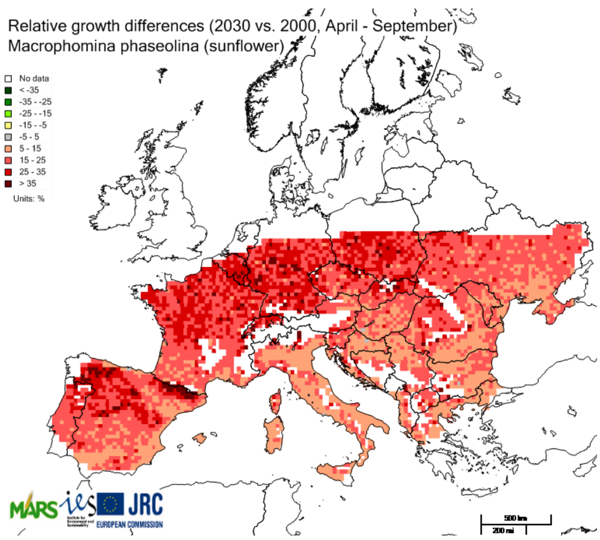
Influence of the climate changes on the fungus Macrophomina phaseolina

Macrophomina phaseolina is a pathogen that is developing in conditions of hot and dry climate. Temperature growth in the temperate regions accompanied by the absence of the rainfalls could create great problems in the sunflower crops [24]. High temperatures and the deficit of water in soil affects the sunflower plants development making them vulnerable to the attack of the pathogen *M. phaseolina* that due to the microsclerotia that are forming in the plant tissues (in roots and stems) succeeds to survive in unfavourable conditions [18][50].

The question that arises is:"*Exist there climatic scenarios in Europe for the future evolution of the pathogens that survive in soil in the case of major climate changes*". The answer is "*Yes. Exist.*"

Regarding the fungus *Macrophomina phaseolina* there was realised a study on the potential answer in the cases of climate changes predicted for Europe. There were realised several experiments simulating conditions of high temperature (demanded by this pathogen). The simulation was realised in Europe with the help of IPCC A1B emission scenario as an achievement of the global climatic model Hadley - CM3. There have been obtained more many simulations of daily weather data for a period of 30 years. The scenarios focused on the year 2030 were compared with those from the year 2000. The response of the fungus *M. phaseolina* has leaded to the conclusion that it will grow and develop better in areas from Central Europe and in Southern Europe. The analysed fungi in the framework of this climatic scenario have shown a general trend to adapt in the cooler areas from Europe [42].

According with the results of this climatic scenario, there is believing that the fungus *M. phaseolina* will register increases of the incidence in countries from the continental Mediterranean areas as is Italy, France, Spain, but also it will enter in countries from Central Europe with relatively cooler climate. The spreading trend of this pathogen specific for warmer areas to the temperate areas was highlighted during the last years, there being reported more often great damages in the crops from these areas where the pathogen was appearing only occasionally only in the year with favourable weather conditions [42] [50] (Map 1).



Map 1. The relative growth differences of the spread of *M. phaseolina* in sunflower in the climatic scenario 2030 vs. 2000.
Source: Manici *et al*. (2012) [42].

In the year 2021 this fungus has destroyed several sunflower crops from Western Romania (Banat Plain, part of the Pannonian Plain) [20].

Can we control this pathogen?

Charcoal rot pathogen is very difficult to control, mainly due to its extraordinary capacity of survival of the microsclerotia in soil. From this point of view the chemical control of the disease is extremely difficult and inefficient from economic point of view.

In this way, the prevention measures represent the fair approach for the control of this pathogen [31]. There is recommended the use of resistant hybrids, irrigation of the crops in drought conditions accompanied by high temperatures, destruction of the infected litter, cultivation of the crops in conditions of proper soil texture, crop rotation *etc*. Regarding the crop rotation there are mentions assuming that it isn't always effective due to the fungus polyphagia (it can infect over than 500 species of cultivated and wild plants) [30][28][46]. Docea *et* Severin [27] recommends the use for seeding of the seed free of microsclerotia, superior quality soil works, crop hygiene and crop rotation.

The chemical control of the fungus *Macrophomina phaseolina* is extremely difficult because there aren't existing fungicides to control the pathogen at the root level. Nowadays are ongoing numerous researches in this topic [16][41][43]. In laboratory research developed by Csüllög *et* Tarcali [23] they show that fungicides aren't efficient against this fungus. They have tested several fungicides: azoxystrobin, cyproconazole, prochloraz and pyraclostrobin. From those only prochloraz has stopped the growth of the hyphae and microsclerotia. The conclusion of the research is that only the genetic resistance could have efficient results in the control of charcoal rot. In the infected soils can be applied fumigations with allowed substances. This methos is quite costly and pollutant, from this reason being used at small spatial scale [46].

Practically the fumigation substances are forbidden, but bio-fumigation could be an alternative for the management of the charcoal rot pathogen in sunflower. Bio-fumigation consists in cultivation of a cover crop from the family *Brassicaceae* and its incorporation in soil with the purpose to produce biocide substances in soil. Very recent researches show the biocide effects of the isothiocyanates on the pathogenic fungi from soil [1]. The efficiency of the bio-fumigation is variable being influenced by many factors shows Motisi *et al.* [44]. The same author brings in attention growths of the attack intensities of some pathogens after the application of bio-fumigation [44]. Thus, there are necessary more researches to attest if bio-fumigation is effective in the control of the pathogens from the sunflower crops and to highlight the potential disadvantages of this method [1].

A non-pollutant method that can be used for charcoal rot control is solarization of the infested fields. This methos is also difficult to be applied on big surfaces. At the application of this method the land cannot be cultivated.

There is interest also in the biological control by using antagonists (fungi and bacteria) and mycorrhizae. In this way are ongoing numerous tests in laboratory regarding their efficiency in the control of charcoal rot.

There is known from long time that the arbuscular mycorrhizae have positive effects on plants, favouring the absorption of the nutrients and protecting the plants against the attack of some pathogens and pests [43]. In the case of sunflower crop there was noticed that the symbiosis with arbuscular mycorrhizae cannot stop the infection with *M. phaseolina* [43].

In the integrated pathogens control systems of the sunflower crop the biological agents (fungi, bacteria and viruses) can replace some chemical treatments. The antagonist fungi *Trichoderma viride* and *Trichoderma harzianum* proved to be effective for the control of the fungus *M. phaseolina* [7]. In general, the fungi from the genus *Trichoderma* proved to be effective biological control agents in the management of this sunflower pathogen [34]. From the *Trichoderma* genus, *T. longibrachiatum* has reduced the mycelium growths of the charcoal rot fungus by modifying its structure, there being implied the direct inhibition and the microbial organic volatile compounds (antibiosis) [34].

Very good efficiency was registered in the case of the combinations between the fungus *Trichoderma harzianum* and the bacteria *Pseudomonas fluorescens* that have reduced the germination of the charcoal rot sclerotia in a rate of 60 % in conditions of natural infection [53].

Bacterial biological agents from the rhizosphere area are now more tested for the biological control of the fungus *M.*

phaseolina. Some rhizobacteria have proved their capacity to inhibit the growth of this fungus. Thus, *Bacillus amyloliquefaciens* and *Bacillus siamensis* have proved a very good fungistatic effect on the charcoal rot sclerotia [56][33]. The results obtained by Torres *et al.* [56] show that the rhizobacteria *Pseudomonas fluorescens* and *Bacillus subtilis* can inhibit *M. phaseolina* according with *in vitro* and *in vivo* tests. A recent study shows that *B. contaminans* could stop the development of *M. phaseolina* by reducing its pathogeny [59].
In the management of the charcoal rot of the sunflower crops is essential the use of a control strategy that includes preventive measures, biological measures and less the chemical measures, last ones being mostly inefficient. Only in this way it can be avoided the harvest loses that the pathogen is able to produce, thus being important to diminish the impact of the pesticides on the environment by limiting their excessive use [58].

CONCLUSIONS

Charcoal rot of sunflower roots and stems is a very dangerous plant disease mostly in the tropical and subtropical areas. In the last years it was noticed the expansion of the disease in new areas, mostly due to the climatic change. The pathogen *Macrophomina phaseolin* is expanding slowly and surely in the areas with relatively cooler climate on the background of temperature increase and the water deficit in soil. In temperate areas the presence of this pathogen is more often reported, not sporadically as it was in the past.
The invasive feature of the pathogen *M. phaseolina* was highlighted in many studies. Thus, the great number of host plants, the distribution at global level and climate changes show that this fungus has potentially great importance for the future of sunflower crop.
The analysed literature from this work shows that this fungus is difficult to be managed due to the survival mode as sclerotia into the soil. The inefficiency of the chemical control methods was highlighted in most of the published articles until in 2021. The approach of the prophylactic and biological control methods is essential in present. The new directions in charcoal rot control research from nowadays with emphasis on the biological control agents are encouraging, even there are needed more numerous tests in field natural conditions.

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IMPACT OF COVID-19 PANDEMIC ON CAPITALIZING THE PRODUCTION OF FAMILY FARMS IN CĂLĂRAȘI COUNTY, ROMANIA

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Abstract

The health crisis caused by Covid-19 generated, among many other effects, a series of dysfunctions in the agri-food system, respectively in farms, in the supply chains with inputs and agri-food products, at the level of food demand. In the existing context in the Romanian agriculture, with millions of family farms, mostly subsistence and semi-subsistence ones, we initiated the present study in Călărași county obtaining information on the main challenges facing family farms during the health crisis and we summarized the farmers' proposals regarding the expectations they have from the local and national authorities in order to ensure the conditions for capitalizing the farm products. The questionnaire was applied in the agri-food markets in Calarasi and Oltenita municipalities, as well as in 9 localities in Călărași county, with a population of over 5,000 inhabitants, where weekly markets and fairs for the exploitation of agri-food products are organized. 61 questionnaires were applied and analyzed, through the survey-interview carried out between June and August 2021. The main challenges they face refer to the change of consumption patterns, blockages in the peasant markets and the increase of online deliveries, syncope in the agri-industrial processing sector, the closure of the firms from HORECA, but also of the schools, canteens, etc. All these challenges had the effect, first of all, of reducing the farmers' income due to the agricultural production decline.

Key words: *COVID-19, crisis, economic effects, family farm, impact*

INTRODUCTION

In Romania, there is a long tradition regarding the development of a family-type agricultural activity, over time the family farms contributing both to obtain the agricultural products and to preserve the cultural-craft activities, on which the principles were based, including the development principles of the agri-tourism segment and environment protection [5].

Small subsistence and semi-subsistence farms are important in Romania because they support the food security and the rural population income. They have a much greater productive diversity than large farms and supply the agri-food markets of cities with fresh and quality products [1]. At the same time, they have a remarkable resilience and are important for the environment, because they use traditional, ecological technologies, less chemical inputs [3].

In addition to the state financial support needed to consolidate and increase the performance of family farms, farmers' access to knowledge and markets is particularly important. In turn, family farms in Romania must create as soon as possible their own structure of production and distribution chains directly to consumers [7]. An important exercise in this direction was carried out during the critical period of COVID 19, especially at the beginning of the pandemic, when consumers faced a crisis in the supply of food from globalist networks, moving to local food systems [2]. In fact, there was a first selection of local producers, able to obtain food and adapt to the new conditions of operation on the market, determined by the sanitary restrictions on public mobility (online orders, home delivery, invoicing with mobile means, card payment, etc.) [12]. Thus, it was found that the main challenges facing farms often reflect common issues to all types of small enterprises: poor endowment with modern means of production, lack of a production planning system, lack of marketing knowledge to support the products sale, but also lack of technical means to prepare products for distribution on the market, lack of financial resources and poor power of market negotiation [9]. FAO warns that there is a risk of a food crisis that would primarily affect the most vulnerable farmers, especially small and medium-sized ones, who face challenges in accessing markets to sell the products and to purchase essential inputs. [11]. Incomes decrease, traffic restrictions and social distress imposed on the population in general led to a reduction in demand in agri-food fairs and markets. Moreover, social distancing measures led to increased costs for small farmers who sell their products directly in urban markets, as they have to buy protective equipment for themselves and stalls, as well as additional packaging [4]. If before COVID crisis, more than 20% of farmers' incomes came from the sale of agri-food products, animals and poultry, the pandemic caused an increase in costs for farmers and, as a result of the contraction in demand, a substantial reduction in agricultural producers whose welfare depends mainly on the sale of farm products [10].

MATERIALS AND METHODS

As research methods, we used documenting, the analysis and data processing from a secondary analysis. These methods are based on the sinthesis processes, induction and deduction, analogy and comparative analysis. Once the information was defined, known and interpreted, the next step was the detailed documenting of the interest field. In the analysis activity, the study of the documentation available for the field or for the analysed system is a starting point.
The documenting, the analysis and the data processing and the information obtained from the following sources: scientific papers in the field, reports and national and international studies on the socio-economic implications of COVID -19 health crisis, the official websites of the ministries managing this crisis, papers from the literature, as well as a questionnaire-based survey.
We elaborated a questionnaire with 9 open and grid questions, respectively, 2 filter questions on the size of the farm and the age of the business administrator and 7 questions related to the implications of COVID-19 health crisis on how to capitalize the production, income, product demand agri-food and consumer behaviour, the opportunity to join agricultural cooperatives or producer groups, as well as their expectations from bodies empowered to support family farms. The questionnaire was applied in the agri-food markets in Calarasi and Oltenita municipalities, as well as in 9 localities in Călărași county, with a population of over 5,000 inhabitants, in which weekly markets and fairs for the exploitation of agri-food products are organized.
61 questionnaires were applied and analyzed, through the survey-interview carried out during June-August 2021.
By using the questionnaire, information was obtained on the main challenges faced by the family farms during the health crisis and we summarized the farmers' proposals on their expectations from local and national authorities to ensure the conditions of use of farm products. This information was used to supplement the survey data in the data collection process. The questions asked through the questionnaire and the survey also followed information on the desire of small farmers to join agricultural cooperatives and producer groups, respectively, as regards the advantages and disadvantages of this association.

RESULTS AND DISCUSSIONS

COVID-19 pandemic, still ongoing, significantly affects the activity and sales of agricultural products by farmers.
These issues resulted from the survey interview based on the questionnaire, applied to 61 small producers of vegetables and fruits, respectively, canned vegetables, compotes, jams, fruit juice, sour soup, pickled cabbage, etc., but also dairy products, from meat and pastries, from the family farms of Calarasi

county, as presented in the answers to the 9 questions.

1.In what category is your farm included, regarding the area exploited -up to 5 ha; between 5-10 ha; between 10 -30 ha; between 30-50 ha? The results are presented in Fig. 1.

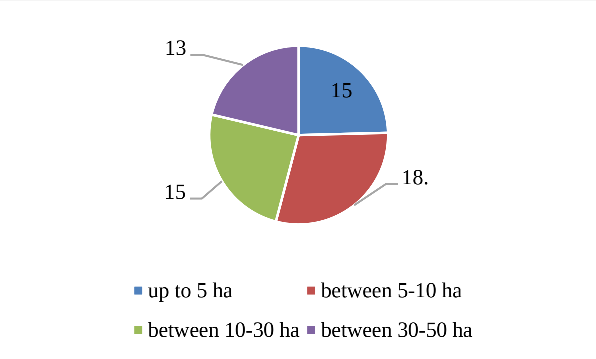

Fig. 1. Number of producers participating in the survey, on categories of farm size – no of producers
Source: Results of the survey.

For the questionnaire-based survey, we selected, for each category of the farm according to the size of the exploited area, an approximately equal number of respondents, between 13 and 19, so that the information collected should cover equally all categories of family farms.

2. Mention the age category in which the farm administrator is included:–up to 30 years; between 30-45 years; between 45-60 years; over 60 years (Figure 2).

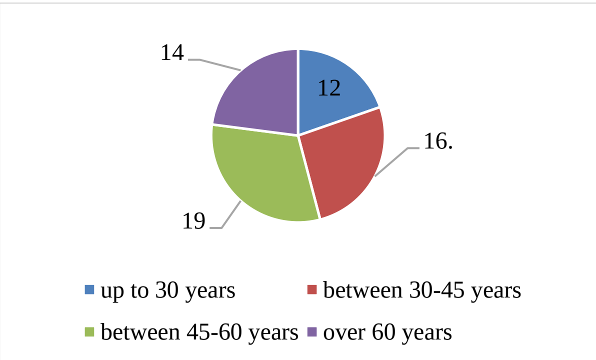

Fig. 2. Inclusion of producers participating in the survey, on age categories – no of producers
Source: Results of the survey.

It should be noted that the number of farmers over the age of 45, in a percentage of 54.1%, in our study, exceeds the number of those included in the age categories up to 45 years.

3. If you were affected by COVID -19 crisis, mention 4 major effects of the crisis on your business (Figure 3).

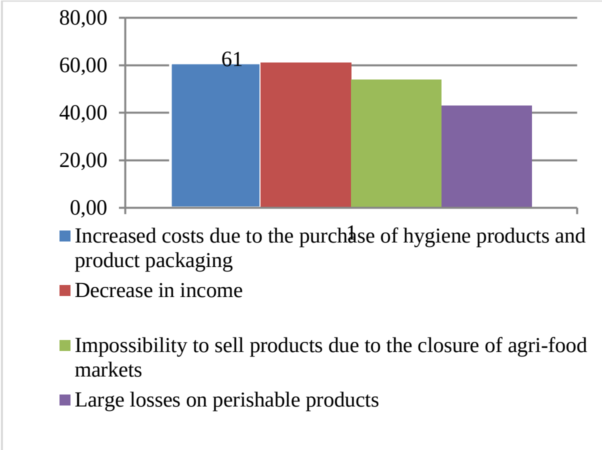

Fig. 3. COVID-19 crisis effects on the family farm business – no of producers
Source: Results of the survey.

Most of the respondents mentioned as effects of COVID-19 crisis on the sale of products, the following aspects: the increase of costs as a result of the purchase of hygiene products and product packaging -61 producers; decrease of income -61 producers; the impossibility of selling the products as a result of the closure of the agri-food markets -54 producers and high losses on perishable products - 43 producers.

4. How much did the income decrease compared to 2019, before the crisis: -up to 20%; between 20-40%; between 40-60%; over 60%? **(**Figure 4**).**

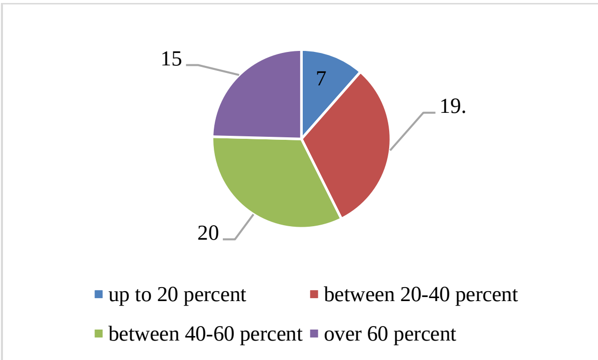

Fig. 4. Appreciations on the reduction of family farm incomes during the crisis - no. of producers
Source: Results of the survey.

We note that 39 of the surveyed producers estimate that the income of family farms in the context of Covid-19 pandemic was reduced by 20-60%, and 15 of them even mention a percentage of over 60% of the decrease in farm income. The worst affected were farmers who worked an area of over 10 ha and who did not have adequate long term storage space for the obtained production.

5. How did you capitalize the products in the conditions of closing the markets/ peasant/agri-food fairs? (Figure 5).

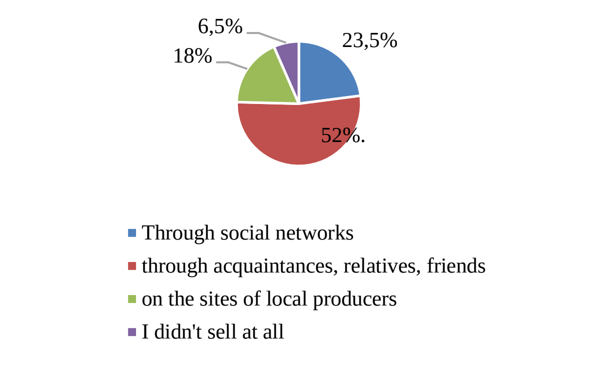

Fig. 5. Modality of capitalizing the family farms products during the crisis - % producers
Source: Results of the survey.

During the pandemic crisis, as a result of the closure of agri-food markets and fairs, 32 producers (52% of the survey participants) capitalized the products through acquaintances, relatives and friends, and 41.5% of the surveyed producers used social networks and agricultural producers' sites, as seen in Figure 5.

6. Do you think that digitizing the production sale is an effective solution? Mention the advantages and disadvantages of this way of selling (Figure 6).

Regarding the opportunity to capitalize the products through online platforms, a number of advantages and disadvantages were mentioned, respectively, they are not advantages because all buyers want to see the goods when they buy it but not the pictures on the internet (31.1%); you can have constant customers (11.5%); you can sell them from home; high transport and packaging costs (24.6%); it takes time to travel to the client (18%); declining sales; you must have knowledge of PC operation and marketing (14.8%) etc.

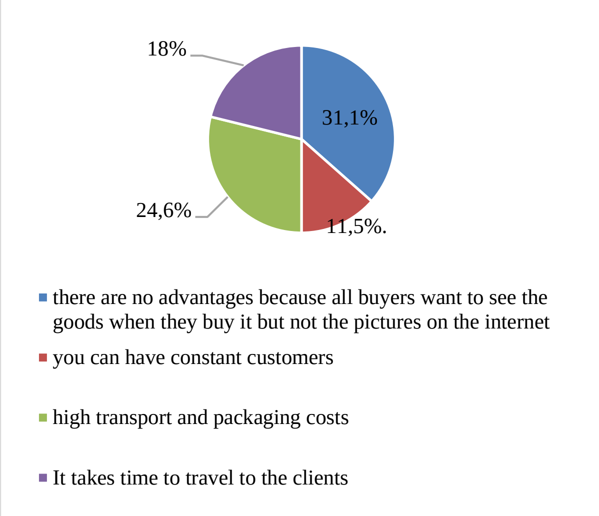

Fig. 6. Appreciations on digitalizing the family farm production sale - % of no producers
Source: Results of the survey.

It is needed to provide adequate knowledge among farmers, respectively, knowledge and skills on modern and innovative methods of processing and marketing of agricultural products, by organizing courses and information events with this specific [8]. In addition, there is support for the continuation of activities aimed at digitizing the production sale, especially for small farmers, such as the “basket with vegetables”, online platforms, etc; Particular attention should be paid to support the transport of these products as the vast majority of farmers who joined such platforms claim high transport costs; This crisis also highlighted the need for farmers to acquire the minimum IT knowledge required in the use of IT products (interactive maps, creative local platforms, interactive networks) [6].

7. Do you think that consumer behaviour changed during this period? Mention 3 factors in this regard (Figure 7).

Agricultural producers mention that consumer behaviour changed, in the sense that they bought products in larger quantities in certain periods and there were days when they did not sell anything (39.3%); changing the rate between fresh products and basic products (37.7%); the hygiene conditions in which the products were capitalized were very important (27%).

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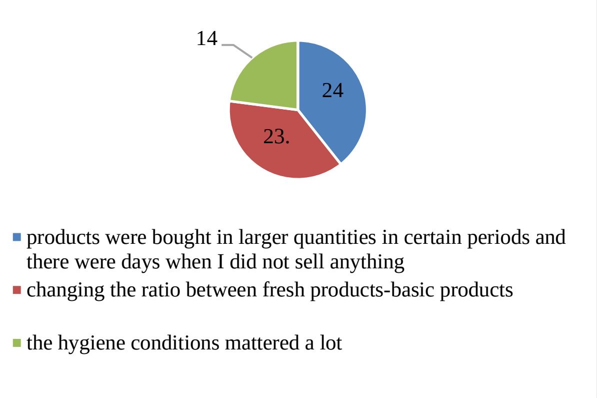

Fig. 7. Appreciations on the modification of consumption behaviour during Covid-19- crisis - no. of producers
Source: Results of the survey.

8. Do you think that your association within an agricultural cooperative or producer group would be a feasible solution in crisis situations?

At this question, only 33 of the 61 producers interviewed answered that it would be a good solution to facilitate the sale of products, especially perishable ones, according to the procedures and standards imposed by the hygiene and food safety requirements. The association can lead to an increase in the degree of technologization of farms, a more efficient organization of production, an improvement of the farmers' position in the value chain and increased negotiation power, but also to facilitate communication between farmers and provide access to marketing and products online sales services, counselling, training and consulting.

The establishment of producer groups in the agricultural sector aims at improving and adapting the production to market requirements and consumer preferences [10]. The main objective is to capitalize the members' products and relieve the producer of the burden of selling production, which directly contributes to a better integration of agri-food producers in the market and in short supply chains.

9. What are your expectations from the local authorities regarding the capitalization of the products obtained in your farms? (Figure 8).

As mentioned in Figure 8, 41 agricultural producers want the local authorities to maintain the safe functioning of peasant markets adapted to the pandemic; the support of the authorities is needed to ensure the continuity of sales in terms of hygiene and safety for both farmers and consumers.

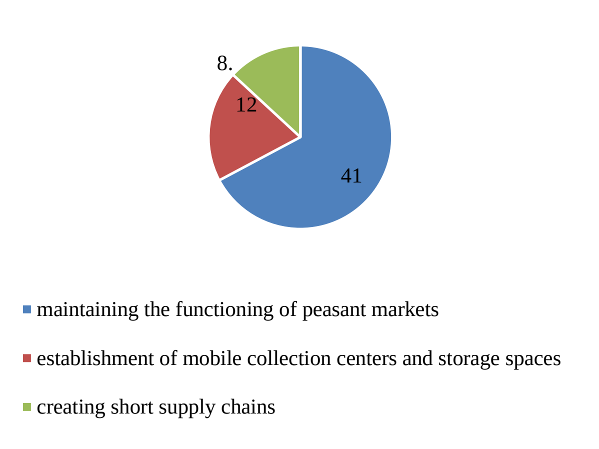

Fig. 8. Expectations of small producers, from the local authorities during Covid-19 crisis - no. Of producers
Source: Results of the survey.

12 producers, among those interviewed, mention that they expect from the local authorities, the establishment of mobile collection centres and storage systems that could help reduce crop losses. This investment is of critical and medium- and long-term strategic importance for the development and resilience of national food chains [6].

It is also worth mentioning the strengthening of partnerships between national authorities and economic actors, between local farmers and the main national retail networks - the Romanian Farmers Club considers absolutely necessary the responsibility and solidarity of the national retail networks for the reconsideration and consolidation of the partnership with the Romanian farmers, first of all by ensuring the priority and fast access to the shelf of the agri-food products provided by them [10]. The creation of short supply chains opens up market opportunities for farmers and other rural entrepreneurs to diversify the product range, promote and sell products in local markets or close to the source of production, either individually or jointly [12].

CONCLUSIONS

From the survey-interview based on the questionnaire on the capitalization of the production of family farms during COVID-19 crisis, the following conclusions resulted:

-Limiting farmers' access to markets to capitalize the production resulted from the imposition of transport restrictions and quarantine measures. There were major problems with the sale of fresh food. The traffic jams and travel checks led to a reduction of income and a significant loss of perishable crops.

-Change in consumption habits / patterns and consumer behavior*:* in this period of crisis there was an increase in both basic food products and ready-to-eat products that can be stored. These trends led to difficulties in selling perishable agricultural products and reduced income for many farmers;

- Strong growth in electronic commerce.

For many small farms, the sale of agricultural products was critical. Since the beginning of the crisis, part of society became aware of the need to support, in particular, small local farmers, and consumption of nearby farms was promoted on social media. Both online product sales and home delivery have accelerated.

-The closure of HORECA sector also affected many farmers who had contracts with these units (mainly for dairy, fruit and vegetables, wine, etc.).

-Excessive agricultural products - production goes to waste - reduced consumer income, diminished need for food products, the closure of schools and canteens led to a surplus of agricultural products.

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STUDY ON ENGLISH LANGUAGE SKILLS IN THE EDUCATIONAL SYSTEM. CASE STUDY

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Abstract

This paper aims to present issues related to the situation of the English language level acquired by teachers in the pre-university educational sector in Călărași, the importance of acquiring language skills, general aspects about pre-university education in Călărași. These are some of the main aspects presented in the paper. Knowledge of English is important for a number of reasons. One of these is access to information that can only be found in English, much of the content on the Internet, books, specialized works, documentaries, movies, etc. Another reason to learn English is to get a better job. The requirements of certain positions are knowledge of English, so it gives you a chance to get a good job and the opportunity to progress professionally. The study was conducted on the basis of a questionnaire, which included 14 questions addressed to 174 teachers in pre-university education in Calarasi county.

Key words: education, English language, skills, schools

INTRODUCTION

According to the Common European Framework of Reference for Languages: learning, teaching, assessment, language competence includes lexical, phonetic, syntactic and other knowledge and skills of the language system [3]. The term language proficiency refers to “the intuitive knowledge of grammatical rules, which underlies the speech that a native sender has already formed and which enables him to produce and recognize correct messages [2]. Communication is a fundamental function in the educational sector, representing a precondition in performing all other functions. Communication is defined as the process of substantial energetic and/or informational exchange between elements of a system or between several systems. In the case of the educational system, it makes intrasystematic exchanges, such as material, affective-motivational, informational, and intersystematic exchanges, between the educational system and other systems [4]. English is an international language used in many sectors and fields of activity, trade, business, communications, aviation. entertainment, science, diplomacy, etc. Due to the need to know English for several reasons, more than one billion people in the entire world population have knowledge of English, at least at a basic level, being the most studied language as a secondary language. The most important aspect is communication, that is performed mainly by means of a lanugage, and without it, any type of activity, daily, simple or complex, cannot be perceived. Communication became indispensable in all aspects of social life [5]. The present paper aims at presenting aspects regarding the level of English language acquired by the teaching staff in the pre-university institutions in Călărași municipality, the importance of acquiring linguistic competences, general aspects on pre-university education in Călărași.

MATERIALS AND METHODS

In order to carry out the study, we applied a non-standard questionnaire in fifteen state pre-university educational institutions in Călărași county, Călărași locality to gather information and opinions of 174 teachers on the importance of knowing English in teaching, the preferred ways to learn skills in English, the skills they want to acquire in English. data on the age group in which they fall, gender, level of teaching, level of education, level of knowledge of the English language in which they are located, etc. The questionnaire contains 14 questions as follows:

Q1- Which is your gender?
Q2- Which is your education level?
Q3- How old are you?
Q4-What specialization did you obtain at the end of the studies?
Q5-Which is your teaching level?
Q6- Do you have English skills?
Q7- Which is your level of English skills?
Q8- Why did you learn English ?
Q9- Were there any situations when you felt the need for English?
Q10- In your teaching activity, do you consider necessary English?
Q11- Did you participate in English learning programs?
Q12- What types of materials would you like to study in English?
Q13- In what context you consider that you would acquire English skills?
Q14- What skills do you want to develop in English?

The questionnaire was applied in February 2019. The advantage of such research is to obtain accurate, rigorous, representative data, which can be statistically analyzed.

RESULTS AND DISCUSSIONS

The pre-university system is an integral part of the national education constituted as a system, bringing together the state education units, private and confessional, authorized or accredited. It is organized by levels, forms of education and, where appropriate, fields and profiles, ensuring the necessary conditions for the acquisition of key competencies and for progressive professionalization [7]. The population of Călărași County was 295,496 inhabitants on July 2016, according to data provided by the Regional Directorate of Statistics [8]. Out of the total people living in poverty, 56.1% have a low level of education, 37.1% have a high level and 6.9% have a high level of education. In the 2017-2018 school year, at the level of Călărași county, there were 101 educational units with legal status, of which 97 were state-owned. The promotion rate in 2017-2018 was 95.31% in primary education, 79.20% in secondary education, 72.16% in high school day education. The lowest percentage was 47.86% in post-secondary education [10]. As a result of the mobility actions of the teaching staff, there was a decrease of 97.12 in the number of norms/teaching positions from 2013 to 2019, in proportion to the decrease in the number of students and classes [9]. The questionnaire was applied in 15 educational institutions: “Mircea Vodă” Secondary School, Călărași; ”Mihai Viteazul” Secondary School, Călărași; ”Nicolae Titulescu” Secondary School, Călărași; ”Tudor Vladimirescu” Gymnasium School, Călărași; ”Constantin Brâncoveanu” High School, Călărași; Secondary School no. 7 ”Gheorghe Florea” Călărași; ”Carol I” Gymnasium School, Călărași; Calarasi Economic College, (the former commercial high school, in 1993, it received the name of economic and Services College Călărași)[6]; Barbu Știrbei Călărași National College (starting with the school year 1999-2000, it received the present name) [1]; Mihai Eminescu Theoretical High School Călărași; Danubius High School Calarasi; "Dan Mateescu" Technological High School, Calarasi; Calarasi Car Transport Technological High School; Ştefan Bănulescu Technical College Călărași; Sandu Aldea Agricultural College Călărași.

In the second subchapter we structured the sample by age categories, level of education, level of teaching, gender. The questionnaire was applied to 174 teachers from the 15 educational units.

Structure of respondents by gender

The structure of respondents by gender reflects that 79% of the sample members was represented by women, and the rest by men (Table 1).

Table 1. Structure of respondents on gender

No. crt.	Gender	No of answers	Percent
1.	Feminine	137	79
2.	Masculine	37	21

Source: Results carried out by the author based on questionnaire.

Structure of respondents by education level
At the question "Which is your education level?" 77% of respondents had high education, 14% graduated a Master study, 6% had post-university studies and only 3% had a medium training level (Table 2).

Table 2. Structure of respondents on study level

No. crt.	Study level	No of answers	Percent
1.	Medium	5	3
2.	High education	135	77
3.	Post university	10	6
4.	Master	24	14

Source: Results carried out by the author based on questionnaire.

Structure of respondents by age category age
Among the respondents, the ones of 36-50 years have the highest share, followed by the ones of 51-65, while just 1% represents the young category of 20-25 years (Table 3).

Table 3. Structure of respondents by age category

No. crt.	Categories of age	No of answers	Percent
1.	20-25	2	1
2.	26-35	22	13
3.	36-50	84	48
4.	51-65	66	38

Source: Results carried out by the author based on questionnaire.

Structure of respondents by job specialization obtained at the end of the studies reflects a large variety of professions as shown in Table 4.

Table 4. Specialization obtained by respondents

No crt.	Answer	No of answers	%
1.	Mathematics	25	15
2.	Biology	7	4
3.	French language	12	7
4.	Sports	4	2
5.	Primary education teacher	28	16
6.	Informatics	6	3
7.	Engineer	11	6
8.	Romanian language and literature	14	9
9.	Physics	5	3
10.	Psychologist	8	5
11.	Music education	4	2
12.	Chemistry	6	3
13.	History	11	6
14.	Geography	8	5
15.	Philology	4	2
16.	Theology	4	2
17.	Others	17	10

Source: Results carried out by the author based on questionnaire.

Structure of respondents by teaching level
Most of the questioned teachers have teaching charge for subjects at the high school level, accounting for 46%, while the lowest share of 16% belongs to the ones teaching pupils in primary schools (Table 5).

Table 5. Structure of respondents of teaching level

No. crt.	Teaching level	No of answers	Percent
1.	Primary	28	16
2.	Secondary	66	38
3.	High school	80	46

Source: Results carried out by the author based on questionnaire.

The structure of respondents related to English skills
At the question "Do you have English skills?", the answers proved that 77% have English skills (Table 6).

Table 6. English skills

Nr crt	Answer	No of answers	Percent
1	Yes	134	77
2	No	40	23

Source: Results carried out by the author based on questionnaire.

The structure of respondents by level of English learning
Regarding the level of English language learning, most of the respondents are at a beginner level, in proportion of 50%, followed by respondents who are at an intermediate level, in proportion of 41%, and the remaining 9%, is at an advanced level (Table 7).

Table 7. Level of English language

No. crt.	Level	No of answers	Percent
1.	Beginner	87	50
2.	Intermediate	71	41
3.	Advanced	16	9

Source: Results carried out by the author based on questionnaire.

At the question: **"Why did you learn English ?"**, of the 174 respondents, 63% said that their reason for learning English was for personal development, 52% for communication, 18% for other situations, 6% for the current job and only 1% answered that they had learned English for a job abroad (Table 8).

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Table 8. Reasons for English learning

No. crt.	Answer	No of answers	Percent
1.	For personal development	109	63
2.	For the present job	11	6
3.	For a job abroad	1	1
4.	For communication	90	52
5.	Other situations	32	18

Source: Results carried out by the author based on questionnaire.

At the question **"Were there any situations when you felt the need for English?"**, 98% of the interviewed persons answered yes, they needed English in various situations (Table 9).

Table 9. Situations when needing English

No. crt.	Answer	No of answers	Percent
1.	Yes	171	2
2.	No	3	98

Source: Results carried out by the author based on questionnaire.

Table 10. English need for teaching activity

No. crt.	Answer	No of answers
1.	Yes, for European projects developing	27
2.	Yes, for communication, information, documentation	51
3.	Yes, as it is an international language	28
4.	Yes, for personal and professional development	10
5.	Yes, for educational software using	15
6.	Yes, because there are terms, notions, neologisms, names in English	10
7.	Yes, to cope with the technology	8
8.	Yes, because it is useful in all activities	12
9.	No, because it is not useful for the study discipline I teach	7
10.	No, because children do not know well Romanian language	6

Source: Results carried out by the author based on questionnaire.

At the question **"In your teaching activity, do you consider necessary English?"**, the majority of respondents consider that it is important to know English in the teaching activity. 29% argued that English is necessary for communication, information, documentation, at an equal rate of 16%, respondents consider English important for European projects and because it is a language of international circulation, 9% consider it is important for the use of educational software, 7% answered that English is useful in all activities, 6%, respondents believe that English is important for personal and professional development, and due to the fact that there are terms, notions, names, neologisms, taken from the English language.

On the last two positions, at a level of 3%, the respondents do not consider English important because it is not useful for the study discipline they teach and the pupils do not yet know Romanian well (Table 10).

At the question **"Did you participate in English learning programs?"**, 73% answered " Yes" (Table 11).

Table 11. Participation in English learning programs ?

Nr. crt.	Answer	No of answers	%
1.	Yes	127	73
2.	No	47	27

Source: Results carried out by the author based on questionnaire.

At the question **"What types of materials would you like to study in English?"**, the results are shown in Table 12.

Table 12. Types of materials to study in English

No. crt.	Answer	No of answers	%
1.	Audio Material	101	58
2.	Video Material	78	45
3.	Interactive exercises	94	54
4.	Written materials	53	31

Source: Results carried out by the author based on questionnaire.

There were received the following answers:
31% respondents prefer the audio materials,
29% prefer the interactive exercises,
24% like the video materials and the rest of the respondents, in a percentage of 16 %, answered "I prefer written materials" (Table 12)

Regarding **the context in which the interviewed teachers would learn English language skills**, most of the respondents, 73%, consider language skills training under the guidance of a teacher as a good way to learn English, 33% chose online courses as a good way to learn English, 16% of them preferred school and the fewest of them, 8%, considered college to be a good way to learn English language skills (Table 13).

Table 13. Context to acquire English skills

No. crt.	Answer	No of answers	%
1.	Online courses	56	33
2.	Linguistic skills courses with a teacher	127	73
3.	At school	27	16
4.	At faculty	13	8

Source: Results carried out by the author based on questionnaire.

The respondents' answers at the question **"What skills do you want to develop in English?"** are sown in Table 14.

Table 14. English skills developing

No. crt.	Answer	No of answers	%
1.	Oral expression	153	88
2.	Grammar	64	37
3.	Written expression	58	33
4.	General vocabulary	70	40
5.	Oral messages understanding	70	40
6.	Written messages understanding	59	34

Source: Results carried out by the author based on questionnaire.

The last question in the questionnaire refers to the skills that the subjects want to develop in English. Many of them chose several skills from the 6 they want to develop. Most respondents, 88%, chose oral expression as the ability they want to acquire, equally, in proportion of 40%, they chose as skills that they are interested in assimilating, the general vocabulary and comprehension of oral messages, 37% want to deepen their English grammar, 34% of them are interested in acquiring knowledge of written messages and 33% chose written expression.

CONCLUSIONS

The aim of this paper is to study the knowledge of English from the perspective of teachers. Nowadays, the knowledge of English has become a necessity, globally, more than a billion people with knowledge of English, at least basic, this being the most studied language as a secondary language. The most important aspect for which we need to know English is communication, which is done mainly through a language, and without which no activity, everyday, simple or complex, can be conceived. Communication has become indispensable in all areas of social life [3].

Following the study, we found that the acquisition of skills in English is a plus for those who acquire communication skills in this language, English being a language of international circulation.

Some of the advantages of knowing English are: access to information that is only available in English; obtaining a good job, whose requirements include knowledge of English at a certain level; professional progress; communication with different people from different countries, assimilating knowledge about different cultures; facilitating travel to foreign countries, making it easier for us to manage; personal development, etc.

In order to carry out the case study, we applied a non-standard questionnaire among 174 subjects, represented by teachers from 15 pre-university institutions. Then we interpreted the questionnaire. In the surveyed sample, the largest share is held by women, who fall into the age category 36-50 years, have higher education, and teach in high school. Most of the interviewees are specialized as teachers in primary education. Regarding the English language skills, most respondents stated that they have language skills at a beginner level. The main reason they learned English is personal development. Most respondents consider it is important to know English in teaching activities. They freely and openly expressed their views on the need to know English, arguing in large part that it is necessary for communication, information, documentation; for the fact that English is a language of international circulation and for the development of European projects.

To a smaller extent, respondents do not consider it is important to know English, arguing that pupils do not yet know Romanian well and that English is not useful to them in the study discipline they teach.

Most respondents agree to participate in English language learning programs. The context in which they prefer to study English is through language skills training courses under the guidance of a teacher, many of whom want to learn to express themselves orally. Throughout our lives we never stop learning, no matter how old we are and no matter how much knowledge we have acquired, there will always be opportunities to learn if we want to. Therefore, we believe that it is never too late for someone to learn English, given that it is an easy language to learn. Being spread everywhere, we inevitably intersect with it.

We consider that of all the many accessible methods of acquiring English language skills, attending a language skills training course under the guidance of a teacher is the most effective method in terms of the fact that the teacher sends the necessary information, organizes interactive activities according to the level of knowledge and the pupils shortcomings, it solves the problems encountered by them, facilitating the assimilation of knowledge, so that pupils are motivated to study and progress. In order to learn and improve a foreign language, it is important to practice the acquired knowledge as often as possible. Dialogue, reading and writing, constantly trained, are effective ways to increase the level of knowledge of the language, thus reducing the possibility of forgetting the knowledge acquired.

This paper presents the level and need for knowledge of English in the pre-university educational environment. Continuing education of teachers is indispensable in improving the development of teaching.

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ANALYSIS OF CORRELATION BETWEEN THE LEVEL OF RURAL COMMUNITIES DEVELOPMENT AND THE DEGREE OF STAKEHOLDERS INVOLVEMENT. CASE STUDY, CĂLĂRAȘI COUNTY, ROMANIA

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Abstract

The citizen participation in decision-making is a basic democratic process. We live in an open society, where we have the opportunity to participate in the decision-making process and the good developing of the community. Although the process is long, the civil society participation strengthens the democratic system, as the key component of a democracy is public participation, which ensures the transparency of the decision-making process and the efficiency of the governing act. Based on these considerations, we carried out a survey in 24 rural localities in Călărași county to see the respondents satisfaction on the achievements in the commune, assessments on the interest of local elected officials in the development of the commune, economic implications of lack of specialists, active involvement of the inhabitants of the commune in making decisions for the development of the community in which they live. The research was based on the survey method based on questionnaire and the data were processed by the method of analysis and comparison, using also χ^2 *test. The questionnaire covered a number of 8 items, to which a number of 762 persons answered. The questions were structured on 2 levels, respectively, 4 filter questions and 4 grid questions, with 3 or 4 predefined answers. These questions were analyzed according to 5 criteria, namely: by the locality size according to the number of inhabitants, by the respondents' age, by the level of education, by gender and by social status. Analyzing the degree of respondents' satisfaction with the achievements of the commune, it is found that the answers differ significantly depending on the commune size according to the number of inhabitants, age, education, gender, social status. The most satisfied are those in communes with a population of over 6000 inhabitants (86%), men (81.6%), those with higher education (83.1%).*

***Key words*:** *community, decision, rural development, citizen participation*

INTRODUCTION

In the contemporary specialized literature, in research centers, in university centers of the world, valuable theories were developed regarding the modeling of rural communities through co-participatory actions and self-organization actions. The model is given by the study of Kenneth P. Wilkinson, entitled "Phases and roles in community action" [cited in 2] and which is rich in the issues addressed and its bibliographical references. It starts with the "power structure" identified by: "community leaders"; "Social forces" and "group performance" and briefly analyzes the concept of social process as "relationships between stakeholders and their activities", which materializes through action program, events, etc. and how the community evolves. [2 and 23].

The development of rural communities does not aim exclusively on decision-makers at central, regional or national level [1]. In order to ensure the rural areas development, it is necessary to mobilize all stakeholders (local authorities, organizations and civil society representatives) and, implicitly, to form a strong partnership between them. The role of the partnership is to set out the main challenges at the local level, set priorities, identify development solutions and implement integrated measures and strategies [9], [20].

The strategies are based on the links between the participating stakeholders, with multiple effects on local development and general programs at regional, national and community level. They must be designed to capitalize the social, environment and economic strengths or “strengths” of the community. The local communities differ as regards capacity, cooperation and/or conflict experiences, and institutional culture [10]. Therefore, it is very important that the partnership is designed according to the realities of the local context. Civil society was recognized as the “third” key sector as regards the positive influence on the state, but also on the market. Therefore, it is seen as a more and more important agent for promoting good governance through transparency, efficiency, opening, responsiveness and respnsibility [8]. In our country, the citizen participation in the socio-political life of the local community as a whole is quite low.

The main cause would be the conception according to which the state is obliged to do everything for the good of its citizens [4 and 16]. At the same time, it takes time for them to learn the rules and regulations specific to active and responsible social behavior. The evolution of the civil society, in the world, and in Romania, proves that, in the future, it will know an important increase of its own role, both in the community in which it exists and at international level [14 and 15]. Thus, the role of civil society in rural development will become much more important, its organizations participating actively in everything that is undertaken at the local, national, regional and international levels. Due to the fact that, through civil society organizations, citizens have the opportunity to express their agreement and commitment to the economic and social development of their community, we can say that they play a key role in creating a democratic European model. [5 and 19].

In the rural areas of our country live the vast majority of those who are at risk of social exclusion due to poverty, which is highlighted by poverty in small villages, which have an aging population, to large communities, which are characterized by low human capital, poor employment and improper houses [17 and 6].

The citizen participation in decision-making is a basic democratic process. We live in an open society, where we have the opportunity to participate in the decision-making process and the good developing of the community. [15]. Although the process is long, the civil society participation strengthens the democratic system, as the key component of a democracy is public participation, which ensures the transparency of the decision-making process and the efficiency of the governing act. It is essential that the mechanisms and tools for participation and influence in the decision-making process are well known, accepted and used by both parties: authorities and civil society [21].

The citizen participation policies must reflect the priorities of the local public administration and the interest of the community, with the general aims of: To encourage citizens to play an active role in the welfare of the community; To ensure the best possible living area for citizens, ensuring full and timely public access to public policy and decision-making, and ensuring that they can be influenced through full opening and immediate access to public information; To ensure the representation of all interests in the decision-making process, balancing different values and needs; To encurage trust between citizens, local elected officials and the local public administration executive; Development of a new approach to local government management, focused on citizens [7], [3] and [13].

MATERIALS AND METHODS

In order to see the degree of stakeholders participation/ involvement in the rural development decisions at the level of the community in which they live, the research was based on the survey method, based on questionnaire and χ^2.test. The concordance test χ 2 (“hi-square”) is a general test, which can be applied to any statistical distribution to which we can calculate the cumulative distribution function. The χ 2 test is applied to grouped data (or frequency data) and aims to associate the columns and rows of a table with two inputs, cross frequencies concerning discrete or discretized variables and is calculated after making contingency tables, in which the data are classified according to one, two, or more segmentation variables [12 and 22].

The steps taken in evaluating the results of the questionnaire using the χ2 method are the following: ***formulating the null hypothesis H0,*** which states that there is no causal link or association between the two variables-questions; ***choosing the level or threshold of significance*** α and calculating the number of degrees of freedom of the table, according to the formula (r-1)*(c-1); based on which, its value is taken from the distribution table χ2, χ2 theoretical; ***comparison of the obtained results*** [11] 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 or if the existence of a null hypothesis is admitted and therefore there is no association or potential relationship between the studied variables; *calculation of the contingency coefficient C*, which has the role of measuring the degree of association between the variables of the contingency table.

It is compared χ2calculated with χ2theoretical for different probability thresholds. Pearson coefficient is calculated regardless of the nature of the variables (continuous or discrete) and regardless of the nature of their distribution (normal or not), in the research population, according to the mathematical model proposed by statistician Karl Pearson. [2, 4]. The closer the value of C is to 1, the more closely the variables are correlated. The survey was used to survey the opinion of the population - a questionnaire with a number of 4 items, to which a number of 762 persons answered. The questions were structured on 2 levels, respectively, 4 filter questions and 4 grid questions, with 3 or 4 predefined answers. These questions were analyzed according to 5 criteria, namely: by the size of the locality according to the number of inhabitants, by the age of the respondents, by the level of education, by gender and by social status.

The 762 respondents were distributed as following: **according to the size of the locality:** over 6,000 inhabitants - Borcea, Chirnogi, Dragalina, Modelu, Dor Marunt, Roseti - 200 respondents; between 4,000-6,000 inhabitants - Ciocanesti, Curcani, Cuza Voda, Frumusani, Perisoru, Jegalia -202 respondents; between 2,000-4,000 inhabitants - Chiselet, Dorobantu, Ileana, Independenta, Nana, Unirea -200 respondents; less than 2,000 inhabitants - Ulmu, N. Balcescu, Gurbanesti, Frasinet, Dichiseni, Căscioarele. **By age**: up to 30 years 112 respondents, between 31-40 years 216 respondents, between 41-50 years 206 respondents, between 51-60 years 104 respondents, over 61 years 104 respondents; **by level of education**: 26 respondents with primary school, 166 respondents with secondary school, 404 respondents with high school and 166 respondents with higher education; **by gender**: men 458 respondents and women 304 respondents; **by social status**: farmer 106 respondents; employee 424 respondents; registered unemployed 28 respondents; unregistered unemployed 26 respondents; without status 108 respondents, retired 70 respondents.

The respondents were asked to make assessments on the degree of satisfaction with the achievements of the commune, assessments on the interest of local elected officials in the development of the commune, lack of specialists, active involvement of commune residents in making decisions that could influence achievements in the commune.

RESULTS AND DISCUSSIONS

The population of Călărași county decreased from 343 thousand inhabitants in 1992 to 314 thousand inhabitants in 2019, respectively by 5.4 thousand inhabitants, considered statistically very significant negative. From the total population in 2019, 126 thousand inhabitants live in urban area (40.01%) and 188 thousand inhabitants live in rural area (60.99%) [18]. The population of Călărași county is organized into communes and villages, respectively 48 communes with 158 villages in 1990 and 50 communes with 160 villages in 2019 [18].

Our study included the population of 24 localities of Calarasi county, grouped in 4 categories, depending on the number of population in the commune.

At question: *Are you satisfied with the achievements in your commune ?,* the analysis of the degree of satisfaction of the respondents with the achievements in the commune shows that there are very significant differences between the studied communes.

Table 1. Analysis of the evaluation of the correlation between the degree of satisfaction of the respondents and the achievements in the commune

Size of commune according to no of inhabitants	UM	Are you satisfied with the achievements in the commune ?				Total	
		Very much	Much	Little	Not at all	no	%
over 6,000	No	172	28	0	0	200	26.2
between 4,000-6000	No.	16	76	102	6	200	26.2
between 2000-4,000	No.	44	120	34	4	202	26.6
under 2,000	No	16	84	50	10	160	21.0
Total	No	248	308	186	20	762	100
	%	32.55	40.42	24.41	2.62	100	x
CHIINV (Chi theoretical)	≥	12.24	14.68	16.92	21.67	27.9	
CHIINV (Chi calculated)	215.8					***	

Source: Own calculations.

Thus, 86% of the respondents from communes with a population of over 6,000 inhabitants and 22% from communes with a number of inhabitants between 2,000 and 4,000 inhabitants are very satisfied, as seen in Table 1. Satisfied are the inhabitants of communes with a population between 2,000 and 4,000 inhabitants, 60% and in communes with a population of up to 2,000 inhabitants, 42%. Little and not at all satisfied are those in communes with a population between 4,000 and 6,000 inhabitants, 54% and those in communes with up to 2,000 inhabitants, 50% (Table 1).

Analyzing the degree of satisfaction according to age, it is found that the differences in appreciation are distinctly significant. Thus, those who are very and much satisfied are 83% in the 31-40 age category and 78% in the 41-50 age category (Table 2).

Table 2. Analysis of the evaluation of the correlation between the degree of satisfaction of the respondents and the achievements in the commune according to the age of the respondents

Age	**UM**	Are you satisfied with the achievements in the commune?				Total	
		Very much	Much	Little	Not at all	No	%
Up to 30 years	No	30	54	44	4	132	17.3
Between 31-40 years	No	94	72	46	4	216	28.3
Between 41-50 years	No	60	96	50	0	206	27.0
Between 51-60 years	No	36	38	22	8	104	13.7
Over 61 years	No	28	48	24	4	104	13.7
Total	**No**	248	308	186	20	762	100
	%	32,6	40.4	24.4	2.6	100	x
CHIINV (Chi theoretical)	≥	20.5	23.5	26.3	32.0	39.3	
CHIINV (Chi calculated)	26.32			**			

Source: Own calculations.

Depending on the level of training, the degree of satisfaction is different. The most satisfied are those with secondary education (83.1%), followed by those with higher education (75.9%) and those with secondary education (69.3%) (Table 3).

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Table 3. Analysis of the evaluation of the correlation between the degree of satisfaction of the respondents and the achievements in the commune depending on the training level of the respondents

Training level	UM	Are you satisfied with the achievements inn the commune?				Total	
		Very much	Much	Little	Not at all	no	%
Primary	No.	6	6	10	4	26	3.4
Secondary	No.	32	94	38	4	166	21.8
High school	No.	122	158	112	12	404	53.0
Higher education	No.	88	50	28	0	166	21.8
Total	No.	248	308	186	20	762	100
	%	32.55	40.4	24.4	2.6	100	X
CHIINV (Chi theoretical)	≥	12.2	14.6	16.9	21.7	27.9	
CHIINV (Chi calculated)	38.9					***	

Source: Own calculations.

Analyzing the degree of satisfaction according to gender, it is found that there are distinctly significant differences. Thus, women respondents are very, much satisfied, 81.6%, while men respondents 67.2% (Table 4).

Table 4. Analysis of the evaluation of the correlation between the degree of satisfaction of the respondents and the achievements in the commune, depending on the gender of the respondents

Distribution on gender	UM	Are you satisfied with the achievements in the commune?				Total	
		Very much	Much	Little	Not at all	No	%
Masculine	No	130	178	136	14	458	60.1
Feminine	No	118	130	50	6	304	39.9
Total	No	248	308	186	20	762	100
	%	32.5	40.4	24.4	2.6	100	*
CHIINV (Chi theoretical)	≥	4.6	6.3	7.8	11.3	16. 27	
CHIINV (Chi calculated)	10,4			**			

Source: Own calculations.

Those who are dissatisfied, at all, are 3% for men respondents and 2% for women respondents (Table 4.).

Depending on the professional status, the differences in the degree of satisfaction are distinctly significant. The most satisfied, respectively very much, are employees (76.9%) and the unregistered unemployed (76.9%), followed by farmers (75.5%) (Table 5).

At the questions if there is a link between the disinterest of local elected officials, the lack of specialists or the active involvement of the commune inhabitants and the achievements of the commune, the answers are significantly differentiated according to the status of the respondents.

At question about the disinterest of local elected officials at the locality level, the respondents assessments are very different. Thus, it is considered that it is influenced 97% in communes with a population between 4,000 and 6,000 inhabitants, 73% in smaller communes with a population between 2,000 and 4,000 inhabitants and only 29% in communes with more than 6,000 inhabitants (Table 6).

Table 5. Analysis of the evaluation of the correlation between the degree of satisfaction of the respondents and the achievements in the commune according to the professional status of the respondents

Professional status	UM	Are you satisfied with the achievements in the commune ?				Total	
		Very much	Much	little	Not at all	no	%
Farmer	No	32	48	26	0	106	13.9
Employee	No	166	160	92	6	424	55.6
Registered unemployed	No	0	12	16	0	28	3.67
Unregistered unemployed	No	8	12	4	2	26	3.4
Without status	No	24	46	32	6	108	14.2
Retired	No	18	30	16	6	70	9.2
Total	No	248	308	186	20	762	100
	%	32.6	40.4	24.4	2.6	100	x
CHIINV (Chi theoretical)	≥	19.3	22.3	25.0	30.6	37.7	
CHIINV (Chi calculated	29.3			**			

Source: Own calculations.

Table 6. Analysis of the evaluation of the correlation between the disinterest of the local elected officials and the achievements in the commune

Size of commune accoding to no of inhabitants	UM	Dissinterest of local officials:			Total	
		Very much	Much	little	no	%
Over 6000	no	2	56	142	200	26.2
between 4000- 6000	no	116	78	6	200	26.2
between 2000-4000	no	96	50	56	202	26.6
under 2000	no	70	54	36	160	21.0
Total	no	284	238	240	762	100
	%	37.3	31.2	31.5	100	x
CHIINV (Chi theoretical)	≥	8.6	10.6	12.6	16.8	22.5
CHIINV (Chi calculated)	132.2					***

Source: Own calculations.

These answers show the capacity of the local communities to have achievements, even if, perhaps appearantly, the local elected official do not demonstrate a visible involvement. The evaluation of the disinterest of the local officials depending on age is not significantly different depending on the respondents age, in the sense that the appreciation very much, much and little are relatively equal appreciations of over 60%.

However, the appreciation of very much and much has together 68.4%, thus demonstrating that the local elected officials are evaluated as ineffective due to lack of interest (Table 7).

Table 7. Analysis of the evaluation of the correlation between the disinterest of the local elected officials and the achievements in the commune, depending on the age of the respondents

Age	UM	Disinterest of local elected officials			Total	
		Very much	Much	Little	no	%
Up to 30 years	No	46	46	40	132	17.4
Between 31-40 years	No	70	60	86	216	28.4
Between 41-50 years	No	76	66	64	206	27.0
Between 51-60 yeras	No	36	32	36	104	13.6
Over 61 years	No	52	34	14	104	13.6
Total	No	284	238	240	762	100
	%	37.3	31.2	31.5	100	x
CHIINV (Chi theoretical)	≥	11.0	13.4	15.5	20.0	26.1
CHIINV (Chi calculated)	13.4		*			

Source: Own calculations.

The evaluation of the disinterest of the local elected officials according to the degree of professional training is significantly different appreciated by the respondents. Thus, it considers that disinterest is a cause of failures in the commune 142 respondents with high school education, namely 70.2%, 63 respondents with high school education respectively 75.9% and 44 with higher education, representing 53% (Table 8).

Table 8. Analysis of the evaluation of the correlation between the disinterest of the local elected officials and the achievements in the commune, according to the training level of the respondents

Training level	UM	Disinterest of local elected officials			Total	
		Very much	Much	Little	No	%
Primary	No	14	10	2	26	3.4
Secondary	No	78	48	40	166	21.8
High school	No	144	130	120	404	53.0
Higher education	No	38	50	78	166	21.8
Total	No	284	238	240	762	100
	%	37.3	31.2	31.5	100	X
CHIINV (Chi theoretical)	≥	11.0	13.4	15.5	20.1	26.1
CHIINV (Chi calculated)	21.87				**	

Source: Own calculations.

The evaluation of the disinterest of local elected officials in the commune according to gender is also significant. Thus, the appreciations of much and very much as disinterest are 73% for men and 61% for women (Table 9).

Table 9. Analysis of the evaluation of the correlation between the disinterest of the local elected officials and the achievements in the commune, depending on the gender of the respondents

Distribution on gender	UM	Disinterest of local elected officials			Total	
		Very much	Much	Little	No.	%
Masculine	No	186	150	122	458	60,1
Feminine	No	98	88	118	304	39.9
Total	No	284	238	240	762	100
	%	37.3	31.2	31.5	100	x
CHIINV (Chi theoretical)	≥	3.2	4.6	5.9	9.2	13.8
CHIINV (Chi calculated)	6.4			*		

Source: Own calculations.

The evaluation of disinterest of local elected officials depending on the professional status is very different. Thus, appreciations very much and much are at farmers 77.3%, 91% at retired and 60.8%% at employees (Table 10).

We find that the disinterest of local elected officials in local achievements is differentiated from the commune, depending on education, gender function and professional status and undifferentiated depending on the degree of vocational training.

Knowing the important role of the specialists in the development activities of the commune, the answers of the respondents were analyzed according to the studied criteria.

The respondents appreciation regarding the correlation between the lack of specialists and the development of the commune, depending on the domicile, is found to be very significant.

Table 10. Analysis of the evaluation of the correlation between the disinterest of the local elected officials and the achievements in the commune, depending on the social status of the respondents

Professional status	UM	Disinterest of the local elected officials			Total	
		Very much	Much	Little	No	%
Farmer	no	42	40	24	106	13.9
Employee	no	126	132	166	424	55.6
Registered unemployed	no	20	6	2	28	3.7
Unregistered unemployed	no	10	10	6	26	3.4
Without status	no	42	30	36	108	14.2
Retired	no	44	20	6	70	9.2
Total	no	284	238	240	762	100
	%	37.3	31.2	31.5	100	x
CHIINV (Chi theoretical)	≥	13.4	15.9	18.3	23.2	29.6
CHIINV (Chi calculated)	29.6					***

Source: Own calculations.

Thus, the evaluation is very much 99% in communes with a population between 4,000 and 6,000 inhabitants, 91% in communes with a population between 2,000 and 4,000 inhabitants and 79% in communes with over 6,000 inhabitants. In communes with a population of up to 2,000 inhabitants, the respondents who complain about the lack of specialists reach 82% (Table 11).

The appreciation of little, almost does not exist in the studied communes being of 2% in the communes with population between 4,000 -6,000 inhabitants, of 8.9% in the communes with population between 2,000 and 4,000 inhabitants, of 21% in the communes with over 6,000 inhabitants and 0.05% in small communes, below 2,000 inhabitants (Table 11).

Table 11. Analysis of the evaluation of the correlation between the lack of specialists and the achievements in the commune depending on the respondents' domicile

Size of commune according to no of inhabitants	UM	Lack of specialists			Total	
		Very much	Much	Little	no	%
Over 6,000	No	74	84	42	200	26.2
Between 4,000-6,000	No	148	50	2	200	26.2
Between 2,000-4,000	No	96	88	18	202	26.6
Under 2,000	No	64	68	28	160	21.0
Total	No	382	290	90	762	100
	%	50.1	38.1	11.8	100	x
CHIINV (Chi theoretical)	≥	8.6	10.6	12.6	16.8	22.5
CHIINV (Chi calculated)	42.6					***

Source: Own calculations.

From the respondents' appreciation regarding the correlation between the lack of specialists and the development of the commune according to age, it is found that they appreciate very much and much their lack, being over 85% of the respondents. Thus, in the age group under 30, it is 86%, in the age category of 31-40 years it is 88%, in the age category of over 61 years of 94.2%, and those of in the age category of 41-50 years being 88%. Regarding the correlation between the lack of specialists and the development of the commune depending on the level of education, it is found that 88% of those with high school education, 90.3% of those with secondary education and 83% of those with higher education appreciate very much the lack of specialists.

From the respondents appreciation regarding the correlation between the lack of specialists and the development of the commune according to the respondents gender, it can be seen that 88.7% of men and 88.8% of women appreciate this lack very much. The appreciation of little being 12% for men and 11% for women. Regarding the correlation between the lack of specialists and the development of the commune depending on the professional status of the respondents, it is found that 91% appreciate this lack, retired, farmers and those without professional status by 90%, employees by 87%.

One of the success factors of the achievements at the level of rural communities is the degree of active involvement of the inhabitants of the commune. The analysis shows that at the level of communes there are very significant differences of appreciation, being appreciated by very much and much of 89.1% of respondents from communes with a population between 2,000 and 4,000 inhabitants, 82% of communes with over 6,000 inhabitants and 64% of those in communes with a population between 4,000 and 6,000 inhabitants (Table 12).

From the analysis of the correlation between the active involvement of the inhabitants and the achievements in the commune, depending on the respondents age, it is found that there are no differences between the different age categories. Thus, in all categories the answers are very much between 76% in the age category 41-50 years and 82% in the category over 61 years, thus proving the same appreciation.

Table 12. Analysis of the evaluation of the correlation between the active involvement of the inhabitants and the achievements in the commune

Size of commune according to no of inhabitants	UM	Active involvement of commune inhabitants			Total	
		Very much	Much	Little	No	%
Over 6,000	No	16	66	18	100	26.2
Between 4,000-6,000	No	46	82	72	200	26.2
between 2,000-4,000	No	138	42	22	202	26.6
Under 2,000	No	76	56	28	160	2.,0
Total	No	292	312	158	762	100
	%	38.3	40.9	20.7	100	x
CHIINV (Chi theoretical)	≥	8.6	10.6	12.6	16.8	22.5
CHIINV (Chi calculated)	87.4					***

Source: Own calculations.

Table 13. Analysis of the evaluation of the correlation between the active involvement of the inhabitants and the achievements in the commune, depending on the training level of the respondents

Education level	**UM**	**Active involvement of commune inhabitants**			**Total**	
		Very much	Much	little	no	%
Primary	No	10	16	0	26	3.4
Secondary	No	80	50	36	166	21.8
High school	No	150	168	86	404	53.0
Higher education	No	50	78	38	188	21.8
Total	No	290	312	160	762	100
	%	38.1	40.9	21.0	100	x
Indicators	Test $\chi 2$, significance threshold					
	≤	0.2	0.1	0ţ05	0.01	0.001
CHIINV (Chi theoretical)	≥	11.03	13.4	15.5	20.1	26.12
CHIINV (Chi calculated)	13.8		*			
Coefficient Pearson	0.187					

Source: Own calculations.

Table 14. Analysis of the evaluation of the correlation between the active involvement of the inhabitants and the achievements in the commune, depending on the gender of the respondents

Distribution on gender	UM	Active involvement of the commune inhabitants			Total	
		Very much	Much	little	no	%
Masculine	No	180	170	108	458	60.1
Feminine	No	110	142	52	304	39.9
Total	No	290	312	160	762	100
	%	38.1	40.9	21.0	100	x
CHIINV (Chi theoretical)	≥	3.2	4.6	5.9	9.2	13.8
CHIINV (Chi calculated)	4.1	*				

Source: Own calculations.

Table 15. Analysis of the evaluation of the correlation between the active invovement of the commune inhabitans and the achievements in the commune, depending on the profesional statute of the respondents

Professional status	UM	Active involvement of the commune inhabitants			Total	
		Very much	Much	Little	no	%
Farmer	no	46	38	22	106	13.9
Employee	no	158	174	92	424	55.6
Registered unemployed	no	14	14	0	28	3.7
Unregistered unemployed	no	12	12	2	26	3.4
Without status	no	38	46	24	108	14.2
Retired	no	22	28	20	70	9.2
CHIINV (Chi theoretical)	≥	13.4	15.9	18.3	23.2	29.6
CHIINV (Chi calculated)	7.5					

Source: Own calculations.

From the analysis of the evaluation of the correlation between the active involvement of the inhabitants and the achievements in the commune, depending on the respondents gender, it is found that there are no differences between the answers. The answers, very much and much, are between 76% for men and 82% for women (Table 14).

From the analysis of the evaluation of the correlation between the active involvement of the inhabitants and the achievements in the commune, depending on the professional status of the respondents, it was also found that there is no significant difference between the respondents answers. The answers of very much and much, have a share of 71.4% for retired, 77% for those without status, 78% for employees, 79% for farmers and 92% for the unemployed (Table 15).

The opportunity must be given to all persons to participate fully in the economic, social, political and cultural life of the society in which they live and to enjoy the benefits of such participation. Ensuring equal opportunities means eliminating the undesirable effects of circumstances beyond the control of individuals on their quality of life [21].

CONCLUSIONS

The correlation between the level of development of the rural communities in Călărași county and the level of involvement of the factors responsible for the development of these communities was analyzed through the answers to the questions: Are you satisfied with the achievements in the commune ?; How do you appreciate the involvement of local elected officials ?; Do you consider the lack of specialists to be an impediment to development ?; Are you actively involved in the problems of the commune?

Analyzing the degree of satisfaction of the respondents with the achievements of the commune, it is found that the answers differ significantly depending on the size of the commune according to the number of inhabitants, age, education, gender, social status. The most satisfied are those in communes with a population of over 6,000 inhabitants (86%), men (81.6%), those with higher education (83.1%). It should be noted that over 72% of respondents say they are satisfied with the achievements of the commune in which they live.

Analyzing the question regarding the evaluation of the involvement of local elected officials in the development activities of the commune, it is found that disinterest is evaluated very significantly by categories of communes and social status and significantly different depending on education and significant gender and age. The activity of the elected officials is considered as disinterest with the appreciation of very much and much, of over 68% of the respondents, which represents a lack of communication, because over 72% of the respondents are satisfied with the achievements of the commune.

Analyzing the appreciation regarding the lack of specialists in the achievements of the commune, it is found that there are very significant differences of answers between the communes. There are no significant differences of appreciation between the groups of gender, age, education and social status, showing that 50.13% appreciate ***very much*** and 38.06% appreciate ***much*** the lack of specialists in the expected achievements in the commune.

The evaluation of the active involvement of the inhabitants in the achievements of the commune, presents significant differences at the level of communes, where communes with a number of inhabitants between 2000 -4000, have 90% of respondents, with appreciations of ***very much and much***, while in communes with a population between 4000-6000 inhabitants is 44%. On the studied groups there is a high involvement with V***ery much and Much***, of 71.4% for retired, of 77% for those without status, of 78% for employees, of 79% for farmers and of 92% for the unemployed.

Analyzing the collected data shows that there is a significant difference in the degree of appreciation of strongly organized communities, regarding the influence they can have in the community development at the level of communes, studies and social status. It is found that the appreciations ***very much and much*** are more, as the level of education increases: from 38% in primary education, to 56% in secondary education, to 63% in high school and 79% in higher education.

Analyzing the answers to the question according to the degree of vocational training, we find that there is also a very significant difference between the answers at the level of the categories of communes, at the level of the degree of training, at the level of the social status. It was found also that those who belong to non-working categories are not consulted in very large proportions: 74% of the non-working status, 71% of the registered unemployed, 69% of the unregistered unemployed and 66% of the retired.

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EVALUATION OF APPLE ORCHARDS VIA THE EXPERT SYSTEM CROM

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Abstract

Although the cultivation of fruit trees is a traditional activity in Romania and our country has natural potential in this regard, both the cultivated area and the fruit production have decreased lately. That is why the NRDP 2014-2020 included a sub-programme for this sector, with sub-measures to redress the field and successfully respond to current challenges, including the impact on the environment. Today, growing concerns about the negative impact that agriculture has on the environment have led to the adoption of agricultural systems aimed at achieving sustainable yields. In this context, Expert System CROM ensures the sustainable development and the conservation of natural resources existing in tree plantations. The following study focuses on some research carried on the management of natural resources, using the CROM Expert System, in the field of apple orchards and lands. Apple orchards and farmlands were graded with additional points starting from 36 to 100 by implementing the Expert System CROM and were classified into three classes: unrestricted, with some restrictions and unsuitable for apple cultivation.

Key words*: *apple orchards, Expert System, consumption, Romania

INTRODUCTION

It is known that Romania has pedoclimatic conditions favorable to the cultivation of a large number of fruit-growing species and that it has a tradition in the field of fruit growing, materialized by the existence of acknowledged fruit-growing basins.
Despite these facts, the cultivated area and the fruit production constantly decreased. Thus, the fruit-growing area of Romania involved more than 100,957 km^2 and covered 1,341 localities [11].
In 2018 a total fruit-growing area of 137.3 thousand ha was obtained [8].
One of the main reasons of the decline in the case of the fruit growing division may be the low preference for the consumption of local fruits manifested by Romanians, although fruits are important components of diets and healthy lifestyles, which more and more people are adopting lately.
As will be seen from the materials presented, Romanians rank well below the European average of the daily consumption of fruits and vegetables. Thus, at the level of 2019 and 2020, according to NIS, Romanians included in the monthly menu an average of 4 kg of fruits [9].
The expected recovery of the fruit growing sector will bring on Romanian's tables fresh fruits, new varieties, more attractive and tastier, but will address to fruit growers challenges related to the impact that the

technologies applied in orchards will have on the environment. Consequently, the achievement of future harvests must be based on sustainable practices.

Their starting point is the fruit-growing ecosystem, which is characterized by specific relationships on the exchange of energy and substances with the environment [4].

Over time, in these interconditioning relationships, food chains are formed and stabilized, determining and influencing the absorption processes through the exchange, formation, translocation and deposition of newly formed substances and energy exchanges.

In the case of plantations under the impact of pollution, in the food chains of the ecosystem also enters the pollutant, which disrupts its normal functioning with direct consequences on tree growth, fruit production and quality [5].

In this situation, CROM Expert System asseses the meteorological components that affect the phenological phases of the apple adopting an original method.

MATERIALS AND METHODS

Expert System CROM develops and establishes scientific indicators and criteria proper for the plantations characterizations. This system is depending on an authentic methodology developed by “ICPA”, which evaluates the soil, climate and land resources, with addition points [3], [5], [13], [14], [15].

In this research, Expert System-CROM was used to determine the natural resources of apple orchards and trees lands:

- meteorological components were graded depending on the repetition frequency of the excellent climatic intervals and temperature thresholds, during a period of 10 years. The mark for climate resources can fluctuate between 0 and 40 addition points;
- soil conditions are allocated from 0 to 25 addition points;
- relief conditions, considering their role in the ecosystem of fruit trees receive 0-15 addition points.

In order to examine the fruit-growing orchards and lands with the Expert System, depreciation points are deducted and addition points are added.

Considering the values achieved, the fruit-growing orchards and lands will be categorised in three groups:

- without natural restrictions;
- with natural restrictions;
- unsuitable for apple trees cultivation.

RESULTS AND DISCUSSIONS

A study published by Eurostat, which was based on a questionnaire conducted in 2019, shows that small amounts of fruits and vegetables were consumed in the European Union. Thus, 33% of the respondents stated that they did not eat fruits or vegetables daily, 12% of the population consumed daily more than five snacks recommended by specialists, and 55% up to four servings of vegetables or fruits each day.

According to this study, Romania ranked last in the EU due to the quantities of fruits or vegetables that people include in their daily menu (Fig. 1). Thus, 24% of the respondents indicated that they prefer to eat a portion or up to 4 portions containing vegetables or fruits per day, while only 2.4% consumed more than five servings. The questionnaire showed that 67.5% of Belgians ate 1-4 portions of vegetables or fruits per day. Following are Spain and Italy with a percentage of 65.7%, as the Mediterraneans are well known for their healthy lifestyle. In the top states that commonly eat much more than 5 servings of vegetables or fruit per day we found on the first place with 32.9% Irish people, second the Dutch - 29.5% and third Danes with 22.9%. An interesting fact can be observed, namely that among the Dutch surveyed, there were a higher percentage of those in the category who consume more than 5 fruits per day.

At European level, the average number of vegetables and fruits consumed per person per day indicated that 12.4% ate more than 5 servings per day and 54.7% of Europeans surveyed had up to 4 snacks of vegetables and fruits in their daily menu [7].

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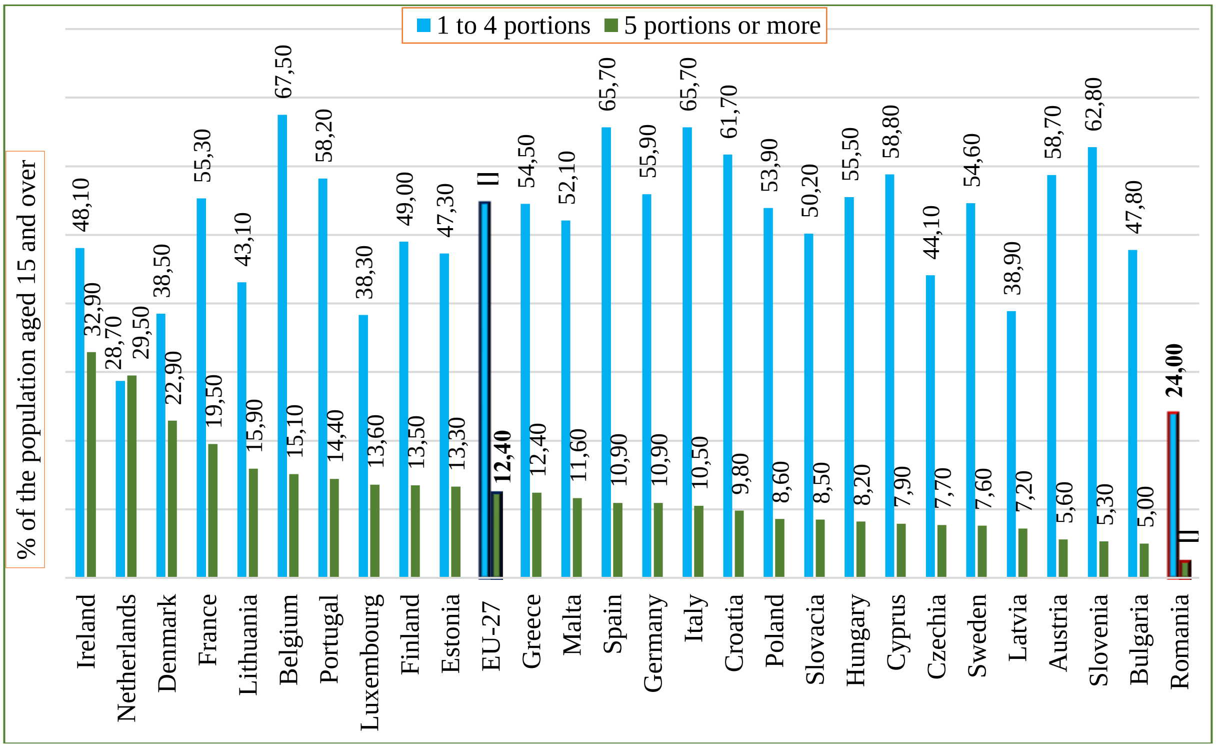

Fig. 1. Situation of vegetables and fruits consumption per day in EU Member States, 2019.
Source: own design after [7].

In order to eliminate the deficiencies in this sector and to capitalize on the country's fruit potential, including research in the field, both of which are not properly exploited, a thematic sub-program for the fruit growing domain has been set up. For the first time in Romania's rural development policy, the sub-program was achieved in PNDR 2014-2020. Within it, the fruit-growing sector is approached in an integrated way, starting from production to the consumer [1].
5 sub-measures were granted for The fruit-growing sub-program:
Measure 4:
• 4.1a - investments in orchards,
• 4.2a - investments in the processing / marketing of fruit products.
Measure 9:
• 9.1a - establishment of producer groups in the fruit sector.
Measure 16:
• 16.1a - establishment and operation of operational groups,
• 16.4a - supports horizontal and vertical cooperation between actors in the supply chain.
Along with plums, the apple is a fruit appreciated by Romanians, a fact highlighted by the cultivated areas and the obtained productions. Studies conducted by Dana D. et all., 2020, show that the area cultivated with apples ranked Romania in 2018 on the 3rd place in the European Union, and the production of apples occupied the 2nd place after that of plums at the level of the country [6]. Therefore, the projects with non-reimbursable funds financed by PNDR 2014-2020 had as main objective this species.

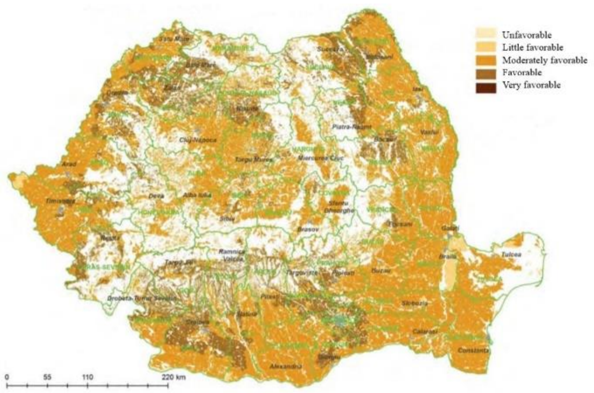

Fig. 1. Map of climatic and pedological favorability areas for apple species in Romania
Source: [10].

Apple is an important element for the health of the population, primarily due to its composition, where we find, among other things, vitamins and soluble fibres.

In Romania, the old saying "Un măr pe zi ține doctorul departe/one apple a day keeps the doctor away" is well known, which emphasizes the aspect mentioned above.

Another reason why this fruit is appreciated is because it has few calories and is therefore used in diets [12].

The Expert System CROM comes to the aid of apple growers, which assesses the climatic, soil and land resources that must be analyzed when setting up apple orchards and other fruit farms. These resources are listed below:

Quantification and expertise of climate resources

Such indicators are the minimum temperature with different values when decrease suddenly or slowly, thermic amplitude and rainfalls in the period of V-VII months. According to this method, the frequency of repetitiveness of thresholds and optimal climatic intervals in the last 10 years is expressed by frequency (%) in five classes: null, very low, low, moderate and optimum. Thermal resources are the decisive factor that influences the normal development of the growth and fruiting phenophases, expressed as intervals and thresholds:

o Air temperature:

- minimum absolute which may drop sharply or slowly - 0 to 4 addition points;
- thermal amplitude for the months XI-II - gained 1-2 addition points;
- average for the month V- gained between 3 and 11 addition points;
- average for the months V-X - 3 to 13 addition points;
- annual average granted between 8 and 17 additional points;

o Rainfalls (in months V-VII) - 9 or 10 addition points (Table 1).

Table 1. Quantification and expertise of climate resources for apple trees

Expertise class	The climatic intervals and thresholds														Addition points
	The average air temperature (^{0}C)						The minimum absolute air temperature (^{0}C)				The thermic amplitude of air (0C)		The rainfalls (mm)		
	Annual	Addition points	Months V-X	Addition points	Month V	Addition points	Decreases abruptly	Addition points	Decreases slowly	Addition points	Months XI-II	Addition points	Months V-VII	Addition points	Total
	7-10		≥16		>12		<-22		<-32		>20		250-300		
	Frequency %		Frequency %		Frequency %		Frequency %		Frequency %		Frequency %		Frequency %		
Without climatic restrictions	90-100	17	90-100	13	90-100	11	90-100	3	90-100	4	90-100	2	90-100	10	60
With climatic restrictions	60-80	11	60-80	10	60-80	10	60-80	1	60-80	2	60-80	1	60-80	9	44
Excluded for apple trees	< 60	8	< 60	3	< 60	3	< 60	0	< 60	0	< 60	1	< 60	9	24

Source: [3], [5].

Quantification and expertise of land resources

When setting up a fruit plantation, the land resources are taken into account, which are obtained following specific research. The results of these studies are materialized by the land characterization indicators. They are of several categories and indicate the availability for the cultivation of apples in the respective land. Thus, they can be:

o unsuitable for growing apples,

o land suitable for apples, of two categories: with or without restrictions.

The addition points awarded by the land due to the above-mentioned indicators are as follows (in ascending order):

-The slope: from 0 to 2;
-The deep erosion: from 0 to 3;
-The landslides: from 0 to 4;
-The land exposure: 1;
-P.A. (Porosity of aeration): 1;

- V.S.N.P.G. (Non-pseudo gleyed and non-gleyed soil volume): 1 or 2;

-The erosion of surface: 2 or 3 (Table 2).

Table 2 Expertise and quantification of land resources for apple trees

Expertise class	Slope		Aspect		Quantification of relief conditions: The erosion – Surface erosion		Quantification of relief conditions: The erosion – Deep erosion		Quantification of relief conditions: The landslides		Quantification of drainage conditions: V.S.N.P.G.		Quantification of drainage conditions: P.A.		Addition points
	%	Addition points	Orientation	Addition points	Characterization	Addition points	Characterization	Addition points	Characterization	Addition points	% vol.	Addition points	% vol.	Addition points	Total
Without land restrictions	≤ 10	2	Plan E, NV, S, SV	1	without erosion weak erosion	3	Absent stream, drain	3	Absent	4	≥ 91-71	1	16-30	1	15
With land restrictions	11-15	1	V, SE, N-NE, in Dobrogea	1	moderate-strong erosion	3	low density deep erosion	1	stabilized landslides	2	51-70	2	≥ 31	1	11
Excluded for apple trees	> 15	0	N, NE, in Dobrogea	1	very strong-excessive erosion	2	high density deep erosion	0	semi-stabilized and active landslides	0	≤ 50	1	≤ 10	1	5

Source: [3], [5].

Quantification and expertise of soil resources

Soil resources characterization indicators received differentiated addition points. These indicators are as follows:

- alkalization and salinization of soil,
- content of calcium carbonates,
- content of exchangeable Al,
- V.E.A. (edaphic active volume),
- industrial pollution of soil,
- reaction of soil (Table 3).

Table 3 Expertise and quantification of soil resources for apple trees

Expertise class	V.E.A.		Soil reaction		$CaCO_3$ content				Salinization of soil		Alkalization of soil		Industrial pollution of soil		Addition points
	%	Addition points	pH (H_2O)	Addition points	Depth of Cca, Cpr, Rrz horizons Cm	Addition points	Active $CaCO_3$ in carbonates horizon %	Addition points	Characterization	Addition points	Characterization	Addition points	Pollutant concentration ppm	Addition points	Total
Without soil restrictions	101-76	1	5.1 - 8.4 exchangeable Al content < 50 ppm	2	≥ 150-101	1	Absent ≤ 8.0	2	Non salinized	4	Non alkalized	6	Pollutant concentration < alert values	9	25
With soil restrictions	51-75	1	> 5.0 exchangeable Al content < 50 ppm > 8.5 V_{Na}< 5%	1	100-51	1	8.1 - 12	2	Salinization >100 cm	2	Alkalization >100 cm	2	Alert threshold	4	13
Excluded for apple trees	50	0	> 8.5 V_{Na} < 5%	3	≤ 50	1	>12	1	Salinization <100 cm	2	Alkalization <100 cm	0	Intervention threshold	0	7

Source: [3], [5].

According to Table 3, the additional points received for soil resources were as follows (in ascending order):

- 0 or 1 - for the edaphic active volume of soil;
- from 0 to 6 - for the soil alkalization;
- from 0 to 9 - for the industrial pollution of soil;
- 1 or 2 - for the calcium carbonate content;
- from 1 to 3 - for the soil reaction;

- from 2 to 4 - for the soil salinization.

In Table 4 we will see how is calculated in the CROM Expert System the value of natural resources for apples, land and orchards.

Table 4 Assessment and calculation of the natural resources for apple trees lands and orchards in the Expert System-CROM

Expertise class	Natural resources			Total addition points
	Climate	Land	Soil	
Unrestricted	60	15	25	100
With some restrictions	44	11	13	68
Unsuitable for apple cultivation	24	5	7	36

Source: [5].

Depending on the addition points they have obtained following the Expert System method, the orchard lands will be divided into three categories, which indicate whether or not they are suitable for apple cultivation:

- without natural restrictions,
- with natural restrictions,
- excluded for apple trees cultivation.

For the fruit sector in Romania, the EU's food policy is a real support because it promotes a healthy diet and thus stimulates the consumption of fruits and vegetables, products that have superior nutritional value.

As the EU attaches great importance to nutrition, which is highlighted in its food policy, where the importance of this area continues to grow, the CAP can also support nutrition by supporting supply and demand, ie the consumption of vegetables and fruits [7].

The production, processing and promotion of healthy food are priorities of the Farm to Fork Strategy regarding the food security and sustainable food systems.

Healthy diets have also been found to be environmentally friendly, as they help reduce animal emissions and carbon sequestration [2].

CONCLUSIONS

Currently, the focus is on obtaining products through sustainable technologies. At the same time, consumers are demanding healthy foods, which are the result of environmentally friendly technologies.

The Expert System CROM meets these demands through its assessment ensemble that points out the natural resources needed for orchards.

Apple is included in the category of elements on which are based the nutrition and diets of the population and in this regard, the CROM Expert System has been used to determine the land and apple orchards natural resources.

The CROM Expert System aims to conserve the natural resources of tree plantations through efficient and sustainable management.

By applying the CROM Expert System, the apple orchards received 36 - 100 additional points for resources, as follows:

- land resources receive 5-15 addition points,
- climate resources receive 24-60 addition points,
- soil resources receive 7-25 addition points.

These points will help classify the lands in the 3 types of categories, favorable or not for growing apple trees.

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PROGRESS IN GENOMICS AND BIOTECHNOLOGY, THE KEY TO ENSURING FOOD SECURITY

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Abstract

Genome manipulation is one of the emerging fields with impressive implications for genetic modification and biotechnology. Targeted genome editing has the general objective of improving the quality and productivity in agriculture, which includes the creation of plants with improved value in terms of composition and nutritional properties and with characteristics that provide resistance to various biotic and abiotic stressors. On the other hand, the progress and development of biotechnology can be the most viable solution for a modern agriculture, favoring the development of sustainable production methods. In this context, the purpose of the paper was to provide a summary of the achievements of genomics and biotechnology with application in agriculture and especially the role of these modern technologies on food security, in the context of unprecedented population growth and climate change. The used methods included searching of the multiple databases and hand searching of the specialized literature with the latest publications in the field. As results, it can be appreciated that the genomics and biotechnology can be an alternative and sustainable management tools to such important sector like agriculture. Thus, the gene editing can make agricultural systems more efficient being involved in creating resistant crops to disease, pests, drought, or other climate change. Also, the biotechnology strategies lead to obtaining a higher yield, improving the quality and diversification of products, in conditions of reduced use of nitrates and other chemical fertilizers and the rational use of water. The development of genomic and biotechnological technologies is one of the few ways that can bring an extensive wave of innovation and really represents the key to effective solutions for solving of the main current global challenges.

Key words: *genome editing, CRISPR/Cas9 system, agricultural biotechnology, sustainability*

INTRODUCTION

Genetics and genomics are very closely related fields in biology. Genetics studies the whole process of inheritance and other related factors, while genomics studies the genome of organisms, *i.e.*, the nucleotide sequences of DNA or RNA. Usually, genomics tries to determine the entire nucleotide sequence of nucleic acids in organisms. In addition, the relationships and interactions within the genome are studied in genomics [17].

Because each nucleotide sequence in genes encodes proteins, and therefore the properties of each protein are determined by genes, the study of genes and its coding has great potential in identifying important DNA sequences for different applications.

Biotechnology is a top field, the development of which is supported both by recent discoveries in biology, microbiology, biochemistry, genetic engineering, etc., and by the demands of society on certain issues it is currently facing: energy and food crisis, ecological problems and bioremediation.

Modern biotechnologies have begun to take shape with the spectacular advancement of genetic engineering techniques and have become a real industry, with an exceptional potential for innovation and a wide variety of activities in agriculture, food industry, medicine industry, environmental protection, biofuels industry etc. [6, 7, 31].

Agricultural biotechnology is an integral part of the vast field of biotechnology and is based on the controlled artificial use of genetic information of plants, animals, and microorganisms.

Agricultural biotechnology consists of a set of scientific techniques used to create or modify plants, animals, and microorganisms. Basically, the term biotechnology refers to a series of methods and techniques that use, as tools, the living cells of organisms or part of these cells or their products (such as genes and enzymes).

Biotechnology integrates several modern techniques, including genetic engineering. The use of new methods in agriculture must be market-oriented, thus ensuring the sustainable viability of agricultural holdings [12, 26, 27, 28, 29, 30, 31].

Biotechnology can provide real opportunities in various fields. In addition to traditional agricultural products, such as food, animal feed and fiber, new agricultural or non-agricultural products may appear, including pharmaceutical products such as oral vaccines, products with higher levels of essential amino acids or vitamins, or with a content improved by fatty acids. The elimination of allergens and anti-nutrient factors from food products may also become possible.

It is expected that in the near future an increased range of better quality and healthier food and feed will be available in less-favored regions, in difficult climatic conditions, in drought conditions or in in the case of less fertile soil. Thus, the correct use of biotechnology can be one of the keys to this evolution.

Biotechnology can provide interesting ways to produce energy in rural areas, thus leading to an increase in the income of rural areas. These opportunities need to be considered in the light of the imperatives of security and food supply, health and environmental protection and sustainable landscape management.

Modern agricultural biotechnologies have the ability to solve many important problems in agriculture: somatic hybridization, in vitro cell cultures and tissues; improving plants and animals to obtain highly productive lines, resistant to diseases, pests and extreme environmental conditions; improving animal nutrition and health; preservation of plant and animal genetic resources; obtaining plant and animal products with an improved nutritional profile, for healthier, safer and higher quality food; recycling of agricultural waste products; soil and water bioremediation; production of auxiliary energy sources, based on organic waste resulting from agriculture, animal husbandry or food industry, etc.

Advances in genomics studies have sparked a revolution in basic and applied research, primarily in fields such as medicine and agriculture. It is said that genomics will transform science and technology and caused an extensive wave of innovation. It is therefore considered that the time has come for the world's states to become seriously involved in the research and development of genomic technologies and to start together proposing effective solutions to global challenges [31].

This review paper it started with the current certainty of two essential global challenges: the population is growing, and climate change is setting new patterns in agriculture. In this context, agrigenomics is a viable solution because, through it, researchers can adapt animal breeds and plant species for ensuring food security.

Agrigenomics refers to the genetic study of crops and animals and how genes influence their development. Thus, the application of genomics in agriculture allows improving the sustainability and productivity in the production of crops and animals.

The paper briefly outlines some of the achievements of genomics and biotechnology with application in agriculture. These achievements can be effective solutions to some prospects that are not exactly promising in terms of food security, in the context of unprecedented population growth and climate change.

MATERIALS AND METHODS

The used methods included searching of the multiple databases and hand searching of the specialized literature with the latest

publications in the field. The main databases were Web of Science and Google Scholar as well as EFSA and Global Market Insights.
The topics followed in this research were: the gene editing (CRISPR) technology and its aid in the adaptation of plants and animals to climate change; plant genome sequencing; enzymatic preparations with high cellulase and hemicellulase activities to improve feed quality and milk production; biotechnological methods to increase the digestion of fiber by ruminants and thus their performance, etc.
By systematic and thorough search of some topical references, were identified a breadth of relevant results. Some data were transposed in the form of adapted tables, in order to better highlight the results in the field.

RESULTS AND DISCUSSIONS

Food security is part of the security of every state in the world and of global security. Ensuring food security means eliminating both obvious hunger - subnutrition and hidden hunger - malnutrition. Today, the issue of food security is a complex and global one, a top priority for ensuring global stability.
Any situation that disrupts the supply and access to food leads to food insecurity. Continued productivity gains are essential due to unprecedented global population growth. In addition to this real demographic explosion and climate fluctuations or changes, there are other factors that can contribute to food insecurity in a very complex way, such as: loss of some agricultural land, civil and economic disturbances, COVID pandemic, gender inequality and labor migration, limited infrastructure, etc. [1, 19, 21, 25, 32, 34].
Genetic bioengineering is the main tool with which biotechnologies are continuously improved. The genomics of an organism represent all its hereditary information and its DNA or RNA code in the case of viruses.
In the past, the selection of plants and animals was based only on phenotype, but in present, based on the molecular selection techniques, this process is faster and cheaper. At the same time, the selection is made with much greater precision. This will create improved plant varieties, healthier and more productive animals, better adapted to climate change, which will ensure food security for all mankind [2, 3, 5, 10, 11].
The gene editing aid in the adaptation of plants and animals to climate change or help mitigate the effects of climate change on agriculture [8, 9, 18]
Nuclear DNA was first edited in the early 1970s, chloroplast DNA was first edited in 1988, and animal mitochondrial DNA was edited in 2008. However, no previous instrument successfully edited the plant's mitochondrial DNA. Some researchers from Japan have used this technique to create four new lines of rice and three new lines of canola [37]. Researchers hope to use the technique to address the current lack of mitochondrial genetic diversity in crops, an extremely vulnerable point in human nutrition. The mitochondrial genome of plants is huge, the structure is much more complicated, genes are sometimes duplicated, and the mechanisms of gene expression are not well understood. The four new rice lines and three new canola lines that Japanese researchers have created are proof that the developed system can successfully manipulate even the complex mitochondrial genome of plants.
This is an important step in mitochondrial plant research. Researchers will further study the mitochondrial genes responsible for male plant infertility in detail to identify possible mutations that could create greater diversity in crops. The team says that the real benefit of the work is adding genetic diversity to crops, even more so than improving yields [37].
As for the potato, it is a genetically complex tetraploid species. The complex genome of potatoes comprises approximately 39,000 genes. From a large genetic background, the researchers identified 2,622 genes that led to the improvement of this crop at the beginning of its domestication [16]. The study of the spectrum of genetic diversity, from the wild past to its cultivated present, can provide an essential source of untapped adaptive potential.
In the near future, it will be possible to identify and study genetic introgressions and hybridization episodes throughout history in order to find the target genes during

domestication to control variance for agricultural traits [16]. Many of these will help hybridization efforts focus on ensuring food security, adapting to climate differences, combating various pathogens, or improving yields.

In the context of actions aimed at helping to combat climate change that concern the entire international community, when the European economy aligns with the objectives of the Green Deal, an important achievement generated by the combined efforts of Corteva Agriscience and PepsiCo was the completion of full plant genome sequencing of oats. This great success, which has been due to a sustained collaboration between academia, government, and the private sector, aims to help increase the resilience of food systems, but also to produce more vigorous, more stable, tasteful and improved nutritional qualities of oat varieties [14].

The publication of the oat genome is a stimulus for international agronomic innovation, which could increase the resilience of the food system from several perspectives. One of these is sustainability - improvement, which aims to increase productivity and obtain stronger varieties, with increased resistance to disease and able to reduce crop losses. In terms of nutritional qualities, oats are known for fiber and essential nutrients they contain. In this sense, understanding the whole genome of the plant creates the possibility for researchers to focus on the desired qualities, being, ultimately, for the benefit of consumers, who want a higher nutritional profile of this plant and not only [14].

Among those who contributed significantly to the project are Corteva, through its advanced sequencing technology and analytical capabilities; Charlotte University of North Carolina, which provided data and studies on the Sequencing and Field Crop Development Center of the University of Saskatchewan, Canada, which provided the oat variety. Through the approach of providing free access to information, these institutions not only promote the science of oat improvement but thus contribute to solving the challenges in the field of agriculture in general but also to improving food and nutrition security in particular.

In plant breeding programs, creating the desired plant could take years and generations. The ability of researchers to accurately modify plant genomes has been limited until the advent of genome editing technology [10]. Today, genome editing allows the same result to be achieved as with traditional breeding methods, but with greater precision and efficiency [23]. DNA sequencing technology has made it possible to decipher the complete genome sequence of many plant species at an unprecedented rate and at a low cost. Knowledge of plant genomes and transcripts makes it possible to create new varieties through molecular design and bioengineering.

The CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) system is an essential feature of the bacterial genetic code and its immune system, functioning as a defense system that bacteria use to protect themselves against virus attacks [18]. Once activated, Cas (CRISPR-associated) genes produce special enzymes that can act as "molecular scissors" that can cut DNA. Basically, CRISPR technology transforms a bacterial immune mechanism into a tool that can edit in a simple and cheap way the genome of all plant and animal organisms.

The genome is the complete set of genetic "instructions" that determine how an organism develops. CRISPR allows the extremely precise "cutting" of DNA fragments from an organism's genome and the modification of its sequence, which is why it is considered a "genetic scissors" (Figure 1).

This versatile technology has rapidly expanded its use to modulate gene expression, ranging from genomic sequence correction or modification to epigenetic and transcriptional changes. CRISPR technology is an engine for basic research. Genomic editing with CRISPR/Cas9 is much faster and cheaper than previous methods [4, 18, 20, 36].

CRISPR has great potential in food production, to improve crop quality, to achieve disease resistance and herbicide resistance.

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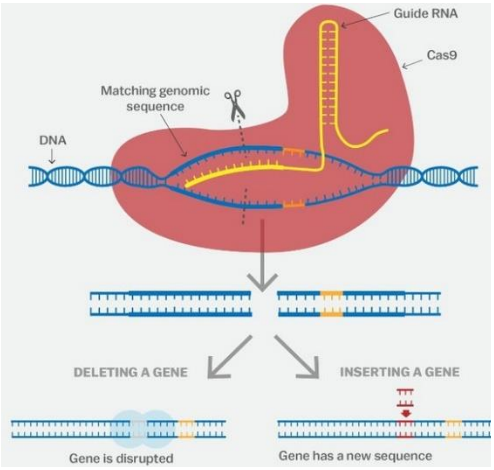

Fig. 1. CRISPR is a gene-editing technology for editing genomes.
Source: [39].

Unlike GMO (genetically modified organisms) methods, CRISPR-Cas9 does not involve the introduction of DNA from compatible plants with asexual reproduction. This key difference could allow genomic editing methods, such as CRISPR-Cas9, to gain wider consumer acceptance, as well as a slightly simpler regulatory process.
This modern genomics technology has already been successfully applied to many plant and animal species, some of which are specified in Table 1.

Table 1. CRISPR gene-editing system applications for different traits to a few species

Species	Trait targeted	Genes edited	References
Banana	Semi-dwarfed	Ma04g15900	[35]
Maize	Drought tolerance	ARGOS8	[36]
Rice	Drought tolerance	EPFL9	[40]
Cattle	Thermotolerance	SLICK	[4]
Chicken	Yield	G0S2	[24]
Goat	Yield	Fat-1 into MSTN	[41]
Pig	Yield	IGF2	[20]

Source: Own calculation based on [18].

CRISPR also offers the opportunity to address the issue of food allergies by rewriting those regions of the gene that are recognized by the immune system and that cause an allergic reaction. CRISPR-Cas9 is also being studied to modify the DNA of wheat to eliminate gluten, making it suitable for patients with celiac disease.
Climate change will further increase the need to use CRISPR technology to protect food and agricultural industries from new bacteria. Gene editing can make farming more efficient. It can reduce the global shortage of food for basic crops such as potatoes and tomatoes, and it can create crops that are resistant to drought and other effects on the environment.
In the next years, growing demand for CRISPR/Cas9 technology will favour the gene editing market value. Thus, the CRISPR/Cas9 segment is estimated to register growth of more than 15% by 2026 (Figure 2) [15].

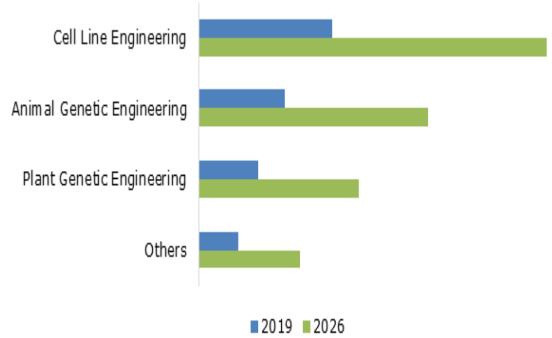

Fig. 2. Global Gene Editing Market
Source: [15].

The variety of biotechnological processes is very large, the field of application of biotechnology being constantly expanding.
The use of microorganisms for human purposes is not limited to the production of various substances by industrial microbiology, but also includes areas such as food industry, wastewater treatment, biotransformation or biodegradation of waste, biogas production, biomass production, implementation of symbiotic systems at plants and animals, genetic bioengineering, etc.
Agricultural biotechnology includes plant biotechnology and animal husbandry biotechnology. While plant biotechnology refers to the use of plant cell cultures as well as genetic engineering techniques for modern and unconventional plant and animal breeding, animal husbandry biotechnology

refers, in particular to animal nutrition, increasing animal resistance to pathogens, obtaining animals with increased production of meat, milk, eggs, wool, etc. and conservation of animal genetic resources.

The feed industry is an important sector in agriculture. A lot of feed additives are currently used, and new concepts are continuously developed: enzymes, pre-biotics, pro-biotics, dietary amino acids, metabolic modifiers, etc. Enzymes, for example, are the biological catalyst which improve the nutrient availability from feed stuffs, ensure lower feed costs and reduce anti-nutritional effects from some feed ingredient [22].

Cellulases and hemicellulases have a very wide range of applications in this industry (Table 2).

Table 2. Some enzymes used in feed biotechnology and their effects

Enzymes	Effects
Cellulases Hemicellulases	Increasing of fodder flexibility; Improving the nutritional quality of feed and animal performance
Β-glucanase Xylanase	Release of nutrients from cereals; Improving the absorption of fodder and animal performance
Pectinase	Preservation of feed quality for ruminants

Source: Own calculation based on [15].

β-glucanases and xylanases have been used successfully in non-ruminant diets to hydrolyze non-starchy polysaccharides (NSP). The presence of high concentrations of NSP in the cereal-based diet leads to low feed conversion rates, low weight gain of young animals, especially of chicks [33].

The addition of β-glucanases and xylanases during feed production has led to the degradation of NSP and has significantly improved the digestion and absorption of feed components and weight gain by chicks and laying hens [33]. Carbohydrases supplementation has an important role in poultry diets with high NSP contents (Figure 3).

Econase XT is an enzyme preparation with endo-1.4-beta-xylanase as the main activity. The product is currently authorised for its use in feed for chickens and turkeys for fattening and reared for laying/breeding and for weaned piglets [13].

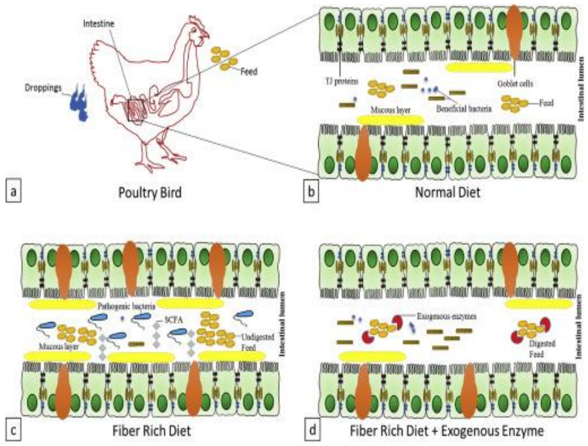

Fig. 3. Exogenous feed enzymes (EFE) supplementation with high NSP diets to improve energy utilization and performance to poultry
Source: [33].

Some of the benefits of adding Econase to the diet of chickens are: increased flexibility in diet formulation; use of cheap raw materials; increase in the energy value of cereals; improved digestibility, improved feed conversion; clean eggs with more colorful yolks; less waste, etc.

Similar results were obtained with other enzyme preparations with xylanase and β-glucanase. Due to the success of these enzymatic preparations in the diet of chickens, has been promoted their use in the diet of pigs too. In fact, supplementing the diet with xylanase-based multienzyme preparations has reduced the cost of feeding pigs and facilitated the use of cheap feed [38]. Despite this progress, more studies are needed to recommend the right combination of hydrolyzed enzymes to be included in a wide range of pig diets.

In general, there is a growing interest in the use of enzymatic preparations with high cellulase and hemicellulase activities to improve feed, milk quantity or ruminant weight gain [22]. However, the success of the use of these enzymes in the diet of ruminants depends on several factors: their stability in feed (during and after processing) and in rumen; the ability of the enzymatic components to hydrolyze the polysaccharides in the plant cell wall; the ability of the animals to use the reaction products efficiently. Therefore, enzymatic preparations should be permanently characterized by in vitro and in vivo experiments.

The ruminant feed diet, which contains cellulose, hemicellulose, pectin and lignin, is more complex than the one based on cereals for chickens and pigs. Enzyme preparations with high cellulase, hemicellulase and pectinase content have been used to improve the nutritional qualities of feed [22]. However, the results of adding enzymatic preparations containing cellulase, hemicellulase and pectinase to the diet of ruminants are still insufficient. Some studies have shown substantial improvements in feed digestibility and animal performance, while others have reported adverse effects or non-effects [22]. Considerable fundamental and applied studies are needed, along with the use of improved enzymes to increase the digestion of fiber by ruminants and thus their performance.

Attempts have even been made to clone cellulase and xylanase genes to produce transgenic animals that may secrete the necessary enzymes in the gastrointestinal tract to facilitate efficient digestion of feed [38]. Such a study would have a considerable impact on understanding the role of cellulases and related enzymes in feed digestion and animal performance.

The huge advances in genome structure and function (based on the transition from single gene analysis to whole genome analysis, complete genome and transcriptome sequencing, and understanding how genes are expressed together) provide the opportunity to genotypically select organisms based on whole genome sequences or some SNP (single nucleotide polymorphisms) matrices of the whole genome [31].

CONCLUSIONS

The discoveries in the field of genomics and bioengineering are the ones that currently have the greatest influence in terms of understanding the mechanisms that coordinate the functions of organisms and the way of transmitting data that provide the specific features of an organism. Genetic editing can make agricultural systems more efficient, reduce the overall food shortage for basic crops, and create resilient crops that are not affected by disease, pests, drought, or other climate change.

In the near future, it will be possible to identify and study genetic introgressions in as many plant and animal species as possible, in order to find the target genes during breeding, which will control the variability for the desired agricultural traits. Many of these will help hybridization efforts focus on adapting to climate differences, fighting different pathogens, or improving yields. The progress and development of biotechnology can be the most viable solution for a modern agriculture, favoring the development of sustainable production methods, obtaining a higher yield, improving the quality and diversification of products, in conditions of reduced use of nitrates and other chemical fertilizers and the rational use of water.

Some of the most important advances in genomics and biotechnology, which offer the hope of future food security, are the following: obtaining of the new cellular lines for many interest products; production of proteins, amino acids, vitamins, enzymes and other organic components for human or animal consumption; increasing the resistance of plants and animals to pathogens and tolerance towards adverse environmental factors; conservation of plant and animal genetic resources, etc.

However, these opportunities need to be considered in the light of the imperatives of human health and environmental protection as well as a sustainable landscape management.

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USE OF MOLECULAR MARKERS IN PLANT BIOENGINEERING

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Abstract

Genetic markers represent different forms of the same gene that control mutant phenotypic expression and allow individual quantification of genes. One of the basic criteria in the molecular markers usage is the molecular polymorphic capacity of plant genetic material. This paper aimed to distinguish and generalize some of the relevant results regarding the applications of different molecular markers in plants bioengineering. Thus, the paper describes the main categories of markers used in plant bioengineering, with topical examples of their utility in modern plant breeding programs. The used methods included searching of the various databases (Web of Science, Google Scholar, The Food and Agriculture Organization, The International Service for the Acquisition of Agri-biotech Applications) and identification some relevant results. From this point of view, the results indicate the immense opportunity of molecular markers in the individual study of plants, without conditioning the stage of their development. Some of the practical applications of molecular markers in plant genetic programming relate to the investigation of the diversity of genetic material; precise location of genes; germplasm certification, etc. Molecular markers applications generate an explosive growth of vital information for genetic research, the natural consequence being the rapid advancement of basic and applied knowledge. However, correct and objective information to the general public is an important step in making it easier to accept innovations in plant bioengineering and enables progress in agriculture.

Key words*: *genetic markers, DNA, PCR, applications, polymorphisms

INTRODUCTION

Plant bioengineering is an area of paramount importance, as it can provide solutions to many major global problems, one of which is ensuring global food security.
Genetic diversity is critical for a population to adapt to changing environments [5, 6, 31, 32].
The marker represents an identifiable DNA sequence that facilitates the study of the inherited transmission of a character or gene. The genetic markers are used to map the order (sequence) of genes along chromosomes and to track the hereditary transmission of certain genes. Genes closely related to the marker will generally be transmitted (inherited) with it. Markers should be easily identifiable at the phenotype level.
Molecular markers are genetic markers that can mark the presence of a certain gene in DNA. Genetic markers are mutant alleles that mark the presence of a gene at the individual level and control easily identifiable characters. They are of two types: (a) morphological markers, which control morphological characters (for example, the red colour of the maize grains is determined by the R^r gene or the R^{st} gene for variegated grains) and (b) biochemical markers, which control some biochemical properties.
The molecular markers are the most used due to some advantages: their unlimited number, the location in uncoded regions of the DNA as well as the fact that they are not influenced by the environmental conditions or the stage of plant development. The most important characteristics of molecular markers are the following: they can be obtained in unlimited numbers, from any tissue, at any stage of development; are independent of gene

expression and are not influenced by environmental conditions; are not subject to selection pressure; usually, it does not show non-allelic (epistatic) interactions and does not show pleiotropy; are simple transmitted via mendelian way, etc. Molecular markers can be dominants (when heterozygotes do not differ from homozygous) or co-dominants (when heterozygotes can be clearly distinguished from both homozygous parents).

Marker deletion via transposons is a process that allows certain genes to "jump" to a certain position in the plant's genome. The process is analogous to site-specific recombination, with transposons ("jumping genes") being used instead of recombinase and recognition sites. They contain a gene that encodes a special enzyme (transposase), which recognizes certain signals in DNA. The enzyme cleaves the DNA fragment flanked by these signals and integrates it randomly into the genome. The gene of interest or the marker gene can be placed in the "jumping" sequence, so that the two genes can be separated from each other after transposase activation [28].

The term *Free Marker Technology* refers to any technology used to remove selected marker genes from transformed cells, tissues, or plants. Such technologies are based on cotransformation, transposable elements, situs-specific recombination or intrachromosomal recombination.

Obtaining of transgenic plants without antibiotic resistance markers can be achieved by application one of two main strategies: (1) excision or segregation of marker genes from the host genome after regeneration of transgenic plants; (2) transformation without marker. The second strategy is based on the transformation of plant tissue explants or cells with a virulent strain of *Agrobacterium tumefaciens* and the selection of transformed cells or shoots after PCR analysis. This strategy has proven to have the advantage of improvement frequency of transformation of recalcitrant species [28].

Marker genes can be used to identify those cells into which the new gene has been stably integrated and expressed, provided that the marker gene for selection is located alongside the gene of interest in the pattern used for transformation. The most commonly used marker genes are genes for resistance to antibiotics or herbicides. All of these genes give genetically modified cells the ability to detoxify substances that would otherwise be fatal. For example, a gene for herbicide resistance confers tolerance to cells on that herbicide. After transformation, they come into contact with the substance encoded by the marker gene (which may be included in the culture medium). This is the time when only those plants that have the marker gene stably integrated and properly expressed in their cells will survive. Transgenic plants will be regenerated from these cells [28].

The use of molecular markers for the detection and exploitation of DNA polymorphism is one of the most significant achievements of molecular genetics.

The advantages of markers in selection, for studies of diversity and in the context of marker-assisted selection have been highlighted in many results [2, 4, 18, 20, 22, 24, 25].

The possible advantages of markers implementing in the genetic improvement of plants were suggested a long time ago but their real potential was developed after 1970, with the expansion of new techniques for testing variability at the DNA level. It can be appreciated that the family of molecular markers was founded by the development of RFLP technology in the 1980s, first for human genetics and later for plants. From this point of view, they began to be used successfully to establish genetic diversity and distance, based on DNA polymorphism and especially for the accurate detection and identification of genes of interest [11].

Combining classical plant improvement techniques with those of molecular biology through the prism of molecular markers (MAS technology) is one of the most important methods in modern agriculture. For the study of a large number of plants, the cost-benefit ratio must also be evaluated. From this point of view, the costs of making molecular methods are very rarely compared and can vary considerably, depending on the availability of automated equipment and technical experience [9].

Molecular techniques for detecting variation at the DNA level require the use of a wide range of molecular markers: RFLP (*Restriction Fragment Length Polymorphism*), RAPD (*Randomly Amplified Polymorphic DNA*), AFLP (*Amplified Fragment Length Polymorphism*), SNPs (*Single Nucleotide Polymorphisms*) and so on. All of them differ from each other in several respects: development costs, polymorphism level, automation, recognition of a certain sequence, etc. [1, 11].

However, it is very important to know exactly each class of molecular markers and the information level of each in order to identify those that correspond optimally to the proposed purpose.

The paper describes the main categories of markers used in plant bioengineering, with topical examples of their utility in modern plant breeding programs.

There are two main classes of molecular markers, namely: (a) traditional markers and (b) markers based on the in vitro amplification reaction of DNA by PCR (Polymerase Chain Reaction) technology. The first category includes protein markers, RFLP markers and markers resulting from DNA sequencing. On the other hand, the category of PCR-based molecular markers includes RAPD, micro and minisatellite markers, AFLP, SSCP (Single-strand Conformation Polymorphism), ASAP (Allele specific Associated Primers) and EST (Expressed Sequence Tag) markers.

In another classification, there are markers that allow the detection of monolocus polymorphism (RFLP, PCR) and markers that allow the detection of polylocus polymorphism, i.e., at different genes or different chromosomes (RAPD).

MATERIALS AND METHODS

The topics followed in this research were: an overview of the global bioengineering situation, in terms of areas and the main transgenic crops which can support a rapidly growing world population; the advantages of the molecular markers compared to traditional phenotypic ones; DNA marker applications for improvement in various plant species; some practical applications of different molecular markers (RFLP, RAPD, STS, SSR, AFLP, etc.) and some briefly new issues about Vertebrate Genome Project (VGP).

The used methods included searching of the various databases and hand searching of the specialized literature with the latest publications in the field and identification of some relevant results. The main databases were Web of Science and Google Scholar as well as FAO (The Food and Agriculture Organization) and ISAAA (The International Service for the Acquisition of Agri-biotech Applications). Some relevant information was transposed in the form of adapted figures and tables.

RESULTS AND DISCUSSIONS

As the global population explosion progresses, more food, energy and goods are needed. The problem is that of limited natural resources, which forces us to produce more with less, to ensure global food security but in conditions of environmental protection. Although a controversial topic, plant bioengineering has led to significant improvements in crop yields, which support a rapidly growing world population. In the future, genomic screening will provide an even more complete picture of all organisms and will most likely find the solution of the many of the serious problems which humanity encounters.

The United States is a world leader in terms of cultivated area with genetically modified plants. Thus, 38% of the genetically modified global agricultural production is in the USA. Over 90% of the five major crops grown in the United States are GMO. These crops are: corn, rapeseed, soybeans, cotton and sugar beet. Most processed foods in the United States contain ingredients from genetically modified crops, and the first GM foods were approved for consumption in 1994 [10].

In addition to the above-mentioned genetic bioengineering crops, the United States also cultivates herbicide-tolerant alfalfa, virus-resistant pumpkin and papaya hybrids, mechanical damage-resistant potatoes, and browning, which produce low levels of acrylamide when found in high temperatures, late blight resistant potatoes and more suitable for storage. Browning-resistant apple varieties as well as browning-resistant mushrooms are also grown. Pink pineapple, created by Del Monte Fresh Produce, has recently appeared on US markets, containing low levels of enzymes that turn lycopene (pink pigment) into beta-carotene (yellow pigment) [10].

Therefore, USA remained as the top producer of biotech crops globally [17], which planted 71.5 million hectares in 2019. Brazil landed on the second spot, with 52.8 million hectares (Table 1).

Table 1. Top 10 countries in terms of Global Area of Biotech Crops in 2018 and 2019 (million hectares)

Rank	Country	2018	2019
1	USA	75	71.5
2	Brazil	51.3	52.8
3	Argentina	23.9	24
4	Canada	12.7	12.5
5	India	11.6	11.9
6	Paraguay	3.8	4.1
7	China	2.9	3.2
8	South Africa	2.7	2.7
9	Pakistan	2.8	2.5
10	Bolivia	1.3	1.4

Source: Own calculation based on [17].

From the initial planting of 1.7 million hectares in 1996 when the first biotech crop was commercialized, the 2019 planting indicates a major increase (Figure 1).

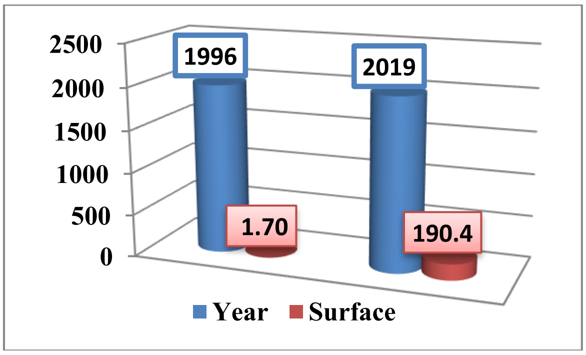

Fig. 1. Global area of Biotech crops, 1996 to 2019 (million hectares)
Source: Own design and calculation based on [17].

About future prospects, scientists all over the world are combining their efforts to develop new biotech crops and traits that will be beneficial to farmers and consumers [17].

The use of molecular markers in plant bioengineering is one of the high-performance research technologies. Molecular markers are of great importance in assessing the hereditary composition of the body and are the main driving forces of improvement, which are based on morphological characteristics, which largely depend on environmental conditions.

Some DNA marker applications for improvement in various plant species are highlighted in Table 2.

Compared to traditional phenotypic markers, the molecular ones have a number of advantages, such as the ability to improve the efficiency of plant breeding in general and the selection through molecular markers linked to the research character, in particular.

One of the major benefits of molecular markers is that they can predict the plants performance according to specific traits without lengthy and laborious tests in the greenhouse or field. From this point of view, the most important applications of molecular markers in plant bioengineering are represented by genetic fingerprinting and mapping, marker-assisted selection, backcross acceleration and detection of diversity and genetic differences between different populations. Variations within the DNA of genes or gene loci that correlate with different phenotypes of the plant can be used as molecular markers; however, in addition to these, there are other categories of molecular markers: hybridization-based and PCR-based molecular markers. The different types of molecular markers can be characterized by several methods for highlighting the polymorphisms present in the DNA sequence. DNA sequencing provides accurate and reproducible data that can be applied to a wide range of variations by selecting target regions in the genome, according to the intended purpose.

DNA sequencing has taken on an unprecedented scale since the advent of the PCR technique, which has made it possible to amplify orthologous regions of DNA from any organism of interest with astonishing speed [13]. There are currently universal PCR primer sets that allow the amplification and subsequent sequencing of certain DNA regions in almost any plant of interest [27].

RFLP markers are molecular markers based on the hybridization difference between a cloned or PCR-derived DNA fragment, with DNA fragments from the sample to be analysed, which were obtained after restriction enzyme digestion. The marker is specific to a single restriction enzyme.

Table 2. Some examples of DNA marker applications

Application	Marker	Plant species	Ref.
Genetic diversity, DNA fingerprint and germplasm conservation	DArT; ISSR and RAPD; CDDP; RAPD and ISSR	*Zea mays; Ricinus communis; Musa L; Gloriosa superba; Oryza sativa L.*	[3, 19, 16, 30, 23]
Marker-assisted selection	SSR; SRAP	*Manihot esculenta; Camellia oleifera;*	[26, 12]
Association mapping	SSR	*Chickpea*	[19]
Hybrid identification	SSR; EST and SSR	*Citrus aurantifolia and Citrus limon); Elymus sibiricus*	[14, 34]

Source: Own calculation based on [1].

RFLP markers have some advantages that give them the priority to use compared to RAPD markers: they are codominant and are not affected by environmental conditions; any DNA source can be used for analysis; they can also be used in populations where the phenotypic effects are not obvious [33].

Although RFLP markers have a codominant phenotype and are virtually unlimited in number, they have been overcome by the advent of other simpler, cheaper, and much faster technologies, such as PCR technique.

However, it should be mentioned the role that RFLP technology has played since its discovery, by contributing to the development of knowledge on the detection of specific nucleic acid sequences, genetic fingerprinting, the characterization of genetic diversity or breeding patterns in plant and animal populations, etc.

In plants, two sources of DNA clones are used for RFLP mapping: complementary DNA clones and genomic clones, derived from the complementary DNA restriction [29].

A restriction fragment length polymorphism is said to occur when the length of a detected fragment varies between individuals, indicating non-identical sequence homologies. Each fragment length is considered an allele, whether it actually contains a coding region or not, and can be used in subsequent genetic analysis (Figure 2).

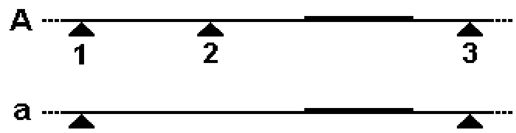

Fig. 2. The mechanism by which the size of a particular restriction fragment can be variable
Source: [29].

In recent years, many of the DNA fragments used in the RFLP technique have been sequenced and therefore, it is now possible that, based on sequence similarity, specific primers can be synthesized, which can be amplified by the PCR technique.

These markers are called STS (Sequence tagged sites) and are often used in plant bioengineering to identify and select genes of interest but only if they are associated with distinct expressions.

With the advent of PCR technology, a new generation of automated markers has appeared, almost infinite in number and relatively fast to test. Consequently, there is a wide range of molecular techniques, based either on the use of restriction enzymes or on target site PCR technology or both. Thus, SSR, AFLP and RAPD are some of the widely used PCR-based markers.

The advantages of the PCR technique in plant bioengineering are enormous. Depending on the purpose, any type of primer can be chosen, even non-specific ones. All types of primers used in PCR technique can be used in different combinations, and their potential for use in various experimental purposes is practically unlimited.

RAPD markers are generated by PCR via a single primer. They detect the polymorphism of DNA nucleotide sequences using a single primer with the arbitrary nucleotide sequence.

The RAPD technique is used in many genetic analyses. It is a less laborious method and allows obtaining an overview of the polymorphism at the level of a genome, faster and cheaper than other techniques, such as RFLP.
Microsatellites or simple repetitive sequences are present in all organisms, including plants. They are a major source of genetic variability, useful in plant bioengineering. They are considered neutral selective markers because they are not located inside or near the coding sequences and therefore cannot cause a gene to be disrupted and are not subject to selective pressure from a neighbouring gene [15, 21].
Metabolic markers are an alternative to the controversial genes for antibiotic resistance. They allow plants to be grown on unfamiliar culture media or to produces metabolic products that allow only transgenic to grow. Once the transgenic cells have been identified, the marker genes are no longer needed. This is why the most effective ways to achieve transfer without marker genes, or to remove them after transformation, are sought [8].
In 2018 have been marks 20 years since the inception of the National Plant Genome Initiative (NPGI), which is dedicated to advancing crop improvement through genome sciences. Many examples of the involvement of genomics in increasing of genetic progress to plants are presented in the literature, such as barley (in Germany) or pearl millet (in France). In fact, the pearl millet was re-sequenced from almost 1000 varieties in order to establish with certainty the evolution of this highly topical plant in terms of high tolerance to drought [7].
An example of a bold and current global initiative is the Vertebrate Genome Project (VGP), from which is expected to achieve all four stages of vertebrate genome sequencing, progressively, from each all order, genera and species of vertebrates [7].
The practical applications of molecular markers can be structured as follows: use in linkage analysis and genetic mapping; use in phylogeny and evolution studies; germplasm diversity analysis; variety genotyping; the study of hybridization and introgression; use in taxonomy and systematics, etc. However, the analysis of the plant genome via molecular markers has generated an enormous amount of extremely useful information in the scientific community in the field and beyond.

CONCLUSIONS

The use of molecular markers in plant bioengineering is one of the high-performance research technologies, which allows a maximum resolution for the identification of different genetic variations. This technology generates an explosive growth of vital information for genetic research, the natural consequence being the rapid advancement of basic and applied knowledge.
The genetic basis of molecular labelling methods is DNA, which allows the labelling of any genomic region. The use of molecular markers is suitable for the analysis of any tissue and organ, regardless of the stage of development of the organism. Compared to traditional phenotypic markers, the molecular ones have a number of advantages, such as the ability to improve the efficiency of plant breeding in general and the selection through molecular markers linked to the research character, in particular. In addition to these important advantages, molecular markers offer many other opportunities: accurate identification of gene locations; detecting morphologically invisible mutations, but of major importance for plant improvement; usefulness in genetic and phylogenetic analysis, etc.
The implementation of high performance technologies has already made it possible to complete the genome sequencing of several plants and animals. Plant bioengineering promises finding of big solutions for a small planet.

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CHARACTERIZATION OF A PASTURE AREA BASED ON SOIL AGROCHEMICAL INDICES AND IMPROVEMENT MEASURES

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Abstract

The study evaluated the quality of the soil within an agricultural area, the category of pasture use, in terms of agrochemical indices. A surface of 485.94 ha was studied, from the area of Brebu Nou locality, Caras-Severin County, Romania. The agricultural land under study falls into the category of pasture use. Soil samples were taken, and the agrochemical indices determined for the evaluation of the studied agricultural land were represented by the soil pH, humus content (H, %), phosphorus content (P, ppm), potassium content (K, ppm), nitrogen index (NI, %), and the degree of supply of basic cationic (V, %). The data obtained for the 119 studied plots were grouped in 10 groups, depending on the pH value, with a variation of 0.1 pH units per group. Based on the determined agrochemical indices, a high variability was found regarding the soil supply with phosphorus (CV_P = 56.1509) and the soil supply with potassium (CV_K = 42.5579). Low values of CV were recorded for pH (CV_{pH} = 4.7231) and for humus (CV_H = 5.2127), and intermediate values for NI (CV_{NI} = 25.2418) and for V (CV_V = 24.8559). From the analysis of the average values, on the 10 groups obtained, it was found that 79% of the studied area (385.15 ha) has a strongly acidic pH (groups G1 - G7), and 21% of the surface (100.79 ha) has a moderate acidic pH (groups G8 - G10). According to the PCA, PC1 explained 44.051% of the variance and PC2 explained 32.812% of the variance. Regression analysis facilitated the obtaining of models in the form of equations ($p < 0.001$, $R^2 = 0.764$ to $R^2 = 0.827$), and 3D and isoquants graphical models, which described the variation of phosphorus and potassium in relation to soil acidity and soil humus.

Key words: *acidity, calcareous amendments, models, pasture, soil pH, soil quality*

INTRODUCTION

The evaluation of agricultural lands based on specific, ecological and agrochemical indicators, is important and has been used in various studies in relation to the category of land use [9], different types of agricultural systems [10], [27], agricultural practices and technologies [3], [5], [32], [34], [35], agricultural crops and production [21], [29], economic aspects [19], soil type and fertilizers [4], soil health [17], [26], [36], soil improvement measures [2], [12], [36], soil protection policies [20].

The variation of the agrochemical indices is the result of the factors and conditions of soil formation and evolution, but also of the anthropic factor through some agricultural practices [8], [28].

Soil limitations in terms of their health, as well as agricultural production and farm profitability, have been studied and ranked among the main limiting CEC (cationic exchange capacity), nutrients and soluble carbon [36].

Acidity is a limiting factor in soil fertility over large areas of land around the world, and numerous studies have addressed issues regarding soil acidity assessment, adverse effects on crops, and the formulation of remedial solutions [1], [11], [22], [30].

In relation to the acidification phenomenon, studies have been conducted on soil monitoring in different soil and climate zones, at different categories of agricultural land use, and correlated with agricultural crops, crop technologies, and improvement measures [16].

The acidity of the soil in the case of pastures has a number of disadvantages, which are found in the floristic composition, biomass production and its quality, which is a major

constraint in economic and social terms, but also ecological. Various studies have been conducted to assess the level of acidity on grassland land, in relation to soil and climate conditions, nutrient regime, the presence and effect of aluminum, changeable forms (Al^{3+}), and ameliorative measures [25], [18], [31].
The present study analyzed and characterized the soil quality based on agrochemical indices, within an agricultural area with land occupied by pastures.

MATERIALS AND METHODS

The study evaluated the quality of the soil within an agricultural area, the category of pasture use, in terms of agrochemical indices.
The land taken in the study with an area of 485.94 ha is located in the area of Brebu Nou locality, Caras-Severin County, Romania, Figure 1. The study was conducted in 2020, and the samples were taken in April.

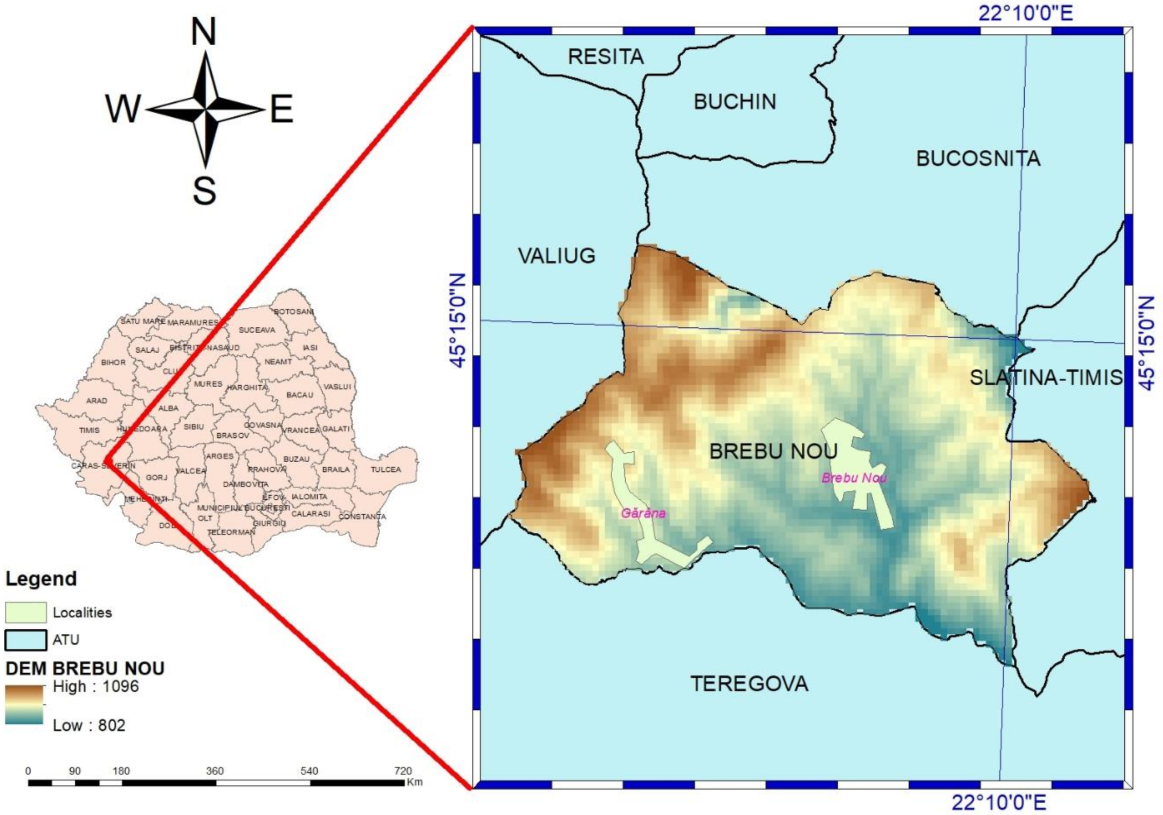

Fig. 1. Study area, Brebu Nou locality, Caras-Severin County, Romania [7]
Source: Original image, generated by authors.

Considering the orography of the land in the study area, the land area approached included plots with variable area, between 0.03 ha to 62.20 ha.
The agrochemical indices taken into account and determined for the assessment of the soil quality were represented by pH, phosphorus content (P, ppm), potassium content (K, ppm), humus content (H, %), nitrogen index (NI, %), the degree of saturation in basic cations (V, %). Standardized laboratory methods were used for the determination [23], [6], and the determinations were made within the OSPA Timisoara Laboratory.

Depending on the pH values, a grouping of plots was made in 10 groups (G1 to G10), with a variation interval between groups of 0.1 pH units. The degree of spatial variability of the land was evaluated in terms of soil pH, humus content (H) and main macro elements (P, K).
Data analysis was performed through the Anova Test to assess the presence of variance in the data set, and statistical safety (Alpha = 0.001, $p < 0.05$).
Descriptive statistical analysis was used to evaluate the variation of the data (min, max), to calculate the standard error (SE), the

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coefficient of variation (CV). The correlation analysis was used to evaluate the direct interdependence between the analyzed agrochemical indices (correlation coefficient, r). PCA was used to evaluate the distribution of land groups (based on soil pH) in relation to the main agrochemical indices considered.
PAST software [13], EXCEL calculation module and Wolfram Alpha (2020) software [33] were used for data analysis and graph generation.

RESULTS AND DISCUSSIONS

The study analyzed an area of 485.94 ha, in the area of Brebu Nou locality, Caras-Severin County, Romania, in order to characterize the agricultural land in the category of pasture use. From the analysis of the main agrochemical indices of land characterization, data were obtained for 119 plots. The data were grouped into 10 groups, depending on the pH value, with a variation of 0.1 pH units per group. For the grouping of the studied area, the soil pH was taken into account, because it presented the most restrictive values, in terms of soil fertility and agricultural productivity. The data obtained are presented in Table 1.

Table 1. Field groups according to pH values

Groups	Surface	Agrochemical indices (average value)			
		pH	V	H	NI
	(ha)		(%)		
G1	15.95	4.45	11.49	4.61	0.53
G2	27.03	4.54	11.49	4.06	0.47
G3	18.82	4.68	11.49	4.50	0.52
G4	120.13	4.73	13.70	4.55	0.63
G5	62.07	4.86	20.87	4.21	0.88
G6	139.08	4.95	20.87	4.55	0.95
G7	2.07	5.06	20.87	4.33	0.91
G8	29.76	5.13	14.76	4.29	0.64
G9	67.79	5.23	14.36	4.28	0.62
G10	3.24	5.40	20.87	4.32	0.90
TOTAL	485.94				
SE		±0.02	±0.37	±0.02	±0.01

Source: Original data, results from field study and soil sample analysis.

The content of phosphorus (P, ppm) and potassium (K, ppm) was determined, and the values were in great limits of variation, in accordance with the orography and the natural factors of influence on the land, the pasture category, in the study area. In the case of phosphorus, the values were in the range P = 23.23 to 35.30 ppm (average values per study group), and potassium was in the range K = 136.70 to 352.50 ppm (average values per study group). The graphical distribution of the P and K values, with the representation of the outliers' values is shown in Figure 2.

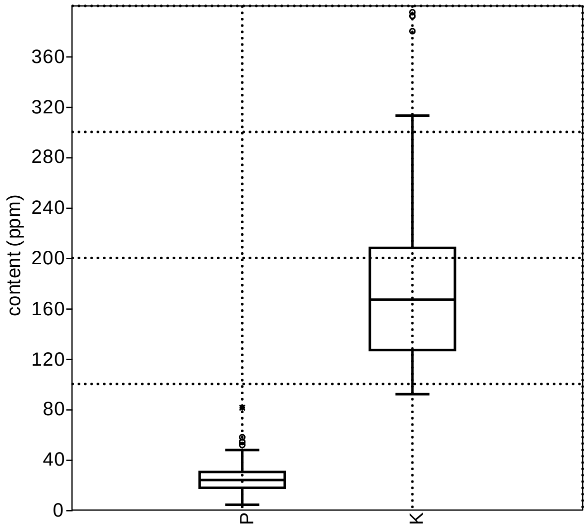

Fig. 2. Graphic distribution of variation range for P and K (ppm) and outlier values, pasture land, Brebu Nou, Caras-Severin County, Romania
Source: Original chart, general based on the results obtained.

Anova Test, single factor, highlighted the presence of the variance in the data set, and the statistical safety of the data obtained for the characterization of the land under study, Table 2.

Table 2. Anova Test, single factor (Alpha=0.001)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3442006	6	573667.7	256.7718	5.7E-185	2.1086
Within Groups	1845411	826	2234.154			
Total	5287417	832				

Source: Original data, obtained from the calculation

The analysis of the land surface studied under the aspect of spatial variability was made in relation to each agrochemical index considered, through the coefficient of variation (CV). Thus, based on the determined agrochemical indices, a high variability was found regarding the supply of soil with phosphorus (CV_P = 56.1509) and the supply of soil with potassium (CV_K = 42.5579). Low values of CV were recorded for pH (CV_{pH} = 4.7231) and for humus (CV_H = 5.2127), and intermediate values for nitrogen index (CV_{NI} = 25.2418) and for degree of saturation in basic cations (CV_V = 24.8559).

The soil pH showed a reduced spatial variability, but the pH values frame the soil in the group of moderately - strongly acid soils [23], [6]. The reaction of the soil greatly influences the regime and the availability of nutrients for crop plants, and in the case of the present study, the pH values were in the range with high effects of decreasing the bioavailability of phosphorus in particular, but also potassium (as macro elements considered).

Due to the fact that pH was the most restrictive factor for soil fertility, a ranking of the plots studied according to pH values was made and a grouping of them in 10 groups, with a variation of 0.1 pH units (Table 1).

Analyzing the total area studied in relation to the 10 groups obtained, we found a different share of area on each group. Thus, most of the studied area (139.08 ha) was in the pH = 4.90 - 5.00 group, with a value of 28.62%, followed by the pH = 4.70 - 4.80 group, in which it was 120.13 ha, with a value of 24.72%. The smallest area (2.07 ha) was in the pH = 5.0 - 5.1 group, with a value of 0.43%. The percentage values of the studied area are shown graphically in Figure 3.

From the analysis of the average values of the 10 land groups, PCA led to the diagram in figure 4. PC1 explained 44.051% of variance and PC2 explained 32.812% of variance. The main components considered were the soil pH, the content of P, K and H, as a biplot. In relation to these components, the analyzed groups were oriented in relation to the recorded values, respectively the groups G5, G7, G8, G9 and G10 were associated with the pH; Groups G2, G3 and G5 were associated with P and K, and groups G1, G4 and G6 were associated with H.

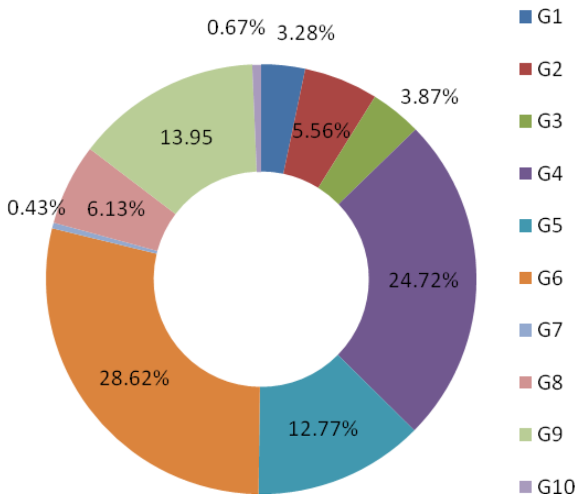

Fig. 3. Distribution by pH groups of the studied land area, pasture category, Brebu Nou area, Caras-Severin County
Source: Original chart, generated based on data.

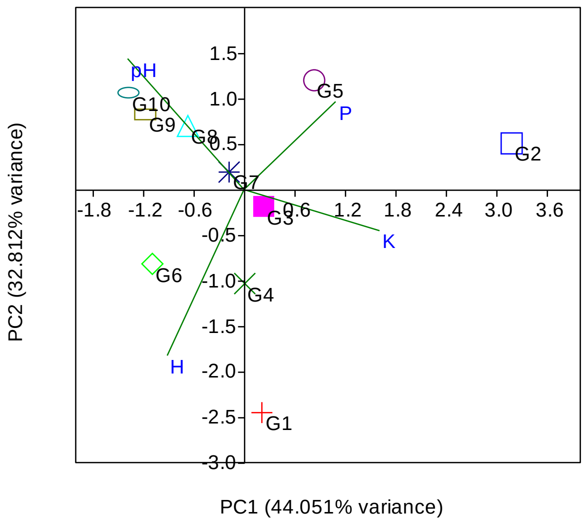

Fig. 4. PCA diagram, correlation matrix, in relation to pH, P, K, H indices
Source: Original diagram, generated based on data.

Under the present conditions, identified on the basis of the soil agrochemical indices considered, an assessment was made of how soil pH and humus content (H, %), as agrochemical indices, with high soil stability, influenced the variation the content of phosphorus (P, ppm) and potassium (K, ppm). For this, regression analysis was used.

The variation of the phosphorus content (P, ppm) in the soil depending on the soil pH and degree of saturation in basic cations (V, %) was described by equation (1), under conditions of R^2 = 0.764, $p < 0.01$, F = 74.0726. The graphical distribution of the variation P

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according to the pH of the soil (x-axis) and the degree of cationic bladder (V, %) is shown in the form of a 3D model in figure 5 and in the form of isoquants in figure 6.

$$P = a\,x^2 + b\,y^2 + c\,x + d\,y + e\,xy + f \qquad (1)$$

where: P – phosphorus content in the soil (ppm);
x – soil pH;
y – degree of saturation in basic cations (V);
a, b, c, d, e, f – coefficients of the equation (1);
a = 3.3556850
b = 0.0941337
c = -5.0087355
d = 6.7661717
e = -2.0514464
f = 0

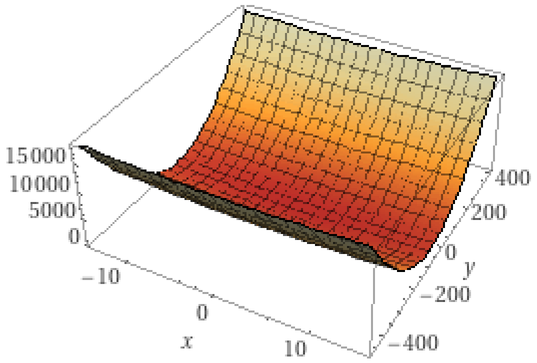

Fig. 5. 3D graphical representation of variation of phosphorus content (P, ppm) depending on soil pH (x-axix) and V (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data

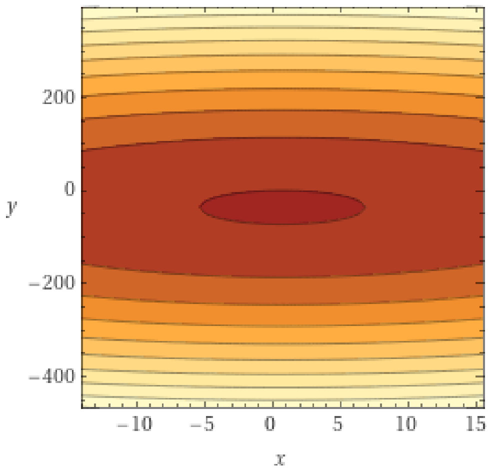

Fig. 6. Graphic representation in the form of isoquants regarding the variation of the phosphorus content (P, ppm) depending on the soil pH (x-axix) and V (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data.

In relation to the pH of the soil and the humus content (H, %), the variation of the P content was described by equation (2), under conditions of R^2 = 0.827, p <0.001, F = 108.7696. The graphical distribution of the variation P as a function of pH and H is represented in the form of a 3D model, figure 7, and in the form of isoquants, figure 8.

$$P = a\,x^2 + b\,y^2 + c\,x + d\,y + e\,xy + f \qquad (2)$$

where: P – phosphorus content in the soil (ppm);
x – soil pH;
y –humus content (H);
a, b, c, d, e, f – coefficients of the equation (2);
a = -1.3193847
b = -35.5914707
c = -97.9359179
d = 175.4431978
e = 21.3810539
f = 0

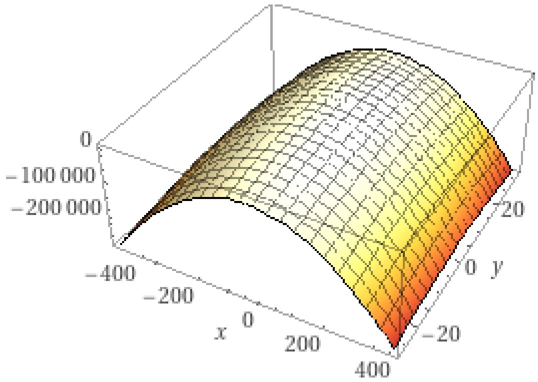

Fig. 7. 3D graphical representation of variation of phosphorus content (P, ppm) depending on soil pH (x-axix) and H (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data

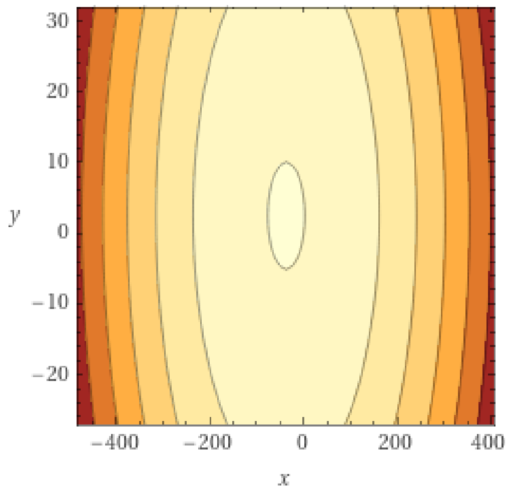

Fig. 8. Graphic representation in the form of isoquants regarding the variation of the phosphorus content (P, ppm) depending on the soil pH (x-axix) and H (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data.

The variation of the K content in the soil as a function of pH and V was described by equation (3), under conditions of $R^2 = 0.827$, $p < 0.001$, $F = 84.3391$. The graphical distribution of the variation K as a function of pH and V is represented in the form of a 3D model in Figure 9 and in the form of isoquants in figure 10.

$$K = a\,x^2 + b\,y^2 + c\,x + d\,y + e\,xy + f \qquad (3)$$

where: K – potassium content in the soil (ppm);
x – soil pH;
y – degree of saturation in basic cations (V);
a, b, c, d, e, f – coefficients of the equation (3);
a = -119.4370042
b = -0.6498946
c = 589.1927351
d = -129.9921807
e = 30.7210689
f = 0

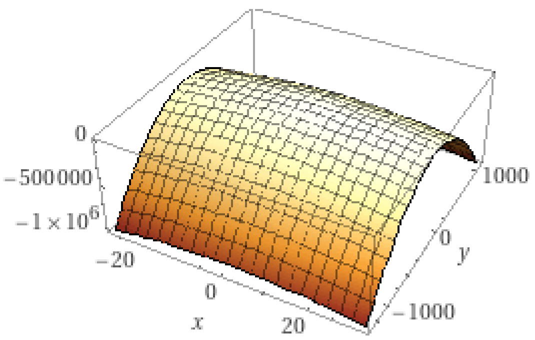

Fig. 9. 3D graphical representation of variation of potassium content (K, ppm) depending on soil pH (x-axix) and V (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data

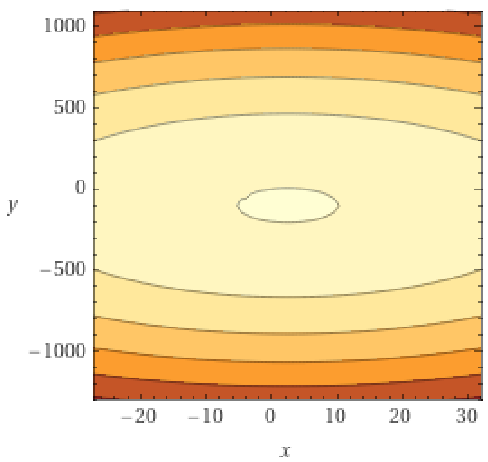

Fig. 10. Graphic representation in the form of isoquants regarding the variation of the potassium content (K, ppm) depending on the soil pH (x-axix) and V (y-axix), pasture category, under study conditions
Source: Original graph, generated based on data.

In relation to the scale of pH values, and interpretation of soil acidity, from the analysis of average values, it was found that 79% of the analyzed area (385.15 ha) had a strongly acid pH (groups G1 - G7), and 21% of the surface (100.79 ha) showed a moderate acid pH (groups G8 - G10), Figure 11. From the studies at national level, and the monitoring of the soils, in Romania the acid soils amount to about 3.5 million ha [14], with limitations regarding the agricultural productions, in relation to the category of use of the agricultural lands.

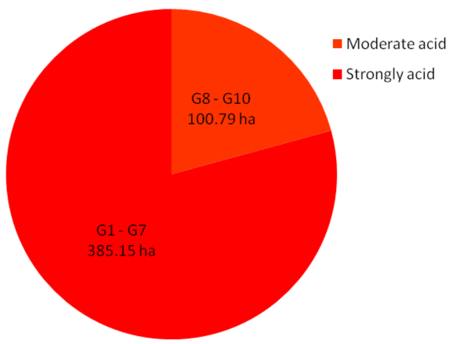

Fig. 11. Graphic representation of the land surface studied in terms of soil acidity intensity
Source: Original graph, generated based on calculated data.

Given the limitation of the production potential of agricultural land, pasture category, taken into account, due to the moderately acidic and strongly acidic reaction of the soil, a first recommended measure is to improve soil acidity by applying calcareous amendments.
The correction of the soil acidity is imposed on the entire surface, with variable doses of amendments in relation to the concrete situation for each plot, quantified by the values of the studied agrochemical indices. The estimated effect is expected starting with the first year from the treatment of the soil with amendments, and continues for a period of 3-4 years, in relation to the dose of amendment applied, as well as subsequent agro technical works.
Soil improvement by correcting acidity is a necessary and more accessible method of improving the nutrient regime of the soil for plant nutrition, in the context of a sustainable management of acid soils [24], [11], [15].

At the same time, against the background of the current energy crisis, and the high prices of synthesis fertilizers, soil improvement measures can compensate, even if partially, the application of fertilizers, by mobilizing nutrients from the soil. Limestone amendments are more affordable in price compared to synthetic fertilizers, and such ameliorating products come from natural deposits, present in our country, and thus are more accessible to farmers. The application technique is a classic one, adapted to local field conditions, and can be accompanied by a superficial soil harrowing work to incorporate the applied product, and increase the effectiveness of the improvement work. In addition, surface organic fertilizers (manure from cattle or sheep) can be administered, which supplement the nutrients and increase the effectiveness of the soil amendment work [24], [15].

From the analysis of the graphical models obtained for the variation P and K depending on the soil pH, V (%), and H (%), a pronounced dependence of the phosphorus content (P, ppm) and potassium (K, ppm) on pH was found, as well as the degree of saturation in basic cations.

The analysis of the variation of P in relation to soil pH and V (%), equation (1), figures 4 and 5, showed that at a variation of pH in the recorded range (4.45 to 5.40; average values), a high importance a shows the degree of soil saturation in basic cations (V,%).

Associated with low pH values (high acidity) the content of basic cations (eg Ca, Mg) is low in the soil, and the P regime is deficient for plants. The administration of calcareous amendments (eg calcium carbonate, calcium oxide, dolomite), will lead to an increase in the content of basic cationic in the soil, which will lead to the correction of the pH and the improvement of the nutrient regime (especially P) for plant nutrition.

CONCLUSIONS

Soil acidity is a major limiting factor for the study land area, which accounts for 79% of the pasture area as strongly acidic pH and 21% of the area as moderate acidic pH.

The high variability showed the content of P and K, nutrients whose regime was pronouncedly affected by both the pH of the soil and the degree of soil saturation in basic cations (V, %). The main ameliorating measure is the correction of acidity by applying calcareous amendments, associated with other agro technical and cultural measures.

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STATISTICAL ASSESSMENT OF THE AVERAGE YIELDS OF CUCUMBERS AND GHERKINS IN SOME BALKAN COUNTRIES

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Abstract

Data concerning harvested area and production of cucumbers and gherkins have been extracted from the website of FAOSTAT. They have been presented and saved in a separate Excel file. The calculated average yields of the indicated crops in five Balkan countries (Greece, Romania, North Macedonia, Albania and Bulgaria) have been studied in the period 1999-2020. The mentioned information has been compared, assessed and summarized. Analysis of variance and Tukey's range test have been applied to the considered data about average yields. The results showed that the indicator (harvested area) for these two crops had significantly bigger values for Romania in the interval from 2001 to 2020. At the same time, the values of the other examined indicator (average yields) for Greece were relatively higher during 2014 as well as 2018. A similar situation was observed for Romania in 2004, 2008 and 2018, while for Bulgaria in the two years - 2014 and 2016. This indicator for Albania and North Macedonia increased gradually during the bigger part of the period. The statistical evaluation of the average yields of cucumbers and gherkins for the studied Balkan countries formed three groups with statistically significant differences.

Key words*: *analysis of variance, assessment, Balkan countries, cucumbers and gherkins

INTRODUCTION

Due to the fast growth of internet there has been big volume of information is produced and shared by various administrations in nearly every business, industry and other fields [8]. Due to this high explosion it’s really a big challenge to store, manage and access knowledge from this [8].

Organisations gather increasingly large and complex data sets each year [7]. After the data is stored in a precise structured format, further analysis and visualization of data is essential to discover the hidden valuable insight from the large dataset (Mahajan & Gokhale, 2019 [13]). The study of Khusainova, R. M., et al., 2016 [9] notes that the application of statistical methods in economics plays an important role, as it deals with the processing and analysis of vast amounts of information about socio-economic phenomena [9].

The information about two vegetable crops has been studied by using some of these statistical methods in the current work. It should be emphasized that growing vegetables in certain regions is particularly important. The study of Schreinemachers, P et al., 2018 [17] notes that now is the time to prioritize investments in vegetables, thus providing increased economic opportunities for smallholder farmers [17]. World vegetables production grew faster between 2000 and 2019 [4]. The share of onions, cucumber and gherkins, and eggplants increased, while that of cabbages almost halved and that of tomatoes remained stable according to FAO 2021 [4]. In 2019, the East European cucumber and gherkin market increased by 9.1% to $4.5B, rising for the third consecutive year after four years of decline (www.globaltrademag.com [6]). In addition, cucumbers and gherkins are a group of cucurbitaceous vegetables that are mainly used as salad vegetables [1]. Specially, data concerning the indicated two crops are the object of consideration in this study.

The aim of this article is to present a statistical assessment of the average yields of cucumbers and gherkins in five Balkan countries (Greece, Romania, Albania, North Macedonia and Bulgaria) during 1999-2020.

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MATERIALS AND METHODS

The paper considers two basic characteristics of the listed above crops. In this connection, the indicators - harvested areas and production have been examined for the indicated time interval. The mentioned information has been provided from the website of FAOSTAT [5]. It has been extracted and organized into an Excel file. The average yields of the cucumbers and gherkins for the presented time period in these five Balkan countries have been calculated. Using lists of data and filters in Excel [14], [3] users could display the relevant subsets [10] for the surveyed objects.

The examined information about the indicated crops for Greece, Romania, North Macedonia, Albania and Bulgaria has been compared, assessed and summarized. The statistical method as analysis of variance [16] has been used for studying the average yields of the considered crops. The main task of analysis of variance is to determine the individual or combined influence of one or more indicators (factors) on another indicators and to evaluate these influences [12]. In addition, the Tukey's test [18] is used for the investigated objects in this work.

The percentage change (H_{ij+1}) of the considered indicator (average yields) for each year compared with the preceding one has also been calculated:

$$H_{ij+1} = \frac{h_{i\,j+1}}{h_{ij}} * 100 - 100$$

where: $h_{i\,j+1}$ and $h_{i\,j}$ - the average yields of the studied crops for i^{-th} country during j^{-th} and $j+1^{-st}$ year, 1<=i<=5, 1<=j<=21.

The R Commander [15] and MS Excel [11], program products have been used for the statistical data processing [2]. The obtained results have been presented in tabular or graphic form and the relevant conclusions have been drawn.

RESULTS AND DISCUSSIONS

The information concerning the mentioned crops has been studied during 22 years period. Applying certain filters, the following subsets of data are obtained and visualized:

- One or more indicators for the examined time interval in the considered countries;
- Indicators values for the listed objects for one or more years;

-Chosen value for a given indicator (harvested area, production or average yields) in certain country;

As can be seen from Figure 1, the obtained subset about harvested area in the considered Balkan countries for two years time interval is presented. It should be noted that the other examined elements could also be found and displayed for definite interval of years.

	A	B	C	D	E
1	**Area**	**Element**	**Year**	**Unit**	**Value**
2	Albania	Area harvested	1999	ha	1300
3	Albania	Area harvested	2000	ha	1100
24	Romania	Area harvested	1999	ha	8336
25	Romania	Area harvested	2000	ha	9031
46	Bulgaria	Area harvested	1999	ha	10351
47	Bulgaria	Area harvested	2000	ha	9495
68	Greece	Area harvested	1999	ha	2819
69	Greece	Area harvested	2000	ha	2819
90	North Macedonia	Area harvested	1999	ha	1183
91	North Macedonia	Area harvested	2000	ha	1197

Fig. 1. Obtained objects for the two years period
Source: Data from FAOSTAT [5].

The analysis of the data on harvested area showed that the values of this surveyed indicator were quite higher for Romania in comparison with those ones for the other four countries in the interval 2001-2020 (Fig. 2). A significant decline of this variable for cucumbers and gherkins in the indicated country was calculated for 2018. In this case, it was more than 45%.

The same process was observed in Bulgaria for the period 1999-2001 and 2003-2005. The decrease of the indicator was about 61% for the first three years and more than 80% during the second three years period.

The situation was quite different for the examined information about harvested area for the listed crops in Albania.

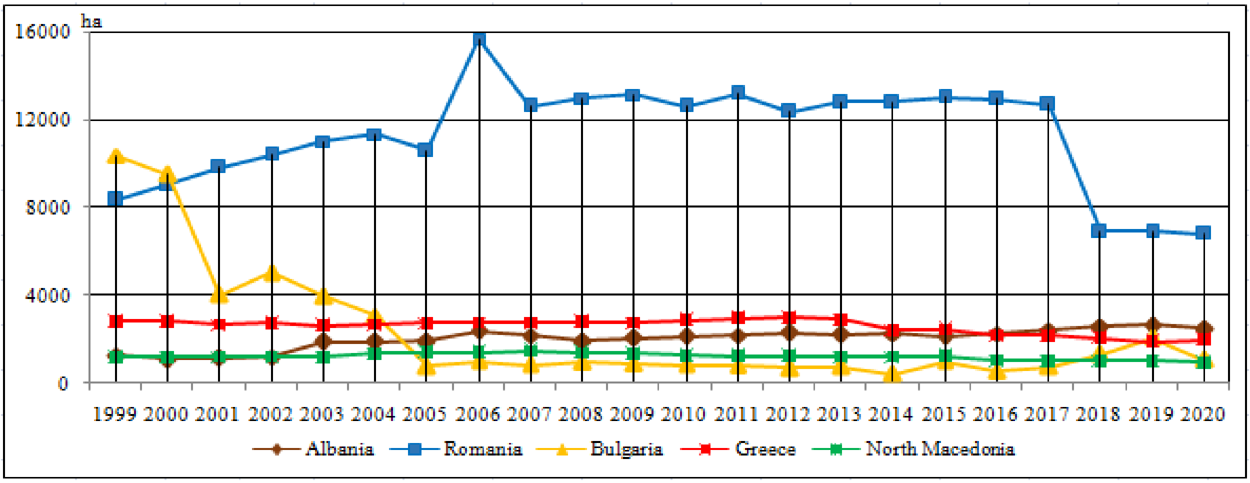

Fig. 2. Graphical analysis of the harvested area for the studied countries during 1999-2020
Source: FAOSTAT [5].

The growth of the indicator was 53.59% during the first seven years (2000-2006) of the interval. The same dependences were established from 2016 to 2019, but in this case the increase was significant smaller about 14.54%.

The reduction of the indicator values for Greece was more than 22.70% in the years between 2015 and 2019. The reverse process was observed in two time intervals. The first of them includes 2003-2007, while the second one contains 2009-2012. The increase of the harvested area in these periods was about 4.5% and 7%, respectively.

The change of the indicator for cucumbers and gherkins in North Macedonia was insignificant during 1999-2002 as well as 2016-2019 (Fig. 2). The period from 2003 to 2007 is characterized with a continuous growth of this studied variable from about 23%. A certain decline was calculated during 2008-2013. It was about 12.86%.

Analyzing the presented results from Figure 3, it can be summarized that the production of cucumbers and gherkins for Romania in 2004, 2011, 2015 and 2017 is quite higher in comparison with this one for the other studied countries. Three periods are formed where the values of this indicator for Romania increased. The first of them includes 2000-2004, while the second and the third one contains the years 2007-2011 and 2013-2015. In this case the growth of the variable was more than 1.9, 1.6 and 1.16 times respectively in the listed subintervals. A quite big decline was observed at the last four years of the considered period. It was about 1.7 times.

The production of cucumbers and gherkins in Albania increased continuously for almost all studied time interval with exception of some individual years – 1999-2000, 2006-2007 as well as 2020. The growth of the variable was more intensive in the years between 2015 and 2019. It was more than 1.5 times.

A similar situation was observed for the production of the examined crops in North Macedonia in the periods 1999-2006, 2008-2012 and 2014-2016. A certain reduction of the indicator was established during the last three years. In addition, the same dependences were observed in 2007 and 2013.

An interesting fact should be noted. Relatively high values of the production of cucumbers and gherkins in Greece were visualized on the diagram from figure 3 for the considered 22 years interval. But a slight decline of this indicator was calculated for five consecutive years from 2010 to 2014. It was about 8%. The lowest value was registered in 2017.

A significant decrease of the production from these crops in Bulgaria was established for the first three years of the surveyed period. It was more than 2.7 times. The same process was observed for the subinterval from 2009 to 2012. It should be noted that the decrease here was smaller (about 2.05 times). The indicator grew slightly in 2002-2004, 2007-2008 as well as 2013-2016.

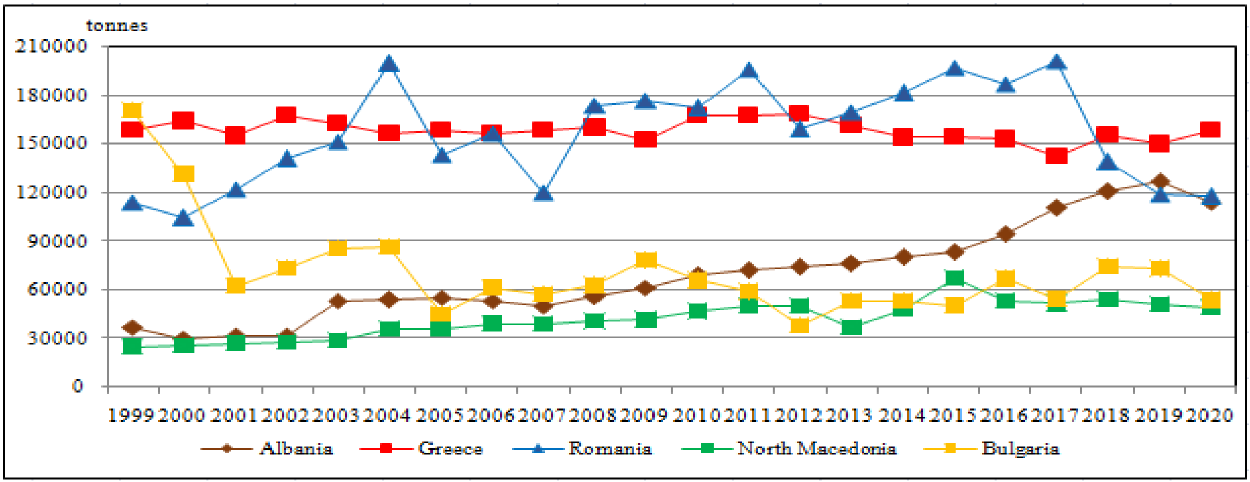

Fig. 3. Visualization of the produced quantities for the studied crops in 22 years interval
Source: FAOSTAT [5].

Another fact is of an interest. The highest value of the examined indicator for Bulgaria was registered for the first year (1999) of the time interval.

The current work evaluates the average yields of cucumbers and gherkins for the listed above five countries in the years between 1999 and 2020. For this purpose, the method of the analysis of variance (Anova) is applied. As can be seen from table 1, the calculated value of the significance level is less than α (α=0.05). Therefore, there are statistically significant differences between the considered data.

Table 1. The obtained results from the performed analysis

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	32,535.61	4	8,133.90	32.11	2E-17	2.458
Within Groups	26,596.96	105	253.30			
Total	59,132.57	109				

Source: Own calculation on the basis of data from FAOSTAT [5].

The results from Tukey's test are displayed on Table 2. They presented the following groups, which were obtained from the performed assessment:

- Bulgaria and Greece are included in one group. The values of the examined indicator (average yields) for these countries are the higher;
- North Macedonia and Albania are presented in the next group. There are no statistically proven differences in the average yields of the listed crops in these two countries;
- The lowest values of average yields of cucumbers and gherkins during the studied time period is observed in Romania. The indicated country forms a separate group.

Table 2. Evaluation of the data concerning the average yields (t/ha)

Considered countries	**Evaluation**	
Romania	14.142	a
Albania	33.209	b
North Macedonia	35.151	b
Bulgaria	56.380	c
Greece	61.736	c

Values in column followed by the same letter do not differ significantly
Source: Own calculation on the basis of data from FAOSTAT [5].

This work also calculates the percentage change in the average yields of the examined crops for each year compared with the preceding one for the indicated countries. The obtained results from the data processing were presented on Table 3. Relatively higher values of the variable H_{ij+1} (i=1, j=15, j=19) were established for two nonconsecutive years in Greece. Therefore, during 2014 as compared to 2013, the average yields grew by 14.86%. A similar situation was observed for 2018 where the increase was about 15%.

The variable H_{ij+1} (i=2, j=9) was significantly higher for Romania in 2008. Compared to the year 2007, the average yields of cucumbers and gherkins increased by 40.78%. The same process was observed in 2004 and 2018, where H_{ij+1} (i=2, j=5, j=19) was 28.26% and 26.73%, respectively. A bigger decline was calculated during 2000, 2005-2006 as well as 2019. It has varied in range from approximately 14.41% to 26%.

Table 3. Percentage change (H_{ij+1}) of the average yields for each year of the examined period

Year	Greece	Romania	Albania	North Macedonia	Bulgaria
2000	3.74	-15.79	-4.18	1.77	-16.14
2001	-0.89	7.96	2.03	2.52	13.01
2002	5.62	8.98	-4.17	2.47	-6.29
2003	0.88	1.18	5.20	5.91	46.70
2004	-5.29	28.26	0.38	9.01	30.23
2005	-1.25	-23.35	1.73	-1.40	105.85
2006	-1.81	-26.05	-22.06	8.35	7.71
2007	1.50	-4.67	1.80	-5.54	8.44
2008	-0.06	40.78	27.65	10.15	-3.94
2009	-4.19	0.38	2.99	5.25	37.77
2010	6.33	1.42	6.90	19.94	-13.53
2011	-3.46	9.16	2.46	7.465	-2.740
2012	0.31	-13.56	-1.69	2.13	-27.88
2013	-2.13	2.94	7.13	-24.89	30.54
2014	14.86	6.99	1.76	30.79	79.48
2015	-1.41	6.90	10.03	34.51	-60.37
2016	10.96	-4.87	7.72	-4.86	144.84
2017	-5.55	9.80	8.52	-2.04	-41.07
2018	15.00	26.73	3.56	5.50	-23.30
2019	4.42	-14.42	2.13	-6.25	-35.85
2020	1.58	0.45	-4.66	5.76	42.14

Source: Own calculation on the basis of data from FAOSTAT [5].

The values of the variable H_{ij+1} were positive during almost all surveyed time interval for North Macedonia. They were negative for six nonconsecutive years. The reduction was quite big only for 2013. It was more than 24.89%. In addition, during 2015 as compared to 2014, the average yields of cucumbers and gherkins grew by 34.51%.

A similar situation was observed for the studied values of the variable H_{ij+1} in Albania. The average yields of the indicated crops increased gradually during 2013-2019, 2007-2011, 2003-2005 and 2001. The significant growth was calculated in 2008. Compared to the year 2007, the change of the indicator H_{ij+1} (i=3, j=9) was about 27.65% (Table 3). A big decline of the average yields of cucumbers and gherkins was established in 2006.

The calculations show that the variable H_{ij+1} (i=5, j=6, j=15, j=17) has relatively higher values for the following years in Bulgaria - 2005, 2014 as well as 2016. During 2015 as compared to 2014, the average yields of the mentioned crops decreased by 60.37%. This obtained decline was the biggest during the studied time period.

Summarizing the results from the data processing, it should be noted that an increase in the average yields of these two investigated crops was registered in the following countries - Romania, Greece, North Macedonia and Bulgaria. At the same time a small decline of the indicator was observed only in Albania.

CONCLUSIONS

The studied information related to the indicated crops (cucumbers and gherkins) has been extracted from the website of FAOSTAT. It has been structured and saved in a separate xlsx file. The average yields of the cucumbers and gherkins during the considered time interval in five Balkan countries have been calculated.

The article presents a statistical assessment of the average yields of the indicated crops in these studied countries (Greece, Romania, North Macedonia, Albania and Bulgaria) for the period from 1999 to 2020.

The obtained results from the data processing showed the following:

- The values of the indicator (harvested area) for these two crops were quite higher for Romania in comparison with those ones for the other four countries during 2001-2020. A certain growth of the variable for Albania was calculated in the period 2000-2006 and 2016-2019. The same process was observed in North Macedonia for 2003-2007, as well as in Greece for two subintervals 2003-2007 and 2009-2012. The decrease of the indicator for

Bulgaria was significant for the period 1999-2001 and 2003-2005.

- The values of the second studied indicator (production of the listed crops) for Romania were significantly bigger for the period 2004, 2011, 2015 and 2017, while for Greece they were comparatively high in 1999-2020. One steady increase of the variable was observed for almost all studied time interval in Albania and North Macedonia, but in Bulgaria the reduction of the production of these crops was quite big in the first three years - 1999-2001;
- The average yields of cucumbers and gherkins for Greece were significantly higher in 2014 and 2018. A similar situation was observed for Romania in 2004, 2008 and 2018, while for Bulgaria in two years - 2014 and 2016. This indicator for Albania and North Macedonia increased gradually during the bigger part of the considered time interval;
- The statistical evaluation of the average yields of cucumbers and gherkins for the studied five countries formed three groups with statistically significant differences.

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OPTIMIZATION OF NO-TILL TECHNOLOGY ELEMENTS FOR WINTER WHEAT GROWING IN DRY CONDITIONS

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Abstract

Improvement of the technology for the cultivation of winter wheat in the arid zone of the Stavropol Territory based on the optimization and renewal of the varietal base of winter wheat grown using the No-Till technology. The work was carried out in 2019–2020 in the arid zone of the Stavropol Territory. In the experiment to study the assessment of varieties of winter wheat grown according to the predecessors of peas and sunflower, we studied 15 varieties. The economic variant, variety Yuka, was used as a control one. The total size of the experimental plot is 1.9 hectares. The yield of the predecessor peas was 23.92-39.44 q/ha, depending on the variety. The highest-yielding variety turned out to be Tanya (39.44 q/ha), which is 12.6% higher than the economic variant Yuka (35.04 q/ha). An increase of 4.8-7.1% in relation to the economic variant Yuka was given by the varieties Aksinya and Volny Don. All studied varieties showed a fairly high degree of resistance to the development of pathogens. The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after peas was noted in the Alekseich variety – 67% prevalence and 0.63% intensity, and the lowest in the Aist variety – 22% and 0.33%, respectively. The highest prevalence and development rate of pyrenophorosis in winter wheat plants sown after sunflower was observed in the Krasa Dona variety – 47% prevalence and 0.63% intensity, and the lowest in the Niva Stavropolya variety – 21% and 0.33%, respectively.

Key words: *winter wheat (Triticum), technology, predecessor, variety, economic effect, yield*

INTRODUCTION

Over the past fifty years, with a doubling of the world's population, grain production has tripled, but energy consumption has increased almost fourfold, therefore, all over the world, in order to save resources, it has become urgent to replace traditional grain cultivation technologies with technologies based on minimum and "zero" tillage [2][3].
In resolving this issue, Russia lags far behind such technically developed countries as Canada, USA, Australia, France, Germany, despite the fact that the need for innovative technologies in the country is felt much stronger [8].
Therefore, the development of resource-saving technologies for the cultivation of grain crops aimed at preserving and increasing soil fertility, stabilizing the productivity of agrocenoses of grain crops, and reducing costs is currently of great scientific and practical importance [7].
Wheat is a crop that belongs to one of the first plants cultivated by humans. More than seven thousand years ago, wheat was grown in Asia Minor. Its extensive development began about 145 years ago [5].
Winter wheat, being one of the main food crops in the North Caucasus, occupies 70% of all sown areas [10].
In modern conditions, the progressive development of agricultural production largely depends on the development of soil-protecting, resource-saving and energy-saving technologies. Agricultural technologies involving tillage are labor-intensive and energy-intensive. Today, the technology of direct sowing or No-Till is widely used in many countries of the world, which is implemented on an area of more than 100 million hectares. No-Till technology takes its rightful place in the fields of the Stavropol Territory. No-till is a crop cultivation technology that requires optimization of technology elements [12].

MATERIALS AND METHODS

The production experience was carried out on the fields of JSC Agroholding Energomera, LLC Khleborob in 2019 and 2020. Sowing of winter wheat was carried out using the No-Till technology at the time optimal for the zone. Technological techniques in technology are generally accepted for the zone. The seeding rate is 4.5 million viable seeds per hectare.

According to the scheme of agroclimatic zoning of the Stavropol Territory, the land use of LLC Khleborob belongs to the 2nd (arid) zone. Humidification is characterized by a hydrothermal coefficient, where HTC = 0.7-0.9. The willow zone in which the farm is located is characterized by an arid climate, rather mild winters with little snow, the seasons change relatively evenly, without sudden changes. The meteorological station for recording meteorological phenomena is located in the regional center of Svetlograd, where there is a base of long-term observations of climate changes. The arid zone is characterized by a large number of days with dry wind phenomena. The number of days with strong winds over 15 meters per second per year is more than 50 days. Strong winds contribute to the drift of snow cover from fields to low places. During the warm period, the presence of days with winds contributes to the development of wind erosion. This fact once again speaks of the advisability of using technology without tillage.

The soil of the experimental site is ordinary powerful medium loamy chernozem, which is characterized by a low humus content of 3.95%, a very low content of nitrate nitrogen (1.45 mg/kg), an average content of mobile phosphorus – 18.2 mg/kg (according to Machigin’s method), and the average supply of exchangeable potassium – 222 mg/kg. The physical properties of chernozems are favorable for the cultivation of winter wheat.

In the arid zone, where the experiments were carried out, on average, according to long-term data, 400-450 mm of precipitation falls during the growing season. During the study period, 200 ... 225 mm fell, which is 145 ... 170 mm less than the average long-term. Unfavorable conditions for moistening were complicated by the uneven distribution of precipitation over the periods of development.

In the autumn period of the 2018/19 agricultural year, 78 mm fell, in 2019/20 – 59.4 mm, which is almost 2.5 times less than the average long-term norm (120 mm). The amount of precipitation in 2019/20 was not evenly distributed, which affected the duration of the germination period. But a long warm temperature regime (15 ... 17° C) allowed the winter wheat plants to leave in the winter in the phase of three or four shoots. In the sowing period of 2018/19, only 11.0 mm fell, which is 65 mm less than the average long-term norm, which negatively affected germination.

The winter of the study period was rather mild, but in the spring of 2020, in April, a return of spring frosts was observed, when the temperature dropped to -13° C, which adversely affected the development of plants. The fall of 30 mm of precipitation in three spring months led to the fact that the development of only one main shoot was noted on winter wheat plants, which was the reason for the low yield. In late May-early June, the average daily temperature was 4 ... 5° C higher than the multiyear temperature. High temperature conditions, lack of precipitation and dry wind phenomena affected the quantity and quality of the crop.

Before sowing winter wheat, weeds are treated with Tornado 500 herbicide at a rate of 2 l/ha using a John Deere 4730 self-propelled sprayer.

After tillage, sowing is carried out with simultaneous application of Ammophos fertilizer 12:52 (John Deere 8345 RT tractor + CASE PRD 500 sowing complex). The optimal seeding rate in the area of unstable moisture is 4.5-5.0 million germinating seeds per hectare. The optimum seeding depth is 3.5-4 cm. It is important that the seeds fall into the moist soil layer during sowing. The optimal sowing dates in the zone are in the third decade of September and the first decade of October.

RESULTS AND DISCUSSIONS

In the course of the research, counts and observations were carried out in the main growth phases of winter wheat plants – before going into winter, in the spring tilling phase, in the flag leaf phase and in the full ripeness phase. We noted full ripeness in the third decade of June, since the conditions during the period of plant growth and development were severely arid, and the lack of moisture contributed to the drying of winter wheat plants on the vine [6].

The experiment became necessary in connection with the emergence of new products on the market, the growing need for updating the varietal base, the need to find varieties that are resistant to various unfavorable conditions. It is especially important to note that at the moment, with the emerging dry periods when growing winter wheat, there is a need for varieties with a stable yield. Selection of a more productive variety according to the sunflower predecessor, since the share of this crop as a predecessor is more than 45% every year [4].

In this regard, the aim of the research is to improve the technology of growing winter wheat in the arid zone of the Stavropol Territory based on the optimization and renewal of the varietal base of winter wheat grown using the No-Till technology [9].

To solve this goal, the farm laid an experiment to study the assessment of varietal characteristics of winter wheat grown according to the predecessors of peas and sunflower, 15 varieties were studied in the experiment. The economic variant, variety Yuka, was used as a control. The total size of the experimental plot is 1.9 hectares.

The counts and observations were carried out in accordance with generally accepted methods:

phenological observations, determination of the structure and accounting of the yield were carried out according to the method of state variety testing;

registration of diseases by indicators: distribution, or the number of affected plants in crops, intensity or degree of development.

technological quality of grain - GOST R52554-2006;

grain glassiness,% - (GOST 10987);

protein content,% - (GOST 13586.1);

gluten content,% - (GOST 13586.1);

GDM readings, rel. units – (GOST 13586.1);

During the growing season, winter wheat goes through the corresponding phases of development associated with the formation of new organs. The passage of development phases, the intensity of growth and productivity of plants are in a certain dependence on the conditions of existence. Plants develop best with optimal provision of all the necessary processes of their life.

In the conditions of autumn, spring and summer, we carried out phenological observations for the onset of the main phases of growth and development of plants of new varieties of winter wheat.

In the autumn, during the research period, favorable conditions developed for obtaining friendly seedlings of winter wheat. All cultivars tested in the production experiment in the winter have gone bustling, all cultivars had from 3 to 5 shoots. The winter during the research period was rather mild. The stubble that remained on the surface had a positive effect on the retention of snow, which had a positive effect on the overwintering of winter wheat plants.

The resumption of spring vegetation began in the first ten days of March, and by the time the plant counts were carried out, the winter wheat plants had grown well.

When calculating the number of stems on average for 2 years, we obtained the following results 283-519 pcs/m^2 and 315-504 pcs/m^2, respectively, depending on the predecessor. There were no significant differences between the predecessors, and the differences between the varieties are due to the varietal characteristics.

The number of stems is directly related to the coefficient of bushiness.

In the spring, when examining winter wheat varieties according to the pea predecessor, the highest tillering coefficient was noted in the Aist variety – 5.7. The coefficient is somewhat lower for the varieties Steppe and

Niva Stavropolya. The lowest coefficient for the varieties Krasa Dona and Alekseich is 3.1.

According to the sunflower predecessor, the tillering coefficient was somewhat lower, since it is a rather tough predecessor for winter wheat. The highest tillering coefficient for winter wheat plants, according to the sunflower predecessor, was noted in the varieties Tanya and Stavka – 4.0, and the lowest in the variety Sila – 2.1.

The commercial variety Yuka had a similar situation. According to the predecessor sunflower, the tillering coefficient was 2.2, and according to the predecessor peas – 4.0.

But the further course of the growing season cooled with an acute shortage of soil moisture and high temperature conditions. The totality of external factors contributed to the fact that in plants of all varieties of winter wheat self-shedding of lateral shoots was observed, which subsequently led to the fact that one, maximum two productive stems remained on the plant. Basically, this was observed for the predecessor sunflower, the yield of which was in the range of 17-18 q/ha. According to the predecessor peas, which dries up the soil to a lesser extent and ensures its fertility, the yield was almost 100% higher.

During the period of the exit phase in the tube, the main elements of productivity are formed in cereals, such as the length of the ear, the height of the plants. Productivity elements are varietal traits. The predecessor, varietal characteristics and prevailing weather conditions had a significant influence on the formation of productivity elements [11].

In general, when evaluating the length of the ear, it should be said that according to the predecessor sunflower it was within 4-6 cm, while according to the predecessor peas this figure was 7-8 cm. Such indicators are natural.

The shortest spike according to its predecessor, sunflower, was noted in the varieties Steppe, Ksenia, Volny Don – 4 cm, and in the varieties Alekseich, Nador and Karolina 5 as the longest – 8 cm.

According to the pea predecessor, in almost all cultivars the spike length was 8 cm, with the exception of Krasa Dona and Volny Don cultivars, which is characterized either by varietal characteristics or belonging to a certain ripeness group, and during the period of ear length formation these cultivars were influenced by external factors.

As for the height of plants, it should be said that according to their characteristics, all studied varieties belong to the group of short-stemmed and medium height.

The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after peas was noted in the Alekseich variety – 67% prevalence and 0.63% intensity, and the lowest in the Aist variety – 22% and 0.33%, respectively. The highest prevalence rate and intensity of development of pyrenophorosis in winter wheat plants sown after sunflower was noted in the Krasa Dona variety – 47% prevalence and 0.63% intensity, and the lowest in the Niva Stavropolya variety – 21% and 0.33%, respectively. It is worth noting that on the varieties Aist, Stavka, Ksenia, Niva Stavropolya, MV Nador, there are plants infected with the wheat striped mosaic virus, the prevalence is 5-7%. Leaves and stems are damaged by powdery mildew on the following varieties Karolina 5, MV Nador, Aist: prevalence – 6-8%. On the MV Nador cultivar, we note single spots of basal wheat bacteriosis on the leaves and stem: the prevalence is 3%.

The priority of a variety in the formation of the yield of any agricultural crop is determined by the level of its genetic potential for productivity, which is the primary and leading factor [4, 6]. Cultivation technologies, despite their great influence on productivity, only contribute to a greater or lesser extent to the realization of the genetic potential of the variety.

At the same time, the efficiency of growing winter wheat is largely determined by soil and climatic factors, agrotechnical methods, the direction to reduce costs [1, 2, 3], as well as the use of chemicals and mineral fertilizers.

An important condition for growing this crop is to obtain high quality grain, which is determined by both agrotechnical factors and varietal characteristics. There are a number of different opinions about the role of the variety. The contribution of the winter wheat variety to the yield increase is on average 50%, the remaining 50% are fertilizers, remedies, a predecessor, and a method of basic soil cultivation.

The share of the variety in the yield of this crop is 20-27%, fertilizers – 20-25%, plant protection products – 15-18%, mechanization and tillage – 12-15%. The magnitude of the factors noted may vary from year to year depending on weather conditions, farming culture, placement in crop rotation, organizational, economic and material resources invested in production.

The studies carried out under the conditions of production experience for the study of winter wheat varieties allowed us to obtain data on yield depending on the predecessor (Table 1).

Analyzing the data obtained, we can say that the yield for the predecessor of peas was 23.92-39.44 q/ha, depending on the variety. The highest-yielding variety was Tanya (39.44 q/ha), which is 12.6% higher than the economic variant Yuka (35.04 q/ha).

An increase of 4.8-7.1% in relation to the economic option was given by the varieties Aksinya and Volny Don.

Table 1. Productivity of winter wheat varieties grown according to the predecessor sunflower (on average for 2 years)

№	Variety	Costs, rub/ha	Yielding ability, q/ha	Increasing, q/ha	Increasing, %	Economic effect, rub/ha
1	Yuka (k)	3,857.00	17.43		-	0
2	Tanya	3,724.00	17,86	0.43	2.5	541.52
3	Sila	3,534.00	12.24	-5.19	-29.8	-4,612.10
4	MV Nador	4,256.00	16.11	-1.32	-7.6	-1,651.52
5	Steppe	3,610.00	17.45	0.02	0.1	265.36
6	Aist	4,142.00	11.53	-5.90	-33.9	-5,894.71
7	Karolina 5	3,211.00	17.66	0.22	1.3	859.55
8	Stavka	2,926.00	15.27	-2.16	-12.4	-1,121.57
9	Ksenia	3,534.00	17.04	-0.39	-2.3	-49.71
10	Niva Stavropolya	3,344.00	14.69	-2.74	-15.7	-2,087.59
11	Bagira	3,344.00	18.09	0.66	3.8	1,136.88
12	Volny Don	3,610.00	16.20	-1.23	-7.1	-920.57
13	Krasa Dona	4,085.00	14.33	-3.10	-17.8	-3,177.02
14	Lydia	3,952.00	15.75	-1.68	-9.6	-1,689.44
15	Aksinya	3,812.00	16.63	-0.80	-4.6	-719.68
16	Alekseich	3,534.00	16.50	-0.93	-5.4	-564.34

Source: Own calculation

But the yield is not the main indicator, since the yield is also assessed by economic effect, which consists of production costs.

Evaluating the economic effect, it should be said that it turned out to be quite low, since the seeds of these varieties have a high cost, which affected production costs.

Varieties Lydia (35.79 q/ha), Bagira (33.44 q/ha), Ksenia (33.88 q/ha) and Karolina 5 (32.61 q/ha) by 3.3-6.8% had a lower yield relative to the Yuka variety, but economic effect had a positive effect, which allows them to be recommended for further production testing. According to the sunflower predecessor, the average yield for 2 years was formed quite low for all varieties. The economic option was exceeded by the varieties Steppe (17.46 q/ha), Karolina 5 (17.66 q/ha), Tanya (17.86 q/ha) and Bagira (18.09 q/ha). The excess was 1.0-3.8% (Table 2).

The cultivar also plays a major role in the formation of grains with a high protein and gluten content. However, under the same conditions, their genetic properties are not always realized.

During the research period, the protein and gluten content was subject to large changes depending on the cultivation techniques, such as the predecessor.

The highest protein content in the winter wheat grain for both predecessors was noted for the Aist variety (17.8 and 19.3%, respectively).

Table 2. Productivity of winter wheat varieties grown according to the predecessor peas (on average for 2 years)

№	Variety	Costs, rub/ha	Yielding ability, q/ha	Increasing, q/ha	Increasing, %	Economic effect, rub/ha
1	Yuka (k)	3,857.00	35.04		-	
2	Tanya	3,724.00	39.44	4.40	12.6	-30.20
3	Sila	3,534.00	23.92	-11.11	-31.7	29.06
4	MV Nador	4,256.00	34.76	-0.28	-0.8	-1,420.28
5	Steppe	3,610.00	35.73	0.69	2.0	-357.84
6	Aist	4,142.00	27.54	-7.50	-21.4	-37.99
7	Karolina 5	3,211.00	32.65	-2.39	-6.8	270.63
8	Stavka	2,926.00	31.96	-3.08	-8.8	301.99
9	Ksenia	3,534.00	33.88	-1.16	-3.3	279.13
10	Niva Stavropolya	3,344.00	29.85	-5.19	-14.8	98.78
11	Bagira	3,344.00	33.44	-1.60	-4.6	320.16
12	Volny Don	3,610.00	37.52	2.48	7.1	-99.42
13	Krasa Dona	4,085.00	34.40	-0.64	-1.8	-357.00
14	Lydia	3,952.00	35.70	0.66	1.9	143.32
15	Aksinya	3,812.00	36.71	1.67	4.8	-26.95
16	Alekseich	3,534.00	35.45	0.41	1.2	-789.93

Source: Own calculation.

We observe a clear pattern in the protein content depending on the precursor; in most cases, the protein content of peas is higher than that of sunflower. The increase is insignificant, but, nevertheless, it amounted to approximately 3.0-5.0%, depending on the variety.

CONCLUSIONS

In the course of the studies carried out, the following conclusions should be drawn that in the arid zone of the Stavropol Territory, using the No-Till technology when growing winter wheat according to the predecessor sunflower. It is recommended to sow winter wheat varieties Tanya, Steppe, Bagira, Karolina 5, giving an increase in yield of 1.0-4.0% in relation to the economic option with an economic effect of 235.36-1136.88 rub/ha; sowing winter wheat varieties Tanya, Volny Don and Aksinya according to the predecessor of peas, giving an increase in yield of 4.8-12.6% in relation to the economic option.

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ECONOMIC EFFICIENCY OF MECHANIZATION TECHNOLOGY OF MINIMUM WORKS IN MAIZE

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Abstract

Large-scale application in Romania of work systems that aim to preserve soil fertility is of primary importance given that increasing arable areas are cultivated without consulting a specialist and without a system in which to take account of the short-, medium- or long-term consequences on the soil. The purpose of soil preparation works performed after the ploughing consist of breaking and crushing the structural soil clods and soil structural macro-aggregates in order to sow. For the execution of mechanized soil scarification, the preparation of the germination bed and of the sowing of maize is important for the choice of the types of tractors according to the technological work process and the biological properties of crops depending on the following indicators: gauge, size, plot size, energy consumption of agricultural machinery, land condition, humidity, and manoeuvrability. This paper aims to highlight the usefulness and economic efficiency of conservative (unconventional) works because this cultivation technology contributes to: reducing soil works to a minimum by reducing the number of machines; reducing soil setting by reducing the number of passes and work operations; reducing water and wind erosion by leaving plant remains on the soil surface; maintaining soil humidity by reducing evaporative water losses because the layer of plant remains are left on the ground; increasing the soil water capacity due to the layer of plant remains that slows water drain on the soil surface thus increasing the infiltration time; improving the physical structure of the soil; increasing the content of humus; and developing biological activity in the soil. From an economic point of view, the method is less costly because it reduces fuel consumption and working time with machines. The use of modern mechanization technologies has a great economic efficiency due to the following: works are carried out in a short period of time, so that the optimal time of technological work is respected; the number of aggregates is reduced; the number of passes on the ground is reduced; the setting of soil is reduced; wage costs are reduced; fuel consumption is reduced.

Key words: *economic efficiency, mechanization, maize, soil*

INTRODUCTION

Soil works have been an integral part of agriculture since the beginning and they serve important purposes, such as: the preparation of the germination bed, reduction of soil compaction in order to increase aeration and enhance a better development of the root system of the plants, reduction of the weeding degree, incorporation of fertilizers and amendments, and plant remains management. [20].

The conventional system is characterized by strong annual soil aeration by furrow turning, which is then followed by other secondary works [7],[2]. Depending to the intensity and frequency of soil work, three major categories of methods are distinguished in this system, namely: aeration by ploughing with furrow turning, discing aeration, and low aeration. This soil-aeration system defines the type of conventional agriculture [17].

The need for unconventional system works is due to the existence of economic benefits:

-Soil works time is 2-4 times shorter;

-Fuel consumption per area unit is reduced by 30-50%;

-The need for agricultural machinery per area unit is reduced [3], [9].

-Soil structure is restored and soil compaction is reduced both at the surface and in the ground [6], [8].

-The content of organic matter in the soil is increased [11], [16].
-Soil water permeability is increased and global soil drainage is improved;
-Soil erosion is reduced;
-Plant remains on soil surface or incorporated at a depth of 10-15 cm (where biological activity is maximal) contributes to the growth of fauna and flora in the soil [1].
-The quality of ground and surface water is maintained (nutrients and pesticides applied are no longer washed by erosion, and more intense biological activity – associated with the organic matter in the soil – uses and decomposes these entrants) [10], [18].
-Air quality is maintained by reducing fossil fuel emissions (diesel) used in field traffic and by reducing carbon eliminated in the atmosphere (being fixed by increasing the organic matter in the soil) [14].

MATERIALS AND METHODS

Experiments were made at S.C. Ineu S.R.L., on the territory of the Commune of Orţişoara, Timiş County, Romania. For the execution of mechanized scarification, the preparation of the germination bed and the sowing of maize, John Deere 6190R and John Deere 8285R tractors were used.
The choice of aggregates was made according to direct operating costs. If two aggregates, according to work costs, require the same production costs, the one that satisfies the requirements of the machine system is selected.
When performing works with different agricultural aggregates, always choose the optimal variant that is appreciated by the minimum number of aggregates taking part in the execution of the work or the minimum amount of time or depending on fuel consumption.
Agricultural aggregates, moving in the field, consume a large amount of energy, which is the question of determining the scientific basis of constructive and exploitation parameters to which energy consumption is minimal.
The energy source in the construction of an aggregate is the tractor entering all agricultural aggregates, as the essential element in a mechanization technology [19], [21].
Low-work technologies, those with minimal works, and generally soil conservation technologies applied on large areas because this increases economic efficiency. The working organs of machines used in minimal soil technology are of the chisel aeration type [4], [5]. By applying these working methods, an average energy consumption and labour force is achieved in relation to the classic system [12].
Taking these considerations into account, the technology of minimal soil works for cereal culture includes the following mechanized works: scarification, soil preparation, and sowing [13], [15].
Agricultural aggregates used for minimal soil works were:
-***The scarification aggregate***: John Deere 8285R tractor + Maschio Gaspardo Artiglio Magnum 500 scarifier;
-***The soil preparation aggregate***: John Deere 8285R tractor + Vogel & Noot Disc Terra Disc 600 disc harrow;
-***The sowing aggregate***: John Deere 6190R tractor + Gaspardo MT 12 sower [1].

RESULTS AND DISCUSSIONS

An optimal mechanization technology consists in a judicious correlation of agricultural works and aggregates within the technological process to achieve production yields with as low as possible labour and fuel consumption.
Artiglio Magnum 500/11 scarifier from Maschio Gaspardo is intended for deep soil aeration up to a depth of 40 cm. It works in aggregate with the John Deere 8285R tractor. The scarification work was performed by moving the aggregate according to the shuttle method. Economic indices require both knowledge of consumption per area unit and cost per ha, per cost elements. Production costs for carrying out a mechanized agricultural work consist of indirect costs and direct costs.
Direct costs C_d are calculated with the relationship:

$C_d = C_S + C_c + C_A + C_{dt}$

in which:

C_S - costs for salary (retributions);

C_c - fuel costs;

C_A - depreciation costs;

C_{dt} -costs of technical service of the aggregate.

Costs on of salary are expressed according to the hourly tariff salary S_h and the coefficient C_m.

The salary of a mechanizer is about RON 9,680 per month. Twenty-two working days/month, i.e., 176 h/month, correspond to an hourly tariff salary of RON 55 per hour. Costs of salaries per ha will be:

$C_S = C_m \cdot S = 0.34 \cdot 55 =$ **18.7** RON/ha

Fuel costs C_c are established according to fuel consumption G_{ha} (l/work unit) and fuel price p_1 (RON/l), i.e.:

$C_c = G_{ha} \cdot p_i = 15 \cdot 6.5 =$ **97.5** RON/ha

Costs of depreciation of the aggregate C_A are calculated for both tractor and scarifier taking into account the initial value of the aggregate V_i and the residual value of the aggregate V_r, the exchange capacity W^r_{sch}, the number of exchanges n_s, the number of days worked in a year n_z and service life D expressed in years, i.e.:

$C_{A\ tractor} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z \cdot D = 500{,}000/ 23.68 \cdot 250 \cdot 10 = 8.44$ RON/ha;

$C_{A\ plough} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z\ D = 200{,}000 / 23.68 \cdot 250 \cdot 8 = 4.22$ RON/ha;

$C_A = 8.44 + 4.22 =$ **12.66** RON/ha.

Costs of technical service of the aggregate C_{dt} are: technical maintenance costs, technical review costs, and repair costs. These costs are determined for the entire duration of service for the tractors and machinery in the aggregate.

For the tractor, technical service costs are calculated with the relationship:

$C_{dt\ tractor} = V_i \cdot C_{ha} / C_n = 500{,}000 \cdot 10 / 90{,}000 = 5.55$ RON/ha

in which:

V_i - the inventory value in RON;

C_n - normal fuel consumption during service in l;

C_{ha} - fuel consumption per ha in l.

For the plough, technical service costs are calculated with the relationship:

$C_{dt\ scarifier} = V_i / W_n = 200{,}000/70{,}000 = 2.85$ RON/ha

in which:

V_i - the inventory value in RON;

W_n - the volume of works during service, in ha.

Values G_n and W_n have been experimentally determined and can be found in maintenance technologies, revisions, and repairs of tractors and agricultural machinery.

The costs for the technical service of the aggregate are:

$C_{dt} = 5.55 + 2.85 = 8.40$ RON/ha.

Direct costs for a scarified ha are:

$\boldsymbol{C_d = C_s + C_c + C_A + C_{dt} = 18.7 + 97.5 + 12.66 + 8.40 = 137.26}$ **RON/ha**

Auxiliary costs C_{ac} are costs for main and auxiliary materials, costs for storing and preserving tractors and agricultural machinery. They are calculated by a percentage (15-20%) of the direct costs:

$C_{ac} = 0.2 \cdot 137.26 =$ **27.45 RON/ha.**

The total cost of a scarified ha will be:

$\boldsymbol{C_T = C_d + C_{ac} = 137.26 + 27.45 = 164.71}$**RON/ha.**

Germination bed preparation works aim at: land levelling, weed control, and creating a layer of ground, loose soil along the sowing depth, ready to receive the seed.

Vogel & Noot Terra Disc 600 disc harrow

The Vogel & Noot Terra Disc 600 disc harrow is intended for the preparation of the germination bed. It works in aggregate with the John Deere 8285R tractor.

The main *mandatory agrotechnical requirements to be achieved* through the works system for winter crops are.

-The soil should be mobilized at a minimum of 18 cm, optimally 20-22 cm;

-Until winter sowing, soil works should ensure the accumulation of sufficient humidity for seed germination;

-The soil for winter sowing should not be too shredded because it may be too slightly shattered by the wind; a too shredded soil at the surface forms a crust and frost-thawing favours plants uprooting; clods up to 5 cm prevent snow shattering from the wind, favour the accumulation of water in the soil on slope land, and prevent crust formation in spring;

-Through the work system, soil should be cleaned of weeds so that it can be seen under normal conditions and prevent, after the plants sprout, competition by other plant species.

When preparing the germination bed, in addition to land levelling and soil shredding, an essential objective to be pursued is the preservation of water in the soil, which is achieved by its superficial mobilization and, as low as possible, by works to reduce the losses of water by evaporation. Correct adjustment and use at optimal time of machine aggregates prevent the risk of situations in which the work is repeated for the correction of the germination bed. By reducing the number of passes on the ground, fuel savings are achieved and the danger of soil compaction is reduced (it affects the aero hydric regime and the development of the root system).

Calculus and formation of aggregates for germination bed preparation

The traction resistance force of the disc harrow is:

$R_M = K \cdot B_l = 750 \cdot = 4.500$ *daN*

in which:

K - the specific resistance in DAN/M;

B_1 - the working width of the combiner in m.

Speed work

Comparing the resistance of the aggregate to soil preparation R_m with the traction force Ft that the John Deere 8285R tractor can develop, choose the speed with which the work will be done. Work speed will be:

$v_l = v_t(1-\delta) = 3.2 \cdot (1-0.1) = 2.9\ m/s = 10.4\ km/h$ *h.*

Aggregate working capacity for land preparation

The actual hourly working capacity is calculated with the relationship:

$W_h^r = 0.1 \cdot B_l \cdot v_l \cdot K_s = 0.1 \cdot 6 \cdot 10.4 \cdot 0.8 = 5\ ha/h$

Real work capacity per shift is calculated with the relationship:

$W_{sch}^r = W_h^r \cdot T_s = 5 \cdot 8 = 40\ ha/sch$.

For a three-day work, an aggregate for land preparation is used.

The method of work movement is that of circular paths with turns to 90^0.

The duration of a work cycle is:

$T_c = L_l \cdot n_l / v_l$ = 1,000 · 2 / 2.9 = 689 sec.

The theoretical surface worked after a cycle is determined with the relationship:

$W_c = L_l \cdot n_l \cdot B_l / 10^4$ = 1,000 · 2· 6 / 10,000 = 1.2 *ha/cycle*

The theoretical working capacity will be:

$W_h = 3{,}600 \cdot W_c / T_c$ = 3,600 · 1.2 / 689 = 6.26 *ha/h*

Fuel consumption per ha will be:

$C_{ha} = C_h / W_h$ = 45l/ha / 6.26 ha/h = 7.18 l/ha

Calculus of economic indices

Consumption of h/aggregate:

$C_a = \frac{T_s}{W_{sch}^r} = \frac{8}{40} = 0.20$ h-aggregate/ha

The coefficient C_m for servicing the aggregate:

$C_m = C_a \cdot m = 0.20$ h-man/ha

Costs of salary per ha will be:

$C_S = C_m \cdot S = 0.2 \cdot 15 = 3.0$ RON/ha.

Fuel costs are:

$C_c = C_{ha} \cdot p_i$ = 9 · 6.5 = 58.5 RON/ha

Costs of aggregate depreciation is:

$C_{A\ tractor} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z \cdot D$ = 500,000 / 40 · 250 ·10 = 5 RON/ha;

$C_{A\ grower} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z \cdot D$ = 250,000 / 40 · 250 · 8 = 3.12 RON/ha;

C_A = 5 + 3.12 = 8.12 RON/ha.

Costs of technical service of the aggregate are:

$C_{dt\ tractor} = V_i \cdot G_{ha} / C_n$ = 500,000 · 9 / 900,000 = 5 RON/ha;

$C_{dt\ grower} = V_i \cdot W_n$ = 250,000 / 62,500 = 4 RON/ha;

The costs for the technical service of the aggregate are:

$C_{dt} = 5 + 4 = 9$ RON/ha.

Direct costs per ha worked with the combiner are:

$C_d = C_s + C_c + C_A + C_{dt}$ = 3.0 + 58.5 + 8.12 + 9.0 = 78.62 RON/ha.

Auxiliary costs are:

C_{ac} = 0.2 ·78.62 = **15.72 RON/ha.**

Total costs per ha prepared with the combiner will be:

$C_T = C_d + C_{ac}$ =78.62 +15.72 = 94.34 RON/ha.

The Gaspardo MT 12 seed drill is designed for precision sowing (grain by grain) of the seeds of tillage crops. Simultaneously with the sowing work in the nests, the machine also performs fertilization by incorporating solid chemical fertilizers. It is a machine pulled and operated from the John Deere 6190R tractor power tree with which it works in aggregate.

Calculus and formation of sowing aggregates

The traction resistance force of the sowing machine is:

$R_M = K \cdot n = 80 \cdot 24 = 1.920\ daN$

in which:

K - the specific resistance on the coulter in daN/m;

n – number of patina coulters (for sowing + embedding fertilizers).

Speed work

By comparing the traction resistance of the sower R_m with the traction force F_t that the John Deere 6190R tractor can develop, select the rapid speed gear with which the work will be done. Work speed will be:

$$v_l = v_t(1-\delta) = 2.7\cdot(1-0.15) = 2.3\, m/s = 8.3\, km/h$$

h.

The working capacity of the sowing aggregate

The actual hourly working capacity is calculated with the relationship:

$$W_h^r = 0.1\cdot B_l \cdot v_l \cdot K_s = 0.1\cdot 8.4\cdot 8.3\cdot 0.65 = 4.5\, ha/h$$

Real work capacity per shift is calculated with the relationship:

$$W_{sch}^r = W_h^r \cdot T_s = 4.5\cdot 8 = 36\ ha/sch\ .$$

For a three-day work, a sowing aggregate will be used.

The method of work movement is the method of shuttle traveling.

The duration of a work cycle will be:

$$T_c = \frac{L_l\cdot n_l}{v_l} + \frac{L_g\cdot n_g}{v_g} = \frac{(930+42)\cdot 2}{2.3} = 845\,\text{sec}.$$

The theoretical area worked after a cycle is determined with the relationship:

$W_c = L_l \cdot n_l \cdot B_l / 10^4 = 930 \cdot 2 \cdot 8.4 / 10,000 = 1.56$ ha/ cycle.

Theoretical working capacity will be:

$W_h = 3.600 \cdot W_c / T_c = 3,600 \cdot 1.56 / 845 = 6.64$ ha/h

Fuel consumption per ha will be:

$C_{ha} = C_h / W_h = 27.3$ l/h / 6.64 ha/h = 4.11 *l/ha*

Calculus of economic indices

Consumption of h/aggregate:

$$C_a = \frac{T_s}{W_{sch}^r} = \frac{8}{36} = 0.22 \text{ h-aggregate/ha}$$

The coefficient C_m for servicing the aggregate:

$C_m = C_a \cdot m = 0.22$ h-man/ha

Costs of salary per ha will be:

$C_S = C_m \cdot S = 0.22 \cdot 15 = 3.33$ RON/ha.

Fuel costs are:

$C_c = C_h \cdot p_i = 6 \cdot 6.6 = 39$ RON/ha

Costs of aggregate depreciation C_A is:

$C_{A\ tractor} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z \cdot D = 300,000 / 28 \cdot 250 \cdot 10 = 4.\ 29$ RON/ha;

$C_{A\ sem} = V_i - V_r / W^r_{sch} \cdot n_s \cdot n_z \cdot D = 150,000 / 28 \cdot 250 \cdot 8 = 2.68$ RON/ha;

$C_A = 4.29 + 2.68 = 6.97$ RON/ha.

Costs of technical service of the aggregate C_{dt} are:

$C_{dt\ tractor} = V_i \cdot G_{ha} / C_n = 300,000 \cdot 6 / 450,000 = 4$ RON/ha;

$C_{dt\ sem} = V_i / W_n = 150,000 / 55,000 = 2.73$ RON/ha;

The costs of technical service of the aggregate are:

$C_{dt} = 4 + 2.73 = 6.73$ RON/ha.

Direct costs per sowed ha are:

$C_d = C_S + C_c + C_A + Cdt = 3.3 + 39 + 6.97 + 6.73 = 56$ RON/ha.

Auxiliary costs C_{ac} are:

$C_{ac} = 0.2 \cdot 56 =$ **11.20 RON/ha**.

The total cost per ha prepared with the combiner will be:

$C_T = C_d + C_{ac} = 56.00 + 11.20 = 67.20$ RON/ha.

CONCLUSIONS

Based on the experiments in the field of maize and of economic calculus, the following can be concluded:

Fuel consumption for scarified works, soi preparation, and sowing is 30 l/ha, corresponding to ploughing consumption in classical technology.

Taking into account that the price of diesel is 6.5 RON/l, the fuel costs are 195 RON/ha, i.e., 71.72% of the direct costs, i.e., 58.77% of the total costs.

The use of modern mechanization technologies has an increased economic efficiency due to the following aspects:

-Works are carried out within a short term, so that the optimal time of technological work is respected;

-The number of aggregates is reduced;

-The number of passes on the ground is reduced;
-Soil setting is reduced;
-Salary costs are reduced;
-Fuel consumption is reduced.

The use of modern technologies for mechanization, chemical treatment, fertilization, the use of high-productivity hybrids suitable for these technologies has a great economic efficiency in the sense that production is higher even if costs per ha in the current stage are high. Also, the use of herbicides reduces fuel consumption by reducing the number of passes per ha.

The use of complex aggregates when preparing the germination bed and even sowing or maintenance favours soil texture improvement and low soil setting. But perhaps the most important thing is that fuel consumption is reduced per ha that: because of its high price, it increases the costs per area unit; from an environmental perspective, soil processing technology in the conservative (unconventional) system contributes to reducing pollution and greenhouse gases (GHG) in the context of sustainable development.

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TECHNICAL AND RESOURCE USED EFFICIENCY OF RICE PRODUCTION IN THE MEKONG DELTA, VIETNAM

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Abstract

This study aims at evaluating the technical efficiency and resource use efficiency in rice production in the Mekong Delta. This study used a parametric estimation method through the stochastic frontier production function under the translog form, and was performed using software Frontier 4.1. The research data is the Winter-Spring season – one of the main crops in rice production in this region and in the 2017 – 2018 crop year. The results show that the technical efficiency is 91.5%; and a fraction of one quarter of households has still technical efficiency below 90%. Besides, the efficiency of using input resources is not optimal. Many types of materials such as seeds, fertilizers, and pesticides have been used in an excess of the necessary and recommended levels of the agricultural agency. The farm-size is not too large, but it is possible that because there are many farm plots, which also adversely affect the technical efficiency and the resource use efficiency. Positive factors that increase technical efficiency need to be focused on for replication such as educational level, production experience, participation in technical training classes, contract farming. This study is expected to have policy implications for rice production in the Mekong Delta in the near future.

Key words: *Mekong Delta, resource use efficiency, rice production, stochastic frontier production function, technical efficiency*

INTRODUCTION

The Mekong Delta has a natural area of about 4 million hectares, of which nearly 1.7 million hectares are used for rice production, being a key rice production area of Vietnam and one of the few largest rice-producing deltas in the world [7, 12, 3, 37]. Rice in this area is intensively cultivated. There are more than a million small-scale rice farmers in the region who also have long experience in rice farming. Nonetheless, the intensive farming in associating with long experience of rice farming has not identically meant that rice is technically cultivated as well as the resource used for rice is fully efficient.

As being the third world's largest rice exporter, the region's rice production and productivity has increased overtime [13], however, the doses of fertilizer and agro-chemical used for rice also increased pararelly [31, 33]. In addition, the rate of the technical package adoption like 1M5R (One Must Do Five Reductions), 3G3R (3 Gains 3 Reductions) as well as the standardization of products like SRP (Sustainable Rice Platform), VietGAP (Vietnam Good Agriculture Practice), Global GAP (Global Good Agriculture Practice), etc., are also limited despite many state and NGOs technical supports are already given [18, 29]. This implies that inefficiency of resource use in the rice farming might have existed in the region.

The resource use efficiency as well as the technical efficiency is an important concept in economic performances of an agricultural firm. The technical efficiency has been widely studied in agriculture. It was initially proposed by Coelli (1995) [9] which referred to the firm that is more efficiency than the others once its productivity is further enhanced by how input factors are combined and transformed into a higher amount of outputs with the same amount of inputs and technological level applied. Two approaches of the parametric stochastic frontier analysis (SFA) proposed by Aigner et al. (1977) [2], Meeusen and Van den Broeck (1977) [26] and the nonparametric Data Envelopment Analysis (DEA) developed by Charnes et al. (1978) [8] are able to measure the technical efficiency. Each approach has its own advantages and limitations, so that the choice of which approach for use depends on the research objective, type of industry as well as the availability of data [38]. The DEA approach does not need to establish a production function of the firm under observation, nonetheless, DEA fails to take into consideration the possible impact of random shock like measurement error and other types of noise in the data [9, 20, 38] as cited by Ahmadzai and Hayatullah (2017) [1]. Contrarily, the parametric approach with a construction of stochastic production frontier function that is widely used to measure both the level of firm efficiency and error term to captures technical inefficiency across production units [21]. It is therefore the SFA overcomes the limitations of the above DEA approach [1]. Significantly, the stochastic frontier function is able to represent a best-practice technology against which the efficiency of firms within the industry can be measured [9].

The Mekong Delta is formerly considered a favorable region for rice production [15, 32] though recently there always exists number of natural uncertainties affecting rice production, especially they appear much more often in the context of recent climate change. Extreme events of droughts, inundations and abnormal rains are much frequently occurred [36, 34]. Such the stochastic effects are considered as errors beyond the control of the rice farmers; and they need to be measured and isolated from the other deviation causing technical inefficiency. Since this study focuses on assessing the level of technical efficiency as well as technical inefficiencies, and at the same time identifies the factors induced by production units that affected technical inefficiencies, the SFA parametric method is therefore employed. This study will furtherly examine the economic efficiency of key resource inputs such as seed, fertilizer, pesticide, labour, etc. The research findings are expected to be a scientific basic for policy implications.

MATERIALS AND METHODS

Study area and data collection

Rice is a crop that shares largest area in total agricultural land of the delta. This study selected five provinces located in the upper and middle areas of the delta where rice is dominantly and intensively cultivated, including (1) Dong Thap, (2) An Giang, (3) Can Tho, (4) Hau Giang and (5) Soc Trang (Figure 1).

The total surveyed households are 470, spreading relatively evenly over these five provinces, and corresponding to 90 to 100 households for each province. The samples were selected in three stages, firstly by purposive stratification that is, in the intensive rice cultivation area as in the five targeted provinces, secondly, by selecting rice producing with cooperatives, and finally random selection of rice farmers consisting of equal respondents inside and outside of the cooperative on the same adjacent areas. Observational sampling like this is intended to find out how cooperatives affect the technical efficiency and resource use efficiency.

The survey was conducted in 2018; and the data was collected in the Winter-Spring 2017-2018, which is a main seasonal rice crop in the region. The collected data includes demographic characteristics of farmers, technical characteristics applied and economic achieved for each crop. All these features are exploited to serve as inputs for the stochastic frontier production function models as well as the resource use efficiency analysis later in this study.

Analytical methods

This study uses the parametric estimation method by applying the stochastic frontier production function [2, 5, 26]. The estimation method has been widely applied for a vast number of studies in agriculture, particularly adequate for small-scale farm units [6, 25, 28, 1, 23]. The generic form of the function is as follow:

$$Y_i = f(X, B) + e_i \qquad (1)$$

where: Y_i refers to the total rice output of the i^{th} farm measured in kg, f(X,B) is a production function of the vector of inputs X, B refers to vector of parameters to be estimated, and e_i

refers to an error term. The error term in the stochastic frontier production function has two components, which is expressed as follow:

$$e_i = V_i + U_i \qquad (2)$$

where :V_i is an identically and independently normally random error [$V \sim N(0,\delta_V^2)$] that captures the stochastic effects beyon the farmers control; U_i is a one-sided efficiency component that captures the technical inefficiency of the farmer. V_i and U_i are assumed to be the normal and half-normal distributed, respectively.

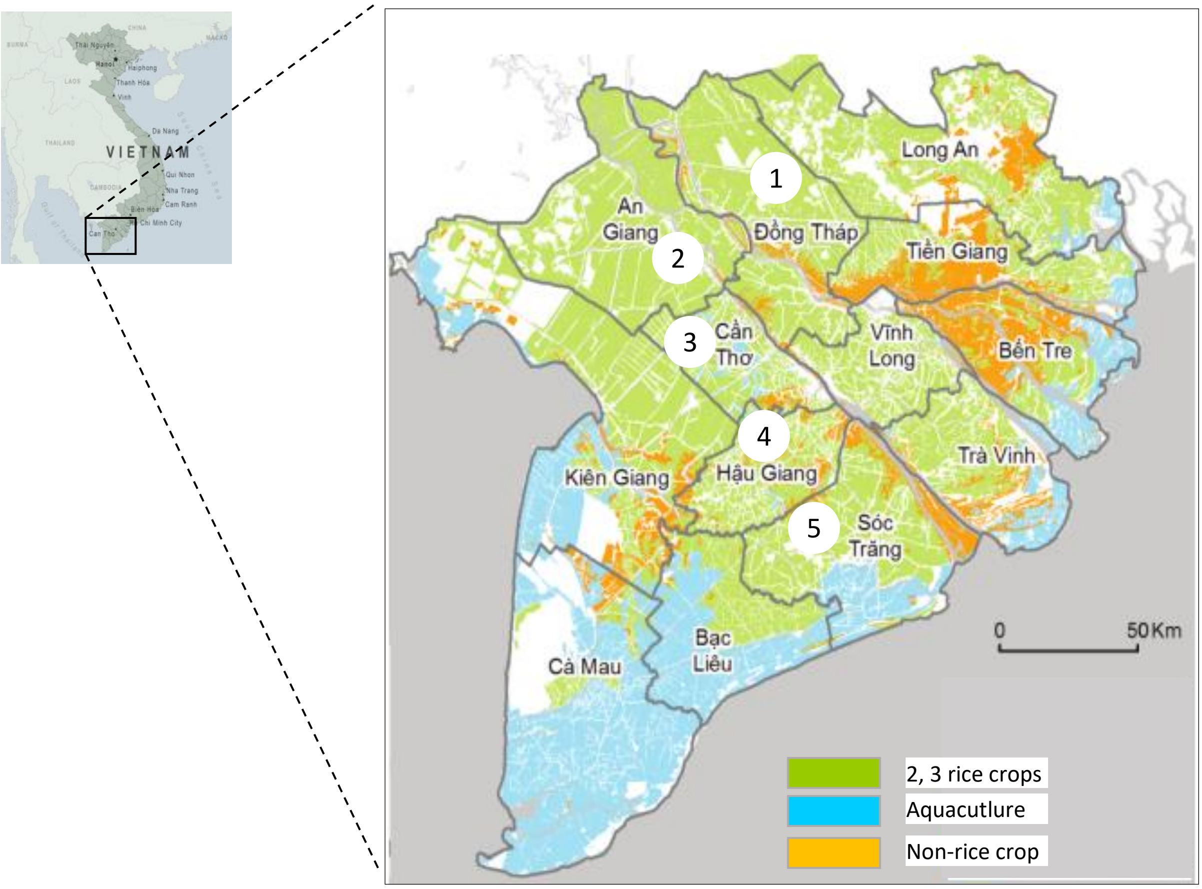

Fig. 1. Relative location of the surveyed sites in the Mekong Delta
Source: Adapted from Chapman et al. (2017).

The technical efficiency of the ith farm is estimated by the ratio of the observed output (Y_i) to maximum possible output (Y_i^*) derived by the stochastic frontier function estimation. The technical efficiency estimation is expressed as follow:

$$TE = \frac{Y_i}{Y_i^*} = \frac{\exp(X_i B)\exp(V-U)}{\exp(X_i B)\exp(V)}$$

or

$$TE = \exp(-U) \qquad (3)$$

So that 0<TE<1;

The equations (1) is written and estimated either by Cobb-Douglas or translog form depending on result of the test of Generalized Livelihood Ratio. For the Cobb-Douglas form, it is written as the (4) as follow:

$$\ln(yield_i) = \beta_0 + \beta_1 \ln(seed_i) + \beta_2 \ln(fertilizer_i) + \beta_3 \ln(pesticide_i) + \beta_4 \ln(labour_i) + \beta_5 \ln(land_i) + (V_i - U_i)$$

For the Translog form, it is written as the (5) as follows:

$$\begin{aligned}
\ln(yield_i) &= \beta_0 + \beta_1 \ln(seed_i) + \beta_2 \ln(fertilizer_i) + \beta_3 \ln(pesticide_i) + \beta_4 \ln(labour_i) + \beta_5 \ln(land_i) + \\
&\frac{1}{2}\beta_{11} \ln(seed_i)^2 + \frac{1}{2}\beta_{22} \ln(fertilizer_i)^2 + \frac{1}{2}\beta_{33} \ln(pesticide_i)^2 + \frac{1}{2}\beta_{44} \ln(labour_i)^2 + \frac{1}{2}\beta_{55} \ln(land_i)^2 \\
&+ \beta_{12} \ln(seed_i)\ln(fertilizer_i) + \beta_{13} \ln(seed_i)\ln(pesticide_i) + \beta_{14} \ln(seed_i)\ln(labour_i) \\
&+ \beta_{15} \ln(seed_i)\ln(land_i) + \beta_{23} \ln(fertilizer_i)\ln(pesticide_i) + \beta_{24} \ln(fertilizer_i)\ln(labour_i) \\
&+ \beta_{25} \ln(fertilizer_i)\ln(land_i) + \beta_{34} \ln(pesticide_i)\ln(labour_i) + \beta_{35} \ln(pesticide_i)\ln(land_i) \\
&+ \beta_{45} \ln(labour_i)\ln(land_i) + (V_i - U_i)
\end{aligned}$$

where:
yield is the rice output per hectare (kg/ha), β_0, … β_4 are parameters to be estimated, seed is amount of seed sown per hectare (kg/ha), fertilizer is dose of fertilizer applied per hectare (kg/ha), pesticide is cost per hectare (1,000 VND/ha), labour is the number of manday worked per hectare (manday/ha), and land is the size of rice land (ha). All of these inputs and output are collected for the main cropping season, namely Winter-Spring (spans from December 2017 to March 2018).
The technical inefficiency determinants are specified as follow:

$$U_i = \alpha_0 + \alpha_i \sum_1^9 Z_i + \varepsilon_i \qquad (5)$$

where:
U_i is technical inefficiency, α_0, …, α_i are the parameters to be estimated; Z_i is a vector of exogenous variables that are likely to affect efficiency, α's are the parameters to be estimated, and ε_i is the random error term. As the dependent variable in equation (5) is defined in terms of technical inefficiency, a farm-specific variable associated with the negative (positive) coefficient will have a positive (negative) impact on technical efficiency.
The pamameters of both functional models expressed by (4) and (5) are joinly estimated by the maximum likelihood method, using Frontier 4.1, and a half-normal distribution of the inefficiency variance was used in the estimation [10].

Estimation of economic efficiency of resource use

Economically, the profit maximization principle states that a firm reaches its profit maximum as long as it keeps its operation at the level where the marginal cost is equal to marginal revenue, in other words, at the point of the firm profit maximization the efficiency of using input resources is optimal. This principle is true for firms that use multi-input factors such as in agriculture, and they are used in this study. Economic efficiency of resource used of a firm is reached an optimal point as long as the marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition. The economic efficiency parameter is hence calculated by using the ratio of MVP of inputs to the MFC. This principle has been applied in many studies [14, 16, 4, 19].

$$r = \frac{MVP}{MFC}$$

where:
r = efficient ratio
MVP_i = marginal value of product of the ith input
MFP_i = marginal factor cost of the ith input

$$MVP_i = \beta_i \frac{\bar{Y}}{\bar{X}_i}.P_y$$

$\bar{Y}$ = Geometric mean of the value of output
$\bar{X}_i$ = Geometric mean of the ith input
β_i = estimated coefficient (elasticity) of the ith input, derived from the function (Eq.4),
P_y = price of output
To decide whether or not an input is used efficiently, the following rules is applied:
r = 1, it implies the input was used efficiently;
r > 1, it implies the input was underutilized and increased utilization will increase output.
r < 1, it implies the resource is over utilized and reduction in its usage would lead to maximization of profit.

The relative percentage change in MVP (Marginal value product adjustment) of each resource required in order to obtain optimal allocation of resources. i.e. r = 1 or MVP = MFC which was estimated using equation below [27].

$$D = (1 - \frac{MFC}{MVP}) * 100 \text{ or } D = (1 - \frac{1}{r}) * 100$$

where:
D = absolute value of percentage change in MVP of each resource.

RESULTS AND DISCUSSIONS

Demographic and farm-specific characteristics

Table 1 presents the values of the variables used in the stochastic frontier production function, and shows the demographic and social economic characteristics of rice-producing households in the Mekong Delta. First of all, rice farmers usually have a fairly old age, averaging 50.4 years, which also entails a very high rice farming experience of nearly 25 years, and most of them are male. Like many other studies, the educational level of farmers is relatively low, only about 6.7 years of schooling, which is likely consistent with other studies in the region [17, 35]. Thanks to the agricultural extension policy implemented over the years [17, 11], up to 74% of farmers have attended training courses on rice cultivation techniques.

Farmers in the Mekong Delta often buy inputs for production at material agents that are available in the countryside and are very convenient. Most of them buy materials and pay after harvest at the end of the crop without necessarily paying at the time of purchase, so they don't need much initial investment; access to loans mainly for rice production is not popular. In this study, only 22% of households have loans and 16% of households pay cash directly when buying materials.

Table 1. Descriptive statistics of variables in stochastic frontier production function model

Variables	Min.	Max.	Mean	Std.
(Y) Yield (kg/ha)	4,000	11,800	7,776	1,185
(Z_1) Age of head (year)	24.0	87.0	50.4	11.3
(Z_2) Gender (1-Male; 0- Female)			0.88	
(Z_3) Experience (year)	2.0	70.0	24.9	11.4
(Z_4) Education (year)	0.0	16.0	6.7	3.4
(Z_5) Training (1-Yes; 0-No)			0.74	
(Z_6) Loan accessed (1-Yes; 0-No)			0.22	
(Z_7) Sell to company (1-Yes; 0-No)			0.13	
(Z_8) Input payment (1-direct; 0-No)			0.16	
(Z_9) Coop. member (1-Yes; 0-No)			0.51	
(X_1) Seed (kg/ha)	93.30	390.00	176.86	47.62
(X_2) Fertilizer (kg/ha)	64.00	688.30	249.50	76.91
(X_3) Pesticide cost(10^3 VND/ha)	68.80	2,165	653.03	329.15
(X_4) Labour (day/ha)	0.60	64.00	13.78	9.29
(X_5) Land (1,000m^2)	1.30	208.00	21.35	23.13

Source: Author's calculation.

Besides, sales of rice products to consumption companies account for a low rate of only 13% as it depends on how well contract farming is built, which is also consistent with other studies [22, 12].

Rice yield is relatively high at 7,776 tons/ha, however the inputs are also high. The average amount of seed used is 176 kg/ha, which is higher than recommended by the agricultural authority [11]. The average amount of fertilizer used was 249 kg/ha, which is the amount of pure NPK fertilizer calculated from commercial fertilizers used by farmers. The amount of pure fertilizer used is much higher than recommended by the agricultural authority [11]. For pesticides, they are calculated by the cost used instead of the quantity, because in fact there are many types of pesticides with very different and complex active ingredients and concentrations. The survey results show that on average, each hectare has cost 653 thousand VND, which is also quite a high expenditure [17].

In fact, in the Mekong Delta, most rice production in the field is mechanized, especially in the stages of land preparation and harvesting [30]. The stages are also done manually or a combination of manual and mechanization is fertilizing and spraying pesticides. Farmers often use manual labor for re-transplanting, weeding and field management, so only about 14 mandays are used. Another feature is that the land area is also shown in Table 1, in which the average farm-size is 2.135 ha per household. This is the total farm-size and it can be split more than one plots of land [24], although the plots may be located in close proximity to each other in the same locality.

Determinants of technical efficiency and resource use

To get the estimated result, the Generalized Livelihood Ratio test is firstly performed and shows that the index λ = - 2 {log [L(H_0) – log[L(H_1)]} = 32.404, where, L (H_0) is the log-likelihood value of the Cobb-Douglas model as the (4) and L(H_1) is the log-likelihood value of the translog model as the (5) above, is larger than the critical value (λ_{table} = 24.996; df=15), so the translog model considered appropriated for further estimation of the stochastic frontier production function.

Accordingly, the stochastic frontier production function under translog form is estimated by the Maximum Livelihood method using the Frontier 4.1 program. The estimated value of σ^2 is positive and 0.120, which is statistically significant at 1% level. These values indicate that there exists sufficient evidence to suggest that technical inefficiencies are present in the data and that the differences between the observed (actual) and frontier (potential) output are due to inefficiency. These imply that the estimated model and distributional assumptions for the error terms are appropriate (Table 2).

Table 2. Maximum Livelihood Estimates of the stochastic frontier production function model

	Coefficient	**SE**	**t-ratio**
β_0 (Constant)	14.988***	1.181	12.695
(X_1) Ln seed (kg/ha)	-0.620	0.599	-1.035
(X_2) Ln fertlizer (kg/ha)	-0.681*	0.520	-1.308
(X_3) Ln pesticide (10^3 VND/ha)	-0.694**	0.346	-2.008
(X_4) Ln labour (day/ha)	0.059	0.292	0.201
(X_5) Ln land (1,000m^2)	-0.489***	0.207	-2.361
½ *Ln $(X_1)^2$	-0.326**	0.181	-1.805
½ *Ln $(X_2)^2$	-0.094	0.101	-0.925
½ *Ln $(X_3)^2$	0.058*	0.042	1.375
½ *Ln $(X_4)^2$	0.059***	0.024	2.418
½ *Ln $(X_5)^2$	0.022*	0.015	1.465
Ln (X_1)*Ln (X_2)	0.240***	0.096	2.501
Ln (X_1)*Ln (X_3)	0.117**	0.066	1.781
Ln (X_1)*Ln (X_4)	0.032	0.049	0.650
Ln (X_1)*Ln (X_5)	0.089***	0.035	2.509
Ln (X_2)*Ln (X_3)	-0.006	0.047	-0.128
Ln (X_2)*Ln (X_4)	-0.017	0.035	-0.486
Ln (X_2)*Ln (X_5)	0.021	0.029	0.714
Ln (X_3)*Ln (X_4)	-0.053**	0.024	-2.206
Ln (X_3)*Ln (X_5)	-0.035**	0.019	-1.892
Ln (X_4) *Ln (X_5)	0.027**	0.016	1.735
Sigma square (σ^2)	0.113***	0.038	2.988
Gamma (γ)	0.883***	0.031	27.721
Log-likelihood:	247.404		
Observations (N):	470		
LR test:	51.343		

***: p<0.01; **: p<0.05; *: p<0.1

Source: Author's calculation.

The estimated results also show that the gamma (ϒ) value is 0.893 (~1), which indicates that technical inefficiency is existing in the production [5, 9]. Specifically, rice production in the Mekong Delta is suffering from a certain rate of inefficiency due to household characteristics and other socio-economic factors.

Estimation results show that input variables such as fertilizers, pesticides have a negative and statistically significant effect on yield. These two types of materials have been used almost beyond the necessary threshold compared to the needs of rice and are also reflected in previous studies [17, 11, 31, 33, 29, 18].

The average farm-size is 2.135 ha, but in some cases up to 2.313 ha, in addition, the farm-size often has more than one parcel of land, making it difficult to manage and take care of. In this study, farm-size hence had a negative effect on productivity.

Meanwhile, seed quantity and labor had no significant impact on yield. In addition, the variable squares and variable interactions also have certain effects on rice yield (Table 2).

The level of technical efficiency averaged of 91.5%, which is quite high (Table 3). However, there is still a certain percentage of farm households with low technical efficiency, in which the ranges of 50 – 60%, >60 – 70%, >70 – 80% and >80 – 90% reach a frequency of 0.64%, 0.85%, 4.26% and 17.45%, respectively.

The majority of farmers (76.81%) achieved technical efficiency levels from over 80 to 90%. The technical efficiency level reached in the current study is much higher than that found by Ho and Shimada (2019) [17].

There are many factors affecting technical efficiency in rice production.

Table 3. Distribution of technical efficiency

Level of technical efficiency	Frequency	Percentage
0.0-<0.5	0	0.00
0.5-<0.6	3	0.64
0.6-<0.7	4	0.85
0.7-<0.8	20	4.26
0.8-<0.9	82	17.45
0.9-<1.0	361	76.81
1.0	0	0.00
Observation	470	
Min	0.525	
Max	0.977	
Mean	0.915	
Std.	0.061	

Source: Author's calculation.

A number of demographic parameters and technical factors affecting technical inefficiency as shown in Table 4, in which a positive sign of co-efficiency has a positive effect on technical inefficiency, which means it has a negative effect on technical efficiency, and vice versa.

The test results show that the age and male sex factors of the household head have an impact on increasing technical inefficiency. This can happen in the elderly, they often have difficulty in accessing and applying new science and technology, or they are also somewhat conservative in the application of new technology. Besides, the elderly farmers are mostly male, so the male gender phenomenon also increases technical inefficiency.

Table 4. Determinants of technical inefficiency in rice production

	Coefficient	SE	t-ratio
α_0 (Constant)	-0.685**	0.404	-1.695
Z_1 Age of head	0.017***	0.007	2.455
Z_2 Gender (1-Male; 0- Female)	0.159**	0.093	1.713
Z_3 Experience (year)	-0.018***	0.007	-2.510
Z_4 Education (year)	-0.075**	0.036	-2.067
Z_5 Training (1-Yes; 0-No)	-0.319***	0.121	-2.648
Z_6 Loan accessed (1-Yes; 0-No)	0.038	0.049	0.779
Z_7 Sell to company (1-Yes; 0-No)	-0.371***	0.111	-3.328
Z_8 Input payment (1-direct; 0-No)	-0.825***	0.345	-2.388
Z_9 Coop. member (1-Yes; 0-No)	-0.038	0.054	-0.716

***: p<0.01; **: p<0.05; *: p<0.1.
Source: Author's calculation.

Factors that negatively affect technical inefficiency are synonymous with positive effects on technical efficiency such as experience, education, and training. These are factors that can easily see their effects in the application of new techniques to rice production. Besides, selling rice to the company also increases the technical efficiency, this happens because when farmers sell rice to the company, it means that they have done contract farming with the company, and at the same time they used the techniques and production processes offered by the company and they increased technical efficiency. Similarly, households that pay cash directly to agents when they buy materials often have financial viability as well as factors of good technology acquisition, which also positively affect the technical efficiency.

Resource use efficiency

Resource use efficiency of different inputs for rice production was determined based on the ratio value (r) of the marginal value of product over marginal cost of each input as showed in Table 5. Overally, the r value of four inputs of seed, fertilizer, pesticides and land size are negative and less than 1, thus these input factors have over-utilized. These indicate the fact that these inputs are being used to an extent that any increase in their uses brings about a decrease in output. Particularly for labor, the r value is almost equal 1, which indicates that the labor input is used at efficient level. Thus, in order to reach efficient level, the input factors such as seed, fertilizer, pesticides and land size should be reduced by an extend of 108.14%, 108.16%, 102.16% and 210.26%, respectively as showed in the last column of Table 5.

Table 5. Resource Use Efficiency

Variables	β_i	MPP_i	$MVP_i = MPP_i{*}Py$	MFC (VND)	r=MVP/MFC	Decision Rule	D= (1-1/r) *100
Seed	-0.62	-27.26	-152,471	12409	-12.29	overutilized	108.14
Fertilizer	-0.681	-21.23	-118,714	9687	-12.26	overutilized	108.16
Pesticide	-0.694	-8.26	-46,225	1000	-46.22	overutilized	102.16
Labour	0.059	33.30	186,221	178362	1.04	~ Efficient	4.22
Land	-0.489	-178.11	-996,179	1,098,400	-0.91	overutilized	210.26

Source: Author's calculation.

The statistical results described in Table 1 as well as the above estimation results show that the majority of rice farmers in the Mekong Delta have long experience but also come with traditional practices, using excessive input materials, negatively affecting technical efficiency as well as resource use efficiency. Many agricultural extension programs with many new forms of technology transfer reach farmers and have certain positive impacts, but are not widespread. One of the reasons for this slowdown is that the rate of production implementation in the form of contract farming and value chain linkage has not been replicated.

The percentage of farmers participating in cooperatives is also limited. Therefore, upcoming policies should focus on these solutions to improve the technical efficiency and resource use efficiency in rice production.

CONCLUSIONS

Rice is the most common and widely cultivated in the Mekong Delta. Rice production reaches a very big quantity and that plays an important role in ensuring the national food security and export. However, the technical efficiency in rice production is not completely optimal, only 91.5%, and a proportion of about 25% of households have their technical efficiency less than 90%. The ratio of resource use efficiency of several inputs such as seed quantity, fertilizer dose, pesticide expenditure and farm-size are being negative because they are used excessively or beyond the ability of farmers to manage.

Besides the negative impacts caused by elder age and traditional customs that the farmers applied, there are a number of socio-economic environmental factors that positively affect the technical efficiency and resource use efficiency, such as participation in technical training courses, cooperatives membership, contract farming, etc., ... For further improving the technical efficiency and resource use efficiency in rice production, policies related to promoting farmers to better implement the above positive measures are really necessary.

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FORECASTING OF ECONOMIC INDICATORS OF AGRICULTURAL ENTERPRISES ACTIVITY IN THE SYSTEM OF ENSURING THEIR MANAGEMENT ON THE BASIS OF SUSTAINABLE DEVELOPMENT: A CASE STUDY OF UKRAINE

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Abstract

The article proved that the application of the «AGMEMOD–Ukraine» model allowed conduct forecasting the development indicators of agricultural producers in the context of sustainable rural development, namely: yield, gross harvest and sown areas of major crops, changes in demographic indicators on the basic and optimistic forecast, the results of which allow competitive strategies, the implementation of which will increase the volume of sales, profits, market share, penetration into a new market segment, etc. It is considered that the use of the model «AGMEMOD–Ukraine», which covers the multicriteria measurement of functional components of agricultural producers, provides an opportunity to analyze and predict not only key competitive advantages but also secondary characteristics, which together have a significant impact on solving problems of strategic management of economic efficiency and competitiveness of agricultural enterprises in Ukraine. According to the results of the study, there were substantiated in the article the main strategic goals and priority areas for the development of agricultural producers.

Key words: *forecasting, agricultural enterprises, management, «AGMEMOD–Ukraine» model, sustainable development*

INTRODUCTION

An important feature of agriculture in the socio-economic aspect is not only the financial efficiency of enterprises, but also the fact that it largely depends on the quality of life of the rural population, and this efficiency depends on food security in general. It should be noted that in addition to those factors related to the technology of production processes, agricultural production is dependent on changes and anomalies of weather conditions, price dynamics in commodity markets, features of government regulation and changes in legislation, and more.

In such conditions, it is very important to make timely and informed decisions to ensure the effective functioning of agricultural enterprises. At the same time, effective management of agricultural enterprises is almost impossible without the use of modern methods of analysis and forecasting. It should be noted that traditional approaches involve the use of correlation-regression analysis to determine the density of the relationship between factor and performance, the relationship between which is random.

However, the intensive development of digital information and communication technologies greatly simplifies the use of special methods of economic and econometric analysis, which also includes forecasting.

Therefore, the study of the process of forecasting economic performance of economic entities operating in the agricultural sector, based on the use of economic and mathematical formulary tools becomes particularly relevant, especially in terms of forming a strategy for sustainable development of such producers.

In the realities of today, new technologies of social forecasting and prediction have become widespread. Such technologies include the Forsyth method, Data Mining, etc.

The problem of forecasting the economic activity of enterprises is not new in economics and is widely disclosed in specialized studies. In particular, in our opinion, it is expedient to highlight the works of such scientists as O. Agres [1], O. Binert [5], L. Brovko [7], N. Chukhray [9], O. Gudz [17], A. Marcuta [20], I. Nademianov [21], T. Shmatkovska [34-36], N. Vavdiiuk [45-46], Y. Yanyshyn [49], and others.

However, the specifics of the functioning of the agricultural sector require special approaches to assessing performance indicators of enterprises.

Economic research in this area requires the use of multifactor analytical models to ensure the reliability of the data.

The researched problems were reflected in the scientific achievements of O. Apostolyuk [2], I. Atamanyuk [3]. A. Boiar [6], M. Dziamulych [10-16], R. Sodoma [37-39], V. Stechel [44], O. Vovchak [47], O. Yatsukh [50] and others.

It is also necessary to note the relevance of research on the use of mathematical and analytical-static tools for evaluating and forecasting the activities of agricultural producers, which are presented in the works of I. Balaniuk [4], Y. Chaliuk [8], V. Fenyves [18], R. Lopatiuk [19], R. Ostapenko [22], A. Popescu [23-32], N. Samarets [33], O. Stashchuk [40-42], I. Yakoviyk [48], I. Zhurakovska [51] and others.

MATERIALS AND METHODS

To ensure the implementation of the process of calculating the parameters of the model, a specialized model «AGMEMOD-Ukraine» was used, which is based on the use of complex mathematical tools. In the «AGMEMOD-Ukraine» model, the value of expected profit per unit of output is calculated by Formula 1:

$$AEGM_{i,m,t} = p_{i,k,t-1} - C_{i,m,t} + SPRT_{i,m,t} \quad (1)$$

where:

$AEGM_{i,m,t}$ – the expected total profit of culture i, of the producer m, in region k and year t is specified;

$p_{i,n,t-1}$ – price of culture i, in region k and year t-1;

$C_{i,m,t}$ – production costs of culture i, producer m (in region k), and year t;

$SPRT_{i,m,t}$ – state support for crop i, producer m (in region k) and year t (if any).

It should be borne in mind that the adjusted expected total profit of the crop ***i*** produced by the producer of group ***m*** in region ***k*** is the sum of the previous year`s price, expected costs, and state support for the production of this crop this year.

Production costs ***(C)*** are calculated by Formula 2:

$$C_{i,m,t} = S_{di,m,t} + F_{ei,m,t} + F_{li,m,t} + S_{ri,m,t} + L_{bi,m,t} + A_{mi,m,t} + O_{ti,m,t} + R_{ni,m,t} \quad (2)$$

where:

$S_{di,m,t}$ – costs of sowing material for crop i, producer m, in region k and year t;

$F_{ei,m,t}$ – costs of fertilizer application for crop i, producer m, in region k and year t;

$F_{li,m,t}$ – fuel costs for crop i, producer m, in region k and year t;

$S_{ri,m,t}$ – costs of third party services for culture i, producer m, in region k and year t;

$L_{bi,m,t}$ – labour costs for culture i, producer m, in region k and year t;

$A_{mi,m,t}$ – depreciation costs for crop i, producer m, in region k and year t;

$O_{ti,m,t}$ – other costs for culture i, producer m, in region k and year t;

$R_{ni,m,t}$ – the lease price of producer land m, in region k and year t, estimated for culture i.

The sown area of the crop is calculated in the model using a two-stage procedure. First, the area of cereals was estimated (Formula 3):

$$HA_{j,m,k,t} = f(Trend_t, AEGM_{j,m,k,t}) \times N_{m,k} \quad (3)$$

where:
$HA_{j,m,k,t}$ – the total area of the group of crops j, i.e. grain producers m, in the region k and year t;
$Trend_t$ – logarithmic trend calculated as ln (t-2008) (figure for 2008 is 0);
$AEGM_{j,m,k,t}$ – the expected total profit of grain or oilseeds producer m, in region k and year t;
$N_{m,k}$ – number of producers in group m in region k.

The specific weight of crops in cereal areas in the process of modelling is calculated by Formula 4.

$$SHA_{i,m,k,t} = f(Trend_t, AEGM_{i,m,k,t}) \quad (4)$$

where:
$SHA_{i,m,k,t}$ – the share of crop i in the area of the relevant crop group (cereals or oilseeds), producer of group m, in region k and year t;
$Trend_t$ – logarithmic trend calculated as ln (t-2008) (indicator for 2008 is 0);
$AEGM_{i,m,k,t}$ – the expected total profit of the crop i of the corresponding group of crops (cereals or oilseeds), producer m, in region k, and year t is specified.

In order to form a forecast model of the economic performance of agricultural enterprises, we conducted an econometric assessment of crop yields. The estimation of crop yield was determined using Formula 5:

$$Y_{ieldi,m,k,t} = f(Trend_t, AEGM_{i,m,k,t}) \quad (5)$$

where:
$Y_{ieldi,m,k,t}$ – crop yield and producer of group m, in region k and year t;
$Trend_t$ – logarithmic trend calculated as ln (t-2008) (indicator for 2008 is 0);
$AEGM_{i,m,k,t}$ – the expected total profit of the crop i of the corresponding group of crops (cereals or oilseeds), producer m, in region k, and year t is specified.

RESULTS AND DISCUSSIONS

To assess the development of the agricultural market, the «AGMEMOD» methodology involves the use of a combination of exogenous and endogenous data. Exogenous data on annual indicators of gross domestic product, gross domestic product deflator, and population are taken from the State Statistics Service of Ukraine (SSSU). Data on the national currency exchange rate are taken from the resource of the National Bank of Ukraine. As these data come from official sources, the methodology of their calculation is relatively consistent and reasonable. In addition, the use of official statistics increases the reliability of the forecast model and simulation results. However, there is one important caveat related to the use of SSS data – indicators are frequently reviewed and updated, so the database used to form the model should be updated in a timely manner. Estimates of exogenous data are taken from databases and reports from the US Department of Agriculture, the Organization for Economic Development and Cooperation, the United Nations Food and Agriculture Organization, and the European Commission. In Fig. 1 we present an algorithm for forming a forecasting procedure according to the AGMEMOD method.
Historical data on endogenous variables are taken from SSSU databases, PSO Statistics, and OECD-PSO. If the required data are not available, they are estimated based on the trend of previous years. In order to build a forecast model according to the types of producers, data from relevant statistical forms developed and implemented by official statistical bodies in Ukraine were used. These forms are developed in the form of questionnaires, which is mandatory for agricultural producers, and which is then used by SSSU to calculate aggregate indicators. The database, formed on the basis of relevant statistical forms, includes annual data on the performance of 8,521 agricultural producers during the period 2008 – 2020. It covers all

regions of Ukraine and 70% of crop production. In the «AGMEMOD-Ukraine» model, agricultural producers make decisions based on the value of expected profit per unit of output, which is calculated according to Formula 1. Thus, the adjusted total profit of crop ***i***, produced by the producer of group ***m*** in region ***k*** is the sum of the previous year`s price, expected costs, and state support for the production of this crop this year. The production costs (***C***) are calculated by Formula 2.

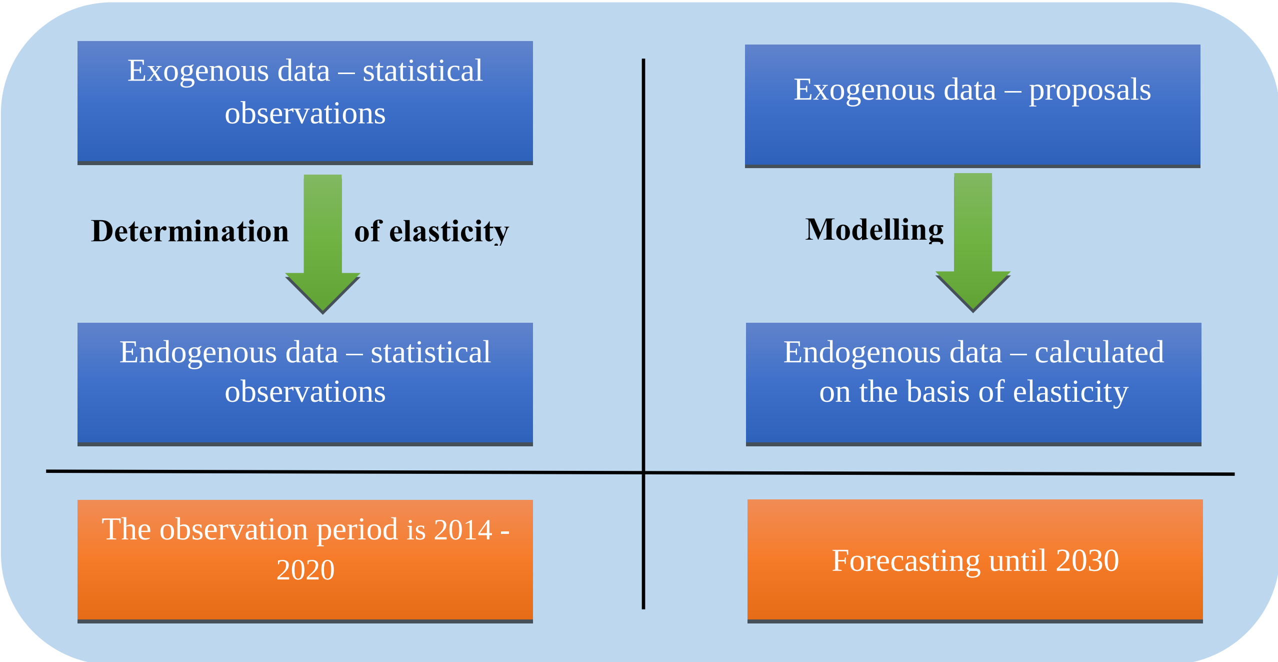

Fig. 1. Algorithm of work and key elements of «AGMEMOD» methodology
Source: systematized by the authors.

All indicators are calculated by us in monetary terms, in addition, such indicators as price, production costs, and government support are adjusted by the deflator of gross domestic product. They are calculated for each manufacturer, region, and year. These indicators are used for econometric estimation of functions of sown areas, shares of areas of separate cultures, and productivity. For the Baseline Scenario, it is assumed that during the forecast period 2021-2030, the real values of production costs will remain unchanged, i.e. at the level of 2020.
The database used, i.e. the specialized statistical forms used in Ukraine, includes data on the total annual value of leased land. Thus, to determine the cost per hectare of leased land for a particular crop, the following calculations were performed: first, the total value of leased land is divided by the area of leased land to estimate the average lease value per hectare; secondly, to adjust the area of land owned by the producer.

Next, we conducted an econometric assessment of grain areas.
The sown area of the crop is calculated in the model using a two-stage procedure. First, the area of cereals was estimated (Formula 3). According to Formula 3, the area of grain/oil producers of group ***m*** in region ***k*** in year ***t*** (*HAj, m, k, t*) depends on the trend of this indicator (*Trendt*), the adjusted expected total profit from grain/oil (*AEGMj, m, k, t*), calculated, the adjusted expected total profit from the group of substitute crops (*AEGMj, m, k, t*) and the number of producers in group m in the region ***k*** (*Nm, k*). The trend is included due to the clear influence of time on the development of this indicator (i.e., increase or decrease in crop area over time). Producers choose between groups of cereals and oilseeds, taking into account the values of the adjusted expected total profit of both groups. AEGM of crop groups is calculated as the average AEGM of all crops in this group is weighted by their production volumes.

Because the equations were estimated for each producer group in each region, in some cases AEGM was used instead of AEGM or domestic or world prices of certain crops. Note that the number of producers in each group and region is determined by us at the level of 2014.

The share of crops in cereals for modelling purposes is calculated by us according to Formula 4. According to Formula 4, the share of crops ***i*** in the area of the group of crops (cereals or oilseeds), producer of group ***m*** in region ***k*** and year ***t,*** in most cases depends on the trend and values of the adjusted expected total profit of this crop and substitute crops. The latter must belong to the same group of cultures as culture ***i***. In other words, after deciding on the total area of grain and oilseeds, the producer chooses among the crops of each group. The choice of substitute crops in a particular equation is based on the production structure of a particular producer in a given region and the statistical significance of the corresponding coefficient.

For groups of crops, the proportion of one of the crops is a residue, so that the sum of the corresponding shares, in the end, was 100%.

We conducted an econometric assessment of crop yields. The estimation of crop yield is determined based on Formula 5.

Table 1. The results of forecasting the dynamics of some exogenous variables of the «AGMEMOD-Ukraine» model for 2023 – 2030

Macroeconomic factors	2017	2019	2021	2023	2025	2027	2029	2030
Population, million people	42.4	41.8	41.3	40.7	40.1	39.5	38.9	38.6
Real GDP in 2000 prices, UAH billion	241.9	260.1	281.2	303.2	328.2	355.8	385.8	401.7
GDP deflator (2000 = 1), UAH basis	9.9	11.1	12.4	13.5	14.5	15.6	16.6	17.1
Exchange rate, UAH / EURO	33.5	29.7	32.7	28.3	27.9	27.7	27.4	27.2
World prices:								
Wheat, USD per ton	211.7	213.1	224.0	233.2	236.9	239.9	242.9	244.4
Corn, USD per ton	163.0	165.9	175.9	182.2	186.7	192.3	198.2	201.2

Source: [43].

Thus, according to the analysis of Table 1 note that starting from 2027, world prices are own calculations based on the trend and the OECD-PSO. The model takes into account the values of each year from 2017 to 2030. The years listed in Table 1 are chosen based on ease of presentation. That is, based on Table 1, we can graphically display the results of our forecast (Fig. 2).

Note that the blue area in the diagram shows the estimated forecast values (Fig. 2, Table 2).

According to the results of the analysis of forecast indicators, we found that in 2030 compared to 2008-2014, the forecast estimates of the model indicate an increase in corn production by 8.3% (up to 21.2 million tons, Fig. 3).

Enterprises with a cultivated area of more than 5,000 hectares and family farms located in the Donbas region are estimated to have the largest increase in production: + 89.4% (up to 96.3 thousand tons) and + 132.9% (up to 233.3 thousand tons), respectively.

Table 2. Results of forecasting for 2030. Area and yield of wheat by producer groups and regions in Ukraine

Producer group	Area, 1,000 hectares Yield, t / ha	Indicator in 2030	Change compared to 2008–2014,%
Mixed forests			
Enterprises ≥ 5,000 ha	Area	134.9	46.2
	Yield	4.6	12
Enterprises < 5,000 ha	Area	631.5	142.6
	Yield	3.8	12.6
Family farms	Area	46.1	1.3
	Yield	4.6	37.4
The region, in general	Area	812.5	104.1
	Yield	4	12.6

Source: adapted from the «AGMEMOD-Ukraine» model

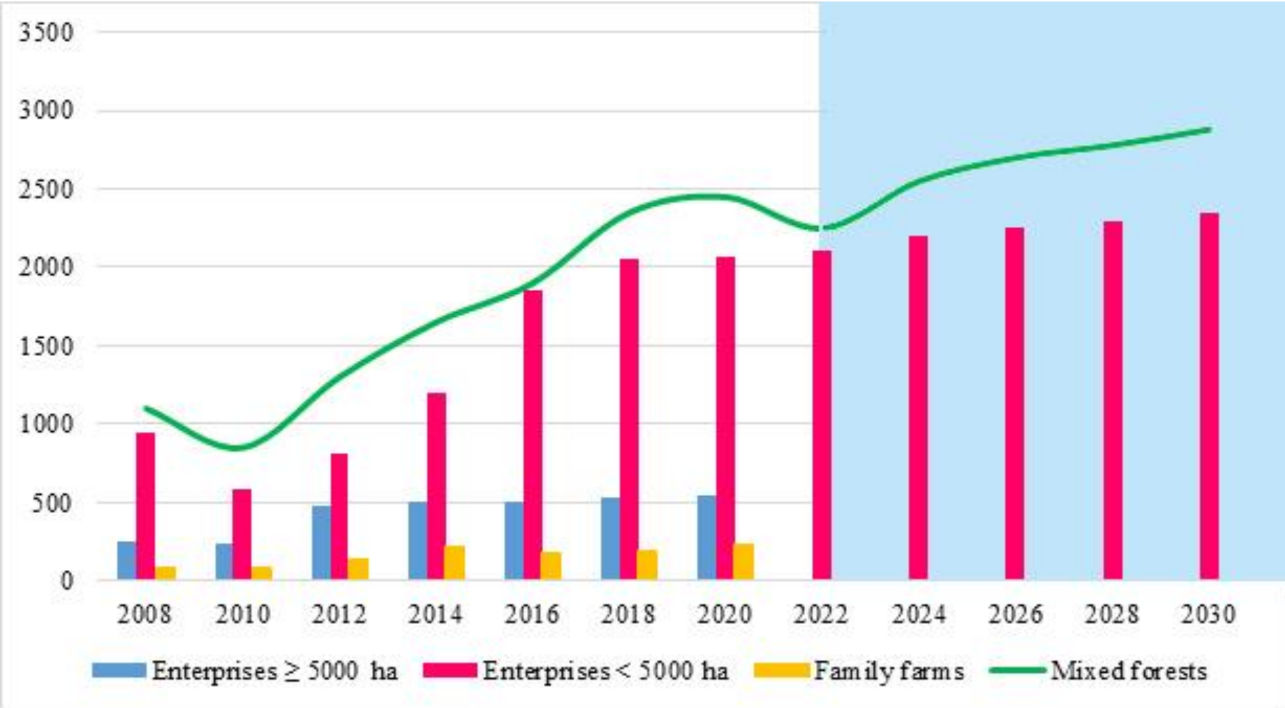

Fig. 2. Results of forecasting wheat production for 2030 by producer groups in the mixed forest zone in Ukraine, thousand tons
Source: adapted from the «AGMEMOD-Ukraine» model.

Enterprises with an area of fewer than 5,000 hectares located in the forest-steppe zone will produce the largest amount of corn, 5.5 million tons. In addition, enterprises with less than 5,000 hectares located in the Donbas region of Ukraine will provide the smallest amount of corn – 0.8 thousand tons – 99.3%.

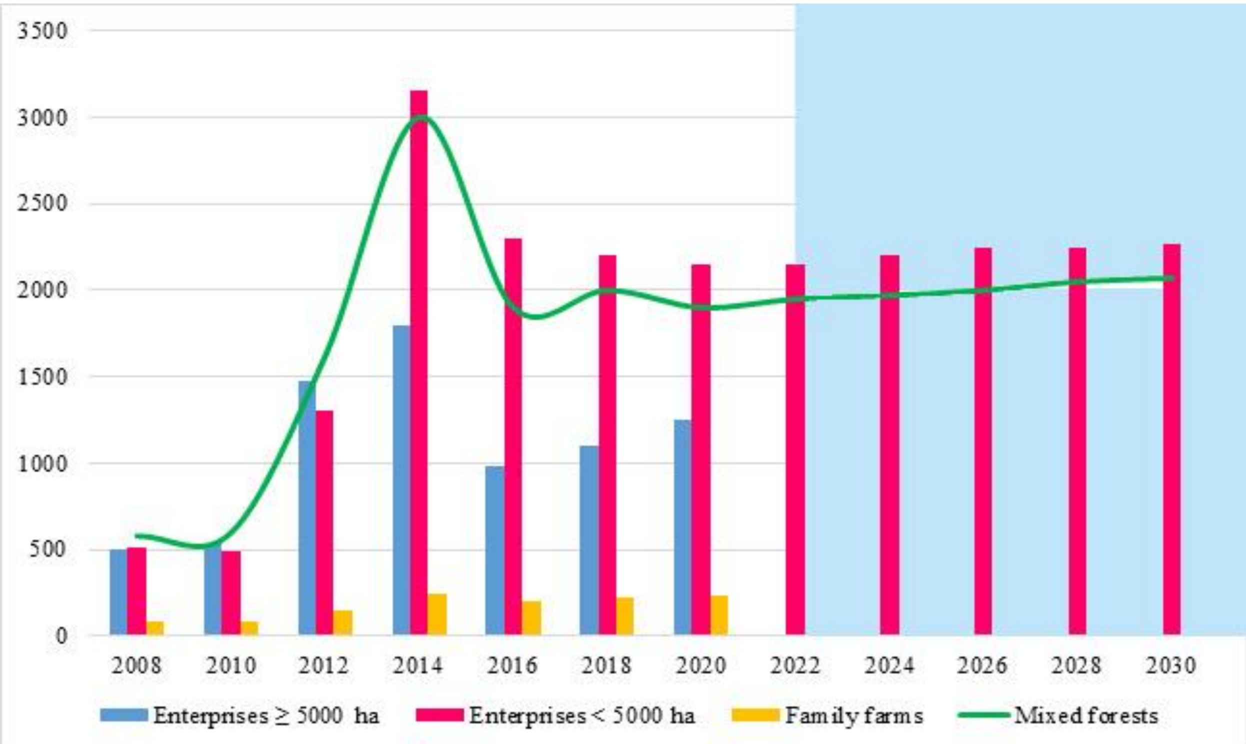

Fig. 3. Expert forecast of corn production by producer groups by regions of Ukraine in 2008–2030, thousand tons
Source: adapted from the «AGMEMOD-Ukraine» model.

It is established that state-owned enterprises are projected to produce 58.7 thousand tons of corn, which is 47.1% less than in 2008–2014. The results of the expert forecast of corn production by producer groups by regions of Ukraine in 2008–2030 are presented in Fig. 3.
It should be noted that the blue area in the diagram shown in Fig. 3 (Table 3), shows the estimated forecast values (namely, the values for 2022–2030).
According to forecast estimates, corn exports in Ukraine by 2030 will decrease by 13.1% (to 9.3 million tons), and imports will remain at a fairly low level – about 18.8 thousand tons.
Due to the increase in poultry production, the use of corn for feed is increasing, thus affecting the volume of exports. In particular, the use of corn for fodder in Ukraine in 2030 will be estimated at about 8.8 million tons, which is 27.1% more than in 2008–2014.
According to the forecast we have substantiated that the use of corn for food in Ukraine will decrease by 14.3% (up to 451.9 thousand tons), which is a consequence of the reduction in per capita consumption and population decline.

Table 3. Results of forecasting for 2030. Area and yield of corn by producer groups and regions in Ukraine

Producer group	Area, 1,000 hectares Yield, t / ha	Indicator in 2030	Change compared to 2008–2014,%
Mixed forests			
Enterprises ≥ 5,000 ha	Area	146.6	-13.4
	Yield	7.5	19.9
Enterprises < 5,000 ha	Area	271.5	34
	Yield	8.1	33.1
Family farms	Area	19.7	-0.2
	Yield	10.6	69.4

Source: developed by the author based on the «AGMEMOD-Ukraine» model.

In the process of forecasting the population, we took into account the assumption that in Ukraine, the population will increase by 1%. Visualization of the results of such forecasting of the population of Ukraine in the baseline and optimistic scenarios is shown in Fig. 4.

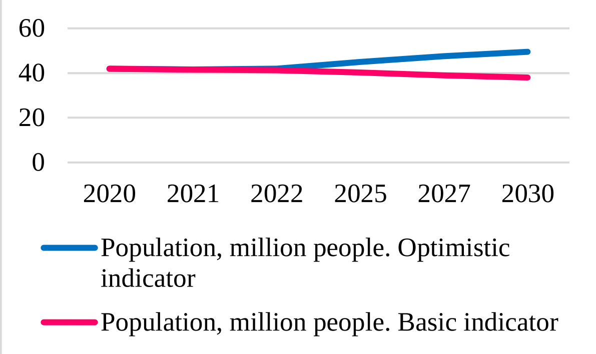

Fig. 4. Results of the population forecast in Ukraine according to the baseline and optimistic scenarios
Source: developed by the author based on the «AGMEMOD-Ukraine» model.

Thus, it is worth concluding that the scenario of development of key performance indicators of agricultural producers in Ukraine according to the «AGMEMOD-Ukraine» model provides for increased yields in all categories of farms, which, in our opinion, includes the import of new varieties and new technologies for plant and crop protection.

CONCLUSIONS

The application of the «AGMEMOD–Ukraine» model allowed conduct forecasting the development indicators of agricultural producers in the context of sustainable rural development, namely: yield, gross harvest and sown areas of major crops, changes in demographic indicators on the basic and optimistic forecast, the results of which allow competitive strategies, the implementation of which will increase the volume of sales, profits, market share, penetration into a new market segment, etc.
We believe that the use of the model «AGMEMOD–Ukraine», which covers the multicriteria measurement of functional components of agricultural producers, provides an opportunity to analyze and predict not only key competitive advantages but also secondary characteristics, which together have a significant impact on solving problems of strategic management of economic efficiency and competitiveness of agricultural enterprises in Ukraine.
According to the results of the study, we have identified the main strategic goals and priority

areas for the development of agricultural producers. In particular, we have grouped and identified the following blocks of strategic goals:

1. Logistics and maintenance unit. The strategic goal here should be the modernization of the material and technical base of enterprises, which is aimed at improving the quality of products and the competitiveness of regional producers. To achieve this goal, the maximum renewal of fixed assets should be identified as a priority area for development.

2. The block of agricultural production, the strategic goals of which, in our opinion, should be to increase crop production; improving the quality of raw materials to ensure its compliance with the technologies of processing enterprises. Increasing the level of productivity and compliance with international quality standards in agricultural production should be a priority to achieve this strategic goal.

3. The infrastructure unit is divided into production, trade, and social infrastructure, each of which has its own strategic objectives. Thus, for the production infrastructure, the strategic goal should be to increase the level of development of storage facilities and warehouses, to store crops in order to sell them at affordable prices.

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WHAT IS THE POTENTIAL FOR COLLECTING AND MARKETING OF NON-TIMBER FOREST PRODUCTS IN HOREZU (VÂLCEA COUNTY)?

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Abstract

Since centuries, the collecting of non-timber forest products (NTFPs) represented one of the main human activities. Initially, the forest products were used in nutrition and traditional medicine, but with the development of society, they became significant sources for different industry branches. Romania has a long history and tradition in harvesting and using NTFPs, hundreds of species being of great interest nowadays. Along the Romanian Carpathians and their nearby territories, several communities are very active in collecting, processing and marketing of NTFPs. The aim of this study was to assess the collecting and marketing potential of NTFPs in Horezu locality (Vâlcea County). The methodology consisted in a questionnaire with 11 questions that was applied in one hundred households across Horezu during April 2020. Collecting of NTFPs represents a current activity, a high share of the inhabitants being interested in obtaining additional income for their family by selling the products either raw or processed. Due to the tourist potential of Horezu, the local people are motivated to collect considerable quantities of certain NTFPs, such as edible mushrooms, wild berries and medicinal plants. The diversification and the intensification of collecting and trading of NTFPs should be done in a sustainable way.

Key words**:** *collecting, forest fruits, Horezu, mushrooms, NTFPs, Vâlcea*

INTRODUCTION

Non-timber forest products (NTFPs), also known as non-wood forest products (NWFPs), complementary products (CPs) or even secondary forest products (SFPs), originate from shrubs, trees or forest stands. These diverse products are of biological origin other than wood and the most common categories consist in: forest fruits, edible mushrooms and truffles, medicinal and aromatic plants, game products, tree saps and resins [2], [4], [12], [23], [24].

Since ancient times, several NTFPs were harvested worldwide and used in a variety of purposes [24], some of them being internationally traded. An example is the perfume (obtained from different plant extract) that is intensively traded between Asia and Europe [1].

Nowadays, even if the medicine or the nutritional behaviors or other human-related activities changed and/or evolved, thanks to their diversity and uses (e.g. medicinal plants, berries, wild foods, edible mushrooms, forage, [2], [6], [17], [18] or even edible insects [16]), NTFPs still remain of great interest for humans, having a significant social and economic contribution to both national and global level [10], [15], [26], [28], especially in developing countries [21], [22], [23], where, for example, in the case of the forest-based communities [19], they represent an important source of income [25], [29].

Even if the great importance of NTFPs is globally recognized, in the vast majority of the European countries, including Romania, forest planning and management is wood-oriented [3]. But, recently, NTFPs gained an increased attention in the so-called circular bioeconomy [20].

In Romania, more than three hundred species (both herbaceous and woody plants and wild animals) play an important role in harvesting and marketing of NTFPs. These include forest fruits, edible mushrooms, medicinal and aromatic plants, game species, or even tree saps [7], [8], [27].

Most of the NTFPs which are harvested at national level have multiple uses in human nutrition, but also in several industrial branches [5].

The aim of this research was to assess the potential for collecting and marketing of non-timber forest products across Horezu locality (Vâlcea County).

MATERIALS AND METHODS

Horezu is situated in the central-western part of Vâlcea County (Map 1), in the center of the Horezu Depression and is bordered on the north by the Căpăţânii Mountains and on the south by Măgura Slătioarei and Negruleşti, Costeşti and Tomşani hills [11].

Horezu is a locality of tourist interest, being famous for its ceramic production and Horezu Monastery - which was included into UNESCO World Heritage Site - being situated in the proximity of Buila-Vânturarița National Park.

Map 1. Location of Horezu on Romania's map
Source: https://ro.wikipedia.org/wiki/Horezu, Accessed on 24th of December 2021 [30].

According to the latest available statistics, in Horezu, there are around 7,200 inhabitants, grouped in 2,300 households [11]. They are involved in several economic activities, including the ones related to forests, several wood and non-wood forest products being harvested and marketed both at local level and national level.

A series of eleven questions aimed at assessing the status and potential of collecting and marketing of non-timber forest products which was also used in a similar study done, in 2018, in Bertea locality (Prahova County) [9] was considered.

Q1. In what way does your family procure non-timber forest products? (a) A family member collects them from the forest; (b) I buy them locally; (c) Other method (please specify which);

Q2. What non-timber forest products do you collect or buy? Specify, please, also the main species for each category, as follow: (a) Medicinal plants; (b) Forest fruits; (c) Edible mushrooms; (d) Other categories (please specify which);

Q3. What amounts of non-timber forest products do you (or your family) collect or buy annually? Specify, please, the quantities for every species/type of non-timber forest products;

Q4. How much do you pay per one kg/piece? Specify, please, prices and quantities for every species/type of non-timber forest products;

Q5. What is the destination of the non-timber forest products that you collected or bought? (a) Family consumption; (b) Income generation through sale; (c) Other purpose (please specify which);

Q6. Taking into account that your answer at Q5 was (b), mention the form in which do you sell the non-timber forest products, for every species/product, where applicable: (a) Fresh, immediately after harvest; (b) Processed/prepared (please specify in what form; e.g. frozen, processed as jams, juices, etc.);

Q7. Which are your favored areas where do you personally harvest non-timber forest products?

Q8. How do you promote these products in Horezu? Could you motivate your answer by presenting a way of promotion?

Q9. What non-timber forest products do you prefer to include in your diet the most? If so, what do you prefer (examples)? (a) Mushrooms; (b) Forest fruits; (c) Medicinal and aromatic herbs;

Q10. Do you consider that a shop where consumers may buy these products is needed in Horezu? (Yes or No).

Q11. Do you consider that a close cooperation between the retailing sector and local harvesters of NTFPs could be helpful for the development of this business in Horezu? (Yes or No).

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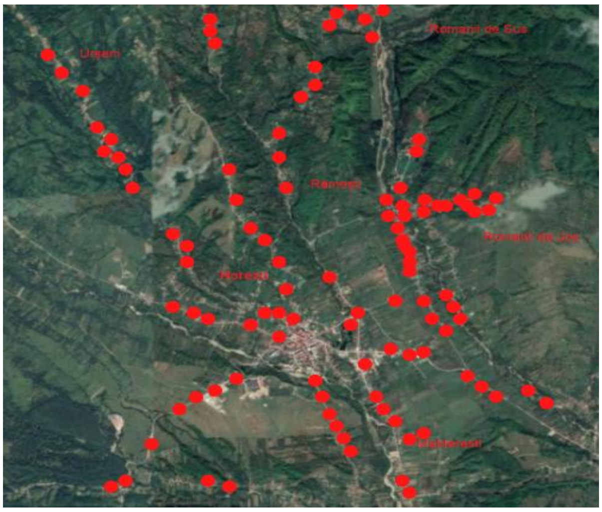
The questionnaire was applied in April 2020 and, by taking into account the number of the households in Horezu, 100 households were included into the study, in order to achieve a probability of 95%, with a sampling error of 10%.

The sampling was calculated by the aid of the instrument available on INFOmass website, which is one of the main companies specialized in the field of opinion polls and market studies in Romania [14].

The households were chosen along the main streets of Horezu, by taking into account an uniform distribution as possible (*i.e.* by choosing one household out of consecutive twenty (Map 2, red dots).



Map 2. Distribution of the questioned households along the main streets in Horezu
Source: Google Maps, https://www.google.com/maps, Accessed on 24th of December 2021 [13].

The answers were centralized by the aid of Microsoft Office Excel, 2016 edition.

RESULTS AND DISCUSSIONS

One hundred households were considered and the answers of the respondents were centralized in an Excel file.

As regards question no. 1, two thirds (*i.e.* 67%) of the interviewees indicated that the collecting of non-timber forest products was done by a family member, 22% reported that they procured NTFPs locally, while only a few (*i.e.* 11%) bought them from the market (Figure 1).

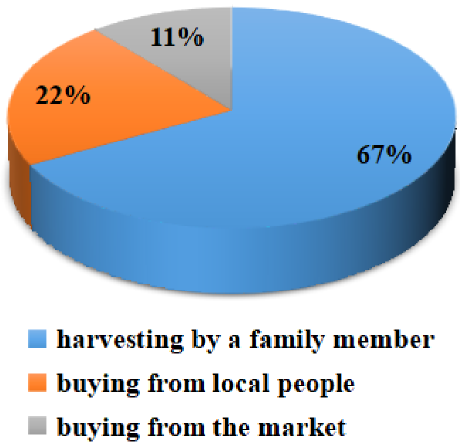


Fig. 1. The main ways of procuring NTFPs in Horezu
Source: original data.

The main types of NTFPs that were harvested and/or bought by the local people consisted in forest fruits, especially berries of European blackberry (*Rubus fruticosus* L.), European red raspberry (*Rubus idaeus* L.), dog rose (*Rosa canina* L.), European blueberry (*Vaccinium myrtillus* L.), edible mushrooms, especially penny bun (*Boletus edulis* Bull.), oyster fungus [*Pleurotus ostreatus* (Jacq.) P.Kumm.], and medicinal plants, mainly flowers of black elder (*Sambucus nigra* L.), common hawthorn (*Crataegus monogyna* Jacq.), common yarrow (*Achillea millefolium* L.) and common nettle (*Urtica dioica* L.). Figure 2 gives an example of short-term storing of the berries of dog rose.

Fig. 2. Short-term storing of berries of dog rose
Source: original.

Regarding the annual collected quantities, the highest average quantities per household were recorded in the case of edible mushrooms (*i.e.* 103.5 kg), followed by forest fruits (*i.e.* 43.3 kg) and medicinal plants (*i.e.* 1.5 kg), respectively (Figure 3).
These values are significant higher than the ones reported in Bertea locality (Prahova County), especially in the case of the edible mushrooms, the harvested quantities in Horezu being twenty times higher than the ones reported in Bertea locality [9]. This could be interpreted by a higher demand/interest, on one hand, or by abundant quantities in Horezu in comparison with Bertea, on another hand.

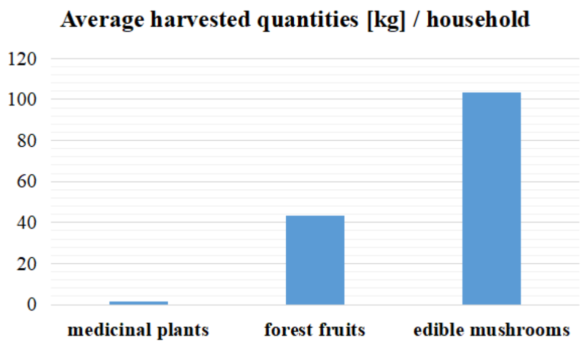


Fig. 3. Average harvested quantities [kg] of NTFPs per household in Horezu
Source: original data.

The highest average prices per kilogram (question no. 4) were recorded for edible mushrooms (18 RON, *i.e.* 3.6 Euro), followed by forest fruits (11 RON, *i.e.* 2.2 Euro) and medicinal plants (7 RON, *i.e.* 1.4 Euro), respectively. These prices were 10-30% higher than the ones reported in Bertea locality (Prahova County) [9]. The higher prices could be explained by the demand of the tourists who are visiting Horezu and who can offer higher prices.
As regards question no. 5, 38% of the respondents declared that they are collecting the NTFPs for their family consumption, while the majority of the people from Horezu (62%) were interested to sale the harvested non-timber forest products in order to obtain additional income (Figure 4), by selling most of the products to the visitors, especially during local events or festivals.

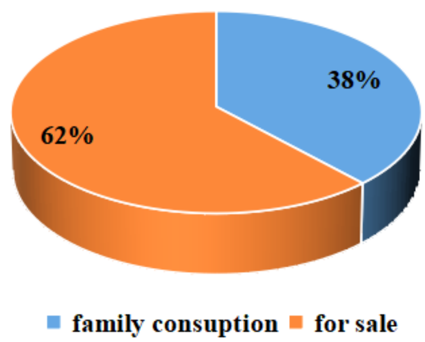


Fig. 4. Purpose for harvesting/buying NTFPs in Horezu
Source: original data.

These people are usually selling the products as juices, jams and syrups. By selling processed products, not raw, the people from Horezu are obtaining higher revenues. These results are different from the ones reported in Bertea locality, where only one person was interested in selling the harvested NTFPs in order to gain additional income [9].
Căpățâni Mountains, Groșet, Barcaciu, Neag's Valley, Băngi's Valley, Cocora and Poiana cu fragi represented the most common places for collecting of non-timber forest products across Horezu Administrative Unit (question no. 7).
82% of the respondents said that the marketing of NTFPs in Horezu should be promoted, during local celebrations and festivals or by creating a storing place with a shop dedicated to the visitors.
Moreover, the vast majority of the respondents declared that they are taking seriously into account to invest in the online marketing (via social media networks and specialized websites), by promoting secondary products derived from NTFPs, such as jams, juices, syrups, and other products (*i.e.* by-products) that could be stored for several months or even for several years under controlled conditions.
Only a low percentage of the interviewees (*i.e.* 18%) considered that the marketing of non-timber forest products should not be intensively promoted (Figure 5).

Fig. 5. Share of respondents' opinion regarding the promoting of marketing of NTFPs in Horezu
Source: original data.

The vast majority of the respondents (89%) were consuming very often the harvested NTFPs, either in raw or processed form (Figure 6). In general, the mushrooms are eaten shortly after harvesting, while the berries are mainly consumed as juices or jams during the cold session.

Almost all interviewees (*i.e.* 86%) considered that a market in Horezu would be more than needed (answers to question no. 10).

Three quarters of the respondents said that a collaboration with the markets existing in Horezu would generate benefits for all shareholders, including, inter alia, the harvesters and the merchants (answers to question no. 11).

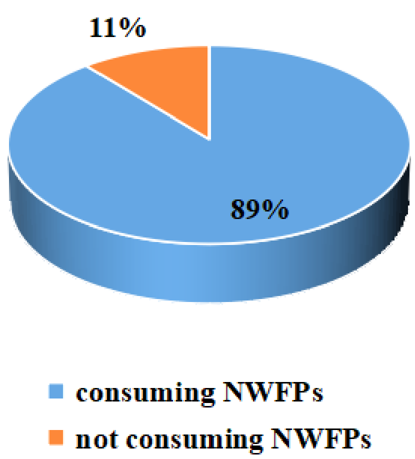


Fig. 6. Share of respondents' opinion regarding the consuming of NWFPs in Horezu
Source: original data.

CONCLUSIONS

In Horezu, harvesting of non-timber forest products represents a current and intense activity, a high share of the inhabitants being interested in obtaining additional income for their family by selling the products either raw or processed, mainly to the tourists during local events.

The tourist potential of Horezu is encouraging the local people to harvest considerable quantities of certain non-timber forest products, such as edible mushrooms, berries, aromatic and medicinal plants. In this context, a diversification and an intensification of product marketing, including the online component, are more than welcome. These activities should be done in a sustainable way, by engaging specialists with different backgrounds, such as, inter alia, forestry, biology, management & marketing and sustainable development.

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QUALITATIVE ASSESSMENT OF THE PERFORMANCE OF LPA MANAGEMENT IN THE REPUBLIC OF MOLDOVA WITH A VIEW TO BRINGING INTERNAL RESERVES INTO LINE WITH THE IMPERATIVES OF RURAL DEVELOPMENT

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Abstract

Lately, the academic world is increasingly concerned with improving the performance of LPA management, which would certainly contribute to improving the quality of life in rural areas. However, in order to improve the quality of an indicator, we first need to know its current level. This article aims to identify and apply in practice a series of qualitative indicators designed to assess the current level of LPA management performance with a view to identifying and aligning internal reserves with rural imperatives. At the same time, the article proposes that this evaluation should be carried out by the final beneficiaries of public services, i.e., directly by the inhabitants of rural localities - this will undoubtedly increase the credibility of the evaluation.

Key words**:** *evaluation, management, performance, public administration, services*

INTRODUCTION

The trends of modernization of LPA management imposed by major changes in society and new approaches to public management require public authorities to implement performance measurement procedures in order to ensure continuous performance improvement. „Numerous efforts have been and are still being made to achieve performance in the public sector in order to improve the quality of services provided to citizens” [9, p. 139], ensure a healthy and safe living environment and the sustainable development of administrative-territorial units. But many of these efforts have not been successful.

In the Republic of Moldova, public administration at all levels, as stated by researcher Dinu Manole in one of his works „shows relatively low performance: it holds the first places in the size of the underground economy, infant mortality, population exodus and poverty rate, these indicators being directly correlated with the quality of public policies” [6, p. 112]. We cannot lay all the blame on the poor quality of public policies, but we have to admit that in the Republic of Moldova the process of public administration reform is a difficult and lengthy one.

The question arises as to why the process of public administration reform in the Republic of Moldova is going so slowly or, better said, is stalling? What are the barriers to the implementation of the Public Administration Reform Strategy 2016-2020? We risk assuming that, in addition to the quality of public policies, the implementation of the Strategy has also met with resistance from the conservative mentality of the civil servant who is still „marked by old traditions, leading to a lack of flexibility and imagination. The literature is difficult to access, and analyses in the field are still timid. Even if more advanced technological facilities exist at some levels, „the knowledge and expertise needed for effective use is often lacking” [1, p. 230]. Legislation in the field often finds administrative staff completely unprepared and unable to implement it effectively, and there is a lack of effort at managerial level to introduce new thinking into decision-making" [3, p. 141-142].

MATERIALS AND METHODS

The purpose of this research is to evaluate the performance of the LPA management, especially the attitudes of the final beneficiaries of the services provided by the LPA – the rural population. For this purpose, quantitative research was used to describe the behavior of a population in relation to the subject studied, using methods of quantification and statistical analysis in interpreting the results. Quantitative research can also be described as „a survey of results, based on representative samples, a numerical evaluation of variables and methods of statistical analysis, and the findings obtained can be used to recommend a final course of action" [7]. The assessment of the employee's performance is done by filling in an evaluation sheet in which the employee's skills and competences are rated with points from 1 to 4 by the superiors according to the following criteria:

- knowledge and experience;
- complexity, creativity and diversity of activities;
- conceptualization and decision-making responsibility;
- leadership, coordination and supervision;
- communication;
- volume, quality and efficiency of tasks performed.

At the end, the assessment average is calculated and the assessment grade is determined on the basis of this accumulated average score. Please note that the maximum bonus of 10% is awarded for a „very good" grade (final score 3.51-4.00 points) and a slightly lower bonus, set by the institution, for a „good" grade (final score 2.51-3.50 points). The other two grades, i.e., „satisfactory" (final score 1.51-2.50 points) and „unsatisfactory" (final score 1.00-1.50 points) do not imply performance and, for these reasons, do not provide for any bonus. The period of application of this performance appraisal procedure for public sector employees has demonstrated the ineffectiveness of this method, in that all employees are rated „very good" by their superiors in order not to deprive them of that „performance bonus" and not to create a negative image in their eyes. Here we must mention that we do not consider the methodology irrelevant, we just consider the evaluation procedure subjective, which leads to the inefficiency of the procedure. However, the performance of LPA management is not limited to the performance of human resources, and their subjective evaluation does not contribute to the development of rural areas. In this context, taking into account the tasks and mission of LPAs to promote the general interests of the inhabitants of an administrative-territorial unit, we believe that the performance of LPA management should be evaluated by the beneficiaries of the services provided by them, i.e., the inhabitants of the administrative-territorial unit. This will ensure better credibility and objectivity of the evaluation results, increase the trust of the population in local elected officials and strengthen the transparency of decision-making. In order to assess the performance of the LPA management in order to identify its weaknesses, we have „resorted to the actual questionnaire of the inhabitants of rural localities in the Republic of Moldova" [11, p. 73]. The questionnaire was designed in digital format, using the Google Forms application. It should be noted that initially the questionnaire was designed for a proportionally stratified sample of 15 people from 10 rural localities, divided into 3 age categories as follows: 5 young people aged 18-25 years, 5 adults aged 26-60 years and 5 elderly people over 61 years. But in the process of distributing the questionnaire things got out of hand, as the people involved in the questionnaire, showing an enormous desire to help and support, randomly forwarded the questionnaire to relatives and acquaintances in several rural localities. Thus, we have to admit that the questionnaire was applied to a simple random sample of 250 respondents of different ages, all of whom met the basic sampling criterion of being inhabitants of rural localities in the Republic of Moldova.

The questionnaire contains 10 questions, the first question being an open-ended question, with the aim of specifying the rural locality, the other questions being closed questions, both single-answer and attitudinal scales. When establishing the attitudinal scale, semantic differentials were chosen, based on the legally prescribed ratings („Very good", „Good", „Satisfactory", „Unsatisfactory"), to ensure comparability of the data and Linkert's scale („Total agreement", „Partial agreement", „Partial disagreement", „Total dis-agreement").

RESULTS AND DISCUSSIONS

The Republic of Moldova has taken „the first steps towards the implementation of performance management in the public sector" [8, p. 105] with the adoption of the Regulation on the evaluation of the professional performance of civil servants, annex no. 8 to the GD on the implementation of the provisions of the Law on civil service and the status of civil servants [4]. Subsequently, the concept of performance bonus was introduced, with the aim of motivating and stimulating staff in budgetary institutions and directing them towards continuous improvement of their individual performance. The evaluation criteria and the method of establishing the final score were described in the Framework Regulation on the method of establishing the performance bonus for staff in budgetary units approved by the Government Decision for the implementation of the provisions of the Law on the Unified Salary System [5]. The first question in the questionnaire asked about the level of development of the respondent's rural locality (Fig. 1) in order to subsequently determine the impact of LPA management performance on it. Thus, of the 250 respondents, the majority say they live in a developed municipality - 36.4% and fairly developed - 35.2%. 24.4% of respondents said they live in a poorly developed municipality, followed by those who say they live in a highly developed municipality - 3.6%.

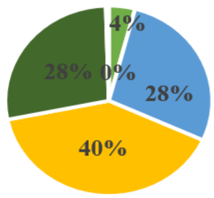

Fig. 1. Assessment of the level of development of rural localities in the Republic of Moldova
Source: Own determination.

From the sample that participated in the questionnaires, only one person claims to live in a rural locality that is below the level of development. Next, we aim to quantify the responses by applying the score from 1 to 4 and determining the final score.

Table 1. Determination of the final score to assess the level of development of rural areas in the Republic of Moldova

Options offered by the attitudinal scale	Number of respon dents	Option score	Total accumula ted score
Strongly developed	9	4	36
Developed	91	3	273
Sufficiently developed	88	2	176
Poorly developed	61	1	61
Below the limit of existence	1	-1	-1
Total:	**250**	*	**545**
Final score: 2,18 points		**Qualifier: Satisfactory**	

Source: Own calculation.

Interestingly, despite a significant share of options for developed and highly developed, the rural area still gets a „satisfactory" rating. The next question comes to give a rating to the contribution of the LPAs to the development of the locality; thus, the contribution of the municipalities was appreciated in part with the rating „Good" - 140 answers or 56% and satisfactory - 62 persons or 24.8% (Fig. 2).
Thus, applying the same procedure for determining the final score, we establish that the contribution of LPAs to the development of rural localities in the Republic of Moldova

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is appreciated by community members with the rating „Good", final score 2.82 points.

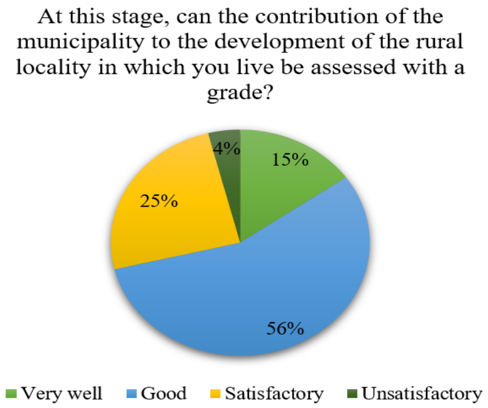

Fig. 2. Appreciating the contribution of LPAs to the development of rural localities
Source: Own calculation.

This result leaves room for controversy in the context that the level of development of rural localities is satisfactory and the contribution of the municipality in this respect is appreciated as good. This speaks of the fact that the population of rural localities has not definitively lost confidence in local elected representatives and is aware of the considerable contribution they make to the development of rural localities. The series continues with the question, which aims to assess the performance of LPA management in rural localities at the perception level, without applying specific evaluation criteria. The authors included this question in the questionnaire with the aim of establishing the subjectivity of the assessment based on mere perception (Fig. 3).

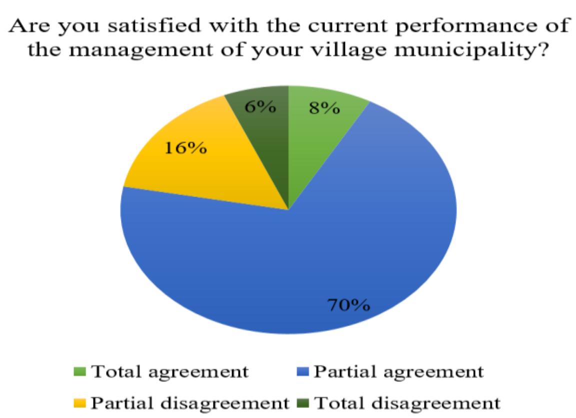

Fig. 3. Assessing community perceptions of LPA management performance
Source: Own calculation.

Analyzing the responses, we find that the vast majority of respondents are partially satisfied with the performance of the LPA, with the option „Partial agreement" being selected by 156 respondents (62.4%). We note that out of the total number of respondents 14 respondents are not satisfied with the performance of LPA management, which is 4 more than the number of respondents who said that the contribution of LPA to rural development so far has been unsatisfactory. Under these circumstances, we find that at the perception level, the performance of LPA management is rated as „Good" (final score 2.93 points) by the community as the final beneficiary of public services.
The survey of rural community members continued with a series of single-answer matrix questions, formulated taking into account the LPA management performance assessment criteria shown in Fig. 4.

Fig. 4. Qualitative criteria for assessing LPA management performance
Source: Own calculation.

In order to assess the quality of services provided by rural municipalities, the authors went along three dimensions, namely:

1. Quality of municipal services.
2. Quality of social services.
3. Quality of administrative services.

In assessing the quality of municipal services, the types of municipal services assessed were sewerage, gas, water, sanitation, public transport, street lighting, road maintenance and green space management. It should be noted that this criterion scored the lowest, with an average of 2.66 points, which still allows it to be rated „good" (Table 2). Analyzing the accumulated scores by types of communal services provided to the inhabitants, we find that the worst quality is provided by the sewerage services, which accumulated a score of 2.32 points, giving it the rating „satisfactory" - this being the only criterion rated by the community members with this rating. The quality of sanitation scored low, with a score of 2.54 points, and the quality of road maintenance scored 2.58 points. The other criteria such as gas supply, water supply, public transport and management of green spaces scored between 2.69 and 2.71. Here we would like to mention that street lighting was rated by the rural community with the highest score - 3.02 points, a score which however did not allow it to be rated „very good". We can assume that thanks to the projects implemented for this purpose, the villages of the Republic of Moldova can boast of a well-developed street lighting system, which can even be considered as performing, given that it has accumulated the highest score, and performance, in fact, implies a clearly superior result compared to another score (Table 2).

Table 2. Final community score for the quality of municipal services in rural areas

No.	Intermediate evaluation criteria	Score
1.	Sewerage	2.32
2.	Gasification	2.70
3.	Water	2.71
4.	Sanitation	2.54
5.	Public transport	2.69
6.	Street lighting	3.02
7.	Road maintenance	2.58
8.	Green space management	2.70
Final average score:		**2.66**

Source: Own calculation.

However, it is important to note that the quality of municipal services is an important indicator when assessing the level of sustainable development, as it directly influences the quality of life in rural areas, which is why it is necessary for local public authorities to pay greater attention to the capacity and quality of municipal services provided in order to improve it. In order to assess the quality of social services in rural localities, ten priority areas were established, including education, health, culture, social services, etc. Analyzing the quality of social services (Table 3), vulnerabilities were established in the areas of activity of community development centers, such as museums, cultural centers (score 2.52 points), social protection services (2.63 points) and social welfare services (score 2.67). The score for these services falls into the „good" category, but compared to the other results they are the worst, so municipalities have some work to do on these criteria. It is indeed sad to see these results, especially for the reason that it is the community development centers that are the promoters of our age-old values and traditions, and the elderly, the people who know our traditions and customs best, do not receive sufficient support to enable them to secure a decent old age. Less satisfied is the rural population and the greening of localities (score 2.60 points), a criterion which, in the context of promoting sustainable rural development, should be improved. Also, in this context, there are reservations about the enhancement of historical monuments, parks and nature reserves (score 2.69), which could be achieved through community involvement, given that the community gives the quality of youth-oriented services and sport a score of 2.70 points. Involving young people in actions to green the countryside could achieve performance on two criteria through a single action. In the context of the Covid-19 pandemic, a pandemic that has focused our attention on making health services more efficient, the score of 2.81 points for these services is explainable. A reasonably good score of 2.85 points is also attributed to cultural events organized by town halls, such as festivals, celebrations etc.

Table 3. The final score given by the community to the quality of social services in the localities

Intermediate evaluation criteria	Score
Early education	3.28
Education (schools, high schools)	3.12
Youth and sport	2.70
Culture (organisation of festivals, celebrations, promotion of national values)	2.85
Activity of community development centres (museums, houses of culture)	2.52
Health	2.81
Social services for the protection of children, the disabled, the elderly, etc.	2.63
Social welfare services for the elderly, disabled people	2.67
Enhancement of historical monuments, parks, nature reserves	2.69
Greening of the locality	2.60
Final average score:	**2.79**

Source: Own calculation.

One thing we are pleased about is the score for education (3.28 for early education and 3.12 for secondary education). The educational services still have some way to go to reach the „very good" rating, but the fact that they scored highest compared to the quality of other social services makes us believe that schooling in the Republic of Moldova still has a future. Discussing the value of education in the lives of rural people, we cannot overlook the statistics presented in Table 3 of this paper which show the monthly expenditure of a rural person on training and education compared to expenditure on drinking and cigarettes. Recall that the ratio was 1 to 3.5 in favor of drinking and cigarettes. Involuntarily the question arises whether the quality of education is really as assessed by the rural population or was this criterion assessed according to its valence in the list of priorities? Administrative services were assessed on the basis of the quality, timeliness and price of issuing various permits and how the LPAs manage emergencies (Table 4). The most appreciated was the efficiency of issuing certificates, permits by LPAs, score 2.92 points, as well as the way emergency management is handled, rated with a score of 2.84 points, presumably as a result of the Covid-19 pandemic.

Table 4. Final community score for quality of administrative services

No.	Intermediate evaluation criteria	Score
1.	Operationality of issuing certificates, authorizations	2.92
2.	Cost of issuing certificates, authorizations	2.81
3.	Method of charging the cost of issuing certificates, authorizations	2.80
4.	Use of information technology to facilitate the issuing of documents	2.80
5.	Management of emergency situations	2.84
Final average score:		**2.84**

Source: Own calculation.

The population is even satisfied to a large extent with the costs charged for issuing these documents (score 2.81 points), but the level of satisfaction decreases slightly with regard to the way costs are charged and the use of information technology (score 2.8 points). We can assume that in order to achieve performance and increase consumer satisfaction, both the way of requesting the document and the cost collection should be digitized, in this context it would be desirable either to have a bank terminal to make payments via bank card, without having to go to one of the commercial banks, or to implement a way of paying for these services via internet-banking applications.

The quality of human resources was again rated „good" by community members, with a final score of 2.80 points. It should be noted that among the qualities rated highest among the employees of the town hall and local councilors were knowledge and experience (score 3.00) and communication skills (score 2.95 points). There is still some work to be done on complexity, creativity and diversity (score 2.82), but it should be noted that sometimes mayors encounter intermediate barriers on their way to performance, which they cannot avoid (Table 5).

Table 5. Final score attributed by the community to the quality of human resources in LPA level I

No.	Intermediate evaluation criteria	Score
1.	Knowledge and experience	3.00
2.	Complexity, creativity and diversity of activities	2.82
3.	Conceptualization and responsibility, including decision-making	2.86
4.	Leadership, coordination and supervision	2.88
5.	Communication	2.95
6.	Volume, quality and efficiency of tasks performed	2.87
Final average score:		**2.90**

Source: Own calculation.

It should be noted here that I was right in saying that there is a small degree of subjectivity in the assessment of employees by employers on legal principles. As far as we can see, the community assesses the quality of human resources with a „good" rating, while employers, however, give a good proportion of their employees a „very good" rating. Further analyzing the criterion „financial capacity", we find that rural residents were consistent in giving scores, thus both for the quality of management of public funds and for the capacity to generate income and attract funds a score of 2.96 points was given, the maximum score recorded for the criteria evaluated by the questionnaire. In this chapter we note that the population in rural areas showed generosity in overestimating, to some extent, especially the capacity of municipalities to generate revenue, or this was caused by a lack of knowledge in the field or the fact that much financial-accounting information is not publishable. The same is noted in the assessment of the quality of strategic planning which the rural community rated with a score of 2.86 points. This can be explained by a lack of managerial knowledge, many people, especially the elderly, probably do not even know what an operational or strategic plan entails and what its usefulness is. Again, we consider the score for this criterion to be overestimated for the simple reason that a large number of municipalities in rural areas do not draw up strategic development plans, limiting themselves to operational plans. We would point out in this context that it would be preferable for the actions planned by the town council to be coordinated with the community through joint meetings, and for local development plans to be made public and accessible to the community at any time, as this is a prerequisite for ensuring transparency in their work. If we talk about transparency of activity, the community rates it with a score of 2.88 points, and for community involvement in the decision-making process it gives a score of 2.71 points. This is a rather high score, but compared to other results presented in the LPA management performance evaluation sheet by the inhabitants of the administrative-territorial unit we consider its level to be sufficient, especially considering that 68.8% of the respondents (Fig. 5) participate for the first time in the LPA management performance evaluation, and 25.6% - rarely. We can assume that for the rural community it is more comfortable and easier not to be involved in administrative affairs, thus the current state of affairs is described as transparent. In fact, community perceptions depend to a large extent on their expectations, considering the evaluation of the quality of communal services, services that affect them directly and from which community expectations are higher than the actual level of these services, the community was less tolerant, giving this evaluation criterion a lower score.

We believe, however, that community members are the right people to evaluate the performance of LPAs because they are the people who actually benefit from the services provided by the LPA, they are the people who know from the inside the problems of the rural locality where they live, they are the ones who can contribute to the diversification of economic activities in the locality, they are the ones who know the traditions and customs of the locality and can continuously promote them. For these reasons, the first level LPAs should identify levers to involve the community in administrative activities, making them understand that the quality of decisions taken by local elected representatives has a direct impact on the living standards of the population in the administrative-territorial unit.

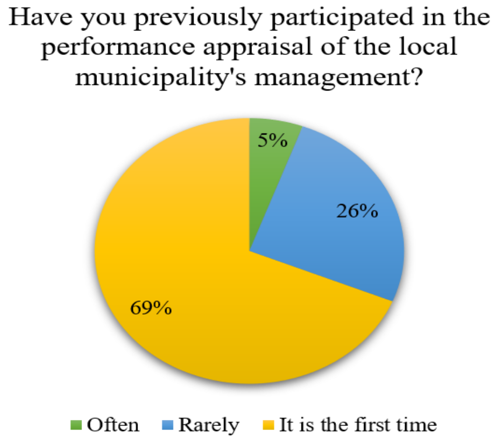

Fig. 5. Assess the degree of community involvement in LPA management performance assessment activities
Source: Own calculation.

Determining, however, the final average score given by the local community to the performance of LPA management, we find that it is rated on average for all five criteria assessed with a score of 2.86 points, a score that gives LPA management performance a „good” rating. But here we come back to performance? But does performance only mean „good”? Performance implies „a great result”, and this „good” means something common, something ordinary and nothing „special”. At international level, the quality of a country's public services is related to three things: „the level of public confidence in public administration, the ease with which economic activities can be carried out, and the level of well-being of society" [10, p. 123]. Linking the quality of socio-economic life in rural localities analyzed above to the quality of public services, we are forced to note that local public authorities have a significant reserve in the direction of increasing the quality of LPA management in order to ensure economic prosperity, social cohesion and well-being of the population in rural localities.

CONCLUSIONS

The pandemic and unfavorable climatic conditions have demonstrated once again that the rural economy, based on agriculture and the processing of agricultural and non-agricultural products, is insufficient and in continuous decline, resulting in a marked degree of underdevelopment and a significant gap with the urban environment and the European countryside. For the Republic of Moldova, rural development is currently a priority, which aims to implement an integrated policy to harness all types of potential in rural areas: livestock farming, agriculture, processing of agricultural products, crafts, rural tourism, agricultural tourism, traditions etc. Taking into account the tasks and „mission of LPAs to promote the general interests of the inhabitants of an administrative-territorial unit" [2, p. 46], we believe that the performance of LPA management should be evaluated by the beneficiaries of the services provided by them, i.e. by the inhabitants of the administrative-territorial unit according to the following criteria: quality of strategic planning, capacity and quality of services provided, financial capacity, permeability of community involvement and transparency of the decision-making process, and, of course, quality of human resources. The performance of LPA management at level I was rated „good" by the population in rural areas, with the LPA management scoring low on the criteria related to the assessment of the quality of communal services (2.66 points), the activities of community development centers (2.52 points), the quality of social services (2.63 points) and the criterion related to community involvement in decision-making (2.71 points). Internationally, the quality of a country's public services correlates with the level of trust people have in public administration, the ease with which economic activities can be carried out, and the level of well-being of society. Linking the quality of socio-economic life in rural localities in the Republic of Moldova to the quality of public services (the criterion that scored the lowest in the assessment - 2.66 points), we have to conclude that local public authorities have a significant reserve in the direction of increasing the quality of LPA management to ensure economic prosperity, social cohesion and well-being of the population in rural localities.

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DISTRIBUTION OF COUPLED SUPPORT FOR BEEF CATTLE IN ROMANIA – AN ANALYSIS IN THE MOUNTAIN AREA

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Abstract

In the period 2015-2019, the beef cattle farming sector (beef cows, beef bulls, crossbred cows with beef breeds, young male and female beef cattle and crossbreeds of young male or female young cattle with beef breeds) benefited from a total amount of 52 million euros as VCS, which represented 7.8% of the total value of coupled support for the livestock sector. The increase in the number of beef cattle, from 8 thousand heads in 2015 to 53 thousand heads in 2019, led to the decrease of the VCS value/head from 1312 euros/head in 2015 to 237.4 euros/head in the year 2019. The comparative analysis (2019 versus 2016) of the coupled support distribution by farm size classes reveals a relatively similar situation. Most beef cattle approved for coupled support, both in 2016 and in 2019, are found on the farms from the size class 101-250 heads, 31.1% and 33.5% respectively, representing 7.6% and 5.8% of beneficiaries.

Key words: *coupled support, beef cattle, mountain area*

INTRODUCTION

Agriculture is the main economic activity in the rural areas in Romania and in most European countries.

The mountain areas are considered disadvantaged areas, due to the limited possibilities of agricultural land use, altitude and weather conditions, slopes, geological substrate and high costs of farming works, due to living conditions, infrastructure, business environment, poor access to education and healthcare services [13].

In EUROSTAT, a mountain area is defined at NUTS 3 (county) level as the region where:

-more than 50% of the surface is covered by mountain areas;

-more than 50% of the region's population lives in topographic mountaineous areas;

-more than 50% of the surface is covered by topographic mountaineous areas and more than 50% of the region's population is living in these mountaineous areas.

In many European countries, in the mountain areas, agricultural delimitation based on topographic criteria or soil characteristics has been progressively used as a spatial context for rural or regional development [4].

According to this definition, in Romania there are 16 NUTS 3 (counties) mountain regions: Covasna, Hunedoara, Maramureș, Brașov, Alba, Bistrița-Năsăud, Caraș-Severin, Harghita, Sibiu, Suceava, Cluj, Prahova, Neamț, Vrancea, Vâlcea, Bacău [6].

In the EU member states, the share of mountain regions (less favoured areas) in total area ranges from: *dominant* (over 60% Slovenia and Austria), *important* (40-50% Spain, Italy, Slovakia, Greece, Bulgaria and Portugal), *significant* (20-30% France, Romania, Czech Republic and Cyprus) to *marginal* (less than 3% Germany and Poland) [14].

According to the European Commission data, in Romania's mountain area, we can find 19.7% of the utilized agricultural area, 18.5% of the labour force directly involved in agriculture, 17.6% of the total number of farmers and 19.5% of livestock herds [14].

According to the same data, the average farm size in the mountain area is 3.9 ha (the third smallest of the EU member states) [15]. The small-sized farms are vulnerable, and many of them have limited prospects of improving their economic performance and getting oriented to the market. These farms generally operate with poor technical equipment and apply traditional farming practices, with low economic efficiency, facing difficulties in the process of adapting to new technologies [15].

In CAP 2014-2020, the EU member states had the possibility to allocate part of the direct payments package (up to 13%+2%) to the ***coupled support scheme*** under Article 68 of the previous CAP 2007-2013 [12].

According to Article 52 (paragraph 3) of (EU) Regulation 1307/2103 on direct payments, the member states can provide coupled support to those sectors or regions where certain farming practices or certain agricultural sectors that are particularly important, out of economic, social or environmental reasons, are facing certain difficulties [10].

Article 52 paragraph (5) provides that coupled support can be granted only to the extent necessary to create an incentive to maintain current levels of production in the sectors or regions concerned; Article 52 paragraph (6) provides that coupled support takes the form of an annual payment and is granted within defined quantitative limits, based on fixed areas and productions or on a fixed number of animals [10].

The most important modification was the removal of the constraint in Article 52 paragraph (5) of the Regulation on direct payments, and Article 52 paragraph (6) has been amended as follows: *coupled support is a production limitation scheme that takes the form of an annual payment based on fixed areas and productions or on a fixed number of animals and which respects the financial ceilings to be set by member states for each measure and notified to the Commission* [10].

Member states' options to implement VCS vary widely, both in terms of supported sectors/products and of the level of support. Member states have repeatedly revised their budgets for coupled support and types of products, but they made only some minor adjustments. All member states, except for Germany, have opted for VCS, using on average 10% of the EU budget for direct payments [12].

Thus, since 2015, nine member states allocated maximum 8% to this scheme (Cyprus, Denmark, Estonia, Greece, Ireland, Luxemburg, the Netherlands, Austria, United Kingdom), three member states allocated more than 8%, but less than 13 (+2)% (Spain, Italy, Romania), eleven member states allocated a maximum percentage of 13 (+2)% (Bulgaria, Czech Republic, France, Croatia, Hungary, Lithuania, Latvia, Poland, Sweden, Slovakia, Slovenia), and three member states (Belgium, Finland, Portugal) needed the approval by the Commission, given their decision to allocate more than 13% (+ 2%) Voluntary Coupled Support (VCS) [3].

More than 70% of the total amount for coupled support was allocated to the three livestock farming sectors (40% for beef, 20% for dairy products and about 12% for sheep and goat meat) [3]. At the same time, member states decided to allocate important amounts for protein crops, fruit and vegetables, sugar beet, rice, grain legumes, potatoes, nuts, hops, hemp, oilseeds, silkworms [3]. In the year 2021, after budget revision, the three sectors (beef, dairy products, sheep and goats) have remained the largest beneficiaries of coupled support, with 73% of the total amount allocated to coupled support [5].

In terms of environmental impact, there are studies that show that coupled support can cause environmentally harmful changes (increase of greenhouse gas emissions), by stimulating overpopulation and surplus production in the livestock sectors, except for the situation in which coupled support contributed to raising animals under extensive system, to maintaining a high natural value farming system [8]. There are also studies that mention that animal production is the main contributor to environment pollution in EU agriculture and consequently it has the greatest potential to reduce greenhouse gas emissions [9]. In this sense, it is worth noting that among the reform proposals of the European Commission for the period 2021-2027, published in June 2018, the implementation of an eco-scheme is mentioned, mandatory to implement by member states under Pillar 1, yet voluntary for farmers, which represents a significant

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innovation in the current green architecture of the Common Agricultural Policy [11].

MATERIALS AND METHODS

The methodology approached for the elaboration of the study on the distribution of coupled support in the period 2015-2019, by size classes of cattle farms in Romania's mountain area, includes methods that combine the consultation of a large number of studies (papers and articles, scientific treatises and other scientific materials published in the country and abroad) and the analysis and processing of data from national databases (Agency for Payment and Intervention in Agriculture-APIA, Ministry of Agriculture and Rural Development-MARD, NAational Institute of Statistics-NIS), Community databases (Eurostat) or international databases (FAOSTAT) as well as from specialized websites. The consultation of literature in this domain is the method used for the preliminary analysis of the European context, highlighting the most relevant results, which could be used as benchmarks to deepen the context analysis at national level. The analysis and processing of statistical data on the distribution of coupled support for beef cattle in Romania, in the period 2015-2019, made it possible to calculate certain indicators, namely: total amount authorized for payment in the sector, total number of animals determined for payment, total number of farmers authorized for payment, value of headage payments, number of heads/number of eligible farms, by size classes, for coupled support at national level, share of eligible farms and animals for coupled support in the mountain area, in total eligible farms and animals at national level.

RESULTS AND DISCUSSIONS

Starting with 2015, in order to increase productivity, maintain production and reduce the risk of abandoning the activities in certain sectors, the CAP reform introduced the ***"coupled support",*** as one of the payment schemes under Pillar I [7]. The financial support granted to the livestock sector in Romania, through this payment scheme, aimed both to cover the expenses incurred for production and to increase the efficiency of agricultural production, to increase production quality and ensure a competitive level on the market [1]. The eligibility criteria for ***the coupled support to the livestock sector (VCS)*** for the cattle sector in Romania are presented in Box 1 [2].

Table 1. The eligibility criteria for the coupled support to the livestock sector (VCS) for the cattle sector in Romania - Box 1

Voluntary coupled support (VCS) for beef cattle
The Order of the Ministry of Agriculture and Rural Development no. 619/2015 specifies that the voluntary coupled support (VCS) for purebred and crossbred cattle in Romania is granted to active farmers who comply with the following conditions: *-have minimum 10 to maximum 250 beef cattle heads raised on holdings with ANSVSA code, consisting of:* *-beef cows; and/or* *-crossbred cows with beef cow breeds; and/or* *-young male and/or female beef cattle; and/or* *-crossbreeds of young male or female young cattle with beef breeds; and/or* *-beef bulls* *-the animals must be identified and registered in the National Register of Holdings* *-all animals from the beef cattle breeds and their crossbreeds for which VCS is requested must be registered in the Genealogical Breed Register* *The beef cattle breeds benefitting from coupled support are the following: Aberdeen Angus, Limousine, Charolaise, Galloway, Highland, Aubrac, Wagyu, Romagnola, Bălțata Românească (raised and exploited for its meat), Hereford, Blonde d`Aquitaine, Salers, Sura de Stepă*

Source: APIA, 2021, Guide for applicants for transitional national aids and coupled support in the livestock sector. Campaign 2021 (Ghid pentru solicitanții ajutoarelor naționale tranzitorii și sprijinului cuplat în sectorul zootehnic, Campania 2021), Code: DPD-SZ-GSANTZSCZ, http://www.apia.org.ro/files/pages_files/Ghid_solicitant_ANT_SC_SZ_Ed_VII.pdf [2].

The coupled support for the beef cattle sector was requested by 24 EU member states in the year 2015 (Poland, the Czech Republic, Lithuania, Hungary, Bulgaria, Slovakia, Portugal, Croatia, Belgium (Wl), Latvia, Slovenia, Estonia, Malta, Romania, Spain, France, Italy, Finland, Sweden, United Kingdom – Scotland, Austria, Denmark, Greece, the Netherlands); since 2017 their number has decreased to 23 (without Estonia), and after Brexit their number was down to 22.

In the period 2015-2019, in Romania, the beef cattle farming sector benefitted from total *coupled support* payments worth 52 million euros, i.e. 7.8% of total VCS value. Seen in evolution, the allocation to the sector has increased only slightly, to 10.9 million euros in 2019, as against 9.5 million euros in 2015; the share in total voluntary coupled support to the livestock sector was down from 9.4% in 2015 to 6.7% in 2019 (Table 2). The reason for this situation is that the annual budget distributed to the sector for coupled support payment was relatively similar year after year, but the number of animals increased 7 times in 2019, as compared to 2015. Thus, the number of beef cattle authorized for payment reached 52,834 heads in 2019, as against 7,520 heads in 2015, following compliance with eligibility conditions for an increasing number of animals. At the same time, through a better information of farmers by the representatives of associations accredited with the maintenance of the Genealogical Register, on the eligibility conditions for coupled support payment, an increasing number of farmers applied for this payment scheme, and consequently their number increased to 1,416 in 2019, from 198 in 2015.

Table 2. Coupled support for the beef cattle sector in Romania

	2015	2016	2017	2018	2019	Total
Value of coupled support for beef cattle (million euros)	9.5	10.1	10.7	10.8	10.9	52.0
% VCS for beef cattle in total VCS livestock sector	9.4	8.9	7.5	7.3	6.7	7.8
Number of farmers	198	395	778	1,113	1,416	3,900
Number of beef cattle (heads)	7,520	13,981	24,626	36,613	52,834	135,574

Source: Authors' processing based on APIA data.

The VCS value per animal head was down to 185 euros/head in 2020, as against 1,312 euros/head in 2015, due to the increase in the number of animals authorized for payment, and TNA (transitional national aid) was 1.0 euro/head in 2020, down from 97.4 euros/head in 2015 (Figure 1).

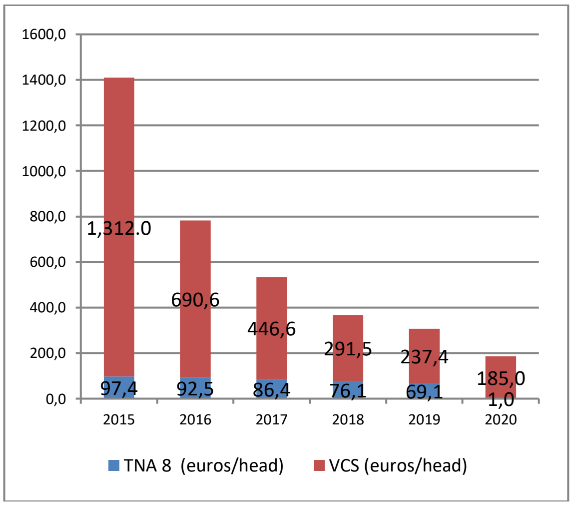

Fig. 1. Financial support (TNA and VCS) to the beef cattle sector in Romania – euros/head
Source: APIA.

Distribution of coupled support for beef cattle in Romania

A comparative analysis of the distribution of the coupled support by size classes of cattle farms in Romania, in the years 2019 and 2016, reveals the following situation:

In the year 2019, 17.7 thousand beef cattle heads (33.5% of total) approved for VCS payment raised on large-sized farms in the size class 101-250 heads, which accounted for 7.6% of the total number of farmers; 11.4 thousand heads (21.6% of total) were raised on farms in the size class 51-100 heads, accounting for 11.9% of farmers (Table 3).

In the year 2016, the situation was quite similar to that of 2019, as the largest number of cattle, i.e. 4.4 thousand heads (31.1% of total) approved for coupled support payment was found on farms in the same size class like in 2019 (101-250), which accounted for 5.8% of total beneficiaries.

At the same time, 3.3 thousand heads (23.4% of total) were found on farms in the size class 51-100 heads, which accounted for 12.4% of beneficiaries (Table 4).

Table 3. Distribution of the coupled support for beef cattle by farm size classes (2019)

Size class (heads)	**10-20**	**21-35**	**36-50**	**51-100**	**101-250**	**Total**
Number of farmers	695	322	123	168	108	1,416
% of total farmers	49.0	22.7	8.7	11.9	7.6	100.0
Number of beef cattle (heads)	9,915	8,587	5,201	11,433	17,698	52,834
% of total beef cattle	18.8	16.3	9.8	21.6	33.5	100.0

Source: Authors' processing based on APIA data.

Table 4. Distribution of coupled support for beef cattle by farm size classes (2016)

Size class (head)	**10-20**	**21-35**	**36-50**	**51-100**	**101-250**	**Total**
Number of farmers	208	82	33	49	23	395
% of total farmers	52.2	20.8	8.4	12.4	5.8	100.0
Number of beef cattle (heads)	2,829	2,204	1,361	3,297	4,381	14,072
% of total beef cattle	20.1	15.7	9.7	23.4	31.1	100.0

Source: Authors' processing based on APIA data.

An analysis of beef cattle distribution across 16 counties (Covasna, Hunedoara, Maramureș, Brașov, Alba, Bistrița-Năsăud, Caraș-Severin, Harghita, Sibiu, Suceava, Cluj, Prahova, Neamț, Vrancea, Vâlcea, Bacău) in **Romania's mountain area** (according to EUROSTAT definition), by size classes, in the years 2016 and 2019, based on APIA information on the total number of farms and total number of beef cattle eligible for *coupled support (VCS)* in the mountain area, reveals the following situation:

In 2019 – out of the total number of 1,416 farms, **876 farms (61.9%)** and out of the total number of 52,834 cattle heads, **31,063 cattle heads (58.8%)** are found in the mountain area (Table 5). Most beef cattle are found in the mountain area (9,903 heads) on the farms in the size class 101-250 heads. These account for 56% of the total number of beef cattle that received VCS in this size class. At the same time, a great number of animals (6,498 heads) beneficiary of coupled support are found on the farms with 10-20 heads, accounting for 65.5% of the total number of beef cattle that received VCS, in this size class.

Table 5. Distribution of beef cattle farms in the **mountain area**, eligible for VCS payment, by size classes, 2019

Size class (heads)	**10-20**	**21-35**	**36-50**	**51-100**	**101-250**	**Total**
Number of farmers in the mountain area	446	198	77	90	62	876
% of total size class	64.5	61.5	62.6	53.6	57.4	61.9
Number of beef cattle in the mountain area	6,498	5,255	3,254	6,153	9,903	31,063
% of total size class	65.5	61.2	62.6	53.8	56.0	58.8

Source: Authors' processing based on APIA data.

In 2016 – out of the total number of 395 farms, **266 farms (67.3%)** and out of the total number of 14,072 cattle heads, **9,284 cattle heads (66%)** are found in the mountain area (Table 6). The largest number of beef cattle in the mountain area (2,769 heads) are found on the farms with 101-250 heads.

Table 6. Distribution of beef cattle farms in the **mountain area**, eligible for VCS payment, by size classes, 2016

Size class (heads)	**10-20**	**21-35**	**36-50**	**51-100**	**101-250**	**Total**
Number of farmers in the mountain area	144	55	20	33	14	266
% of total size class	69.4	67.1	60.6	67.3	60.9	67.3
Number of beef cattle in the mountain area	1,953	1,477	828	2,257	2,769	9,284
% of total size class	69.0	67.0	60.8	68.5	63.2	66.0

Source: Authors' processing based on APIA data.

These account for 63.2% of the total number of beef cattle that received VCS, in this size class. At the same time, a great number of animals (2,257 heads) that received coupled support are found on the farms in the size class 51-100 heads, accounting for 68.5% of the total number of beef cattle that received VCS, in this size class.

CONCLUSIONS

Cattle rearing has permanently been one of the priorities of livestock farming in Romania. Besides the significant share (milk 25.4 % and meat 8%) in animal production value, the large areas under pastures and hayfields, including the communal pastures (about 33% of total agricultural land in Romania) and the importance of milk and meat in covering the protein needs of the population, this sector is important for the rural mountain areas in Romania, being one of the basic occupations of the population, providing reliable incomes for livestock farmers.

Romania, through its potential of extensive grazing and beef cattle farming, is ideally placed to respond to market signals, which estimate an increase in red meat demand, mainly in the developing countries from the Far East; thus, the Romanian farmers can meet this global demand, by increasing production, yet in a responsible way towards the environment, while taking into account the continuous welfare of animals.

But, at present, beef meat in Romania is far from being consolidated, in the sense in which farmers are able to valorize the animals on their farms, at their true potential.

The poorly developed slaughtering/processing networks, mainly in Romania's mountain area, is one of the important causes of the export of live cattle, which steadily increased in the last decade, to the detriment of the export of added value carcasses.

Disease surveillance and endemic disease eradication programs will be fundamental to ensuring a healthy future for beef production in Romania.

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COST AND PROFITABILITY OF CHICKPEA PRODUCTION IN USAK PROVINCE, TURKEY

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Abstract

This study aims to determine the economic analysis of chickpea production of farmers in Usak. In 2018, chickpea production of Usak province accounted for about 4.32% of Turkey's chickpea production. Based on the data obtained from the Farmer Registration System in Central, Banaz, and Ulubey district, it was determined that 77 farmers producing chickpea should be interviewed. The data obtained from the farms' chickpea production were obtained by face-to-face interviews with the farmers of the producer questionnaire developed by these researchers. The data of the study was obtained in 2018. According to the research findings, the average production cost per decare (da) was calculated to be 661.01 TRY. The share of variable costs was 80.98% within the production costs, and the share of fixed costs was 18.02%. It was determined that the kilogram sale price of chickpea was 4.65 TRY. The gross production value (GPV) of chickpea in the region was calculated as 952.33 TRY/da, gross profit 417.06 TRY/da, and net profit 291.32 TRY/da. The kilogram cost of chickpea in the region was 3.23 TRY. The relative profit was determined as 1.44 units. As a result of the research, as the chickpea production areas increase, the fixed costs per decare decrease, and the variable costs increase. In addition, it was determined that the relative profit value was low in enterprises with high production costs per kilogram.

Key words: *chickpea, economic analysis, production cost, profitability, Turkey*

INTRODUCTION

Chickpea (*Cicer arietinum L.*) is one of the most important legumes grown in Turkey, ranking first among the pulse crops in the production area in production.

World chickpea production increased 88.2% times from 8.0 million in 2004 to 15.1 million tons in 2020. In Turkey, it increased by 15% from 0.548 million tons to 0.630 million tons in the same period [6]. Turkey ranks second in the world in chickpea production volume and used to account for 4.2% of the world's chickpea production.

Chickpea production in Turkey also accounted for approximately 4.2% of the overall chickpea production in the world. While chickpea production in Turkey in 2004 met 7.4% of the production in the world, its share decreased to 4.2% in 2020. While Turkey's chickpea area was approximately 5.8% of the chickpea area in the world in 2004, its share decreased to 3.4% in 2020 (Fig. 1). In 2004, the chickpea production of Usak province met approximately 7.7% of Turkey's production. This value decreased to 2.3% in 2020 (Fig. 2).

Although the chickpea production area in Usak did not change in 2011, its production share decreased to 1.6%. As a result of heavy rain in Usak in 2011, approximately 80% of chickpea production was damaged. As of 2017, chickpea production area and production amount are decreasing in Usak province.

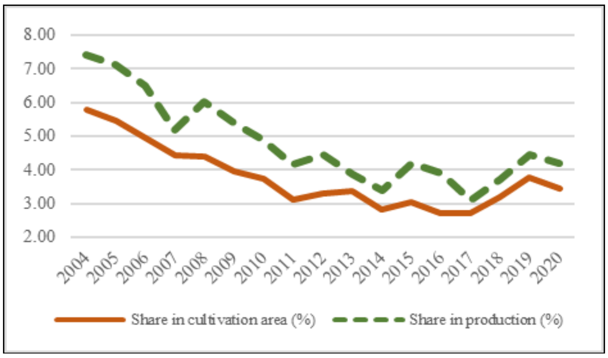


Fig. 1. The share of Turkey chickpea cultivation area and production in world (%)
Source: [6].

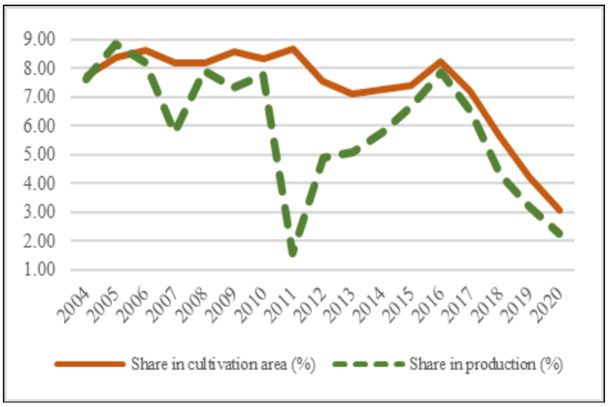
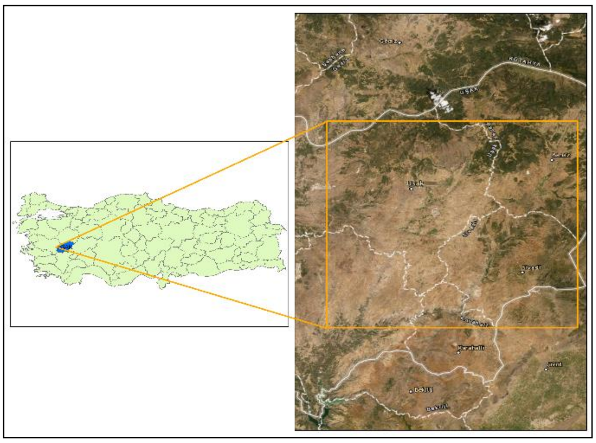


Fig. 2. The share of Usak province in Turkey chickpea area and production (%)
Source: [13].

As a result of the literature review, it was determined that there are many studies on the technical structure of chickpea production [1] [4] [5], but there are fewer studies on its economic analysis [8]. In this study, the cost and profitability of farms chickpea cultivation farms in Usak province were analysed.

MATERIALS AND METHODS

The study's primary material was comprised of original data obtained via face-to-face survey method from 77 chickpea production farms at the Central, Banaz, and Ulubey districts of Usak province.



Map 1. Location map of the study areas
Source: Own calculation.

Survey data belongs to the 2018 production period. In the 2018 production year when the data were collected, Usak province has 5.64% chickpea production area and 4.32% chickpea production in Turkey. Central, Banaz, and Ulubey districts constitute 86.58% of the chickpea production area and 87.83% of the chickpea production quantity of Usak province [13]. For this reason, these districts were chosen as the research area.

In addition, similar previous studies, reports, and statistics on the subject were also used. The research area was given in Map 1.

The total number, size, and addresses of chickpea production farms were obtained from the Usak Directorate of Provincial Agriculture and Forestry. Neyman Method was used to determine the sample volume of the survey. The number of samples was calculated with the formula given below [14].

$$n = \frac{(\sum N_h S_h)^2}{N^2 D^2 + \sum N_h S_h^2} \qquad (1)$$

where:
n: Sample size,
N: Total number of units in the population,
Nh: Number of units in group h,
Sh: Standard deviation of group h,
Sh^2: Variance of group h,
D^2: d^2/z^2,
d^2: Allowed error from population average,
z^2: Value of the allowed safety limit in the distribution table.

The producers participating in the research were divided into four groups according to their land size area. According to this, the farms were divided into four groups as "I group (less than 7.50 decares; 23 farms), II group (7.50-15.00 decares; 15 farms), III group (15.01-30.00 decares; 17 farms), and IV group (>30.01 decares; 22 farms)". Within the total number of farms, the share of farms group I was 29.87%, the share of II farms group was 19.48%, the share of III farms group was 22.08% and the share of IV farms group was 28.57% (Table 1).

Table 1. Sample size

Groups	Chickpea cultivated area*	Number of farms	Percent
I	<7.50	23	29.87
II	7.51-15.00	15	19.48
III	15.01-30.00	17	22.08
IV	30.01<	22	28.57
Total		77	100.00

*1 decares = 0.1 hectares
Source: Own calculation.

The data obtained from the identified farms through questionnaires were uploaded to the computer and evaluated in tables by making statistical software calculations.

Gross production values, net profit, gross profit, and relative profit values for chickpea production were calculated. Gross production value (GDP) multiplied by yield and selling price; gross profit was calculated by subtracting total variable costs from GDP, net profit was calculated by subtracting total production costs from GDP and relative profit was dividing GDP by total production costs [2] [7].

The unique product budget analysis method was used to calculate costs. Total costs were the sum of variable and fixed costs. Variable costs elements; machine rental cost, temporary labour cost, fertilisation cost, pesticide cost, seed cost, marketing cost, and interest of working capital. In calculating the working capital interest, half of the interest rate (6%) applied by Ziraat Bank (state bank) for crop production was used. Fixed costs elements; land rent cost, permanent-family labour cost, and administrative expenses (3% of variable costs) [2] [7]. The exchange rate for 2018 was 1 ($) USA Dollar = 4.82 (TRY) Turkish Lira.

RESULTS AND DISCUSSIONS

Table 2 presents some social-economic-technical information about chickpea production. The average age of the interviewed farmers was 46.79 years. The average age of farmers was 48.26 years in the I farm group, 48.07 in the II farm group, 49.18 years in the III farm group, and 42.55 years in the IV farm group. It was determined that there were younger farmers in the IV farm group. The average education level of the farmers was 7.87 years. The average education level of farmers was 6.09 years in the I farm group, 5.93 in the II farm group, 7.29 years in the III farm group, and 11.50 years in the IV farm group. The lowest level of education was determined to be in farm group II and the highest level of education was determined to be in farm group IV. The average household size of the farmers was 3.78 person. The average household size of farmers was calculated as 4.00 years in the I farm group, 3.80 in the II farm group, 3.65 years in the III farm group, and 3.64 years in the IV farm group. It was determined as the chickpea production area was increased, the farmers' average household size decreased. The experience time of the farmers in agriculture production was found to be 26.91 years. The farmers' average agriculture production experience was calculated as 29.48 years in the I farm group, 27.73 in the II farm group, 28.65 years in the III farm group, and 22.32 years in the IV farm group. The highest experience time of the farmers in agriculture production was at the III farm group. The experience time of the farmers in chickpea production was found to be 25.25 years. The farmers' average experience in chickpea production was calculated as 28.48 years in the I farm group, 26.73 in the II farm group, 27.76 years in the III farm group, and 18.97 years in the IV farm group. The average chickpea cultivated area of the farms in the groups was determined as 4.84 decares for I group farms, 11.13 decares for II group farms, 22.53 decares for III group farms, 73.73 decares for IV group farms, and 29.66 decares for average all farms. Parcels numbers of chickpea production were 2.39 per. Approximately 13.80 kg of seeds were used in chickpea production. The average of farms with non-agricultural income was 30.43% in

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the I farm group, 13.13% in the II farm group, 5.88% in the III farm group, 13.64% in the IV farm group, and 16.88% in all farms. The lowest non-agricultural income was at the III farm group, and the highest non-agricultural income was at the I farm group. The tendency to continue producing chickpea was 3.61 on the average of farms and it was determined that farmers tend to continue production. Farmers reported that their level of knowledge about chickpea production was between low and medium (2.74). Farmers also reported that their satisfaction with chickpea production was close to medium (2.87). The lowest knowledge/satisfaction level was in the first group, and the highest knowledge/satisfaction level was in the fourth group.

Table 2. Some social-economic-technical indicators of farms

Indicators	**Farm groups**				**Farms Average**
	I	II	III	IV	
Age (year)	48.26	48.07	49.18	42.55	46.79
Education level (year)	6.09	5.93	7.29	11.50	7.87
Household (person/family)	4.00	3.80	3.65	3.64	3.78
Experience in agriculture production (year)	29.48	27.73	28.65	22.32	26.91
Experience in chickpea production (year)	28.48	26.73	27.76	18.91	25.25
Chickpea cultivated area (average decare)	4.84	11.13	22.53	73.73	29.66
Parcel numbers of chickpea cultivated area (per)	1.26	1.93	2.65	3.68	2.39
The seed used amount per decare (kg)	14.21	13.95	13.99	13.71	13.80
Non-agricultural income (%)	30.43	13.33	5.88	13.64	16.88
The tendency to continue growing chickpeas*	3.13	3.33	3.47	4.41	3.61
The level of knowledge in chickpea cultivation**	2.43	2.47	2.76	3.23	2.74
The level of satisfaction in chickpea cultivation**	2.39	2.60	2.88	3.55	2.87

*Likert Scale: 1 = Absolutely not thinking; 2 = Does not think; 3 = Undecided; 4 = Thinking; 5 = Definitely thinking
**Likert Scale: 1 = Very low; 2 = Low; 3 = Medium; 4 = High; 5 = Very high
Source: Own calculation.

The production costs of chickpea producing farms were examined under two separate items. These are fixed costs and variable costs. Fixed costs are not dependent on the volume of production but are available on farms. In other words, it does not change according to the production volume. Variable costs are the costs that increase or decrease according to the production volume. This cost depends on whether the product is made or not [10].

Seed cost, marketing cost, machinery rents, fertilisation cost, temporary labour costs, pesticide cost, and working capital interest constituted the variable costs elements.

The average variable costs of the farms engaged in chickpea production were calculated as 15,876.24 TRY. This value varied between 2,005.10 TRY and 42,422.45 TRY in the groups. The interest of working capital (3,663.75 TRY) has the highest share among the variable costs. This was followed by seedling cost (3,558.49 TRY), marketing cost (3,175.02 TRY), machine rental cost (2,595.88 TRY), fertiliser costs (1,329.92 TRY), temporary labour costs (1,156.30 TRY), and pesticide cost (396.88 TRY).

Fixed costs elements of farms producing chickpeas; permanent and family labour cost, land rent, and general administrative expenses. The average fixed costs of the farms engaged in chickpea production were calculated as 3,729.35 TRY. This value varied between 1,043.33 TRY and 8,146.70 TRY in the groups. Land rent cost (2,261.63 TRY) has the highest share among the fixed costs. This was followed by permanent-family labour cost (991.43 TRY) and general administration expenses (476.29 TRY). According to the farm’s size groups, total production costs were calculated as an average of 19,605.59 TRY. This value was calculated as an average of 3,048.43 TRY in the I group, 6,321.73 TRY in the II group, 13,656.88 TRY in the III group and 50,569.15 TRY in the IV group (Table 3).

Table 3. Production costs in farms (TRY/farms)

Production Costs	Farm groups				Farms average
	I	II	III	IV	
Cost (TRY/farms)					
Seed cost	368.91	918.00	2,221.71	9,726.36	3,558.49
Marketing costs	229.13	569.67	1,609.99	9,240.52	3,175.02
Machinery rental cost	314.89	962.33	2,089.41	6,485.68	2,595.88
Fertilisation cost	513.15	515.13	978.06	3,011.23	1,329.92
Temporary labour cost	73.26	280.67	774.41	3,180.68	1,156.30
Pesticide cost	43.04	74.00	395.29	988.18	396.88
The interest in working capital	462.72	995.94	2,420.66	9,789.80	3,663.75
Total variable cost (A)	*2,005.10*	*4,315.74*	*10,489.53*	*42,422.45*	*15,876.24*
Land rent	513.18	941.19	1,723.25	5,405.85	2,261.63
Permanent-family labour cost	470.00	935.33	1,129.41	1,468.18	991.43
General administration expenses	60.15	129.47	314.69	1,272.67	476.29
Total fixed cost (B)	*1,043.33*	*2,005.99*	*3,167.35*	*8,146.70*	*3,729.35*
Total production costs (A+B)	3,048.43	6,321.73	13,656.88	50,569.15	19,605.59

Source: Own calculation.

According to the per decare, total production costs were calculated as an average of 661.01 TRY for all groups. This value varied between 567.99 TRY and 685.87 TRY in the groups.

The share of variable costs was 80.98% in total production cost. This value was calculated as 65.77% in the I farm group, 68.27% in the II farm group, 76.81% in the III farm group, and 83.89% in the IV farm group. This value varied between 387.76 TRY and 575.38 TRY in the groups. The most important cost elements among variable costs were the interest of working capital (%18.69), seedlings cost (18.15%), marketing cost (16.19%), and machinery rental cost (13.24%).

The share of fixed costs was 19.02% in total production cost. This value was calculated as 34.23% in the I farm group, 31.73% in the II farm group, 23.19% in the III farm group, and 16.11% in the IV farm group. As the chickpea cultivated area increases, the share of fixed costs in total costs decreases. The most important cost elements among fixed costs were the land rent cost (11.54%), permanent-family labour cost (5.06%), and general administrative expenses cost (2.43%) (Table 4).

In another study [3] conducted in 2016 in Kütahya province Central, Çavdarhisar, Dumlupınar, and Gediz districts, the total variable cost per decare was found as 190.89 TRY (67.59%) and total fixed cost 91.53 TRY (32.41%). Seedlings costs (29.90%), machinery rental cost (21.72%), and land rent cost (20.27%) were found as the essential costs. The reason for the difference in production costs per decare in TRY is that the dollar exchange rate was low in 2016 when the study was conducted. The exchange rate for 2016 was 1 ($) USA Dollar = 3.02 (TRY) Turkish Lira.

In another study [12] conducted in India in the Kabirdham district of Chhattisgarh, the share of variable cost per decare was found as 72.57% and the share of fixed cost 27.43%. Human labour costs (26.42%), land rent cost (23.39%), machinery rental cost (15.13%), and seedlings costs (14.58%) were found as the essential costs.

In another study [11] conducted in India in Madhya Pradesh state, the share of variable cost per decare was found as 50.30% and the share of fixed cost 49.70%. Labour costs (31.51%), land rent cost (28.78%), and input cost (24.60%) were found as the essential costs.

In another study [9] conducted in India in the Kawardha district of Chhattisgarh, the share of variable cost per decare was found as 66.45% and the share of fixed cost 33.55%. Labour costs (38.33%), land rent cost (30.82%), and seedlings costs (12.75%) were found as the essential costs.

Table 4. Production costs per unit area in farms

Production Costs	Farm groups (da)				Farms average
	I	II	III	IV	
Cost (TRY per decare)					
Seed cost	76.22	82.48	98.61	131.92	119.98
Marketing costs	47.34	51.18	71.46	125.33	107.05
Machinery rental cost	65.06	86.46	92.74	87.97	87.52
Fertilisation cost	106.02	46.28	43.41	40.84	44.84
Temporary labour cost	15.14	25.22	34.37	43.14	38.99
Pesticide cost	8.89	6.65	17.55	13.40	13.38
The interest of working capital	95.60	89.48	107.44	132.78	123.52
Total variable cost (A)	414.28	387.76	465.58	575.38	535.27
Land rent	106.03	84.56	76.49	73.32	76.25
Permanent-family labour cost	97.11	193.25	233.35	19.91	33.43
General administration expenses	12.43	11.63	13.97	17.26	16.06
Total fixed cost (B)	215.56	180.23	140.58	110.49	125.74
Total production costs (A+B)	629.84	567.99	606.16	685.87	661.01
The share in the production costs (%)					
Seed cost	12.10	14.52	16.27	19.23	18.15
Marketing costs	7.52	9.01	11.79	18.27	16.19
Machinery rental cost	10.33	15.22	15.30	12.83	13.24
Fertilisation cost	16.83	8.15	7.16	5.95	6.78
Temporary labour cost	2.40	4.44	5.67	6.29	5.90
Pesticide cost	1.41	1.17	2.89	1.95	2.02
The interest of working capital	15.18	15.75	17.72	19.36	18.69
Total variable cost (A)	65.77	68.27	76.81	83.89	80.98
Land rent	16.83	14.89	12.62	10.69	11.54
Permanent-family labour cost	15.42	34.02	38.50	2.90	5.06
General administration expenses	1.97	2.05	2.30	2.52	2.43
Total fixed cost (B)	34.23	31.73	23.19	16.11	19.02
Total production costs (A+B)	100.00	100.00	100.00	100.00	100.00

Source: Own calculation.

Table 5 presents the cost and profitability status of chickpea production. Production costs, gross product value, gross profit, net profit, relative return, chickpea production cost per kilogram, and net profit per kilogram were calculated to reveal the farms' cost and profitability. These indicators enable enterprises to demonstrate their success. Enterprises make plans for the future by considering these success criteria.

In chickpea production, the gross production value per decare was found to be 952.33 TRY in the average of the enterprises. This value is the lowest in the II farm group with 547.44 TRY per decare. IV farm group had the highest value with 1,089.08. This value was calculated as 573.41 TRY in the I farm group and 660.06 TRY in the III farm group.

The average gross profit of the enterprises was calculated as 417.06 TRY per decare. Gross profit per decare in small-scale enterprises was at the lowest level with 159.13 TRY and 159.68 TRY. It was calculated that this value varies between 159.13 TRY and 513.70 TRY in farms groups. Gross profit was increasing as the scale of the farms increased.

The average net profit of the enterprises was calculated as 291.32 TRY per decare. It was calculated that this value varies between -56.43 TRY and 403.21 TRY in farms groups. Net profit per decare in small-scale enterprises was negative. This value is the lowest in the I farm group and II farm group. Net profit was increasing as the scale of the farms increased.

The yield of chickpea per decare ranged between 107.40 kg and 229.82 kg in the farms' groups. The chickpea yield was 204.59 kg per decare in the average of the enterprises. Therefore, increasing the scale of the enterprises in the region will increase the chickpea yield.

The cost of 1 kg of chickpea of the farms was calculated as 3.23 TRY. This value was 5.86 TRY per kilogram in the I farm group, 4.71 TRY per kilogram in the II farm group, 3.73 TRY per kilogram in the III farm group, and 2.98 TRY per kilogram in the IV farm group.

As the chickpea production area increased in the enterprises, the unit product cost also decreased.

The selling price of 1 kg of chickpea varies between 4.06 TRY and 5.34 TRY in farms width groups. It was calculated as 4.65 TRY in the average of the enterprises.

The net profit of 1 kg of chickpea varies between -0.52 TRY and 1.76 TRY in farms width groups. It was calculated as 1.42 TRY in the average of the enterprises. Net profit per kilogram of the first and second farm groups was determined as negative.

The relative profit was calculated as 0.91 in the I farm group, 0.96 in the II farm group, 1.09 in the III farm group, and 1.59 in the IV farm group. The chickpea relative profit was calculated as 1.44 in the average of the enterprises. It was determined that 44 TRY profit was obtained for each 100 TRY production cost in chickpea production. In addition, as the chickpea production areas increased, the relative profit value also increased. Approximately 42.86% of the chickpea farms in the region made a loss.

In another study [3] calculated the cost of chickpea production per decare was 282.42 TRY, 580.72 TRY gross production value, 2.87 TRY per kilogram chickpea cost, 5.89 TRY per kilogram selling price, 298.30 TRY net profit, 389.83 TRY gross profit, and 2.06 TRY relative profit. According to this study, the relative profit value was found to be low in our study. This is due to the fact that the sale price of chickpeas in our study was low.

Table 5. Cost and profitability in chickpea production

Production Costs	Farm groups (da)				Farms average
	I	II	III	IV	
1. Total GPV per decares (TRY) (6x8)	573.41	547.44	660.06	1,089.08	952.33
2. Variable cost per decares (TRY)	414.28	387.76	465.58	575.38	535.27
3. Gross profit per decares (TRY) (1-2)	159.13	159.68	194.48	513.70	417.06
4. Total production costs per decares (TRY)	629.84	567.99	606.16	685.87	661.01
5. Net profit per decares (TRY) (1-4)	-56.43	-20.55	53.90	403.21	291.32
6. per decares yield (kg)	107.40	120.69	162.61	229.82	204.59
7. Per kilogram cost (TRY) (4/6)	5.86	4.71	3.73	2.98	3.23
8. Per kilogram selling price (TRY)	5.34	4.54	4.06	4.74	4.65
9. Per kilogram net profit (TRY) (7-8)	-0.52	-0.17	0.33	1.76	1.42
10. Relative profit (1/4)	0.91	0.96	1.09	1.59	1.44

Source: Own calculation.

In Figure 3, the chickpea production area and kilogram cost of chickpea 77 chickpea producers interviewed were given.

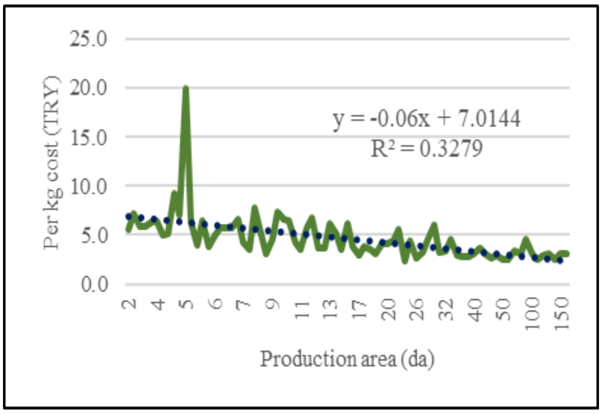

Fig. 3. Per kg cost values according to chickpea production areas
Source: Own calculation.

The kilogram cost of chickpea varies between 2.30 TRY and 19.86 TRY according to the size of the enterprises.

It was determined that the kilogram cost of chickpeas has a fluctuating downward trend. In addition, as chickpea production areas increase, chickpea cost per kilogram decreases.

In Figure 4, the chickpea production area and relative profit of 77 chickpea producers interviewed were given. Relative profit values vary between 0.40 units and 2.61 units according to the size of the enterprises. It was determined that the relative profit values of the interviewed chickpea enterprises showed a fluctuating upward trend. In addition, as the chickpea production areas increase, the relative profit value also increases.

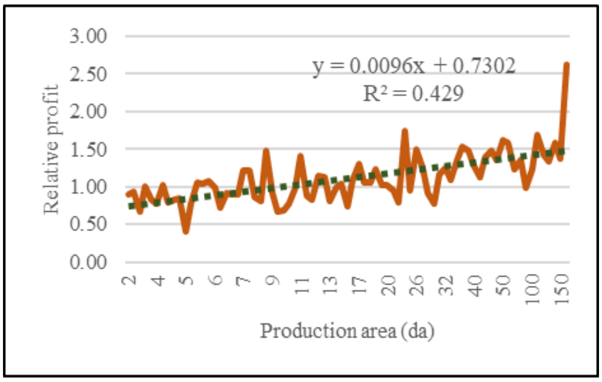

Fig. 4. Relative profit values according to chickpea production areas
Source: Own calculation.

CONCLUSIONS

As a result of this research, in which the cost and profitability analysis of chickpea production in Usak province, it was determined that the chickpea farms' total production costs, 80.98% were variable, and 18.02% were fixed costs. Of the variable costs, 18.69% was working capital interest expense, 18.15% was seed costs, 16.19% was marketing costs, 13.24% was machinery rental costs, 6.78% was fertiliser costs, 5.90% was temporary labour costs and 2.02% was pesticide costs. Of the fixed costs, 11.54% was land rent costs, 5.06% was permanent-family labour costs and 2.43% was general administration expenses. From chickpea farms divided into four different groups, it was determined that large-scale groups are economically more profitable than small-scale groups. The low chickpea yield of small-scale enterprises is due to the lack of organization among the farmers. When farms make their production in cooperation and organization, they can both increase yield and market their products easily. Reducing the cost of inputs that farmers use to produce chickpeas will encourage farmers to chickpeas produce. Especially small-scale chickpea enterprises in the region should be able to obtain cheap inputs in order to continue their production.

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BENEFITS OF IMPLEMENTING THE COMMON AGRICULTURAL POLICY IN THE EUROPEAN UNION IN THE PERIOD 2014-2020 AND ITS FUTURE

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Abstract

This article details the implementation of the Common Agricultural Policy in the European Union on Member States in the period 2014-2020 by highlighting the measures applied, the values allocated and the resulting gains. The funds used under this policy are the European Agricultural Guarantee Fund (EAGF) and the Agricultural Fund for Rural Development (EAFRD) on the basis of agreements between the European Commission and the Member States. The World Trade Organization (WTO) has responded positively to the implementation of reforms and the achievement of the objectives of the European Union's agricultural policy by accelerating development, increasing competitiveness and modernizing the agricultural sector. The Community agricultural sector has developed internal markets, diversified marketed products and developed the activity of services together with a correct efficiency of the use of renewable energy. These targets have had an important effect on protecting the environment through the responsible use of natural resources. The methodology used focused on the study of bibliographic sources, the collection, processing, analysis and interpretation of data provided by the European Commission but also by articles published in journals. Following the research carried out on the basis of the article, the following results were obtained: a) the desire of the European Commission to improve the common agricultural market since its establishment with each implemented period; b) raising awareness among Member States about the maximum use of the two European funds EAGF and EAFRD (currently the average percentage allocated by states was 59%); c) clarifying the European market but also encouraging trade with non-EU countries; d) highlighting in the article and in the tables the data on the topics addressed e) a structured picture of the evolution of the common agricultural policy from the establishment to the present, continuing with a much more concrete future. The formulation of the conclusions followed the situation of the allocated funds, the amounts used, the achievement of the targets and the measures that can be taken further in order to support the activities in the agricultural environment.

Key words**:** *European Commission, P.A.C, funds, measures, agriculture, reforms, pillars, payments*

INTRODUCTION

The common agricultural market was established in 1958 by the Treaty of Rome, which sought to create a free market for agricultural products and to reduce state intervention through mechanisms incompatible with the common market and to develop the Community market [5, 2].

The public authorities in the Community market wanted to regulate agricultural markets and support European agricultural production in relation to other markets. The elements that destabilize an agricultural market are: variable climatic conditions, imbalances between the demand and supply of products that produce price increases or very low prices that lead to food stocks altered or destroyed by these fluctuations.

The European Union has sought to combat climate change by arranging agricultural land to ensure public health by increasing the quality of agricultural products and to develop the rural economy through agri-rural policies [1, 6].

On 1 June 2018, the European Commission submitted a legislative proposal on the Common Agricultural Policy (CAP) 2021-2027. In June 2021, after extensive negotiations between the European Parliament, the European Council and the Commission, an agreement was reached on a new CAP consisting of a legislative package consisting of three legislative proposals: the

CAP Strategic Plans Regulation (repealing the previous Direct Payments Regulation and of the previous Regulation on rural development); Regulation on the financing, management and monitoring of the CAP (repealing the previous Horizontal Regulation); Common Market Organization (CMO) Regulation for agricultural products, amending certain previous legal acts, including the CMO Regulation. Following the formal approval of the necessary legislation by the European Parliament and the Council in autumn 2021, the new CAP will be implemented on 1 January 2023. In order to continue to pay farmers and other CAP beneficiaries, transitional regulations were introduced in 2021 and 2022. The transitional funds will be allocated from the CAP for the years 2021-2027 and will be supported by 8 billion euros through the EAFRD. The transition period is necessary for the continuation of projects and gives Member States time to facilitate the design of other strategic plans supported by the assistance of the European Commission. The transitional regulations are transposed from 2014-2020 with new strategic concepts on the Green Pact to ensure the transition to the future European agricultural policy.

The transition period should give EU countries enough time to design and prepare to implement their respective strategic plans, with the assistance of the Commission. In addition, agricultural intervention is based on the general principles of the sector in the special period, which is largely dependent on climate change and geographical constraints, and is subject to a systemic imbalance between supply and demand, so it has instability, high prices and incomes.

The specific objectives of the CAP are:

-Improving agricultural productivity by promoting technological progress and ensuring the best possible use of factors of production, especially labor;

-Ensuring a fair standard of living in agricultural communities;

-Market stabilization;

-Supply security guarantee;

-Reasonable prices to consumers.

The TFEU (Treaty on the Functioning of the European Union) recognizes that decisions in the agricultural sector are shared between the Union and the Member States. This is contrary to the Committee's doctrine and the general opinion of the legal services. The opinion states that until 27 October 1992, market policy (pillar I of the CAP) is the sole authority of the alliance. The new Article 4 (2) (d) TFEU has an impact on legislative activities in the agricultural sector, as the European institutions apply the principle of subsidiarity in areas which do not fall within the exclusive competence of the Union. Over time, the Common Agricultural Policy has been funded by a single fund, the European Agricultural Guidance and Guarantee Fund (EAGGF), which has been replaced by the European Agricultural Guarantee Fund (EGF) and the European Agricultural Fund for Rural Development (EAFRD) on 1 January 2007.

In 2013, the European Parliament approved two regulations, the Regulation on the new multiannual financial framework and the Interinstitutional Agreement on sound financial management for the period 2014-2020, establishing a total budget under the heading "Conservation and management of natural resources" (including the CAP) of EUR 373.17 billion.

In 2015, the 2014-2020 agricultural financial budget was amended, following the merging of the two pillars of the CAP decided by the Member States, resulting in a final budget of EUR 291.273 billion for direct payments (71.3% of the total CAP), EUR 99.587 billion for rural development (24.4%) and EUR 17.453 billion for market measures (CMO) (4.3% of the total). In total, the budget amounted to EUR 408.313 billion for the period 2014-2020 [4].

The Common Agricultural Policy (CAP) has undergone five major reforms since 1992.

These successive reforms of the CAP have made it possible to harmonize the mechanisms used to achieve the objectives set by the Treaty:

I. The 1992 reform called the "big change" which eliminated the gap between supply and demand for the proper management of agricultural expenditure. The

European Council amended the common agricultural policy by replacing the price protection system with a system of compensatory aid for income. As a result of a significant fall in the guaranteed prices of large crops, the loss of income was fully offset by direct payments per hectare.

II.Agenda 2000 marked a new stage in the completion of the 1992 reform, which set out the following points:

• new domestic and world price adjustments are partially offset by direct aid to producers;

• states provide that they are obliged to respect environmental conditions (cross-compliance) when granting aid and to reduce the possibility of environmental conditions (adjustment) to finance rural development measures;

• reiterates the conclusions of the Cork Conference of 1996 in order to strengthen existing structural measures under the New Rural Development Policy, which will be hereinafter referred to as the "Second Pillar of the CAP";

• stabilizing the budget through a financial framework strictly established for the period 2000-2006.

III.The June 2003 reform, also known as the "mid-term review", towards a policy based on separate aid, has finally become an ambitious agricultural policy focused on four main objectives:

- better connects European agriculture to the world market,
- prepare for EU enlargement,
- to better respond to new social requirements for environmental protection and product quality (public opinion is disrupted by continuing health crises)
- developing the capacity of the CAP to meet the requirements of third countries.

A number of new principles or mechanisms have been introduced:

•the separation of aid in relation to the volume produced and the reduction of agricultural production and trade. The decoupled aid thus became a "single farm payment" based on income stability;

• cross-compliance, whereby single payments depend on compliance with environmental and public health criteria;

• the correlation with the rules of the World Trade Organization, insofar as the ultimate goal of decoupling assistance is to include the single payment plan in the "green box";

• based on the above information, the distribution of payments is made in two ways: the first called modulation by which the transfer between the two pillars of the CAP consolidating rural development and the second way called regional decoupling is done by payments per hectare land uniformly correlated with standards regional;

the subsequent fiscal discipline representing a maximum annual tax by which the budget of the first pillar was frozen;

in 2007 the Single Common Market Organization (Single CMO) was set up to establish the regulatory mechanism for 21 common market institutions;

IV.The 2009 reform called the "Health Check" strengthened the framework of the 2003 reform.

The aim of this reform was to implement the following ideas:

• Strengthening the overall decoupling of aid, phasing out the last payment combined with production and integrating them into a single payment plan for each holding;

• Redirecting the financing of the first pillar to rural development by increasing the modulation rate of direct payments;

• Ensuring flexibility in public intervention and supply control rules so as not to prevent farmers from responding to market signals.

V.The 2013 reform presents a more comprehensive and integrated approach:

The main aspects of the CAP for the period 2014-2020:

• Modification of decoupled aid in a multifunctional aid system;

• The single payment for each holding is replaced by a seven-step or hierarchical payment system, which consists of seven parts:

1) basic payment ”;
2) "green" payment for public environmental goods ("ecological component");
3) additional payment for young farmers;
4) redistributive payment, additional aid may be granted for the first hectares of a holding;

5) providing additional income support in areas facing natural adverse conditions;
6) aid coupled with production;
7) a simplified system for small farmers

In addition, the direct payment schemes available in each Member State are expected to be gradually adjusted and become the minimum payment in euro per hectare by 2019 (the so-called "external convergence" process);

• Consolidation of the two pillars of the CAP;
• Strengthen the instruments of single management of collective management, which have become guarantees that are used only in the event of price crises and market chaos.
• A more integrated approach, with clearer and more focused rural development objectives at the regional level.

Pillar II instruments of the CAP have been simplified in order to provide more competent support on the important factors of: competitiveness, innovation, knowledge-based agriculture, the establishment of young farmers, sustainable management of natural resources and balanced territorial development.

The Agreement on Agriculture entered into force in 1995 following negotiations in Uruguay between 1986 and 1994 and regulated internal support systems for agriculture.

The long-term goal of the "Agriculture Agreement" is to establish a fair and market-oriented system of agricultural trade and to initiate the reform process by negotiating support and protection of commitments and establishing more operationally effective disciplines and rules.

Consequently, agriculture has a special situation given that specific rules are used in this sector.

The Common Agricultural Policy (CAP) has been subject to WTO (World Trade Organization) rules since 1995.

The CAP is also influenced by agricultural agreements from several countries based on several multilateral and bilateral agreements provided under the Generalized System of Preferences (GSP).

The importance of the common agricultural policy lies in the formation of rules and mechanisms for the development of productive capacity combined with the processing of raw materials and the marketing of agricultural goods within the European Union, ultimately resulting in the development of the rural area.

The components of agricultural policy in the European Union are represented by two important pillars: the common market and rural development.

The principles of the CAP underpin rural development through the free movement of goods, the consumption of products from within the EU, financial support, solidarity, resource management and environmental protection. With the help of the CAP, the law implementing the WTO Agreement on Agriculture entered into force on 1 January 1995.

The agricultural agreement has given the WTO member states greater involvement in agricultural policy reform by establishing insurance in three areas of activity:

A. Market access

The agreement on agriculture sought to streamline market access by establishing:

• border protections in customs duties and then gradually reduce them (36% for six years, 1995-2000, compared to the reference period 1986-1988, for developed countries; 24% for developed countries)
• minimum access commitments for third countries for certain non-tariff products, by opening tariff quotas (representing each product group, at the end of 2000, 5% of consumption)
• maintenance of import tariff preferences for at least 1986-1988 (referred to as the "current approach");

Special safeguard provisions will be in force if the volume of imports exceeds a certain ceiling or when the price of imports falls below a certain threshold.

B. Internal support

The agreement on agriculture provides for a reduction in the volume of support, differentiated according to the nature of the aid. The aid is divided into categories, in different "boxes", depending on its effect on the distortion of trade in agricultural markets:

The agreement on agriculture provides for reductions in the volume of assistance, differentiated according to the nature of the aid.

The "Yellow Box", also known as the "Global Support Measures" (AMS), which groups together price supports and aid with production, is not exempt from the reduction commitment. This box will have a 20% discount for six years. reference period 1986-1988.

The "blue box" includes aid related to supply control programs exempted from reduction commitments: for example, aid directly granted on a fixed area and production or for certain head-on regions (in the case approved in 1992 by the CAP).

The "green box" includes two support groups: producers, who are completely separated from production. In which, there are mainly security and income insurance programs (disasters, state funding to participate in crop insurance, etc.), structural adjustment programs and environmental protection programs. All "green box" aid considered to be in line with the WTO framework is fully exempted from the reduction commitments.

C. Export subsidies

Export support measures were to be reduced, over a period of six years, by 21% in volume and 36% in budget in relation to the 1986-1990 reference period (excluding beef, in which case the reference period era 1986-1992). In the European Union, this linear reduction was made for 20 product groups. For processed products, only the budget reduction applies. Export support measures were for a period of 6 years compared to the base period 1986-1990 representing 36% of the budget and in volume 21% (excluding beef, where the reference period was 1986-1992) for 20 of product types. Only budget cuts apply to processed products.

MATERIALS AND METHODS

The document is based on consistent legislation, published reports and articles on this topic. The methods used included literature research, collection, processing, analysis and interpretation of data provided by the European Commission and data provided by other articles on this topic covering the period 2014-2020. The amounts approved, the projects achieved and the measures taken to support the agricultural sector by balancing management, natural resources and the development of agricultural units in accordance with the environment are highlighted in the article.

RESULTS AND DISCUSSIONS

The European Commission Regulation of 2005 divided the European Agricultural Guidance and Guarantee Fund (EAGGF) into two separate funds:

-European Agricultural Guarantee Fund (EAGF)

-European Agricultural Fund for Rural Development (EAFRD).

The EAGF credits or sometimes co-finances with the Member States expenditure on the common organization of the market (CMO), direct support for agricultural holdings, the Union's contribution to initiatives to inform and promote agricultural products on the internal market and in certain countries, Union-specific expenditure, such as veterinary measures, collection and use of genetic resources.

The European Agricultural Guarantee Fund (EGF) is a fund set up by the European Union for the development of agriculture in its Member States through co-management between the EU and the Member States.

The EAGF shall finance the following expenditure in the context of co-administration between the Member States and the Community in accordance with EU law:

• Measures to regulate or support agricultural markets;

• Direct payments to farmers under the Common Agricultural Policy;

• EU financial contributions to measures taken by Member States to promote and promote agricultural products on the EU internal market and in third countries in accordance with programs selected by the European Commission;

• The EU's financial contribution to programs that encourage the consumption of fruit and vegetables in schools.

The EAGF shall finance the following expenditure directly, in accordance with EU law:

•Promotion of agriculture by the Commission directly or through international organizations;

• Measures shall be taken in accordance with Community law to ensure the conservation, identification, collection and utilization of agricultural genetic resources;

•Creation and maintenance of agricultural computer accounting systems;

•The system of agricultural surveys, including surveys on the structure of agricultural holdings

EAFRD co-financing to improve the competitiveness of the agricultural and forestry sectors, agri-environment measures, improve the quality of life in rural areas, encourage the diversification of the rural economy and increase local capacity (LEADER initiative) The main rural development priorities for the 2014-2020 planning period are: Modernizing agricultural production and operations and improving their viability through integration, market opening and agricultural processing;

Encouraging the rebirth of generations of farmers by supporting the establishment of young farmers; Development of basic rural infrastructure as a precondition for attracting rural investment and creating new jobs, and thus promoting the development of rural areas; Encourage the diversification of the rural economy by promoting the creation and development of small and medium-sized enterprises in the rural non-agricultural sector; Through the LEADER approach, community-owned local development is encouraged. LEADER's cross-cutting capabilities increase competitiveness, quality of life and diversification of rural economies and combat poverty and social exclusion; Tables 1 and 2 show the achievements obtained by the EU through the Member States in the period 2014-2020 as a result of the application of the common agricultural policy, the funds allocated and the economic relationship with the non-EU WTO member countries.

Table 1. EAGF expenditure on agricultural market intervention (Euro million- current prices)

	2014	2015	2016	2017	2018	2019	Total
Storage	5.1	18.4	52.4	27.6	182.3	3	288.8
Export refund	4.5	0.3	0.6	0.0	0.2	1.1	6.7
Other market measures	2,579.6	2,698.0	3,185.2	3,061.1	2,544.6	2,427.8	16,496.3
TOTAL	2,589.2	2,716.7	3,238.2	3,088.7	2,727.1	2,431.9	16,791.8

Source: European Commission Financial Report [4].

Table 2. European Agricultural Fund for Rural Development for the period 2014-2020 by theme (Euro)

The capacity of SME's	**58,905,269,208**
Environmental protection and efficient use of resources	51,843,397,581
Adapting to climate change and risk prevention	43,443,023,854
Social inclusion	20,740,564,809
Low carbon economy	8,079,197,579
Technical support	4,611,534,046
Research and innovation	4,142,992,038
Sustainability and quality jobs	3,960,943,224
Information and telecommuncations technologies	1,774,261,901
Education and training	1,675,181,165
Interrupted measures	6,98,676,966

Source: European Commission Financial Report [3].

Table 3.Achievements through EAFRD, 2014-2020

Activity	Planned	Implemented
Organic farming (ha)	11,996,553	45,614,147
Biodiversity (ha)	3,493,459	1,653,207
Diversification of the rural economy (beneficiary)	29,889	16,963
Investments in agriculture (Euro)	17,548,078,382	9,493,540,433
Training (trained participants)	3,583,379	1,878,014
Agricultural consulting services (farmers)	992,718	643,741
Producer groups (farm owners)	32,150	83,775

Source: European Commission Financial Report [3].

Table 4. EU allocations and payments by EAFRD countries, 2014-2020 (Euro)

No. crt.	**Member State**	**EU budget allocation**	**EU payment**	**Percentage implemented**
1	Italy	14,365,475,799	7,022,594,232	49%
2	France	16,684,019,546	10,602,561,771	64%
3	Germany	13,120,478,920	7,251,958,548	55%
4	Poland	11,944,796,992	6,033,738,897	51%
5	Spain	11,405,412,877	5,820,655,880	51%
6	Romania	10,968,146,956	6,897,828,644	63%
7	Austria	5,437,064,684	3,577,363,701	66%
8	Finland	3,377,282,563	2,536,419,966	75%
9	Greece	6,511,852,705	3,280,056,892	50%
10	Portugal	5,442,834,003	3,436,334,542	63%
11	Hungary	4,590,416,862	2,547,338,758	55%
12	Ireland	3,072,543,385	2,233,420,280	73%
13	Czech Republic	3,067,888,199	2,177,738,851	71%
14	Sweden	2,385,869,991	1,556,560,533	65%
15	Bulgaria	3,129,044,775	1,566,577,174	50%
16	Croatia	2,825,458,409	1,643,507,479	58%
17	Slovakia	2,300,176,822	1,124,228,816	49%
18	Lithuania	2,237,680,374	1,294,364,428	58%
19	Latvia	1,420,927,995	1,030,139,481	72%
20	Belgium	879,873,688	476,776,771	54%
21	Netherlands	1,168,188,879	606,228,379	52%
22	Slovenia	1,155,859,177	688,466,466	60%
23	Denmark	1,149,801,999	607,374,496	53%
24	Estonia	1,081,849,629	703,229,626	65%
25	Cyprus	196,504,594	106,819,438	54%
26	Luxembourg	134,886,007	91,045,327	67%
27	Malta	149,263,879	67,519,508	45%

Source: European Commission Financial Report [3].

Table 5. Trade in EU-27 agricultural products and food stuffs by selected countries (2019)

	A. Imports (milion EUR)	**% of row 2**	**B. Exports (milion EUR)**	**% of row 2**	**Libra**
EXTRA-EU TRADE27					
1. Total trade	1,934,944	—	2,132,015	—	197,071
2. Trade in agricultural and food products	121,644	100	181,825	100	60,181
% trade in agricultural products and foodstuffs (2/1)	6.30%	—	8.50%	—	---
Raw materials / primary products	76,168	65.00%	65,281	35.90%	-10,887
Processed (including wine)	12,064	9.90%	38,878	21.40%	24,814
Food and beverages	17,443	14.30%	58,557	32.20%	41,114
Inedible	12,968	10.70%	19,108	10.50%	6,140
SELECTED COUNTRIES					
Argentina	4,365	3.60%	207	0.10%	-4,158
Brazil	10,760	8.90%	1,799	1.00%	-8,961
China	5,331	4.40%	14,491	8.00%	9,160
India	2,609	2.10%	746	0.40%	-1,863
Indonesia	3,882	3.20%	932	0.50%	-2,950
Japan	347	0.30%	7,280	4.00%	6,933
Russia	1,509	1.20%	7,027	3.90%	5,518
Switzerland	4,589	3.80%	8,376	4.60%	3,778
United Kingdom	16,750	13.8	41,215	22.7	24,465
Ukraine	7,024	5.80%	2,455	1.40%	-4,569
United States of America	10,182	8.40%	21,851	12.00%	11,669

Source: European Commission Financial Report [4].

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Table 6. CAP expenditure broken down by Member State (EU-27, 2019)

	1. Breakdown by Member State			
	Direct aid / markets and other measures for 2018 / rural development 2019 (milion EUR)			
Member State	a. Direct aid (the first pillar - EAGF)	b. Total (the first pillar - EAGF) [inclusiv (a.)]	c. Total EAFRD (the second pillar)	(b+c) % of total EU
BE	488.30	553.90	78.90	1.10%
BG	785.30	805.40	308.60	2.00%
HR	278.85	288.20	299.60	1.00%
CZ	854.30	875.30	393.80	2.30%
DK	822.30	833.30	101.10	1.70%
DE	4,794.30	4,910.00	1,273.60	11.20%
EE	133.00	134.20	124.90	0.40%
EL	1,982.30	2,038.70	411.40	4.40%
ES	5,101.40	5,690.70	1,165.60	12.40%
FR	6,935.00	7,480.30	2,063.50	17.30%
IE	1,200.40	1,198.20	324.00	2.70%
IT	3,633.60	4,273.00	1,449.10	10.40%
CY	48.50	55.10	20.90	0.10%
LV	252.60	254.00	206.50	0.80%
LT	468.90	469.30	181.20	1.10%
LU	32.90	33.40	14.40	0.10%
HU	1,265.20	1,303.00	511.30	3.30%
MT	5.10	5.70	19.40	0.00%
NL	679.50	703.80	90.40	1.40%
AT	691.10	716.40	538.10	2.20%
PL	3,387.30	3,415.60	1,092.20	8.10%
PT	671.30	775.10	523.00	2.30%
RO	1,847.40	1,889.80	967.00	5.20%
SI	134.70	142.10	120.10	0.50%
SK	445.10	456.30	209.30	1.20%
FI	523.10	528.40	351.10	1.60%
SE	687.50	709.20	226.30	1.70%
EU	0.00	195.30	0.00	0.30%
UE-27	**38,149.40**	**40,733.70**	**13,066.10**	—

Source: European Commission Financial Report [4].

CAP budget 2021-2027

The amounts involved in the 2021-2027 multiannual financial framework for the continuation of the common agricultural policies are as follows:

- at EU level, the amount is EUR 365 billion, representing 28.5% of the EU's allocated budget:

-in Romania, the amount is EUR 20.5 billion spread over three measures: EUR 13.5 billion for direct payments, EUR 363 million for market support measures and EUR 6.7 billion for rural development.

A new framework for the common agricultural policy 2021-2027

- Member States will present their proposed interventions in the National Strategic Plan for the CAP (NSP) in order to achieve specific objectives at EU level.
- The CAP Strategic Plan will combine most EAGF-funded support instruments (including sectoral plans established under previous CMO regulations) and the EAFRD.
- The strategic plan will be based on a single and coherent intervention strategy that will use commonly defined outcome indicators to set targets for the planning period.
- Under the new CAP framework, EAFRD measures, EAGF direct payment schemes and market measures will be renamed intervention measures.

Common objectives of the CAP

-increasing performance;
-balancing the food chain;
-combating climate change;
-sustainable management of resources;
-conservation of landscapes and biodiversity;
-supporting generational renewal;
-development of rural areas;

-food safety;
-fair income for farmers [9, 3].

CONCLUSIONS

The importance of the agricultural sector in the Romanian economy and the capitalization of European funds to agriculture with priority contributes to reducing the gap between our country and the rest of the EU. Agricultural policy combined with the proper use of resources stimulates investment and reduces the budget deficit.

Improving environmental and climate performance in the new CAP 2021-2027

- more clarity in environmental protection legislation;
- more efficient tools in the application of measures;
-voluntary and mandatory measures appropriate to local relations;
-clearer answers to the proposed targets;
- results-based performance model;
-more intensified desire for knowledge, innovation and digitalization.

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STUDY REGARDING THE USE OF PHYTOSANITARY PROTECTION PRODUCTS IN ROMANIA AND EUROPEAN COUNTRIES IN THE PERIOD 2011-2019

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Abstract

The use of pesticides is a growing problem for the environment given the negative impact it has on the quality of soil, groundwater and surface water, biodiversity and ecosystems, but also on human health. To these are added the emergence of new diseases and pests that must be combated, precisely as a result of changes in the environment and climate change. However, their use is necessary, given the growing need for food, as a result of the exponential growth of the world's population and the reduction of areas for agriculture. The use of the latest generation pesticides, their correct application leads not only to the increase of their productions and to their profitability, but also to the protection of the environment and the preservation of biodiversity. In this paper, we aim to analyze the evolution of pesticide consumption in the E.U. and at the level of Romania in the period 2011-2019. The research methodology involved the bibliographic study, the consultation of domestic and international databases, the analysis of statistical data, their interpretation and the formulation of conclusions on the current situation compared to the base year, so that we can estimate what future developments will be.

Key words: *pesticides, production, consumption, environmental protection*

INTRODUCTION

Agriculture is one of the most important branches of an economy, but it faces the paradigm of increasing production, ensuring increasing food resources, but also the impact that its practice has on the environment [7, 12].

The use of phytosanitary protection substances is one of the major problems facing agriculture, and the development of new products is one of the major concerns of agrochemical companies that develop both new products and new technologies, without being able to fully anticipate the risks that may arise [3, 4].

The category of pesticides includes plant protection products (insecticides, fungicides, herbicides) that have the role of combating diseases and pests, also contributing to influencing vital processes for plants, preserving plant products, destroying some plants or parts of them with negative effect on crops. Besides the disadvantages brought by the use of phytosanitary protection products, with effect on the environment and on human health, they also have numerous advantages [11]. The globalization of trade has been made possible precisely by the fact that the use of chemicals has contributed both to improving the appearance of agricultural products and to the possibility of their long-term preservation [1]. Although there are risks, the consumption of phytosanitary products, worldwide, is constantly growing. Careful monitoring of these consumptions is one of the important objectives of existing policies in the European Union and in the world, given the objectives of limiting climate change, but also of promoting sustainable development models that seek not only to protect the environment., but also ensuring human well-being [5, 6].

At the same time, climate change is contributing to changes in the geographical structure of crops, which are accompanied by migration of diseases and pests that require

more phytosanitary protection and, on the other hand, accelerate their behaviour [13].
Careful monitoring of transparency, transparency in the quantities used will help reduce the risks that pesticide use poses to the environment and to human health.

MATERIALS AND METHODS

The research methodology involved bibliographic study, data collection, processing, analysis and interpretation. In this sense, a significant number of specialized articles were studied, as well as EUROSTAT statistics. Fixed-base and chain-based indices were calculated that highlighted the increase or decrease of the researched phenomenon for the period 2011-2019. We mention the year 2019 was chosen as at the moment while we were running the research work, there were no data for all the EU countries for the year 2020. The basis of the comparison was the year 2011, a function for which the absolute changes for the analyzed interval were determined, according to the following formulas:

$\Delta_{t/1} = y_t - y_1,$

$\Delta_{t/t-1} = y_t - y_{t-1},$ [14]

where:
y_1 - the value of the reference indicator
y_t - the value of the indicator in period t
y_{t-1} - the value of the indicator in the period t-1

RESULTS AND DISCUSSIONS

At the level of existing statistics at the EU level. There is very little data on the consumption of plant protection products, although their use and evidence is regulated by the Common Agricultural Policy, but also by the EU Regulations. 178/2002, 183/2005, 1107/2009 [8, 9, 10].
Therefore, the present study was based on the use of information regarding the quantities of products sold and not used.
Analyzing the situation of pesticide sales in European countries, and starting from Eurostat data, eliminating countries such as Bulgaria, Croatia, Estonia, Luxembourg, Malta and Iceland either due to lack of data or due to their confidentiality, we find that for the period 2011-2019 , the first 5 places were occupied in 2011 by Italy (43,574 tons), Spain (31,343 tons), France (24,496 tons), Germany (10,473 tons) and Portugal (5,767 tons). At the level of this year, Romania ranks 7th, with a sales value of 3,842 tons. The last 5 places were occupied by Cyprus, Sweden, Finland, Lithuania and Norway (Table 1).

Table 1. Evolution of pesticide sales during 2011-2019 (tons)

Country	Fungicides and bactericides	
	2011	2019
Italy	43,574	24,286
Spain	31,343	34,073
France	24,496	24,484
Germany	10,473	10,217
Portugal	9,975	5,767
Poland	6,081	6,867
Netherlands	4,250	3,897
Romania	3,482	4,021
Hungary	2,997	2,796
Belgium	2,452	2,449
Greece	2,256	1,756
Czechia	1,627	1,651
Austria	1,544	2,068
Switzerland	933	954
Slovenia	797	752
Denmark	633	436
Ireland	620	922
Slovakia	541	653
Lithuania	362	575
Cyprus	250	867
Sweden	218	164
Finland	165	2,832
Latvia	148	295
Norway	107	77

Source: own processing according to Eurostat [2].

It can be seen that the consumption of fungicides and bactericides is directly related to the agricultural area owned by these countries. In 2019, Romania maintained the same position (4,021 tons), while Poland climbed to 5th place, and Portugal ranked 6th

(5,767 tons). Finland also ranks 9th and Cyprus 17th, while Lithuania, Norway and Sweden remain the lowest consumers of fungicides and bactericides (Table 1).

Although Italy and Spain ranked 1st and 2nd in terms of sales, we find that sales decreased by 45% in Italy in 2019 compared to 2011, while in Spain they increased by 9%.

Table 2. Evolution of sales of herbicides, haulm destructors and moss killers in the period 2011-2019 (tons)

Country	Herbicides, haulm destructors and moss killers	
	2011	2019
France	29,252	22,484
Germany	17,955	13,941
Spain	13,835	17,023
Poland	12,408	11,705
Italy	8,327	8,524
Romania	6,771	4,013
Denmark	3,692	2,026
Hungary	3,668	3,906
Czechia	3,473	2,399
Netherlands	3,025	2,739
Ireland	2,812	1,845
Belgium	2,611	2,328
Sweden	2,136	1,544
Portugal	1,996	2,222
Lithuania	1,773	1,199
Austria	1,505	1,151
Greece	1,455	1,830
Finland	1,452	1,107
Slovakia	1,080	1,160
Switzerland	919	509
Latvia	722	972
Norway	679	479
Estonia	357	531
Slovenia	264	172
Cyprus	170	168
Luxembourg	102	54
Malta	6	2

Source: own processing according to Eurostat [2].

The largest increases were in Cyprus (+ 246%), Latvia (+ 99%), Lithuania (+ 59%), Ireland (+ 48%) and Austria (+ 34%). The largest reductions in sales of fungicides and bactericides were in Italy (-45%), Portugal (-42%), Denmark (-31%), Sweden (-25%) and Greece (-22%).

Regarding the herbicides, haulm destructors and moss killers, the first 5 places in terms of sales, they were occupied in 2011 by France (29,252 tons), Germany (17,955 tons), Spain (13,835 tons), Poland (12,480 tons) and Italy (8,327 tons). Romania ranks 6th with a sales volume of 6,771 tons (Table 2).

The last places were held by Cyprus (170 tons), Luxembourg (102 tons) and Malta (6 tons). However, we note that although the ranking for the top 5 countries is maintained at the level of 2019, there are significant changes in terms of quantities sold.

Thus, France, although registering a 23% decrease in sales, remains on the same place 1, Germany with a 22% decrease occupies the 3rd place, Poland with a decrease of 6% remains on the 4th place (Table 2).

Italy with a sales increase of 2% % remains on the 5th place, and Spain with an increase of 23% occupies the 2nd place.

Although Romania registered a 41% decrease in sales, it occupies the same place 6. Estonian (49%), Latvia (35%) and Greece (26%) registered significant increases in sales of herbicides, haulm destructors and moss killers.

At the same time, there were significant decreases in sales in Malta (64%), Luxembourg (47%) and Denmark (45%)(Table 2).

Sales of insecticides and acaricides are in line with the same trend of phytosanitary protection substances, with the first places being countries with high agricultural areas or intensive agriculture.

The first 5 places in 2011 were occupied by Germany (11,832 tons), Spain (8,062 tons), Italy (2,494 tons), France (2,190 tons) and the Netherlands (1,898 tons).

The last 5 places are occupied by Sweden, Lithuania, Estonia, Norway and Malta.

What stands out compared to 2019 is a very large increase in the consumption of insecticides and acaricides in countries such as Greece (+ 783%), Austria (+ 550%), Lithuania (+ 187%), Poland (+ 175%) or

Slovakia (+ 133%). In other countries such as Italy and Malta, sales fell by 37%.

Romania maintained its sales level at about 800 tons (Table 3).

Table 3. Evolution of insecticide and acaricide sales (tons)

Country	Insecticides and acaricides	
	2011	2019
Germany	11,832	18,665
Spain	8,062	7,636
Italy	2,494	1,683
France	2,190	4,367
Netherlands	1,898	1,959
Poland	991	2,724
Portugal	878	812
Romania	808	809
Belgium	695	359
Hungary	522	690
Czechia	291	307
Switzerland	261	294
Austria	248	1,613
Cyprus	179	135
Greece	109	965
Slovakia	64	149
Ireland	48	23
Denmark	45	57
Slovenia	38	36
Latvia	34	39
Finland	31	23
Sweden	29	45
Lithuania	26	76
Estonia	19	33
Norway	5	8
Malta	4	3

Source: own processing according to Eurostat [2].

Plant growth regulators registered increased sales. They are very important chemicals, biosynthesized in plants with a deep influence in the physiological processes destined to help plants to grow and develop.

Seed germination, seedling growth and plant development are more and more under the impact of climate change with a negative economic impact on yields and production, and also from a biological point of view.

Plant growth regulators are destined to help plants to adapt much better to abiotic stresses and environment changes.

That is why the sales of plant growth regulators increased from 2011 to 2019 in countries such as Slovenia (+1,180%), Greece (+ 529%), Slovakia (+ 189%) or Estonia (+ 141%).

Romania (-80%), the Czech Republic (-32%) or Germany and Spain (approximately 35%) decreased sales.

The other countries had moderate increases or decreases (Table 4).

Table 4. Evolution of plant growth regulators sales (tons)

Country	Plant growth regulators	
	2011	2019
Germany	3,123	2,089
France	2,532	1,786
Poland	1,593	2,353
Czechia	1,183	435
Lithuania	403	468
Italy	390	455
Romania	335	68
Belgium	269	297
Hungary	224	179
Spain	223	145
Netherlands	206	557
Ireland	188	157
Denmark	173	131
Latvia	164	321
Slovakia	113	322
Austria	59	63
Finland	59	56
Norway	38	37
Switzerland	33	33
Estonia	32	76
Greece	21	134
Sweden	21	34
Portugal	4	5
Slovenia	1	7

Source: own processing according to Eurostat [2].

Sales of other plant protection products increased the most in Cyprus (+ 882%), Slovakia (+ 684%) and Romania (+ 339%). In

Finland the decrease was 99%, and in the Netherlands 94% (Table 5).

Table 5. Evolution of sales of other plant protection product (tons)

Country	Other plant protection products	
	2011	**2019**
Spain	19,421	16,225
Italy	15,443	13,417
France	2,461	905
Netherlands	1,532	96
Finland	1,311	16
Portugal	1,158	1,045
Hungary	1,135	243
Greece	733	181
Belgium	885	682
Poland	689	579
Czechia	462	258
Germany	219	204
Switzerland	91	110
Austria	58	55
Romania	30	132
Ireland	20	17
Slovenia	20	4
Sweden	11	13
Slovakia	9	70
Latvia	6	18
Cyprus	6	58
Denmark	3	9
Norway	0	9

Source: own processing according to Eurostat [2].

CONCLUSIONS

The consumption of pesticides in European countries has not decreased, even if there is more and more talk about the effects of pollution on the environment and the negative impact that their use has.

What stands out is the lack of compact data on pesticide consumption in European countries. The study was based only on information on the quantities sold.

The existence of databases to centralize data and knowledge of the quantities used could contribute to better risk management, but at the same time could be the basis for identifying strengths and weaknesses related to existing environmental policies.

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URBAN TOURISM - COMPONENT OF THE INTEGRATED DEVELOPMENT STRATEGY OF TOWNS. CASE STUDY, CĂLĂRAŞI MUNICIPALITY, ROMANIA

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Abstract

In the context of the accentuation of the urbanization process, the towns become the main source of territorial development. At the same time, however, they face major challenges regarding sustainability, climate change, social cohesion, environment or mobility. In the perspective of 2030, Călărași municipality will be the economic center of interest of South-Muntenia region, through the superior capitalization of the existing resources: the geo-strategic positioning, the natural and anthropic patrimony and the human resource. Based on these considerations, we set out to highlight the tourist potential of Călăraşi municipality in order to identify the types of tourism that can be practiced in the town and its surroundings. The indicators of the tourist infrastructure, respectively, tourist accommodation units, accommodation capacity, analysis of the main tourist traffic - arrivals, overnight stays, average length of stay were structurally determined and analyzed for 2007-2019, after Romania accession to the European Union and before the health crisis Covid-19. The favourable geographical location of the municipality gives it various advantages as regards economy, tourism, and landscape. The proximity to the Danube River, which is a real development potential for leisure, fishing, business or scientific tourism, to which is added the cultural, ecumenical and hunting tourism. The attractiveness of this Danube town can be increased by better capitalizing on the elements of built and natural heritage that complement the urban landscape and neighbourhoods and which can lead to increase the stay of tourists, with economic and social implications.

***Key words*:** *development, municipality, anthropogenic resources, natural resources, urban tourism*

INTRODUCTION

The Catalogue of the national economy sectors includes, along with other services and those of internal and international tourism, leisure, accommodation, transport and public catering, thus highlighting the existence of tourism as a distinct component in the tertiary sector, its activities characterizing through legalities not found in other component sectors of the tertiary sector [1]. The trends in the tourism sector are constantly changing and there is a need to create new criteria for the middle class tourist, which is much more difficult to satisfy through basic services [2]. The impact of tourism on the sectors of the economy of an area is divided in effects of multiplication and stimulation in terms of production, income and employment [2], [8]. Tourism is a sector that encourages private initiative and also prepares a labor force that has a high degree of adaptability to change [7], [14] and [2].
The tourism sector represents over 5% of GDP, providing jobs in the European Union for 12 to 14 million persons [9] and [10].
The tourist product in its various forms is an economic activity of services designed to meet the needs of human society to spend their free time in a pleasant, comforting way and at the same time ensuring the desire to improve knowledge, etc.
The circumscription of tourism within economic concepts and categories helps to make it easier to understand the phenomena and processes that take place in this economic sector [17]. The fact that tourism is a tertiary activity and a need explains why, in times of economic crisis, tourism activity is more depressed than other economic activities [1]. At the international level, urban tourism began to develop gradually since the 80s,

today being a distinct form of tourism whose importance is constantly growing [11].

Thus, there were concerns about specific arrangements for different categories of visitors, and care to harmonize them with the requirements of the best functioning of the urban settlements. By adding tourism to the inventory of the local economic activities of an urban area, it can be considered a catalyst and a factor of urban revitalization for the consolidation of towns, especially as it is an important source of income formation and is responsible for creating thousands of jobs [6].

The tourism in urban area, compared to other forms of tourism, is much more complex and diversified, due to the large number of available resources. The presence of these resources in urban area, but especially their inclusion in various tourist programs and tours bring many benefits to the towns, which means supporting local economic activities and creating new jobs [5].

At the same time, there may be less desired effects, related to the increase in tourist flows, or the lack of concern for new investments in tourism.

In the urban area, most leisure tourism activities are related to the cultural, leisure and business sector. Cultural tourism focused on the cultural sector highlights the talent of artists (painters, sculptors - art exhibitions and galleries, clothes designers), national and regional gastronomy, through specific restaurants, etc.

The types of tourism in the urban area, as a whole, support the interpersonal contacts between the host population and visitors, support the exchange of information, ideas, cultural and tourist experiences. The elaboration of the socio-economic development strategies of the towns, of the general urbanism plans must take into account the support and the amplification of the tourist function [13].

The tourism industry must be in harmony and balance with other economic activities, in order to avoid contradictions [1].

In the conditions in which the urban area is able to support tourism, to offer new facilities for the companies in the field, they determine a faster process of preservation, restoration or urban modernization [12], [5] and [6].

MATERIALS AND METHODS

As research methods, we used documenting, the analysis and data processing from a secondary analysis. These methods are based on the sinthesis processes, induction and deduction, analogy and comparative analysis. Once the information was defined, known and interpreted, the next step was the detailed documenting of the interest field. In the analysis activity, the study of the documentation available for the field or for the analysed system is a starting point.

The documenting, the analysis and the data processing and the information obtained from the following sources: scientific papers in the field, national and international reports and studies on definitions and components of urban tourism, Tempo-online statistical database, papers in the literature, etc. The analysis of the demand and supply of tourism in Călărași municipality included two stages: structural and dynamic analysis of tourist infrastructure indicators - tourist accommodation units, accommodation capacity, analysis of the main tourist traffic - arrivals, overnight stays, average length of stay, capacity utilization index of tourist accommodation service. The existing (installed) tourist accommodation capacity represents the number of tourist accommodation places registered in the last act of reception, homologation or classification of the tourist reception structure with tourist accommodation functions.

These indicators were determined and analyzed for the period 2007-2019, after Romania accession to the European Union and before the period of Covid-19 health crisis.

The quantitative analysis in the studied field of the tourist products offer included a brief presentation of the natural and anthropogenic tourist potential at the level of Călărași county, and implicitly, a detailed quantification of the tourist potential that Călărași municipality possesses.

RESULTS AND DISCUSSIONS

The tourist potential of Calarasi county is given by the multitude of natural and anthropogenic tourist resources that it possesses. The riverside of the county on the Danube is one of its main strengths. The following **nature reservations** were identified and declared on the territory of Călăraşi county: Caiafele Forest (Fundeni commune), Ciornuleasa Forest (Mitreni commune), Fundeni Forest (Fundeni commune), Tămădău Forest (Tămădău commune), Vărăşti Forest (Dorobanţu commune), special area of Avifauna Protection Iezerul Călăraşi (administrative belongs to Cuza Vodă commune and Călăraşi Municipality), Ostrovul Haralambie Nature Reservation (on the Danube river, km 400), Ostrovul Şoimul Nature Reservation (on the Danube river, km 350, near Dichiseni locality) Ciocăneşti Island nature Reservation (on the Danube river, km 395, Ciocăneşti commune) [3, 18].

Among **the archaeological reservations**, at the county level there are the historical monument from Cătălui (Căscioarele commune), the historical monument Mînăstirea (Mînăstirea commune), the historical monument "Frunzărești Monastery" (Fundeni commune), the Church of the former Negoeşti Monastery, Şoldanu commune, the church of the former monastery Plătăreşti (Fundeni commune), St. Andrew Church (Fundeni commune), Radu-Negru Monastery (Modelu commune). Last but not least, on the territory of the county there are the following archeological sites: Coslogeni Pond (Dichiseni commune), Sultana Malul Roşu (Mînăstirea commune), Căscioarele (Căscioarele commune), Gălăţui village (Alexandru Odobescu commune), Păcuiul lui Soare (near Ostrov commune), Durostorum (the perimeter of the Roman settlement extends over an area between Bucharest-Constanta highway near km 131,400 and km 132,100, respectively the Danube River) [3, 18].

Călăraşi municipality is the residence and the largest municipality of Călăraşi county. Located in the south-eastern part of the country and the southern part of the county, on the lower terrace of the Danube, at the contact with the Danube meadow, on the left bank of Borcea branch, the town is at a distance of 120 km from Bucharest, 144 km from Constanţa and 25 km from Drajna (where there is an entrance on the Bucharest - Constanta Highway) [14].

Regarding the tourist attractiveness, Călăraşi municipality leads the ranking both at county level and among the Danube towns and municipalities in South-Muntenia development region which are border crossing points [18].

The geographical location gives the municipality certain advantages from a tourist point of view, such as: its presence on the border with Bulgaria or its proximity to the Danube, which is both a defining element of the natural framework at national level and a connecting factor between the countries of the continent and the Black Sea basin.

Călăraşi municipality is a starting point for a series of tourist routes. First of all, the area around the town offers a rich hunting ground for hunting enthusiasts, and the branches of the Old Danube and Borcea offer numerous fishing places. On the other hand, Călăraşi municipality is also a starting point for five cycling routes (Map 1), combined with segments of water travel. These routes try to highlight the elements of anthropogenic and natural heritage in the immediate proximity such as: Natura 2000 sites (SCI/SPA Canarele Dunării, SPA Iezerul Călăraşi, SCI / SPA Olteniţa-Mostiştea-Chiciu or SCI / SPA Ciocăneşti) or reservations such as Ostrovul Şoimului: P1 Călăraşi - Vicina Forstress (18 km long - water route); C2 Călăraşi - Mânăstirea (47 km long - cycling tourism); C4 Călăraşi - Chiciu - Dorobanţu (46 km long - cycling tourism) [3].

The two cycle tourist routes (C2 and C4) can be extended to Căscioarele and Olteniţa settlements. The possibility of crossing the Danube allows the connection of Călăraşi to tourist routes in the direct proximity of Bulgaria such as "Wine Road on the Danube Hills". Based on these cycling routes, an annual cycling competition "Călărăşene Danube Race" was built. The two routes from

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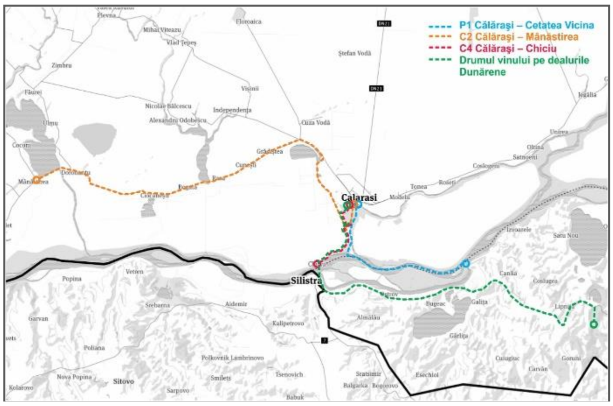
2015 capitalize the connection with Mihai Viteazu commune and the island formed by Borcea branch and the Danube.



Map 1. Cycle toursit routes that start from Călăraşi municipality [15].
Source: Processed using www.mapbox.com

These regional routes use Călăraşi municipality as a starting point, thus using its accommodation infrastructure. A better connection of the municipality with the objectives of tourist interest at regional level could thus help to extend the tourists stay period in the town.

In Călăraşi municipality, the approximately 30 tourist attractions are mostly concentrated in the central area of the town and on the bank of Borcea branch. There are also some local points of interest such as Dumbrava Park or "Tineretului" Sports Complex. Most of the objectives of tourist interest are either constructions included in the list of historical monuments (mainly in the central area) or leisure facilities. Among the objectives of cultural interest is the Municipal Museum, which represents not only the image of the town for tourists, but also an important community asset in the context in which its exhibits are largely donations from Călăraşi inhabitants.

Analyzing the type and spatial arrangement of tourist attractions, it can be concluded that inside Călăraşi municipality, two specific routes can be formed, one for **leisure on the bank of Borcea branch** and a **cultural** one represented by Bucharest Street, adding the **town center** as a major point of interest. In addition to the tourist routes inside the town, there are also those at county or regional level. Moreover, there is a development potential for the following types of tourism:

Leisure tourism - Encouraged by the concentration of specific activities on the banks of Borcea branch, but also by the presence in the town of arranged green spaces and sports facilities.

Cultural tourism - this could develop with the restoration and enhancement of monuments. Cultural facilities such as the Low Danube Museum, the Zoo (having the largest area in Romania) or "Barbu Ştirbei" County Center for Culture and Administration will also contribute to the development of this type of tourism.

Business tourism - based on the role of municipality, public institutions of county interest, as well as on the favourable geographical position on the country border with Bulgaria, in the proximity of the Danube river;

Hunting and fishing tourism - the town is located only 110km from Constanţa and 130km from Bucharest, and the areas known for fishermen and hunters are an attraction regardless of the season.

Scientific tourism - this typology requires the development of the tourist infrastructure of the natural parks, of the protected areas and of the other natural areas.

Sports tourism - is still at the beginning. Currently, Călăraşi municipality is a point of attraction for cycling due to the cycling routes and "Călărăşi Danube Race" competition. It is worth mentioning that the municipality also has a football team in the second league with good chances of promotion. The municipality also has CS Leaders Călărași baseball and CSM Călărași handball teams with remarkable results.

Regarding the tourist reception structures and their accommodation capacity, according to the National Institute of Statistics, [6, 8] Călăraşi municipality had in 2019 11 accommodation units (Table 1) - 4 hotels, 1 hostel, 3 motels, 2 bungalows and 1 tourist guesthouse, which summed 880 accommodation places (Table 2). These hotels ranging from 3 to 4 stars are distributed in the town center (Hotel Călăraşi), on Eroilor Street (Hestia Hotel) and on DN3 on the Borcea branch (Albatros Tourist Complex) and on the Danube bank (Baden Hotel).

From the point of view of the evolution of the tourist reception structures, their number increased by 366.66% in the last 12 years, and their total accommodation capacity tripled (Tables 1 and 2). However, although the number of arrivals in tourist accommodation units increased by 25.86%, as seen in Table 3., the number of overnight stays decreased from 49,650 in 2007 to 28,669 in 2019 (Table 3), situation reflected in the number of overnight stays (Table 4).

Note the migration to accommodation in hostels and bungalows which increased in number of arrivals and overnight stays during the analyzed period Average length of stay, as seen in Table 5, decreased from 3.82 days to only 1.76 days. This aspect indicates that Călăraşi municipality is a short-term tourist destination.

Figures 1 and 2 show that, at county level, the tourist reception structures in Călăraşi municipality represent 53% of the total accommodation units in the county, offering an accommodation capacity of 75.6% of the total [16]. The accommodation offer covers most types of accommodation units.

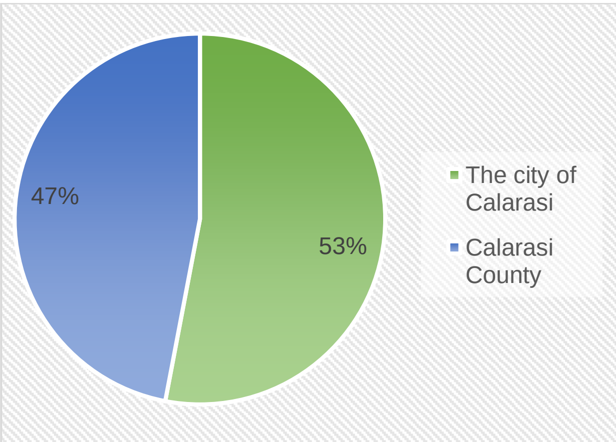


Fig. 1.Tourist reception structures in 2019
Source: Data processing - County Department of Statistics, 2021 [4].

Regarding the function of Călăraşi municipality as a port crossing point, it is in direct connection with Silistra town in Bulgaria, in partnership with which, in 2007, it implemented the project "Cross-border Tourism on the Lower Danube", which had as main results signing a bilateral agreement and an extended partnership in the tourism sector, elaboration of a common strategy in the tourism sector, a common tourist guide for the cross-border area Călăraşi - Silistra, bilingual leaflets, installation of tourist signs indicating the main tourist attractions in the cross-border area [3].

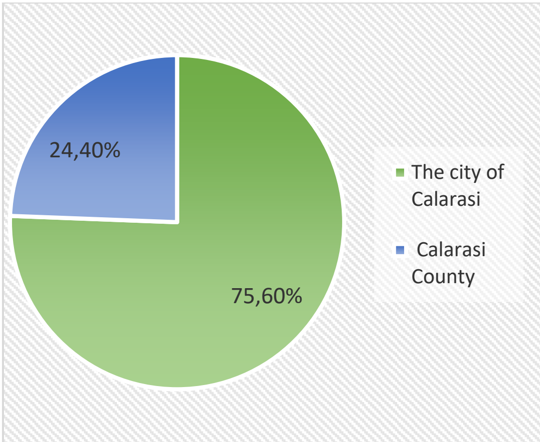


Fig. 2. Capacity of tourist accommodation in 2019
Source: Data processing - County Department of Statistics, 2021 [4].

Among the Danube towns in South Muntenia Region, Călăraşi municipality is the only one where there are bungalow accommodation units, but it does not have accommodation on river and sea vessels such as Giurgiu or camps for pupils and pre-school children such as Zimnicea [18].

The large number of heritage objectives owned by the local administration allows a better protection and capitalization of historical monuments and the concentration of historical monuments with special architectural qualities in the railway station area and the central area contribute to better capitalization and diversification of tourism activities by promoting traditions and of cultural values in Călăraşi municipality.

The large number of heritage buildings owned by the public administration, allows the diversification of economic activities in order to increase the inhabitants life quality, by modernizing public and leisure spaces.

The Danube, an element of international heritage, part of the natural environment, which crosses Călăraşi municipality, contributes to the capitalization and promotion of monumental buildings through tourism.

Table 1. Number of tourist reception structures

Tourist reception structure	Year 2007	Year 2009	Year 2011	Year 2013	Year 2015	Year 2017	Year 2018	Year 2019	Evolution
Total	3	4	7	7	8	9	9	11	366.66%
Hotels	2	2	2	2	3	3	3	4	200%
Hostels			1	1	1	1	1	1	0%
Motels		1	2	2	2	3	3	3	300%
Bungalows			1	1	1	1	1	2	200%
Tourist guesthouses	1	1	1	1	1	1	1	1	0%

Source: Data processing from statistical database TEMPO – Online, series 2007-2020 [16].

Table 2. Capacity of existing tourist accommodation (Places)

Tourist reception structures	Year 2007	Year 2009	Year 2011	Year 2013	Year 2015	Year 2017	Year 2018	Year 2019	Evolution
Total	291	373	473	481	604	686	730	880	302.40%
Hotels	283	283	283	283	406	406	406	540	190.81%
Hostels			40	40	40	40	84	84	210%
Motels		64	124	124	174	198	198	198	309.37%
Bungalows				8	8	16	16	32	400%
Tourist guesthouses	8	26	26	26	26	26	26	26	325%

Source: Data processing from statistical database TEMPO – Online, series 2007-2020 [16].

Table 3. Tourists arrivals in tourist reception structures (Number)

Tourist reception structures	Year 2007	Year 2009	Year 2011	Year 2013	Year 2015	Year 2017	Year 2018	Year 2019	Evolution
Total	12,977	14,743	10,171	9,657	11,699	12,029	13,127	16,333	25.86%
Hotels	12,912	12,792	7,971	7,464	9,119	8,662	9,298	12,886	-0.21%
Hostels			177	196	168	287	540	1,019	575.70%
Motels		1,913	1,881	1,796	2,066	2,713	2,993	2,062	7.79%
Bungalows				75	140	173	118	246	328%
Tourist guesthouses	65	138	142	126	206	194	178	120	84.62%

Source: Data processing from statistical database TEMPO – Online, series 2007-2020 [16].

Table 4. Overnight stays in tourist reception structures (Number)

Tourist reception structures	Year 2007	Year 2009	Year 2011	Year 2013	Year 2015	Year 2017	Year 2018	Year 2019	Evolution
Total	49,650	50,429	23,510	23,500	29,391	27,541	24,848	28,669	-42.26%
Hotels	49,367	30,899	14,153	12,847	14,226	15,102	18,050	20,342	-58.79%
Hostels	:	:	177	395	444	464	649	1,343	718.90%
Motels	:	19,530	9,161	9,990	14,455	11,133	5,628	6,484	-66.80%
Bungalows	:	:	:	268	266	387	305	234	631.25%
Tourist guesthouses	283	:	19	:	:	455	216	266	-6.01%

Source: Data processing from statistical database TEMPO – Online, series 2007-2020 [16].

Table 5. Average duration of stay – no of days

Tourist reception structures	Year 2007	Year 2009	Year 2011	Year 2013	Year 2015	Year 2017	Year 2018	Year 2019	Evolution
Total	3.83	3.42	2.31	2.43	2.51	2.29	1.89	1.76	-217.6%
Hotels	3.82	2.42	1.78	1.72	1.56	1.74	1.94	1.58	-241.77%
Hostels			1,00	2.01	2.64	1.61	1.20	1.32	-75,75%
Motels		10.21	4.87	5.56	6.99	4.10	1.88	3.14	-325.16%
Bungalows				3.57	1.90	2.24	2.58	0.95	-375.78%
Tourist guesthouses	4.35		0.13			2.35	1.21	2.22	-510.34%

Source: Data processing from statistical database TEMPO – Online, series 2007-2020 [16].

CONCLUSIONS

In the context of approaching tourism as a component of the Integrated Development Strategy of Călăraşi municipality, we note the favorable geographical location that gives it various advantages regarding economy, tourism, and landscape. The proximity to the Danube River, which is both a defining element of the national natural framework and a connecting factor between the countries of the continent and the Black Sea basin, is a real development potential for leisure, business or scientific tourism.

Moreover, the attractiveness of this Danube town can be increased by better capitalizing the elements of built and natural heritage that complete the urban landscape and the neighborhoods.

In order to increase the tourist attractiveness of Călăraşi, investments are needed in two key areas: the historic center and the leisure area along the Danube. Thus, it will be important to capitalize the elements of the natural area along Borcea branch by improving the transport infrastructure and completing it with new leisure facilities: park, beach, marina, etc. Based on investments in leisure and tourism infrastructure in Borcea branch area the adjacent island, these special natural resources can be used for leisure tourism, hunting and fishing and sports. At the level of the historical center, the emphasis must be placed on improving the quality of the public space and capitalizing the built heritage by rehabilitating some objectives with a special aesthetic architectural value, such as the prefecture building. In order to be able to extend the overnight period, Călăraşi municipality must rely on the development of the tourist objectives in the region and the continuous promotion of the already established routes.

In order to develop Călărași municipality from tourism point of view, starting from the land ownership as well as from the common interest in this regard, the local public authorities-Călărași Town Hall and Călărași County Council initiated a partnership that will develop through bilateral involvement of resources required: land, qualified human resources, financial resources. Within this partnership, tourism and urban development projects will be initiated and promoted which will result in the economic, social and cultural development of the area, in environment friendly conditions and in the sense of achieving the objectives set by the strategic development documents.

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WEATHER RISKS AS DRIVERS OF STRUCTURAL SHIFTS IN AGRICULTURE IN THE RUSSIAN FEDERATION

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Abstract

The climate trend today is reflected in the national, regional and sectoral socio-economic strategies of both developed and developing countries. Most often, the climate trend is presented in the form of predicted values of temperature increase on the Earth's surface by 1.5-2.0 degrees and the facts of the occurrence of the most probable weather risks. Practice shows that when making forecasts of socio-economic development, adverse hydrometeorological phenomena are not included in the system of significant and naturally occurring factors. Therefore, they do not find the necessary reflection in strategic documents. At the same time, weather anomalies systematically cause material and economic damage. The authors put forward a hypothesis about the significance of the factor of dangerous weather phenomena in the system of climatic factors that determine the level of agricultural production development and structural changes in the branches of the agro-industrial complex. The scientific task, to which the study is directed, is to establish a causal relationship between climatic parameters and production and economic indicators of the efficiency of the crop sub-sector. For this, a unique database was collected, which included values systematized by types of weather anomalies over the past 30 years in the context of the constituent entities of the Russian Federation. This made it possible to determine the most typical dangerous weather phenomena for different regions that cause material damage. In the sub-sector of crop production, these are wind, heavy rains, extreme fire hazard and a combination of these phenomena. A clear relationship has been established between their number and the dynamics of crop production. The most vulnerable categories of producers to each type of hazardous weather phenomena have been identified. The relationship between climatic variables and economic efficiency of the crop production sub-sector is determined. The results of the analysis will serve as a justification for the need to take into account dangerous weather phenomena in the system of the most meaningful trends when predicting the impact of climate change on agricultural production and food security of the country. This will contribute to the development of relevant sectoral and regional adaptation strategies in the face of the onset of the most probable natural and climatic risks.

Key words: *climate change, hazardous weather events, agriculture, crop production, agricultural organizations*

INTRODUCTION

The world community is increasingly agreeing that the risks driven by climate change, in terms of the likelihood of occurrence and the expected size of losses among global risks of social inequality, terrorist attacks, epidemiological threats, etc., are among the most significant threats to the world in medium and long term. There is concern about the risk that states will not be able to minimize the impact of global climate change and adapt to them [27].

Climate change does not consist only in an increase in the average air temperature near the Earth's surface by 1.5-2 degrees. It manifests itself in all components of the climate system, including changes in the intensity and frequency of dangerous and adverse weather phenomena.

The topic of chaotically occurring hazardous weather phenomena and their significance in the system of climatic factors was revealed by the Nobel Prize Laureate in Physics 2021 Klaus Hasselman. He developed a model that "ties together weather and climate", thereby showing that "climate models can be reliable despite the fact that the weather is changeable and chaotic" [28]. According to the regularly published assessment reports of the International Panel of Experts on Climate Change (IPCC) and the United Nations Food and Agriculture Organization (FAO), the number of climate anomalies and macro-level natural disasters in recent decades has increased 4 times in terms of climate disasters, and 6 times in hydrological ones [7]. At the same time, in the countries with the most productive agriculture, an increase in the number of negative weather events, their duration and intensity was observed [3].

National adaptation plans in different states have basic similarities and differences, which depend on the level of development of countries, the degree of exposure of the economy and society to natural and climatic risks, and priorities of state policy. National approaches are based on different scientific theories, different analytical assessments of what is happening, differences in determining national priorities in relation to sustainable development and an ambiguous interpretation of the main provisions of the concept.

The institutional basis of the state policy for adaptation of Russian agriculture to global climate change is made up of a number of regulatory documents at the national (federal) level (Climate Doctrine of the Russian Federation, National Action Plan for the first stage of adaptation to climate change for the period up to 2022, etc.). According to the main statements of the federal law "On Strategic Planning in the Russian Federation", in the regions of the Russian Federation, strategies for socio-economic development for the medium and long term should be developed and approved [5]. Separately, sectoral strategies for adaptation to the consequences of global climate change began to be developed. We have determined that most of these regulatory documents contain only general formulations and goals.

The “Strategy for the development of the agro-industrial and fishery sectors of the Russian Federation for the period up to 2030” in the system of key risks indicates, inter alia, climatic and agro-ecological threats caused by unfavorable climatic changes and abnormal natural phenomena, an increase in the share of degraded lands, and a decrease in land fertility agricultural purposes, the consequences of natural and man-made emergencies [15]. At the same time, in a number of key regions, the factors of the internal environment that threaten the sustainable development of agricultural systems include a high degree of influence of natural and climatic conditions on agricultural production. A detailed analysis of strategic planning documents for the development of the agro-industrial complex of the Krasnodar Territory, Stavropol Territory, Lipetsk, Saratov and Rostov Regions was carried out. As a result, it was found that the vector of adaptation is present in regional strategies in the form of general phrases and statements. The system of tasks marks the implementation of the principles and provisions of the 2030 Agenda for Sustainable Development, international environmental and climate programs and agreements.

The fact of the susceptibility of the region's agriculture to the risks of emergencies and the occurrence of anomalous natural phenomena is highlighted. At the same time, attention is drawn to the underestimation of the accounting of the consequences of the impact of hazardous natural phenomena on various aspects of agricultural production.

The examples of 1998, 2005 and 2010 years show that the repetition of several lean years leads to an imbalance in agricultural production, a sharp reduction in its carryover stocks, thereby creating a threat to domestic food consumption [12]. The growing number of dangerous weather events, an increase in their frequency and intensity, can create risks for the sustainable development of agriculture and food security of the country [21].

In the Food Security Doctrine of the Russian Federation, among the risks and threats to ensuring food security, climatic and agroecological threats are identified, caused, inter alia, by unfavorable climatic changes and anomalous natural disasters [6]. When structuring risks by components of food security, three groups are obtained: risks of ensuring the physical availability of food; risks of ensuring the economic availability of food; quality risks. The risks of ensuring the physical availability of food are directly related to agricultural production [26].

According to experts' forecasts, the number of extreme hydrometeorological events with potential material and social damage will continue to grow [13,18]. The large spatial extent of the Russian Federation, risky farming and differentiated agricultural production determine the high importance of the accelerated introduction of measures to adapt regional agri-food systems to global climatic changes. At the same time, without a quantitative assessment of risks, it is difficult to build a system of adaptation measures aimed at mitigating the consequences of their impact. The current regulatory framework does not facilitate their mandatory analysis and quantitative accounting when developing or adjusting strategies. Shpakova R.N. rightly notes that this is a violation of the principle of realistic strategic planning [22]. The purpose of our study is to identify a causal relationship between climatic, production and economic parameters in the crop production sub-industry. The results of the analysis will serve as a justification for the need to take into account dangerous weather phenomena in the system of the most meaningful trends when predicting the impact of climate change on agricultural production and food security of the country. This will contribute to the development of an up-to-date strategy for adaptation of agriculture in the context of the probable onset of natural and climatic risks.

MATERIALS AND METHODS

In recent years, a large number of studies have been devoted to analyzing the impact of climate change on various aspects of agricultural production. Quantitative measurement, combined with a variety of modeling and observation methods and approaches that focus on fundamental processes, captures the underlying drivers of crop yield, which may well include biophysical as well as production factors. In this regard, in more than half of the works, the risk was fairly assessed in connection with the variability of the yield [2, 4, 16, 24] or the consequences of water scarcity [1]. General issues of the influence of changes in temperature regimes on agriculture are considered mainly as a uniform displacement of the temperature gradient.

Today, the focus is increasingly shifting towards modeling and forecasting socio-economic risks in the context of the prospects for climate change. In general, many Russian researchers come to the conclusion that the shift in temperature regimes will increase productivity in the field of crop production in the Northern and Far Eastern regions of the country, while reducing productivity in the southern and central regions [8,14]. Specialists of the A.I. Voeikov Main Geophysical Observatory, based on the assessment of vulnerability and risks of under-harvesting of spring wheat during droughts, were found that in most of the Central federal district the risk of under-harvesting of spring wheat is assessed as "very low" and "low". Siptits S.O., Romanenko I.A., Evdokimova N.E. provide a forecast assessment of the gross production of grain and leguminous crops in the Russian Federation until the end of the 21st century, subject to the implementation of the climatic scenario RCP 4.5 and maintaining the size of sown areas at the current level by 2080. According to the authors’ calculations, an increase in the average potential gross harvest of grain and leguminous crops is expected [23].

At the same time, Kattsov, V.M., Shkolnik I.M. et al. assessed long-term changes in yield factors in regions specializing in grain production. The authors come to the conclusion that an increase in the number of adverse weather and climatic conditions by the end of the 21st century will have an increasing impact on the process of growing cereals [11].

Does the decrease in productivity of the southern regions compensate for the increase in the growing season and mitigation of risks in the regions of the North and Far East? This issue requires a detailed study of the dependence of the influence of various types of hazardous weather phenomena on the cultivated crop, as well as the structure of producers.

Our focus on hazardous weather events is determined by their direct impact on the leading and export-oriented branch of Russian agriculture - crop production. In our research, we consider the problem in the medium and long term. The hypothesis is put forward that various types of unfavorable hydrometeorological phenomena have a regularity and significant weight in the system of climatic factors affecting the production and economic indicators of crop production, as well as its structural balance.

To test the hypothesis, we systematized adverse weather events that caused material and economic damage by type and duration of exposure. Based on the data of selective federal statistical observation on agricultural production and weather data, Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) has built a system of indicators that allows characterizing the degree of weather impact on the efficiency of the crop production sub-sector. The calculation of the correlation coefficients between production, climatic and economic variables has been carried out. The correlation of the obtained data with the current structural dynamics in the class of crop producers was investigated.

For empirical analysis, the meteorological data sets of the Roshydromet on the number of hazardous weather events on the territory of the Russian Federation were formed. The time period for climate data recommended by the World Meteorological Organization is 30 years. This time interval is adhered to by researchers in the field of climate influence [17]. The maximum length of a number of hazardous weather phenomena types studied by us was 29 years, due to the fact that until 1991 the statistical base in Russia in the chosen direction was fragmented. The sample included 14,014 observations in 84 constituent entities of the Russian Federation in the context of the following types of adverse hydrometeorological phenomena that caused material and social damage: abnormally cold weather, wind, hail, rain, downpour, freshet, flood, extreme fire hazard, a complex of unfavorable weather phenomena [29].

The information base of the study includes the values of indicators calculated based on the materials of the Federal State Statistics Service of the Russian Federation on regional development of agricultural production, reports of the Ministry of Agriculture of the Russian Federation.

Statistical approaches are most often used to study trends in yield under conditions of changes in the natural and climatic environment. However, potential variables explaining yield tend to be confused due to the strong correlation between these variables, which complicates the interpretation of empirically derived relationships.

Therefore, in working with sets of statistical data, combined methods of economic and statistical analysis were used, which made it possible to get an idea of the dependence of climatic, economic and production indicators, as well as correlate with the current structural shifts in the industry.

RESULTS AND DISCUSSIONS

The expediency of using the system of indicators is dictated by the narrow specialization of individual indicators, reproducing only one side of the phenomenon under study. There is a need for the integrated use of a number of indicators in the form of a system that makes it possible to obtain a reliable and versatile description of the trends or phenomena under study.

With regard to our research, indicators were selected that can be conditionally divided into three groups: climatic, industrial and economic.

The group of climatic factors included the types of unfavorable hydrometeorological phenomena most often manifested on the territory of the Russian Federation, as well as the total number of unfavorable weather events that caused material and economic damage.

The group of production indicators includes the gross harvest of grain and leguminous crops, the proportion of economic entities of various organizational and legal ownership in the general structure of crop producers.

The balanced financial result of the crop production sub-sector for the year is taken as the most important economic indicator that allows to reflect the significance of hazardous weather events (Table 1).

Table 1. Description of the analyzed variables

Indicator	Units	Indicator name
Climate		
Total number of dangerous weather events	unit	Sum
Abnormal cold	unit	C1
Wind	unit	C2
Hail	unit	C3
Rain	unit	C4
Complex of unfavorable weather phenomena	unit	C5
Downpour	unit	C6
Freshet	unit	C7
Flood	unit	C8
Extreme fire hazard	unit	C9
Economy		
Balanced financial result	Million roubles	E1
Production		
Gross harvest of grain and leguminous crops of agricultural organizations	Thousand centners/year	P1
Gross harvest of grain and leguminous crops of peasant (farmer) households	Thousand centners/year	P2
Sown area	Thousand hectares	P3
Share of agricultural organizations in the structure of production of grain and leguminous crops	%	P4
Share of agricultural organizations in the structure of sunflower seed production	%	P5
Share of agricultural organizations in the structure of potato production	%	P6
Share of agricultural organizations in the structure of vegetables production	%	P7
Share of households in the structure of production of grain and leguminous crops	%	P8
Share of households in the structure of sunflower seed production	%	P9
Share of households in the structure of potato production	%	P10
Share of households in the structure of vegetables production	%	P11
The share of peasant (farmer) households in the structure of production of grain and leguminous crops	%	P12
The share of peasant (farmer) households in the structure of sunflower seed production	%	P13
The share of peasant (farmer) households in the structure of potato production	%	P14
The share of peasant (farmer) households in the structure of vegetable production	%	P15

Source: Compiled by the authors.

The matrix of paired correlation coefficients of the main production, economic and climatic indicators, built on the basis of systematized data, indicates the presence of a close relationship between some features (Table 2). Table 2 shows that the change in the number of unfavorable weather events causing material and economic damage has the greatest impact on the dynamics of the gross harvest of grain and leguminous crops. This is felt to the greatest extent by agricultural organizations (correlation coefficient -0.807), to a lesser extent - by PFH (peasant (farm) households) (correlation coefficient -0.620). The maximum weather anomalies occurred in 2010 - 1,095 units. While the sown area remained unchanged, the gross grain harvest in the "peak" year decreased by 31% from the average value. The minimum number of dangerous weather events on the territory of the Russian Federation for the specified period was recorded in 1992 - only 299 units. In general, a general tendency for the growth of the number of climatic risks in the territory of the Russian Federation can be noted (Fig. 1).

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Table 2. Matrix of paired correlation coefficients of the main production, economic and climatic indicators of the plant growing subsector in the Russian Federation

	Sum	C1	C2	C3	C4	C5	C6	C7	C8	C9	E1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
Sum	1																									
C1	0.11924	1																								
C2	0.30381	-0.1942	1																							
C3	0.34604	-0.1968	0.07496	1																						
C4	0.13854	-0.1220	0.02438	0.04394	1																					
C5	**0.62592**	-0.0000	0.56471	0.25367	-0.2354	1																				
C6	0.32336	-0.0421	0.33037	0.17722	**0.78274**	0.00037	1																			
C7	-0.2254	-0.2255	0.00422	0.47984	0.24853	0.26776	-0.0532	1																		
C8	-0.3901	-0.2025	**0.78193**	-0.0221	-0.2140	0.48755	0.06136	-0.2564	1																	
C9	-0.0326	0.44312	0.03034	0.08403	-0.3385	-0.0687	-0.1539	0.00981	-0.0829	1																
E1	-0.2712	-0.3375	0.41181	-0.1052	**0.72088**	-0.1628	**0.66028**	0.02505	0.19793	-0.2048	1															
P1	**-0.8069**	-0.4947	-0.1360	-0.1795	0.54742	-0.5104	0.30966	0.02662	-0.3776	-0.1997	0.60056	1														
P2	**-0.6202**	-0.4434	0.12458	-0.0872	**0.77687**	-0.2849	**0.63445**	0.08328	-0.1201	-0.3373	0.73941	0.86532	1													
P3	-0.4635	-0.1721	0.13027	-0.1179	**0.69307**	-0.5459	0.51901	0.07329	-0.0809	-0.3116	0.62550	0.57094	0.69173	1												
P4	0.42173	0.27683	-0.1831	**-0.8200**	**-0.8200**	0.34098	**-0.7068**	-0.1429	0.10805	0.21765	**-0.7839**	-0.7165	-0.9192	-0.8294	1											
P5	0.49121	0.32992	-0.1117	-0.1238	**-0.7534**	0.05736	-0.5558	-0.4455	0.31650	0.18119	**-0.6494**	-0.7266	-0.8368	-0.5089	0.81726	1										
P6	-0.5591	-0.0853	-0.0303	-0.3023	**0.73012**	-0.4167	0.54441	0.07074	-0.3663	-0.1348	0.58353	0.78421	0.84983	0.72129	-0.8830	-0.7856	1									
P7	-0.5699	-0.1352	-0.0096	-0.2660	**0.65843**	-0.2254	0.52508	0.16059	-0.3867	-0.1230	0.49731	0.72525	0.80151	0.56796	-0.7923	-0.7989	0.95166	1								
P8	0.53121	0.27637	0.19161	0.49450	**-0.6440**	0.58185	-0.4575	0.16243	0.39635	0.12909	-0.4825	-0.7128	-0.7452	-0.6315	0.77971	0.60999	-0.8730	-0.7756	1							
P9	**0.60204**	0.57652	0.38946	0.31150	**-0.6247**	**0.78897**	-0.4070	0.11652	0.51410	0.09333	-0.4410	-0.7319	-0.6782	-0.6911	0.72458	0.52457	-0.8062	-0.6760	0.90521	1						
P10	0.53285	0.08510	-0.0109	0.28142	**-0.7523**	0.41831	-0.5760	-0.0826	0.33440	0.14597	**-0.6190**	-0.7662	-0.8530	-0.7685	0.91055	0.79017	-0.9960	-0.9364	0.86910	0.80522	1					
P11	0.54686	0.15602	-0.0049	0.27608	**-0.7319**	0.37424	-0.5733	-0.1181	0.33774	0.16768	-0.5815	-0.7474	-0.8504	-0.7463	0.90256	0.79532	-0.9880	-0.9605	0.85640	0.79113	0.99066	1				
P12	-0.4343	-0.2801	0.16163	-0.1029	**0.81967**	-0.3608	**0.70031**	0.12539	-0.1278	-0.2148	**0.77693**	0.72581	0.92029	0.82784	-0.9992	-0.8148	0.89413	0.80182	-0.8041	-0.7457	-0.9199	-0.9115	1			
P13	-0.5232	-0.3399	0.06744	0.08654	**0.77329**	-0.1315	0.56518	0.40970	-0.3495	-0.1803	**0.66529**	0.75844	0.85736	0.54876	-0.8434	-0.9965	0.82149	0.82129	-0.6652	-0.5937	-0.8257	-0.8291	0.84322	1		
P14	-0.4924	-0.0825	0.06451	-0.2508	**0.77229**	-0.4154	**0.61043**	0.09710	-0.2889	-0.1586	**0.65716**	0.73388	0.84724	0.82101	-0.9355	-0.7868	0.97925	0.90564	-0.8538	-0.7943	-0.9933	-0.9824	0.94276	0.82147	1	
P15	-0.4871	-0.1653	0.01804	-0.2659	**0.74870**	-0.4857	0.57777	0.07049	-0.2686	-0.1972	**0.62491**	0.71561	0.83603	0.85903	-0.9412	-0.7361	0.95231	0.85665	-0.8710	-0.8421	-0.9713	-0.9663	0.94922	0.77829	0.98464	1

Source: Authors' calculations based on data: a) Regions of Russia. Socio-economic indicators. 2020: Statistical collection/Rosstat. - Moscow, 2020, - 1242 p. (In Russian); b) Information about dangerous and unfavorable hydrometeorological phenomena that caused material and social damage on the territory of Russia. (In Russian) [19].

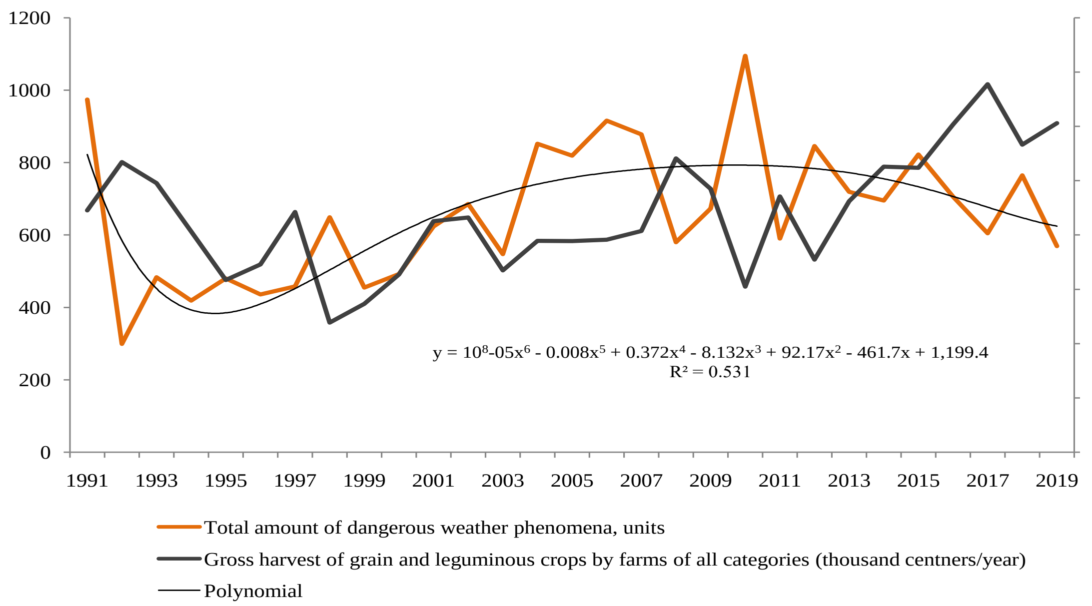

Fig. 1. Dynamics of the total number of dangerous weather events and the gross harvest of grain and leguminous crops by farms of all categories for 1991 - 2019.
Source: Own calculations based on data [20].

In the total number of hazardous weather events, the largest share is made up of wind, rain, extreme fire hazard and their impact in aggregate. Moreover, the greatest impact on the gross harvest of grain and leguminous crops is exerted by rains. Figure 2 clearly shows the trend towards an increase in the amount of rain in the territory of the Russian Federation.

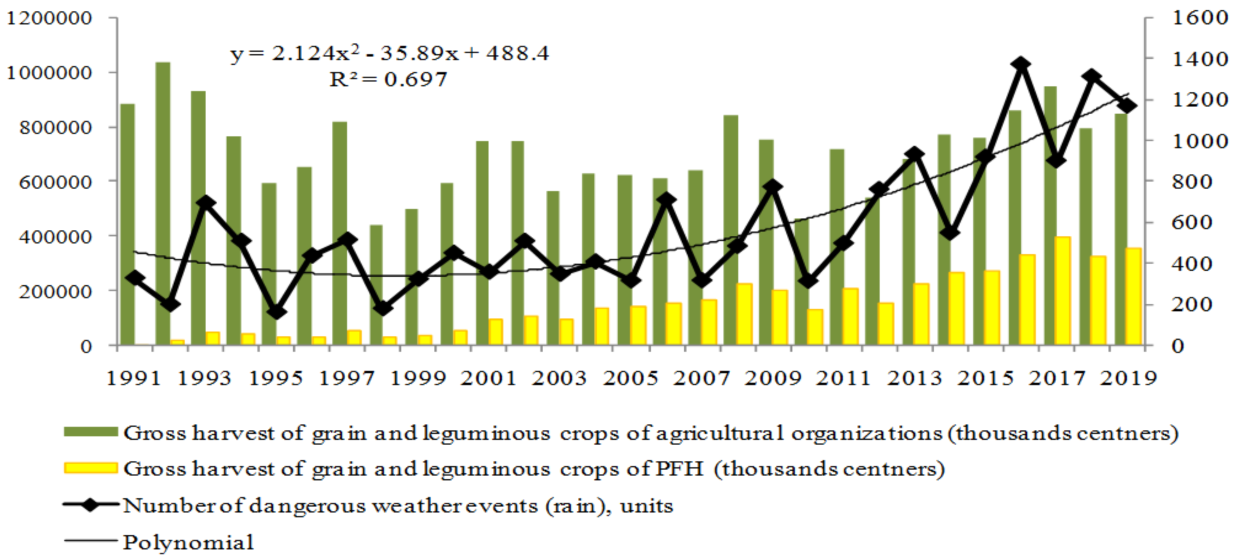

Fig. 2. Gross harvest of grain and leguminous crops by agricultural organizations and PFH in the Russian Federation and the dynamics of rainfall for 1991-2019.
Source: Own calculations based on data [19].

For small producers, who often do not have their own melioration system, the absence of rain threatens to destroy the crop (correlation coefficient 0.777). At the same time, in a rainy year, small forms of farming are able to increase their share in the total structure of grain crop producers, as evidenced by the correlation coefficient of -0.820 for agricultural organizations. The onset of heavy rains is closely correlated with hail precipitation.

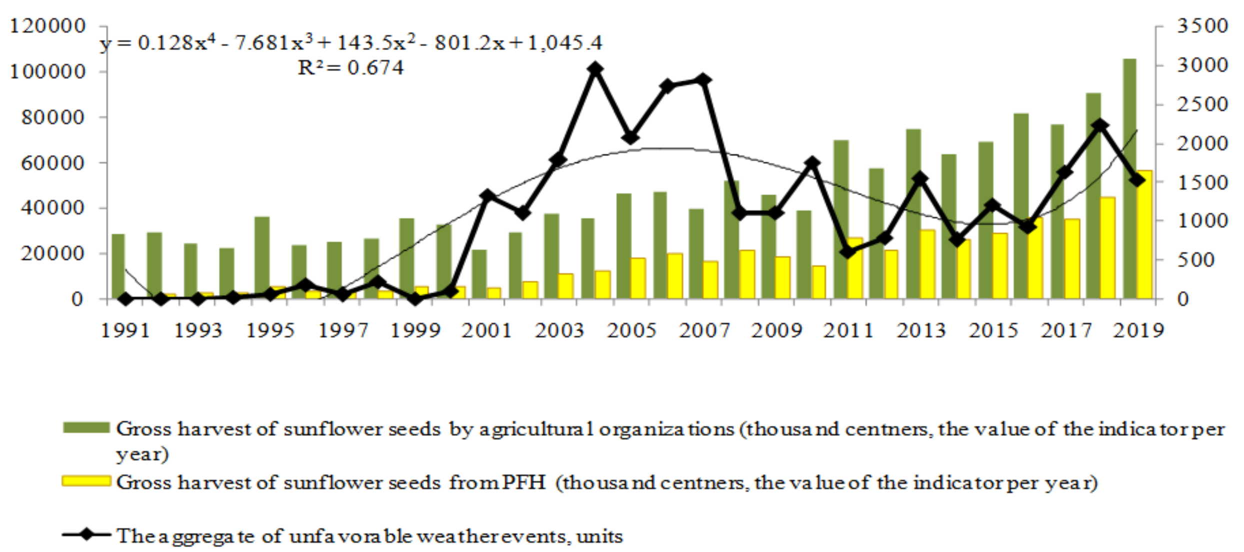

Fig. 3. Gross harvest of sunflower seeds by agricultural organizations and PFH in the Russian Federation and the dynamics of the complex of unfavorable weather phenomena in the territory of the Russian Federation of precipitation for 1991-2019.
Source: Own calculations based on data [19].

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Table 2 shows that the most vulnerable category of producers from such a phenomenon as hail turned out to be precisely large organizations - agricultural holdings.

It is obvious that the factor of weather phenomena affects the change in the share of products produced by small farms in the structure of crop producers. For example, small farmers - sunflower producers are most susceptible to a complex of unfavorable weather events. Moreover, the maximum number of the aggregate of phenomena occurred in 2004 and 2006-2007 (Fig. 3).

The most affected were the Kemerovo Region and Altai Territory, as well as other regions of the Siberian and Far Eastern Federal Districts. In these regions, the production of crop products predominates, mainly by small forms of farming.

The indicators of the ratio of large, medium and small agricultural producers are closely statistically related and, accordingly, multicollinear. The same can be said about the presence of a linear relationship between this ratio and the size of the cultivated area. The larger the size of the sown (planting) area of a constituent entity of the Russian Federation, the smaller the share of households in the structure of producers of the main types of crop production. At the same time, an increase in the share of crop products grown by agricultural organizations in the region is typical (Fig. 4).

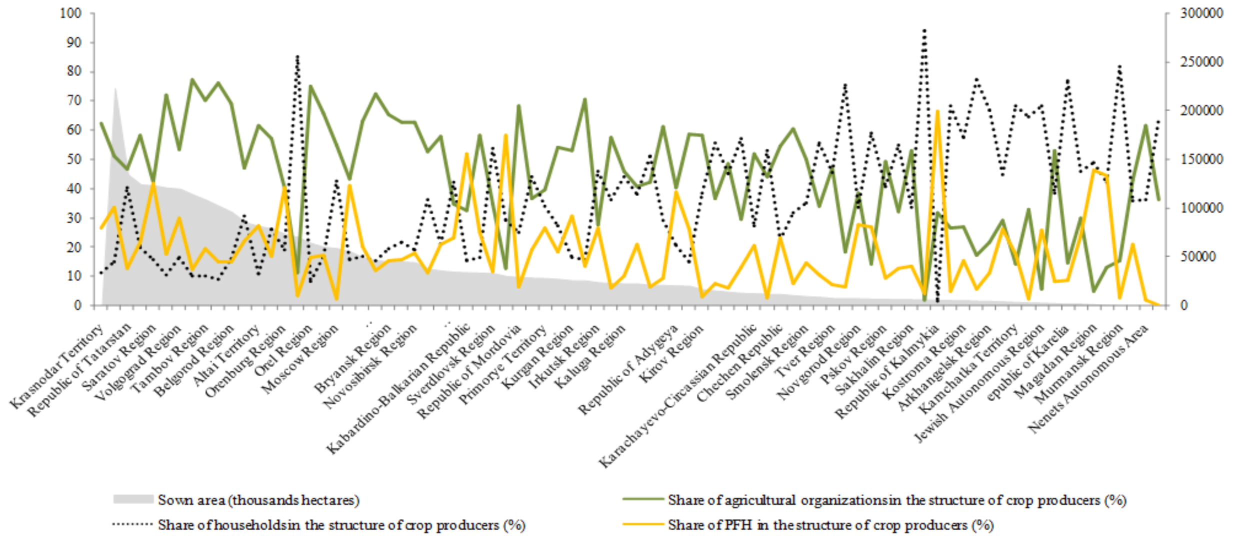

Fig. 4. The structure of crop producers by farm categories and the size of the sown area of the regions in 2019.
Source: Own calculations based on data [19].

Analyzing the structure of crop production by categories of farms, it should be noted that for regions with large sown areas (more than 4 thousand hectares), agricultural organizations dominate (from 60 to 65%). The share of PFH in the total number of crop producers is 20-25% on average. The remaining 15% falls on household farms. These regions include: Krasnodar and Stavropol Territories, Rostov and Voronezh Regions, and the Republic of Tatarstan. The following structure of agricultural producers is typical for regions with average productivity and sown area: agricultural organizations - 50%, PFH - 20%, households - 30%. This includes, for example, the Kirov, Bryansk and Penza regions, the Altai Territory, the Republic of Bashkortostan, etc. In regions with sown areas of less than 1,000 hectares: agricultural organizations - 33.5%, household farms - 51.5%, PFH - 15.0%. The balanced financial result of small businesses is more dependent on the impact of climate risks [9]. Such regions are Kamchatka Territory, Tyumen, Sakhalin and Nizhny Novgorod regions, etc.

The largest share in the structure of crop production is taken by the export-oriented grain industry, and in the leading regions in terms of sown areas, the main share is accounted for by agricultural organizations.

The positive balanced result of the crop production sub-sector is largely due to large integrated structures. The economic impact of climate triggers on the production of the main types of crop products is becoming more and more noticeable precisely in highly productive regions [10]. An effective measure of adaptation to climate change should be the creation of regional climate strategies for the development of agri-food systems. Science-based forecasting is an integral part of strategy development. Moreover, a forecast is a system of interrelated hypotheses. A reliable forecast begins with factor analysis and selection of the most meaningful trends.

When developing model tools for substantiating the directions of strategic development and placement of agriculture in regional agri-food systems, taking into account long-term climatic changes, the most common mistake is the condition of linear growth of greenhouse gas emissions. However, today the emission policy is being actively implemented in the Russian Federation. The new version of the low-carbon development strategy of the Russian Federation until 2050, which assumes the achievement of the country's carbon neutrality by 2060, prioritizes the intensive (target) scenario, which assumes a 79% reduction in greenhouse gas emissions by 2050 [25]. This strategy, in contrast to the previous ones, links the low-carbon transformation in the Russian Federation with economic growth in the context of ensuring the competitiveness and sustainable economic growth of Russia in the context of the global energy transition. At the same time, the expected increase in the absorptive capacity of ecosystems (forestry and agriculture) should be taken into account. In addition, manufacturers will be forced to modernize their production in the direction of "green technologies". Multiplicative micro- and macro-effects should also be considered. The combination of scenarios leads to different expectations.

A preliminary analysis showed that in the system of factors influencing regional crop production, unfavorable weather events have a significant weight. The dynamics of weather risks are superimposed on significant deviations in yield in “peak” and “disastrous” years.

Mass grain production technologies used in Russia, a portfolio of advantages of export-oriented agricultural holdings engaged in crop production, measures of state support for small agricultural producers - all this cannot yet compensate for the increased influence of natural factors. In addition, the asymmetry of the influence of various types of unfavorable hydrometeorological phenomena on different categories of producers is visible. In the future, this will change the ratio of large and small producers in the gross output of major agricultural crops.

Climate risk management tools should take into account the structure of producers, production potential, the types of hazardous weather events most expected in the regions, etc.

The increase in the number of unfavorable meteorological events in regions with a high proportion of crop production in the total volume of crop production in the Russian Federation, and mitigation of climate risks in the Northern and Far Eastern regions against the background of climate warming, will undoubtedly change the structure of regional production and transform production chains. But the increase in their intensity and the unpredictability of the offensive will neutralize the softening of temperature regimes and the expected increase in productivity in crop production in the northern regions.

Changes in natural and climatic characteristics, possibly, will lead in the future to a revision of the criteria for assigning regions to the list of constituent entities of the Russian Federation, the territories of which are considered unfavorable for the production of agricultural products. In accordance with the Agreement of the World Trade Organization on Agriculture, these entities can be exempted from obligations to reduce state support for agricultural producers.

Today, these are, for example, the republics of Komi, Kalmykia, Sakha (Yakutia), Perm and Primorsky Territories, Kaluga and Bryansk

regions, and others. There are 29 regions in total.
The implementation of the strategy for sustainable development of the agro-food complex in Russia must meet the new requirements of the time. It seems relevant to form an institutional environment that will help increase the efficiency of state support for economic entities of various organizational and legal forms in the context of a changing natural ecosystem. We consider it expedient to improve the regulatory framework in the field of methodology for assessing and accounting for extreme weather events. The latter is especially relevant today. Estimates of expected climatic changes should be reflected in regulatory documents. For this, it is necessary to include quantitative characteristics of hazardous weather phenomena in the methodological base, develop a statistical base and a methodology for assessing risks. The data available in open statistical databases on the types of weather risks on the territory of the constituent entities of the Russian Federation are often incomplete, some are completely absent. Official data on damages are difficult to systematize and record. Therefore, the direct impact does not always create an objective picture of the territorial distribution of weather and climatic risks at the regional level, and the indirect one cannot be taken into account due to the lack of approved methods for calculating them.
It is necessary to develop indicators and prescribe them in a legal and regulatory framework. In this connection, we consider it expedient in the Federal Law "On Strategic Planning in the Russian Federation" to duplicate the concept of risk given in "Methodological guidelines for the development and adjustment of the strategy of socio-economic development of a constituent entity of the Russian Federation", and indicate a list of types of possible risks with mandatory inclusion in this list is natural and climatic. As a rule, clarification of terminology in regulatory documents encourages developers to take this parameter into account when developing a strategy or when making a forecast of socio-economic development.
Of course, regional climatic and resource characteristics will determine the specific content of both sectoral and regional strategies for adaptation to climate change, differentiated strategies for the development of various forms of agricultural producers and mechanisms of state support for agricultural producers will be developed.
Sectoral, departmental, regional and territorial adaptation plans should be flexible and mutually agreed. Therefore, actions taken in this direction should be taken in a balanced manner, taking into account specific circumstances and have a complementary character (for example, improving regulatory documents at the sectoral level, and reducing the vulnerability of objects and areas most vulnerable to climatic effects - at the regional and territorial levels).

CONCLUSIONS

The systematization of unique data on weather phenomena made it possible to identify a tendency towards an increase in the number of adverse hydrometeorological phenomena that cause material damage. In the structure of natural risks over the past 30 years, the largest share began to be taken by wind, rain, extreme fire hazard and the impact of such phenomena in aggregate.
In the course of the analysis of correlations, a high connectivity of indicators of weather risks with indicators of crop production was established. A detailed analysis showed that the territorial distribution and dangerous weather phenomena characteristic of the area are closely correlated with the structural balance in the region's agriculture. Large agricultural organizations and agro-holdings occupying up to 80% of sown (planting) areas predominate in the structure of crop producers in more southern regions.
At the same time, the increase in the number and intensity of weather risks in these regions, namely, showers and wind, cause enormous material damage. The softening of the temperature regime and the decrease in the number of weather risks in the Northern and

Far Eastern regions in the medium term is unlikely to contribute to the shift of large-scale agricultural production there. Structural adjustment will be expressed in an increase in the share of households and PFHs in potato and sunflower cultivation.

Thus, the results of the conducted analytical study confirmed the hypothesis that unfavorable hydrometeorological phenomena have a significant weight in the system of climatic factors. It has been proved that weather risks are one of the most significant and meaningful trends that simply need to be taken into account when making forecasts in order to form an export-oriented model of the agro-industrial complex. The factor of hazardous weather events and the structural shifts that they provoke should be taken into account when justifying adaptation measures of regional and sectoral development strategies. For this, it is important to develop a methodological toolkit that allows accounting in the statistical base and assessing weather risks with its further consolidation in the regulatory framework.

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STUDY OF THE IMPACT OF CLIMATE RISKS ON THE DEVELOPMENT OF THE LIVESTOCK SUB-INDUSTRY IN RUSSIA

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Abstract

The purpose of the study is to identify the relationship between the main characteristics of animal husbandry in the regions of the Russian Federation and the most common types of hazardous weather phenomena that occur on their territories. Empirical data for 1991-2019 were obtained from the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) and the Federal Statistical Service of the Russian Federation. Using the methods of classification and mathematical-statistical analysis, five classification groups of regions of the Russian Federation with different livestock specialization were obtained and described. In each of the selected classification groups, the features of the manifestation of a whole spectrum of adverse weather phenomena of a hydrometeorological nature were studied. It has been determined that the most prone to weather risks are highly productive regions (the share of livestock products reaches from 4% to 8% in the Russian Federation) and regions with a low level of self-sufficiency in livestock products (less than 0.5%, respectively). In the course of the study, special attention was paid to small businesses, as the category of rural producers most vulnerable to climate risks. It has been established that large agricultural organizations are less affected by them. Over the past 30 years, heat waves, wind and floods have become the main damaging weather risks in the regions of livestock specialization over the past 30 years. Heat stress is the main climatic trigger for the decrease in the number of farm animals in farms of all categories. It is shown that the greatest influence of changes in the parameters of the climate system on the development of animal husbandry occurs through indirect links: the emergence of new pests and the emergence of diseases, new ways of their transmission; changes in the quality of forage crops and the availability of feed and water; reproductive and genetic variation. The impact is long-term and cumulative.

Key words: *climate change, weather risks, animal husbandry, temperature increase, damage, adaptation*

INTRODUCTION

The World Economic Forum annually publishes the Global Risks Report. It tracks the perception of global risks that humanity may face in the next 10 years. According to the data presented in the 2022 report, the first three lines of the most serious global risks are now occupied by environmental problems: failure to combat climate change, extreme weather conditions and loss of biodiversity [30]. A complex combination of social, climatic and environmental risks causes a threat of deviation from the vector of sustainable development of socio-economic systems, the transformation of established economic ties and chains, a decrease in the level of physical availability of food, and destabilization of the process of ensuring food security of countries [11]. All this creates problems for the life and livelihood of the population on the planet [10].

Under the influence of temperature shifts and changes in productivity, there are shifts in the structure of world agricultural production and a change in the global agri-food market. The depletion of natural resources exacerbates the tasks facing crop and animal husbandry. And if the bulk of scientific research is devoted to the problems of crop production in terms of adapting agriculture to the consequences of global climate change, then there is only a small part of them in animal husbandry.

Animal products provide up to 17% of the world's kilocalorie intake and 33% of the world's protein intake, so they are an important part of the global food system [24]. More than 800 million smallholder farmers and households live off subsistence farming, and livestock rearing is a way for them to survive [34].

The share of small farms in the structure of producers in countries is different [19]. In the Russian Federation in 2020, 37.7% of peasant (farm) households (PFH) and households were engaged in animal husbandry, which in total produced products worth 1,068.5 billion rubles. Therefore, the study of factors that have a varying degree of influence on the dynamics of the development of the livestock sub-sector is of particular scientific and practical interest.

The impact of natural and climatic risks on the livestock sub-sector is difficult to assess, because it occurs mainly in an indirect form. These are the risks of impact on the quality of forage crops and feed, the availability of water, the emergence of new pests; diseases and methods of their transmission; reduced forage yields and changes in diet composition, genetic variability, etc.

According to the Food and Agriculture Organization of the United Nations (FAO), direct impacts are mainly caused by droughts, floods and hurricanes. But direct damage is also difficult to capture statistically. The methodological base of national statistical services in the field of climate change and their assessment is not well developed [27].

Without taking into account the dependence of livestock productivity on climate change, models for predicting food security will be unreliable. The scientific objective of this study is to determine the relationship between the main characteristics of animal husbandry in the regions of the Russian Federation and the most common types of hazardous weather phenomena occurring on their territory. This will help substantiate the directions of adaptation of the sub-sector to the consequences of global climate change.

The methodological approach proposed by the author includes the sequential implementation of two stages of the study. At the first stage, based on the data of selective federal statistical observation on agricultural production, a typology of subjects of the Russian Federation was built according to the share of livestock products in the region in the total volume of livestock products in the country. The second stage includes the study of regional features of the manifestation of a whole range of adverse weather phenomena of a hydrometeorological nature, as well as an analysis of their direct and indirect impact on indicators characterizing the efficiency of the development of the livestock sub-sector in the obtained groups of regions.

The calculations carried out and the conclusions drawn on their basis will contribute to the optimization and harmonization of agricultural methods, the development of a differentiated strategy for the development of regional agrosystems in the direction of adaptation to the consequences of global climate change.

MATERIALS AND METHODS

Foreign and Russian researchers have established in detail the relationship between livestock productivity, temperature shifts and CO2 concentration in the atmosphere. The main block of scientific research is devoted to changing the yield of fodder crops, the quality of fodder and changes in the composition of the diet [3, 31]. A causal relationship with fluctuations in animal reproduction was established by A. Nardone, B. Ronchi, et al. [16], having established its slowdown with an increase in the average air temperature. Another block of researches includes works on infections, livestock diseases and genetic changes [4, 5, 7, 13, 18]. A number of authors pay attention to the problem of water availability, focusing on its shortage [8, 31], pollution and salinity [16]. A small number of studies are devoted to assessing the economic damage from the impact of weather risks on the livestock sub-sector [28].

The identified areas of research have been continued in the form of FAO models and information systems in the direction of the impact of climate on livestock. These are, for example, the system of independent and integrated assessment of the resilience of farmers and pastoralists to climate change [6], the domestic animal diversity information system (DAD-IS). Future animal habitats are modeled using “Hadley's Global Ecological Model #2”. The Global Livestock

Environmental Assessment Model (GLEAM) was developed by FAO to help assess scenarios for climate change adaptation and mitigation in the livestock sector. It allows calculation of livestock production, emissions and mitigation potential using the Tier 2 methodology of the Intergovernmental Panel on Climate Change (IPCC) [9].

Information systems and databases of the Russian Federation in this direction are characterized by significant fragmentation and a large time lag. In our study, we use data from the Federal State Statistics Service, as well as the Unified Interdepartmental Information and Statistical System (EMISS) on the development of agricultural production in the constituent entities of the Russian Federation. Operational information is presented in the reports of the Ministry of Agriculture of the Russian Federation and the Federal State Budgetary Institution "Federal Agency for State Support of the Agroindustrial Complex". Data on the number of hazardous weather events in the Russian Federation and other agrometeorological information were obtained using a specialized electronic platform of the World Agrometeorological Information Service (WAMIS), the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet).

When working with statistical data sets, methods of economic and statistical analysis were used, which made it possible to get an idea of the dynamics of adverse hydrometeorological phenomena in the classification groups of the regions of the Russian Federation and correlate them with the main indicators of the livestock sub-sector.

RESULTS AND DISCUSSIONS

For the distribution of subjects of the Russian Federation into classification groups, the share of livestock products in the region in the total volume of livestock products in the Russian Federation was taken as a key feature. The analysis included regions, in each of which, as of January 1, 2020, this indicator exceeded 0.1%. The sample included 75 subjects of the Russian Federation. Excluded were: Chukotka, Nenets and Yamal-Nenets Autonomous Areas, Murmansk Region, Republic of Tuva, Jewish Autonomous Region, Magadan Region, and the Federal cities – Moscow, S.-Petersburg and Sevastopol. The principle of constructing the classification is based on comparing data for the region with the average values of the corresponding indicator for the Russian Federation (Table 1).

According to the distribution results, the first group included regions that are leaders in the share of livestock products in the total volume of livestock products in the country: Krasnodar Territory, Voronezh and Belgorod Regions, and the Republic of Tatarstan. In the first group, the average indicator of livestock production in actual prices exceeded the corresponding indicator for the country by 4 times. The second classification group included regions located mainly in the Central zone with a temperate climate. Livestock indicators exceed the average for the Russian Federation by 2 times. The third group included the regions of the Siberian and Northwestern Federal Districts with more severe natural and climatic conditions. At the same time, the average livestock production indicators for the group reach the average level of similar indicators for the country. The fourth and fifth groups included regions characterized by a cold or arid climate.

Analysis of the obtained groups of regions in the space of climatic features showed the following feature. The average number of adverse weather events in the regions included in the first and fifth classification groups exceeds the average number of such events recorded throughout the Russian Federation.

In the period from 1991 to 2019, an average of 14.2 units per year was recorded in the regions of the first group, of which the largest share was rain, extreme fire hazard, and wind. In the regions with low productivity, included in the fifth group, the most frequent climate risks were floods, heavy rains and a combination of adverse weather events.

Table 1. Grouping of subjects of the Russian Federation by the average value of the share of livestock products of the subject in the total volume of livestock products of the Russian Federation for 1991–2019

	Number of regions of the Russian Federation	Subjects of the Russian Federation	The share of livestock products in the region in its total volume in the Russian Federation, (%)	Average indicator of livestock production (in actual prices; million rubles)	Average number of climate risks per year, units
		Russian Federation	1.23	23,851.8	10.1
1	4	Belgorod Region, Krasnodar Territory, Republic of Tatarstan, Voronezh Region	5.04	97,560.55	14.2
2	14	Leningrad Region, Chelyabinsk Region, Kursk Region, Moscow Region, Penza Region, Republic of Bashkortostan, Tambov Region, Bryansk Region, Sverdlovsk Region, Republic of Mordovia, Stavropol Territory, Novosibirsk Region, Lipetsk Region, Udmurtian Republic	2.46	47,612.99	7.9
3	20	Altai Territory, Pskov Region, Nizhny Novgorod Region, Tula Region, Republic of Mari El, Tyumen Region, Krasnoyarsk Territory, Irkutsk Region, Kaluga Region, Omsk Region, Kirov Region, Tver Region, Ryazan Region, Perm Territory, Yaroslavl Region, Vologda Region, Orel Region, Rostov Region, Republic of Daghestan, Kaliningrad Region	1.42	27,455.59	7.8
4	13	Orenburg Region, Tomsk Region, Novgorod Region, Vladimir Region, Volgograd Region, Kemerovo Region, Samara Region, Saratov Region, Chuvash Republic, Kabardino-Balkarian Republic, Smolensk Region, Republic of Crimea, Republic of Sakha (Yakutia)	0.76	14,736.46	7.7
5	24	Ivanovo Region, Kostroma Region, Karachayevo-Circassian Republic, Primorye Territory, Astrakhan Region, Republic of Kalmykia, Komi Republic, Ulyanovsk Region, Amur Region, Sakhalin Region, Kurgan Region, Kamchatka Territory, Republic of Buryatia, Republic of Adygeya, Arkhangelsk Region, Khanty-Mansi Autonomous Area–Yugra, Republic of Altai, Republic of Ingushetia, Chechen Republic, Republic of North Ossetia–Alania, Republic of Khakassia, Trans-Baikal Territory, Khabarovsk Territory, Republic of Karelia	0.27	5,295.08	12.9

Source: own calculations based on data [21].

The maximum number of dangerous weather events occurred in the Belgorod region. The share of livestock products produced by the region in the Russian Federation in 2020 amounted to 8.45%. The structure of producers is dominated by agricultural organizations (70.9%), the remaining 29.1% are small agricultural producers. In the Krasnodar Territory, 65.8% of farms are engaged in beef cattle breeding. More than half of the livestock production is produced by small farms in the Republic of Tatarstan and the Voronezh region. There is a high share of the private sector (up to 70%) in the structure of gross livestock production. There is a high level of self-sufficiency of personal subsidiary farms with pork and beef. A similar situation is typical for most regions with favorable natural and climatic conditions (Southern regions and regions of the Central Chernozem region). More northern regions are characterized by an increase in the share of PFHs and agricultural organizations in the structure of meat products producers (Fig. 1, Table 2).

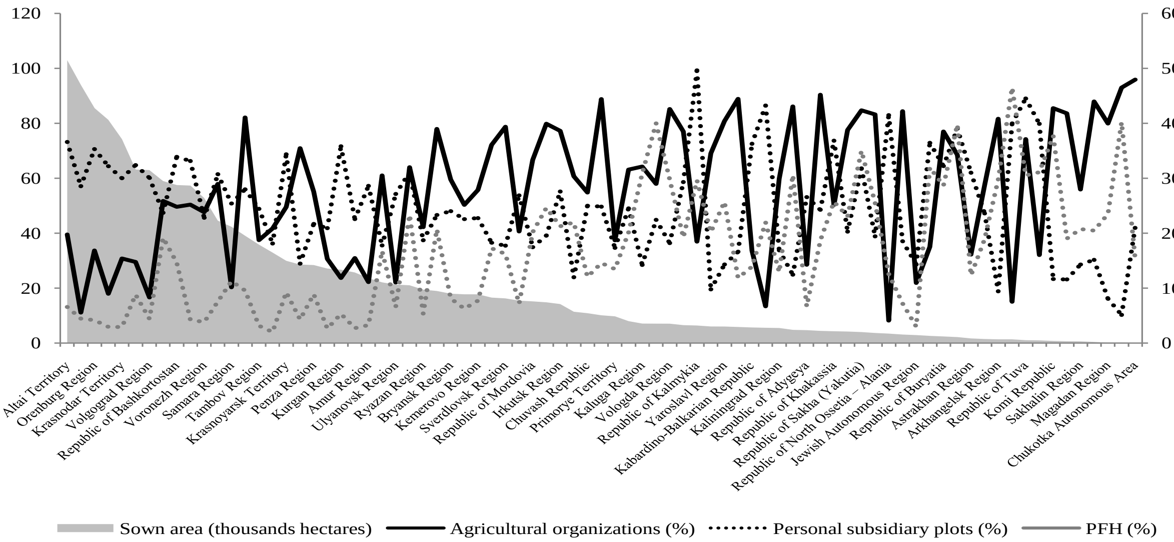

Fig. 1. The share of agricultural organizations, PFHs and households in the structure of livestock production
Source: Own calculations based on data [25].

Table 2. Top 20 subjects of the Russian Federation with the largest number of cattle as of 01/01/2021 (thousand heads)

The subject of the Russian Federation	Total	Agricultural organizations	PFHs	Households
Republic of Daghestan	462.6	42.9	69.2	350.6
Republic of Bashkortostan	386.8	114.5	67.5	204.8
Republic of Tatarstan	335.5	196.4	37.0	102.2
Rostov Region	302.1	37.7	79.8	184.6
Altai Territory	288,2	118.7	39.5	130.0
Republic of Kalmykia	258.3	28.5	134.6	95.2
Orenburg Region	239.9	72.5	48.2	119.2
Krasnodar Territory	212.2	128.2	22.1	61.9
Bryansk Region	205.6	187.1	8.1	10.0
Saratov Region	195.0	31.8	39.7	123.5
Novosibirsk Region	194.0	127.5	23.4	43.1
Trans-Baikal Territory	186.0	12.6	39.7	133.7
Voronezh Region	182.9	130.9	22.3	29.7
Volgograd Region	179.7	13.4	47.7	118.7
Astrakhan Region	156.4	5.3	55.1	96.0
Omsk Region	149.8	69.0	20.7	60.1
Stavropol Territory	142.5	34.3	31.3	76.9
Republic of Buryatia	140.3	19.8	22.8	97.8
Irkutsk Region	138.2	26.9	38.9	72.4
Krasnoyarsk Territory	135.5	72.3	17.0	46.2

Source: Compiled using data from [14].

Closed livestock systems in the form of large agricultural organizations and agricultural holdings better control the effects of climate risks, therefore they are less susceptible to their influence and more stable, unlike small agricultural producers. In this regard, it is advisable to consider the impact of weather anomalies on the dynamics of the production of the main types of farm animals by peasant (farm) households and household households (Fig. 2).

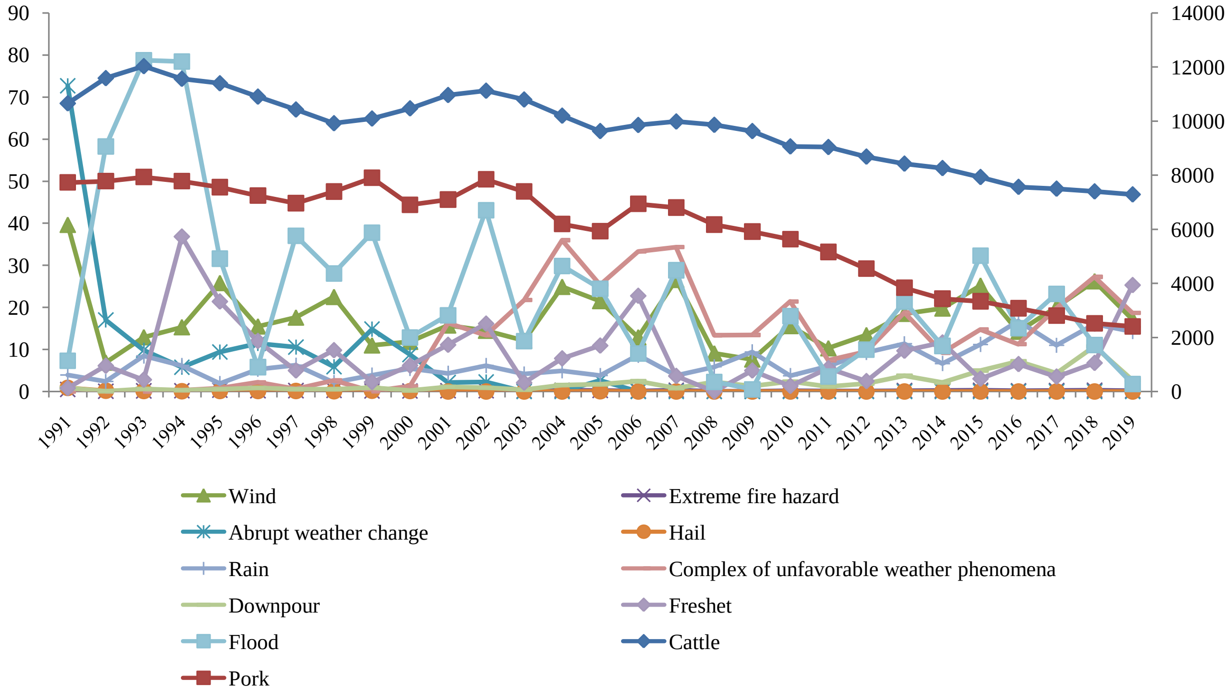

Fig. 2. The volume of the main types of livestock produced by small farms and the dynamics of adverse hydrometeorological phenomena recorded on the territory of the Russian Federation for 1991-2019.
Source: own calculations based on data from the Roshydromet [22].

There is an obvious general downward trend in the dynamics of the number of cattle and pigs raised by households and PFHs. It is due to a significant reduction in federal funding for the main measure of current support in crop production - unrelated support [26]. Most of the federal budget funds were redirected to provide preferential loans that provide for the transfer of compensation not to agricultural producers, but to credit organizations. Subsidies for dairy farming have also been reduced. Subsidies to increase productivity in dairy cattle breeding in the Russian Federation over the past three years have remained at the same level, which, taking into account inflation, has actually turned into a reduction in support. Unlike peasant (private) farms, subsidies for household farms are not available. For this category, separate support measures are provided only for keeping dairy cows, mares over 3 years old; construction of dairy mini-farms; acquisition of breeding stock of animals and birds. Against the background of general trends, one can note sharp fluctuations in the number of livestock in the years of maximum manifestation of weather anomalies.

The analysis showed that abnormally hot weather and extreme fire hazard have the greatest negative impact on the productivity of cattle and pigs. According to the classification proposed by the World Meteorological Organization, these categories include the value of the average daily air temperature above the climatic norm by 7 degrees or more in the period from April to September for 5 days or more. In accordance with the list of the main types of hazardous weather phenomena established by the World Agrometeorological Information Service, weather temperature values exceeding 10,000°C according to the Nesterov formula are considered extreme fire hazards [29, 33].

Heat stress is an urgent problem for beef cattle breeding in most regions of the Russian Federation focused on this sub-sector. An increase in temperature leads not only to the direct death of livestock. According to experts, it is expected that water consumption by farm animals will increase by 3 times [16], the demand for agricultural land will increase due to the need to increase the production of crops for livestock feed [23].

Changes in temperature regimes lead to a shift in natural zones, a change in the growing season, a change in the species diversity of cultivated crops, etc. [20]. An indirect impact on the cultivation of farm animals is a decrease in the quality of feed and its consumption, which leads to a negative energy balance and a decrease in livestock weight gain. An example is the prolonged abnormal heat in 2021 on the territory of the Republic of Bashkortostan. Due to the drought, about 200 thousand hectares of grain crops perished. To date, the Ministry of Agriculture of the Russian Federation has not worked out such an important adaptation mechanism as the "fodder" mutual assistance of farms in the conditions of the current shortage. Farmers faced limitations such as the poor quality of hay, fodder and feed grains. In general, in the Russian Federation, a combination of general economic trends and the impact of the climate factor led to a decrease in the number of cattle in 2021 by 1.5-2%.

Indirect effects are associated with changes in ecosystem parameters and their impact on microbial communities (pathogens or parasites), the spread of vector-borne diseases, and foodborne diseases [12]. For example, White et al. modeled the impact of climate change on livestock using the example of Australian regions and found that as a result of increased tick infestation, livestock lost up to 18% of their weight [32]. In the northern regions of the Russian Federation (Arkhangelsk and Vologda regions), with an increase in the average ambient temperature, an increase in eye and mouth diseases in deer and other ungulates was recorded. Studies show that changes in temperature regimes and relative humidity adversely affect the health of cattle and their reproductive function [1, 2, 15].

Livestock production may also be limited by a number of other factors related to climate variability. Such unfavorable weather phenomena of a hydrometeorological nature as floods and floods cause direct damage to the development of animal husbandry. In the regions of the Russian Federation with a high probability of such a risk, during the years of peak activity, the damage reached 30% of the number of cattle. In addition, floods affect the shape and structure of plant roots, change the rate of leaf growth. This is the reason for the decrease in yield and lack of feed. Hurricane winds (when the speed reaches 33 m/s or more) and tornadoes also cause direct damage to animal husbandry.

The most important task of state regulation of the development of the national agro-food complex is the formation of conditions for the financial stability of agricultural producers. This is a factor in the rational use of the available resource potential and, in particular, the sustainable development of the livestock sub-sector of agriculture.

In the system of mechanisms for adapting agricultural systems to the consequences of climate change, the most effective and popular in the Russian Federation is agricultural risk insurance with state support. As part of the implementation of measures to improve the efficiency of the livestock sub-sector in 2020, 66 out of 85 constituent entities of the Russian Federation took part in the implementation of subsidized agricultural insurance programs. During the campaign, 8,103.4 thousand conditional heads were insured. The insured livestock accounted for 28.0% of the total livestock of farm animals in the constituent entities of the Russian Federation [17]. The leader in 2020 was the Tambov region, in which up to 96% of the available livestock were covered by insurance policies, which was the maximum indicator among all subjects of the Russian Federation.

CONCLUSIONS

Summarizing, we can conclude that changes in the parameters of the climate system have the greatest impact on the development of animal husbandry through indirect relationships. For example, reduced crop yields and lack of fodder, problems with access to water resources, etc.

The main climatic trigger for livestock reduction is heat stress, which results in a complex of such negative consequences as a decrease in animal reproduction, the emergence of new pests, diseases and methods of their transmission, genetic variability, etc. Such extreme weather events as hurricane winds, tornadoes, and floods have a direct impact on animal husbandry.

Using the classification method, groups of regions of different livestock specialization were identified. An analysis of the obtained groups in the context of climatic features showed that the regions included in the first and fifth classification groups are the most exposed to weather risks. The most vulnerable category of producers in the livestock sub-sector are small farms.

The concept of sustainable development of the Russian agro-food complex should take into account the current climate trend, which requires the development of differentiated strategies for the development of industries within the framework of regional strategic planning documents. An analysis of the dynamics of adverse hydrometeorological phenomena in the context of the regions of the Russian Federation in the livestock specialty made it possible to conclude that the consequences of climate change have different effects on different regions. It is expected that in the future this may make adjustments to the strategic planning system in the Russian Federation in terms of the methodology for determining macroregions.

Sustainable development of the livestock sub-sector, in particular, requires the development of an adaptation strategy that should take into account the availability of water resources, ensuring the balance and redistribution of the feed base, the implementation of veterinary measures, the development of appropriate state support mechanisms that should help stabilize the financial condition of economic entities of various organizational and legal forms. engaged in cattle breeding.

The results of the study can provide a scientific basis for developing recommendations for improving state regulation and supporting the development of small businesses in the agro-industrial complex. The author's approach to the study of the response characteristics of different types of agricultural producers to changes in the natural and climatic ecosystem will allow developing and implementing strategic development programs, determining the directions of state regulation and the need for state support. The data obtained can become one of the bases for recommendations for improving the institutional model of state regulation of the Russian agro-food complex.

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ECONOMICS OF CAT FISH PRODUCTION IN OSUN STATE, NIGERIA

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Abstract

The economics of catfish production in Osun State was explored in this study. To choose 80 cat fish producers for the study, a multi-stage sampling technique was used. Descriptive statistics, farm budgeting approaches, and the OLS regression model were used to examine the data. The average age was 40 years, the average years of experience was 6, and the average household size was four people. Personal income (4.50) is the most important source of finance for the respondents' fish farming business, and money lenders (1.45) is the least important source of finance for the respondents' fish farming business. The results also revealed that disease and poor preventive measures (4.20) are the most significant constraints impacting catfish production, while a lack of fingerling supply (2.48) is the least significant constraint. Farmers incurred an average total cost of N 1,677,699.00, with a returning gross margin of N905,668 and net returns/profit of N 206,341. The findings also revealed that the farmers' benefit cost ratio (1.1229) is larger than one, and their gross ratio is 0.8905. The profitability of cat fish production was strongly influenced by pond building cost, startup capital, labor cost, feed cost, and the number of fishes, according to the ordinary least squares regression estimations. The findings show that the catfish farming business is profitable and viable. Cat fish production, on the other hand, would be more profitable if the expenditures of feeding, pond construction, and labor could be reduced. As a result, governments should encourage more people to engage in the industry by subsidizing the inputs available to producers. In addition, farm hygiene and security measures should be recommended to address the issue of ineffective preventive measures as well as the problem of predators and poaching.

Key words: *profitability, cat fish, production, Osun State*

INTRODUCTION

Fish is a valuable and inexpensive source of animal protein that has no religious or cultural stigma attached to it. Fish accounts for roughly 40% of an average Nigerian's animal protein consumption [5; 6; 7], which has helped to alleviate anemia, kwashiorkor, and other malnutrition-related illnesses [13]. It also acts as a source of raw materials for industry and is a key component of animal feed [4].

Fish production generates almost one-third of Nigeria's Gross Domestic Product (GDP) [2], in addition to its consumption and nutritional benefits. Furthermore, it provides full-time employment to a large number of people, as the nation's active population earns a living both directly and indirectly through fisheries-related activities [13]. Despite these enormous potentials and opportunities, domestic fish production, at 0.62 million metric tons, falls short of demand, which is 2.66 million metric tons [7].

To meet Nigeria's ever-increasing demand for fish, a supply of 2.04 million metric tons is necessary, which is currently met through importation [9]. Nigeria imports around ₦288 billion worth of fish every year [3]. These figures reveal a significant discrepancy between supply and demand. As a result, Nigerians should increase their fish production through aquaculture [1].

Currently, many fish farmers work on a small scale, with ponds ranging from homestead concrete ponds (25–40 meters) to small earthen ponds (0.02–0.2 hectares), and the most commonly cultured fish species are catfish, tilapia, and carp [13], though the majority of fish farmers in Nigeria focus on catfish. This can be attributed to a variety of characteristics of cat fish.

Cat fish, for example, adapt to their surroundings, can be easily retailed live at a premium market price, are appropriate for stocking in ponds, handle low dissolved oxygen better, are a rich source of high-quality protein, and are widely accepted as food in Nigeria [12].

Despite these positive features, catfish production remains low. This has been attributed to the fact that the profitability of the catfish business has received little attention [15]. For the long-term survival of the business, a thorough and complete review of the profitability of catfish production is required. For example, if you want to start catfish farming, you must first understand the costs and prospective profits so that you can make the required preparations. Many people enter the catfish business with little economic knowledge of the industry's opportunities and limitations. As a result, due to a lack of sufficient knowledge about the profitability of the agriculture they are embarking into, some make a loss or go out of business after a few years of operation.

Catfish production entails not only the control of biological processes, but also the financial aspects of the business [10]. As a result, the absence of economic data on catfish production makes it difficult to promote its commercialization and persuade investors that it is a viable business [8; 14].

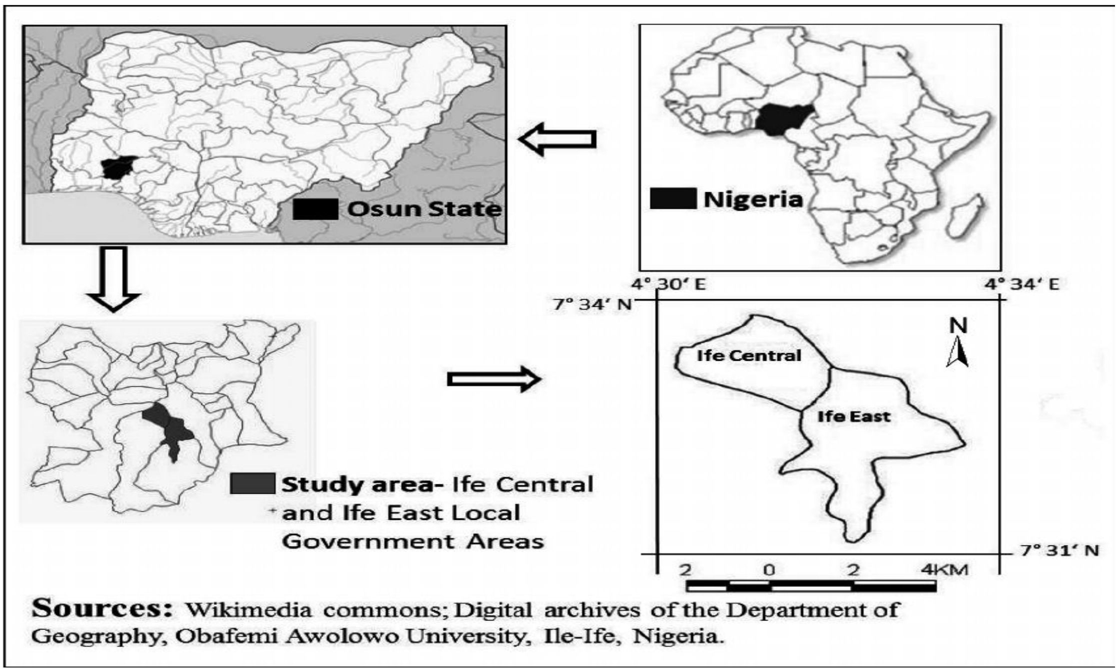
A realistic analysis that offers information on the profitability of catfish farming and the limits to its production, which is the focus of this study, would result in a significant increase in catfish output.

Consequently, the study investigated the economics of cat fish production in Osun State, Nigeria. Specifically, the study describes the socio-economic characteristics of cat fish producers; identifies the main sources of financing for cat fish production; identifies the constraints affecting cat fish production; analyzes the cost and returns to cat fish production; and determines the factors affecting profitability of cat fish production.

MATERIALS AND METHODS

The study area

The study was carried out in Osun state, particularly Ife zone which is an ancient Yoruba city in South-western Nigeria. Osun state lies within latitudes 6° and 9° N of the equator and approximately between longitudes 2° and 7° E of the Greenwich meridian (Map 1).



Map 1. Map of Nigeria, the position of Osun State and Ife Central and East Local Government areas
Source: Wikimedia commons: Digital archives of the Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria.

Osun state is divided into six (6) zones: Iwo, Ikirun, Ilesha, Oshogbo, Ede, and Ile-Ife. Ile-Ife also known as Ife zone is made up of four local government area namely Ife central local government, Ife north local government, Ife south local government and Ife east local government (Map 1).

Ife is about 218 kilometers Northeast of Lagos with a population of 755,260 inhabitants. It is located between longitudes 4°, 30 East and 4°, 34 East and latitudes 7°28 North and 7°45 North of the Equator.

The area is recognized for two distinct seasons: the dry season and the rainy season.

The wet season runs from March to October, and the dry season runs from November to late March.

Ife's residents are largely food crop farmers who are well-known for their palm wine, palm oil, and other agricultural products. Aside from that, they engage in fish farming as a farming activity.

Data and sampling procedure

A multistage sampling procedure was used to select respondents for the study. The first stage involved purposive selection of Ile-Ife zone out of the six zones present in Osun State based on the predominance of cat fish production in the LGAs. The second stage also involved purposive selection of four local governments under Ile-Ife zone based on the predominance of cat fish production in the areas. The local government area selected includes: Ife Central, Ife North, Ife South and Ife East local government. The third stage involved selecting 20 respondents from each of the four local governments using simple random technique. In all, 80 cat fish farmers were selected for the study.

Analytical techniques

Descriptive statistics, farm budgetary technique and ordinary least squares regression model were used to analyze the data collected.

Descriptive statistics

Descriptive statistics such as mean and percentage were used to describe socio-economic characteristics of the cat fish farmers, identify the main sources of financing for cat fish production and the constraints affecting cat fish production

Farm budgetary technique

The cost and returns of catfish production were studied using a farm budgeting technique. Cost and revenue components are included in the farm budgeting technique. The revenue component represents the monetary value derived from total production sales.

Mathematically, it is expressed as follows:

$$TR = P \times Q \qquad \ldots(1)$$

where:

P is the price of output per unit, and Q is the quantity of output.

The total cost of production refers to the total expenditure or expenses incurred by the firm on a specific enterprise during a given period.

These expenses include land rent, pond construction costs, fingerling costs, feed costs, and so on. Fixed costs, which do not vary with the production process, and variable costs, which do vary with the production process, were among the cost components. The straight-line method was used to calculate depreciation, which is the cost of fixed assets consumed over time. It is expressed as follows:

$$D_T = \left(P - L\right) \div N \qquad \ldots(2)$$

where:

D_T =depreciation; P= cost of assets; L= salvage value; N= no of economic life.

Profitability model was expressed as follows:

$$TR = P \times Q \qquad \ldots. \qquad (3)$$

$$TC = TVC + TFC \qquad \ldots \qquad (4)$$

$$GM = TR - TVC \qquad \ldots \qquad (5)$$

$$\Pi = TR - TC \text{ or } GM - TFC \quad \text{(Depreciated value)} \qquad \ldots \qquad (6)$$

$$BCR = TR \div TC \qquad \ldots \qquad (7)$$

$$GR = TC \div TR \qquad \ldots \qquad (8)$$

where:

TR= Total Revenue or Total Income; Q= Quantity; P=Price; TC=Total Cost; TVC=Total Variable Cost; TFC= Total Fixed Cost; GM= Gross Margin; Π= Profit; BCR= Benefit Cost Ratio; GR= Gross Ratio.

Ordinary least squares regression (OLS) model

The parameters that affect the profitability of catfish production were determined using an OLS regression model. The OLS regression model was used because it models the exogenous relationship between socioeconomic circumstances and the profitability of the catfish business decisions made by the producers. The model was chosen based on the premise that the error term (ei) is normally distributed, and as a result, its estimator is normally distributed, linear, and unbiased.

The model for the regression was specified thus:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \ldots\ldots\ldots \beta_8 X_8 \qquad \ldots \qquad (9)$$

= Profitability of cat fish producers(₦)

The explanatory variables are:
X_1 = Pond Construction (₦);
X_2 = Startup capital (₦);
X_3 = Cost of lime (₦);
X_4 = Fingerling’s cost (₦);
X_5 = Labour cost (₦);
X_6 = Feed cost (₦);
X_7 = Number of fishes
X_8 = Years of experience.

RESULTS AND DISCUSSIONS

Socio-economics characteristics of the cat fish producers

Table 1 shows the socio-economic characteristics of catfish producers. The participants' average age is around 40 years old. This shows that the catfish industry employs young and active people. Males make up the majority of the respondents (72.2%). Males are more involved in catfish production than females, according to the findings. The majority of the respondents (74.4%) are married. The findings reveal that married people engage in the catfish business. Also, majority of the respondents had formal education (83%). The findings reveal that educated people work in the catfish industry.

The respondents' average family size is roughly four, with an average dependence size of two. This demonstrates that cat fish farmers do not have enough family members to help them with their business. Farmers' cooperatives are only represented by a small percentage of the respondents (23.8%). The findings suggest that the vast majority of respondents do not belong to a farmers' association, as only a small fraction do. The respondent has an average of 6 years of experience. This demonstrates that the catfish producer has a limited level of experience. This means that the majority of catfish farmers in the study area are amateurs.

Table 1. Socio-economic Characteristics of cat fish Farmers

Variables	Cat fish farmers
Male (%)	72.2
Age (years)	40.46(±7.93)
Married (%)	74.4
Household size (#)	3.78 (±1.35)
Formal education (%)	82.6
Years of farming experience	6.34(±2.82)
Dependency (#)	2.28(±1.84)
Cooperative (%)	69.2

Source: Field survey, 2020.

Main sources of financing for cat fish production

Main sources of financing for cat fish production is presented in Table 2. Six major sources were identified and studied. Personal income ($\bar{x}$=4.50) is the most important source of finance for the respondents’ fish farming business as it ranked the highest, followed by family and friends (2.63), cooperative societies ($\bar{x}$ =1.85), bank loan ($\bar{x}$ =1.73). Agricultural corporation ($\bar{x}$ =1.48) is the second to the least financial source for the respondents’ fish farming business. However, money lenders ($\bar{x}$=1.45) is the least financial source for the respondents’ fish farming business.

The result shows that personal savings is however, the main source of financing for cat fish production.

Table 2. Main sources of financing for cat fish production

Sources	SD (%)	D (%)	U (%)	A (%)	SA (%)	MEAN	STD	RANK
Personal income	0	0	3.75	42.5	53.75	4.50	0.57	1
Family and friends	16.25	30	28.75	25	0	2.63	1.04	2
Cooperatives	48.75	27.5	13.75	10	0	1.85	1.01	3
Bank loan	46.25	40	8.75	5	0	1.73	0.83	4
Agricultural loan	57.59	37.5	5	0	0	1.48	0.59	5
Money lender	60	35	5	0	0	1.45	0.53	6

Source: Field Survey, 2020. SD: Strong disagree; D: Disagree; U=Undecided; A=Agreed; SA= Strongly agreed

Constraints affecting cat fish production

Constraints affecting cat fish production are presented in Table 3.

Twelve constraints are identified and studied. Disease and poor preventive measures ($\bar{x}$=4.20) are ranked the highest among the constraint affecting cat fish production, followed by poaching (4.19). Inadequate knowledge about fish farming ($\bar{x}$=4.05) is ranked the third highest among the production constraint, followed poor demand by consumers ($\bar{x}$=3.78), lack of market ($\bar{x}$=3.64), lack of access to credit ($\bar{x}$=3.43), lack of availability of feed ($\bar{x}$=3.33), low level of education ($\bar{x}$ =3.28), shortage of water ($\bar{x}$=3.20), lack of labour ($\bar{x}$=3.13). However, inadequate supply of fingerlings ($\bar{x}$=2.48) is ranked the least among the production constraint. The result implies that disease and poor preventive measures are the main constraints affecting cat fish production.

Table 3. Constraints affecting cat fish production

Sources	SD (%)	D (%)	U (%)	A (%)	SA (%)	MEAN	STD	RANK
Diseases and poor management	1.3	5	1.3	57.5	35	4.20	0.80	1
Poaching	62.5	6.3	0	0	31.3	4.19	0.73	2
Inadequate knowledge	7.5	5	3.8	42.5	31.3	4.05	1.15	3
Poor demand by consumers	11.4	0	17.5	53.8	17.5	3.78	0.87	4
Lack of market	13.8	2.5	18.8	47.5	17.5	3.64	1.00	5
Lack of access to credit	6.3	21.3	17.5	33.8	21.3	3.43	1.22	6
Lack of feed	17.5	11.4	22.5	18.84	30	3.33	1.46	7
Low level of education	8.8	20	17.5	42.5	11.3	3.28	1.17	8
Shortage of water	7.9	15	43.8	17.5	16.3	3.20	1.12	9
Lack of labour	11.4	16.5	31.6	29.1	11.4	3.13	1.17	10
Government policy	28.9	15.8	21.1	14.5	19.7	2.8	1.497	11
Inadequate supply of fingering	30	23.8	16.3	28.8	1.3	2.48	1.232	12

Source: Field Survey, 2020 SD: Strong disagree; D: Disagree; U=Undecided; A=Agreed; SA= Strongly agreed.

Cost and return to cat fish production

Table 4 presents the costs and returns to cat fish production using average cost of both costs incurred and yield or output data generated by each of the respondents in the last season. The cost of feed accounted for the largest proportion (48.9%) of the total cost of fish farming. This is followed by the cost of labour (3.6%), cost of fingerlings, (2.1%), electricity cost (1.1%), transportation cost (0.8%) and miscellaneous (0.8%), followed by cost of fertilizer (0.6%), security cost (0.4%) and to the least cost, cost of lime (0.1%). The fixed cost consists of land cost, rent, pond construction cost, water pump, pond equipment among other. This accounts for 42% of the total cost. It is evident from the result that an average total cost of ₦ 1,677,699.00 was incurred by the farmers while a returning gross margin of ₦905,668 and the net returns/profit of ₦ 206,341 was realized. The result further revealed that the benefit cost ratio (1.1229) is greater than one for the farmers. The gross ratio for the farmer is 0.8905. This implies for every 89 kobo spent on cat production, ₦ 1.00 returns to the enterprise. These measures of performance indicate business of cat fish production is viable and profitable. This result is in line with previous studies such as [1; 4; 9; 13; 2; 11].

Table 4. Cost and return to cat fish production

Items	**Cost (₦)**	**TVC (%)**	**TC (%)**
A. Variable cost			
Transportation	12,645	1.3	0.8
Fertilizer	10,000	1.0	0.6
Lime	2,173	0.2	0.1
Security	6,852	0.7	0.4
Feed	820,735	83.9	48.9
Labour	59,573	6.1	3.6
Fingerlings	34,844	3.6	2.1
Electricity	18,702	1.9	1.1
Miscellaneous	12,848	1.3	0.8
Total variable cost	978,372	100	58.3
Items	Cost ₦)	TFC (%)	TC (%)
B. Fixed cost			
Land	207,029	29.6	12.3
Pond	126,367	18.1	7.5
Water pump	135,175	19.3	8.1
Pond equipment	18,231	2.6	1.1
Rent	134,609	19.2	8.0
Total fixed cost	699,328	100	42
C. Total cost	1,677,699		
D. Total Revenue	1,884,040		
E. Gross margin	905,668		
F. Net returns	206,341		
G. Benefit cost ratio	1.123		
H. Gross ratio	0.891		

Source: Field Survey, 2020.

Factors affecting profitability of cat fish production

The factors affecting profitability of cat fish production are presented in Table 5. The R-Square was 0.630. This suggests that 63.0% of the variability in the profit of the respondents is jointly explained by variations in the independent variables specified in the model. The F-ratio (28.93) was statistically significant at 1 percent level.

Table 5. Factors affecting profitability of cat fish production

Profitability	**Coefficient**	**Std. Err.**	**t**	**Sig**
Pond Construction Cost	-1.5458**	0.610489	-2.53	0.045
Startup capital	0.0416 **	0.083893	2.50	0.028
Lime	-0.6112	0.29072	-2.1	0.156
Fingerlings cost	-0.2199	0.092248	-2.38	0.331
Labour cost	-0.7947 ***	0.184324	-4.31	0.001
Feed cost	-0.8334 ***	0.102975	-8.09	0.000
Number of fishes	0.5525***	0.195348	2.83	0.004
Years of experience	0.0924	0.128287	0.72	0.484
_cons	4.6173**	6.293728	2.73	0.006

Source: Field Survey, 2020 ***, **and * indicated variables that are significant at 1; 5 and 10 percent respectively
R^2 = 0.63 Adjusted R^2 =0.59 F-test = 28.93

From Table 5, pond construction cost, startup capital, labour cost, feed cost and number of fishes significantly influenced profitability of cat fish production.

The coefficients of startup capital and number of fishes had positive signs. This implies that increase in any of these variables increases the profitability of cat fish production. There is positive relationship between value of fish and startup capital. This implies that increase in the initial capital investment increases profitability of cat fish business. Catfish farming doesn't require a very high initial capital investment. However, huge start-up capital ensures the success and the profitability of the business.

There is a positive relationship between value of fish and quantity of fish which indicates that increase in the number of fishes, more revenue will be realized. The reason cannot be farfetched because revenue is directly proportional to the quantity of fish produced.

However, the coefficient of pond construction cost, labour cost and feed cost had negative sign. This implies that increase in any of these variables decreases profitability of cat fish production. As a result, the more money spent on labor, pond building, and feeds, the less money is made from fish farms in the research area. This necessitates policies that ensure that fish farming inputs are available at affordable prices, making the industry more sustainable. Additionally, in order to grow their earnings from the business, cat fish farmers must be prudent in their spending

It's also worth noting that, as indicated in Table 5, the total sum of the significant variables' production elasticities is less than 1.

This indicates that catfish output in the area of study is declining. This means that a marginal increase in the unit of inputs will lead to a marginal rise in the value of fish output, but at a slower rate.

This indicates that the research area's cat fish farmers are in the second stage of production.

CONCLUSIONS

This study investigated economics of cat fish production in Osun State. A multi stage sampling procedure was employed to select 80 cat fish producers for the study. Data were analyzed using descriptive statistics, farm budgetary techniques and OLS regression model. The study concluded that majority of the cat fish producers are male and at their productive age. The business of cat fish production is profitable and viable. Pond construction cost, startup capital, labour cost, feed cost and number of fishes significantly influenced profitability of cat fish production. However, cat fish production would be more profitable, if the costs of feeding, constructing ponds and labour could be controlled. As a result, governments should encourage more individuals to participate in the business by subsidizing these inputs and recommending farm hygiene and security to address the problem of poor preventive measures as well as the problem of predation and poaching.

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RESEARCHES ON THE RELATIONSHIP BETWEEN LINEAR TYPE TRAITS AND PRODUCTIVE LONGEVITY OF COWS OF UKRAINIAN BROWN DAIRY BREED

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Abstract

The phenotypic relations between type traits and longevity indices in cows of Ukrainian Brown dairy breed in the Sumy region of Ukraine were analyzed. Linear estimation was performed according to ICAR recommendations (2014). In this study 18 traits of type are considered. The average lifetime of cows was 6.7 years, which corresponding to an average productive use of 4.67 years. Longevity yield for cows amounted to an average of 21,517 kg of milk, or 8.8 kg per one day of life, or 13.3 kg per day of productive use. Phenotypic correlations were between final assessment and lifetime (r=0.321), longevity milk yield (r=0.398) and milk fat (r=0.369). In general, phenotypic correlations between linear traits of type and longevity traits varied from -0.192 to 0.422. Sufficient levels of correlations indicated that indirect selection on the basis of height (r=0.122-0.209), body depth (r=0.209-0.268), angularity (r=0.318-0.422), rump width (r=0.226-362), front udder part attachment (r=0.275-0.396), rear udder part attachment (r=0.254-342), central ligament (r=0.245-371), udder depth (r=0.228-0.244) and body condition score (r=-0,192…-0,378) can lead to an effective improvement of cows longevity traits.

Key words: *Ukrainian Brown dairy breed, longevity, linear type traits, correlation*

INTRODUCTION

Longevity of cows, as a selective trait, significantly affected the profitability in dairy industry and allowed to reduce the number of selection traits [35]. The problem of longevity has been an urgent and strategic question in the breeding of animals, as evidenced by numerous studies of scientists all over the world. Therefore, longevity and productivity in dairy cows become the important traits among selection criteria, which closely related to economic efficiency of milk production [11, 12, 14, 25, 17].

From the viewpoint of breeding, productive longevity of cows is quite complex integrated trait that was determined significantly by genetic factors. Unfortunately, the achievement of rapid breeding progress by direct selection on the basis of longevity of dairy cattle has been limited due to the low heritability of longevity from 0.03 to 0.07 [45, 31, 44, 18 29] and time required to accumulate sufficient data for estimating breeding value of animals [39, 9, 22]. In this respect, it was necessary to find and use traits – predictors of longevity. This was especially important in the current conditions of intensive physiological loading on animals. In this aspect, the practice of breeding dairy cattle had proved that animals with a high score for conformation type, with desired dairy forms, strong legs, well-developed morphological udder traits were characterized not only by high performance, but also by strength, resistance to physiological loads, the ability to maximize their genetic productivity potential [40, 4, 2, 36]. Individual conformation traits can be used as predictors of longevity and productivity through their high and average heritability [8, 30, 10, 6, 26, 19].

This conclusion has been confirmed in many studies by genetic, phenotypic correlations among conformation traits and milk productivity, and duration of use cows of different breeds [24]. [33] found positive genetic correlations between longevity and udder traits, and angularity (from 0.22 to 0.48). [1] reported that genetic correlations between milk yield and body structure (except stature-ST and body depth-BD) were positive in the range from 0.188 (rump width-RW) to 0.823 (heart girth-HG) According to [37], genetic correlations among conformation traits and productivity indicated that higher-yielding cows had more angular forms, deeper udder, good rear teats placement, a high rear udder attachment, moderate body condition, strong central ligament and confident locomotion.

While studying the phenotypic and genetic relationships of three locomotion traits with profit, traits of productivity, longevity and fertility, [30] determined the importance of movement traits for production of dairy products. Feet and legs were the traits most genetically correlated to profit although a low value (0.10) was obtained, whereas RLS was the trait most correlated to milk production (0.12). Genetic correlations between LP, FA, RLS, and longevity traits (from –0.10 to 0.05) were low.

[10] found that rump width was positively correlated with milk productivity traits in Holstein and Red-and-White cattle, but was negative in cows of Brown Swiss breed. Therefore, they believed that conformation traits generally can be used as predictors for various purposes in dairy cattle breeding, but may require specific adaptation for each breed.

The purpose of this study was to evaluate the effect of linear type traits on the performance and longevity indicators of the Ukrainian Brown dairy cows breed in adaptation to the conditions of Sumy region of Ukraine.

MATERIALS AND METHODS

Research of relationship between indicators of longevity productivity and type traits was conducted using the data of linear assessment firstborn cows of the created Ukrainian Brown dairy breed (UBDB) in the five farms in Sumy region of Ukraine.

The dataset consisted of records about productive and linear type traits of 1,519 cows collected from January 1st 2006 to December 31st 2016.

The longevity of cows was calculated as the number of days between date of birth and date of withdrawal. Linear assessment was performed according to the recommendations made by [15].

Linear type traits were determined only in cows of the first lactation, classified from 15 to 150 days after calving.

In this study 18 linear type traits: stature (S), chest width (CW), body depth (BD), angularity (A), rump angle (RA), rump width (RW), rear legs side view (RLSV), rear legs rear view (RLRV), foot angle (FA), fore udder attachment (FUA), rear udder height (RUH), central ligament (CL), udder depth (UD), fore teats placement (FTP), rear teats placement (RTP), teats length (TL), locomotion (L), and body condition score (BCS) were considered. 18 linear type traits included in the analysis are given in Table 1. The minimum and maximum deviations of linear traits were estimated in absolute units of measurements on a specific 9 point-scale.

Some type traits, such as angularity, rump angle, rear legs set, locomotion and body condition score were estimated more subjectively, because classifiers took into account a number of appearance aspects when assigning scores to the cow.

Other traits were scored more objectively, because they have been defined as measurement indicators. Only classifiers with more than 30 estimated animals were considered in the experiment.

The true longevity of cows was calculated as the number of days between date of birth and date of culling.

Longevity milk yield was calculated as the sum of the cow milk yield for lactation used during productive use.

Longevity yield of milk fat was determined as the amount of milk fat for used lactation during the productive life of cows.

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Table 1. Description of linear type traits using nine-point scoring range

Standard Traits	Score – min=1		Score – max=9	
Stature	Short	<128 cm	Tall	>150 cm
Chest Width	Narrow	<17 cm	Wide	>32 cm
Body Depth	Shallow body	<61 cm	Deep body	>81 cm
Angularity	Lacks angularity close ribs coarse bone		Very angular open ribbed flat bone	
Rump Angle	High pin bones		Sloped	
Rump Width	Narrow	<16 cm	Wide	>24 cm
Rear legs side view	Straight	>158°	Sickled	<136°
Rear Legs Rear View	Extreme toe-out		Parallel feet	
Foot Angle	Very low angle	<25°	Very steep	>61°
Fore Udder Attachment	Weak and loose	<90°	Extremely strong and tight	>161°
Rear Udder Height	Very low	<26 cm	High	>11 cm
Central Ligament	Convex to flat floor (flat)	0	Deep/strong definition	>6.5 cm
Udder Depth	Udder floor below hock	<-1-2 cm	Udder well above hock	>20 cm
Front Teat Position	Outside of quarter	>19cm	Inside	<4 cm
Rear Teat Position	Outside	>15 cm	Crossing	<0 cm
Teat Length	Short	<1 cm	Long	>9 cm
Locomotion	Severe Abduction/Short Stride		No Abduction/Long Stride	
Body condition score	All profiles extremely concave		All profiles extremely rounded	

Source: [21].

Basic statistical data of the linear type traits (calculated on a 9-point scale) in cows included an average value (x), standard error of linear traits (SE), standard deviation (SD), coefficient of variation (CV %), minimum (Min) and maximum (Max) deviation of economic and linear traits, correlation coefficient (r) between linear type traits and lifetime of cows, quantity of received milk and milk fat per life.

The coefficient of linear correlation was determined by formula of Pearson:

$$r_{xy} = \frac{\sum(x_i - \bar{x}) \times (y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \times \sum(y_i - \bar{y})^2}}$$

where:

x_i – value for variable X;

y_i – value for variable Y;

$\bar{x}$ – average value for X;

$\bar{y}$ – average value for Y.

RESULTS AND DISCUSSIONS

Ukrainian Brown dairy breed was created by interbreed crossing method between the cows of aboriginal Lebedyn cattle and Brown Swiss breed of German, American and Austrian breeding. The purpose of creation of Ukrainian Brown dairy breed was to transform Lebedyn cattle of a combined type (dual purpose breed) to a specialized dairy breed. The new created breed should be characterized by a high milk productivity and strong conformation type, and well adapted to the local feeding and technological conditions of housing. The definition of these important animal abilities of newly created breed was the aim of our research.

The conformation of cows, estimated using linear type traits, served as the basis for all modern type classification systems and foundation for systems of dairy cows description [15].

The data of average values and variability of estimated economic and linear type traits of firstborn cows Ukrainian Brown dairy breed have been presented in Table 2.

The average lifetime of experimental cows of Ukrainian Brown dairy breed was 6.7 years that corresponded to an average productive use of 4.67 years. Longevity milk yield of cows amounted to an average of 21,517 kg of milk, or 8.8 kg per day of life, or 13.3 kg per day of productive use. Longevity milk fat in cows was an average of 819.5 kg with moderate fat content of 3.81%.

Table 2. The average value and variability of cow linear type traits

Linear type traits	x ± S.E.	SD	Cv (%)	Min	Max
Lifetime, days	2,446±19.6	764	31.2	1,142	5,905
Longevity milk yield, kg	21,517±243.0	9,471	44.0	9,014	58,223
Longevity milk fat, kg	819.5±9.25	360	44.0	250.2	2,148.7
Stature (height at sacrum), cm	144.0±0.07	2.7	1.9	139	152
Stature	5.6±0.035	1.35	24.0	1	9
Chest Width	6.2±0.033	1.31	21.0	1	9
Body Depth	6.9±0.044	1.71	24.8	1	9
Angularity	6.7±0.039	1.51	22.7	2	9
Rump Angle	5.1±0.024	0.92	18.1	2	8
Rump Width	5.8±0.024	1.04	18.0	1	9
Rear legs side view	5.1±0.034	1.33	26.0	1	9
Rear Legs Rear View	6.1±0.039	1.52	24.8	1	9
Foot Angle	5.2±0.033	1.30	24.8	1	9
Fore Udder Attachment	6.1±0.033	1.30	21.3	2	9
Rear Udder Height	5.5±0.035	1.38	25.2	1	9
Central Ligament	6.2±0.038	1.50	24.2	1	9
Udder Depth	6.3±0.037	1.43	22.9	1	9
Front Teat Position	4.5±0.034	1.33	29.9	2	8
Rear Teat Position	5.1±0.032	1.24	24.2	2	9
Teat Length	5.5±0.031	1.20	22.0	3	9
Locomotion	6.1±0.043	1.69	27.5	1	9
Body condition score	5.8±0.029	1.14	19.6	2	9

Source: Own calculations.

Cows of Ukrainian Brown dairy breed by the trait height at sacrum 144.0 cm and 5.6 scores that characterize the overall animals development, sufficiently are developed at the age of the first lactation. Cow firstborn, according to the results of point score, were characterized by a good chest and body developmental, and assessment for angularity in 6.7 scores, indicated about cow development in dairy type direction. Rump slope angle and rear legs angle are optimally developed.

Assessment by udder morphological traits indicated about good front udder parts attachment, a well-defined central ligament and high placement. Coefficients of Pearson's phenotypic correlations between the final score, descriptive conformation traits and longevity indicators of cow's productivity have been given in Table 3. The high positive correlations obtained between final score and lifetime ($r = 0.321$), longevity milk yield ($r = 0.398$) and longevity yield of milk fat ($r = 0.369$).

The close correlation between the final assessment and traits of longevity productivity indicated that when selecting of sires to improve the conformation and performance of herd cows, the final score indicators should be taken into account. This conclusion was explained by the fact that focusing on the heritability of each descriptive trait, was sometimes problematic to find a bull with desired all body parts development.

The results obtained on the stock of UBDB cows were similar to those obtained by [8] and [34]. They observed a close linear relationship between final score and longevity in Holstein and Jersey cows, respectively, reducing the risk of culling of animals with a high final score. [13] believed that the final assessment deserved special attention because it was expressing the sum of scores for all group traits of cow conformation [13].

Stature characterizing the overall body structure development of UBDB cows positively correlated with lifetime (r = 0.122), longevity milk yield (r = 0.209) and longevity milk fat yield (r = 0.105), as presented in Table 3. A similar trend was found in studies of [32], who identified that higher cows had better survival chances than cows with lower scores. According to [20] genetic correlation in Canadian Holsteins between lifetime productivity and stature were low and moderate (from 0.14 to 0.25). However, [7] found that cows of the average height or lower than average height live longer.

[34] reported about an intermediate optimum for conformation linear traits and milk productivity. According to studies made by [5] and [8], stature did not have a strong relationship with functional ability to survive.

Table 3. Pearson correlation coefficients (r) between estimation of conformation traits and indicators of cow lifetime productivity

Standard Traits	Lifetime, days	Longevity milk yield, kg	Longevity milk fat, kg
Final score	0.321^{xxx}	0.398^{xxx}	0.369^{xxx}
Stature	0.122^{x}	0.209^{xxx}	0.105^{xxx}
Chest Width	-0.033	-0.054	-0.067
Body Depth	0.268^{xxx}	0.255^{xxx}	0.209^{xxx}
Angularity	0.318^{xxx}	0.422^{xxx}	0.389^{xxx}
Rump Angle	-0.021	-0.019	-0.011
Rump Width	0.226^{xxx}	0.362^{xxx}	0.296^{xxx}
Rear legs Side View	0.183^{xx}	0.125^{x}	0.129^{x}
Rear Legs Rear View	-0.024	-0.017	-0.022
Foot Angle	-0.016	-0.025	-0.015
Fore Udder Attachment	0.275^{xxx}	0.361^{xxx}	0.396^{xxx}
Rear Udder Height	0.254^{xxx}	0.311^{xxx}	0.342^{xxx}
Central Ligament	0.245^{xx}	0.371^{xxx}	0.347^{xxx}
Udder Depth	0.244^{xxx}	0.233^{xxx}	0.228^{xxx}
Front Teat Position	-0.088	-0.037	-0.062
Rear Teat Position	-0.039	-0.021	-0.011
Teat Length	-0.018	-0.081	-0.014
Locomotion	0.137^{x}	0.148^{x}	0.122^{xxx}
Body condition score	-0.192^{xx}	-0.378^{xx}	-0.357^{xxx}

^{x} significant in P <0,05; ^{xxx} significant in P <0,01; ^{xxx} significant in P <0,001
Source: Own calculations.

Whereas, according to [18] height had negative genotypic and phenotypic correlations with longevity indicators.

[43] believed that such different results could be due to differences in the breed or in the definition of traits.

Chest width, one of the type linear traits associated with longevity of cows [28]. But according to [27], between functional longevity and chest width the correlation was negative.

Research data (Table 3) corresponded to results of [27], correlations between the chest width and longevity traits were low and negative (from –0.033 to –0.067).

Depth of body was rather an important linear trait of the conformation for dairy cattle that characterize the digestive tract development depending on the age and period of lactation. Cow with a deep body, are able to process a large amount of coarse fodder, converting it into appropriate productivity. A positive correlation of UBDB cows between body depth and the lifetime of cows (Table 3) was 0.268, with longevity milk yield of 0.255 and longevity milk fat yield of 0.209.

[16] and [27] also reported about positive effect of cows body depth on the duration of life. However, evaluating the genetic correlations between longevity and linear type traits, [33] obtained noticeable negative correlations between longevity and body depth (–0.15).

The angularity was affected positively on the longevity traits of Ukrainian Brown dairy cows with moderate correlation between the angularity and lifetime of 0.318, longevity milk yield of 0.322 and longevity fat of 0.219 (Table 3). [20] also found a strong genetic correlation between lifetime productivity and angularity in Canadian Holsteins (0.44-0.55). According to studies made by [33], genetic correlations between the longevity traits and angularity were moderate, high, and positive (0.22 to 0.48).

The relationship between the trait of rump angle and longevity traits UBDB cows was absent (from –0.011 to –0.021) (Table 3). Similarly, no relationship was found between the rump angle (position) and longevity of American Holstein and Jersey cows in studies of [8]. About the influence on functional survival of Czech Simmental cows especially in extreme classes was reported by [45]. According to their research, cows with a very high or extremely slope rumps were more ready to culling than those who had the best score of 5. Furthermore, cows with extremely raised sacrum were 2.54 times more likely to withdrawal as compared with cows with extremely oblique sacrum. Similar data were obtained by [15], [32] and [7]. According to the studies of [44], the rump angle in Czech Holstein cows was positively associated with longevity traits, with genetic correlations from 0.15 (length of productive life as the functional longevity) to 0.21 (number of lactations initiated).

The rump width of cows had a positive effect on longevity indicators with correlation coefficients on the duration of life (0.226), longevity milk yield (0.362) and longevity milk fat (0.296) (Table 3). According to various scientific studies, rump width was correlated with longevity traits in the positive [43] and negative direction [38, 3, 45].

Scientific research and practice of cattle keeping proved that duration of life and longevity productivity of cows in industrial complexes to a large extent depended on the traits characterizing the legs condition. According to research cows UBDB the rear legs angle was positively correlated with lifetime (r=0.183), longevity milk yield (r=0.125) and milk fat yield (r=0.129), whereas the rear legs set and foot angle had weak negative correlations with longevity indicators. [30] reported that genetic correlations among feet and legs (FL), foot angle (FA), rear legs set (RLS), and longevity traits (from –0.10 to 0.05) also were low. According to these authors, higher scores for FL, FA and RLS were positively related to production and functional traits. The cows that were scored the highest for feet and legs remained in the herd for 307 functional days longer than cows scoring the lowest.

[20] obtained a low genetic correlations between longevity productivity and legs set (from 0.10 to 0.16) and negative for rear heel (–0.16 to –0.27). A negative genetic correlations between rear legs set (side view) and traits of longevity (–0.11 to –0.24) were revealed by [44] in Czech Holstein cows.

The udder of a dairy cow was estimated by the sum of morphological traits, its structure and texture. The using in a system of linear classification cows udder morphological traits, based on the fact that each of them could have predicted effect on the udder health. From the traits of udder structure, the greatest influence on udder health had the udder depth. High-lying udder was less disease-prone. Low location of the udder due to the penetration of bacteria was more favorable to mechanical damage. Good udder technological features required for efficient automatic milking. Breeding cows by udder structure positively influenced (directly or indirectly) on the duration of their economic use [15]. The strong attachment of the front udder was closely related to its shape, size, proportional development, and did not allow the udder to fall below the hock joints with age. The function of the rear udder attachment and the central ligament were similar. According to UBDB cow estimates, fore udder attachment, rear udder attachment, and the central ligament correlated positively with longevity traits, with variability from 0.245 (central ligament - lifetime) to 0.396 (front udder attachment - longevity milk fat). The UBDB cow's udder depth positively correlated with lifetime (0.244), longevity milk yield (0.233) and longevity milk fat (0.228).

The functional longevity of Holstein cows has been studied in 9 geographic regions of the United States by [8], who found that, depending on the udder morphological traits assessment, udder depth, front udder attachment, and central ligament are successively associated with functional longevity, regardless on the region. Genetic correlations were low and moderate between lifetime productivity and udder texture (0.19 to 0.26), rear udder attachment (0.19 to 0.25), and rear attachment (0.10 to 0.22). About sufficiently high genetic correlations between productive life and milk yield, fat, dairy form, and udder traits ranged from +0.22 to +0.46 in Holstein cows of the United States was reported by [42]. The obvious influence of udder depth on the length of productive life of the French Holstein was observed by [23]. Similarly, according to studies of [31], the functional longevity in Italian Brown Swiss dairy cattle had a strong positive genetic correlation with udder depth (0.42 ± 0.10) and at the same time insignificant with fore udder attachment (0.10 ± 0.11), central ligament (0.08 ± 0.12) and slightly negative with rear udder width (–0.10 ± 0.11). When were studied correlations of linear and composite type traits with direct longevity, [38] found a positive correlation with udder depth (0.29), fore udder parts attachment (0.18), and height of rear udder parts attachment (0.14).

The correlations between front and rear teats position and teats length, and lifetime indicators and productive longevity of UBDB cows had a weak negative directionality from –0.011 to –0.088 (Table 3). In the scientific research of other authors, similar correlations had different directions. Negative genetic correlations among longevity and front teats length (–0.07) were obtained by [33]. The strongest correlation was found for rear teats placement (–0.28) and the weakest for teats length (–0.03) [44].

Phenotypic correlations between linear type traits and longevity in Brazilian Holstein cows were insignificant by the traits of teats placement (–0.01) and teats length (0.01) [18]. When assessing the trait of locomotion, the intensity of the animal's movement, fixation of the support phase and transfer of limbs were taken into account. The score decreased for weak movement and if the lameness was present. Firm, confident movement, correct posture of limbs, strength hooves and pasterns increased the level of linear assessment.

Between the locomotion of UBDB cows and longevity traits was determined insignificant but positive correlation, from 0.122 by the trait of longevity milk fat, to 0.148 - by the trait of longevity milk yield. In general, the movement of cows was a quite important in the technological sense linear trait of the conformation, that depending on three other traits that affecting it - angle and posture of pelvic limbs and foot angle [8, 30, 38]. Disadvantages of the traits, angle and posture of pelvic limbs lead to the hooves erosion and erasing its rear wall.

[44] found low genetic correlations between longevity traits and locomotion were for the length of productive life (0.06), number of lactations (0.07), length of productive life as the functional longevity (0.10) and number of lactations initiated as the functional longevity (0.09).

Body condition score of UBDB cows has a negative and reliable relationship with lifetime (r = –0.192), longevity milk yield (r = –0.278) and longevity milk fat (r = –0.357). Similar results were obtained by [41] who found a negative relationship between body condition score and longevity in Brown Swiss cattle. As a consequence, for more well-fed types of animals the period of stay in the herd was reduced.

[16] revealed that cows having higher scores for fatness had higher risk of culling than cows with lower scores. On the contrary, [44] found strong positive genetic correlation between fatness and functional longevity in Czech Holstein cows (0.30).

CONCLUSIONS

Some researchers have evaluated the use of linear type traits as alternative indirect breeding traits of longevity through favorable genetic and phenotypic correlations.

Excellent conformation by final type estimation is an effective factor influencing on the indicators of cows longevity, because actual dairy cows' longevity improved through genetic selection

Phenotypic correlations indicated that indirect selection based on traits of stature, body depth, angularity, rump width, fore udder parts attachment, rear udder parts attachment, central ligament and udder depth can lead to the effective development of longevity traits in cows of Ukrainian Brown dairy breed.

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MANAGEMENT OF SOIL EROSION IN CONDITIONS OF DIFFERENT CROP ROTATIONS AND SHELTERBELTS FUNCTIONS

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Abstract

The results of modeling of potential soil losses due to surface soil runoff according to the current DSTU 7904: 2015 are considered. "Soil quality. Determination of potential threat of erosion under the influence of rains" on the slope of the field with contour-ameliorative organization of the territory (CAOT) on the lands of SE" DG Donetske" of NSC "Institute of Soil Science and Agrochemistry named after O.N. Sokolovsky" Bahmutsky district of Donetsk region, Ukraine. The main tasks of the work were: determination of potential soil losses on the slope of the fields to choose the more appropriate way of management in terms of using the working areas in the research system for black fallow, field crop rotation (excluding the impact of forest shelterbelts and taking into account the impact of shelterbelts), soil protective crop rotation. The use of working areas A and B under black fallow expectedly led to the excess of permissible soil losses in both areas, modeled according to the current DSTU 7904:2015 in Ukraine. Exceeding the allowable soil losses from erosion also occurred in section A under the conditions of its use for field crop rotation. Under the conditions of use of areas for soil protection crop rotation and in the conditions of functional compliance of forest shelterbelts, soil losses in both plots remain within the norm. In order to prevent the concentration of surface runoff from both working areas (A and B) in the lower part of the landfill, it is recommended to periodically apply the "rehabilitation" period with the organizing of soil protection crop rotation after black fallow.

Key words**:** *soil runoff management, modeling, crop rotations, forest reclamation measures, shelterbelts.*

INTRODUCTION

Problems of agriculture adaptation to climate change in the intensification of erosion processes attract the attention of scientists worldwide [1, 22, 24, 26, 27, 30]. Agriculture in Ukraine is an economically important sector, the profitability of which largely depends on climatic conditions, especially on lands at risk of water erosion processes, the area of which is 12 million hectares. Due to this fact, the impact of climate change on the productivity of growing certain crops and soil erosion degradation of Ukraine has become widespread in many domestic and foreign publications [3, 8, 9, 23, 28, 29]. According to research by V. Balabukh [2], in Ukraine since the 90s of the twentieth century, there emerged a tendency of increased number of heavy rains and showers, which reached the criteria of dangerous. In the XXI century, this trend has become even more pronounced throughout Ukraine. For example, in May 2020, after a dry, snowless winter, which caused overdrying and extremely low vegetation density, precipitation fell in a short time, which in many eastern and southern regions was twice the long-term norm.

Donetsk region, located in the east of the country and belongs to the Steppe soil-ecological zone is no exception. The annual amount of precipitation in this zone varies from 330 mm in the south to 500 mm in its northern part, and the appearance of water erosion processes is mainly due to the torrential nature of precipitation in the summer. In general, the Steppe of Ukraine features a high degree of vertical and horizontal detachment of the terrain, and the steepness of the slopes and the depth of local erosion bases have repeatedly been the main reasons for the intensive development of erosion processes [33].

Given this, to combat soil erosion in the most erosive regions of Ukraine in the 70s-80s were organized base farms with contour and amelioration (reclamation) organization of the territory (CAOT), taking into account the division of land into three soil ecological and technological groups according to surface angle, the altered structure of sown areas with a significant share of perennial plantations and periodic introduction of soil-protective crop rotations [28, 29].

Since the contour and amelioration organization of the territory began in the 50s-70s, many elements of the system (such as shafts, terraces, forest shelterbelts) do not function properly nowadays. In addition, the intensification and growth of agricultural production in the region in combination with the rejection of periodic application of soil-protective crop rotations have created the preconditions for soil erosion from sloping areas and the development of erosion processes. On the other hand, the results of contemporary erosion modeling are widely used by land management institutions of Ukraine and relevant divisions of large agricultural enterprises engaged in the development and planning of soil protection measures on agricultural lands. Such modeling involves GIS methods of Earth's remote sensing, which confirmed the high efficiency and met the worldwide existing standards in land use planning [4, 10, 11, 12, 13]. At the same time, the priority of the water regime as an evaluative factor in the study of erosion processes is that oftentimes it limits the fertility of soils in the region [3]. The possibilities of using GIS to study the erosion processes are unprecedented and allow real-time monitoring of areas with a possible risk of erosion or with erosion processes that have already taken place. A number of works are devoted to this issue [6, 11, 32].

The forecast for erosion processes development is based, basically, on the results of their mathematical modeling. In the future, after modeling different scenarios of erosion processes and their minimization with anti-erosion measures, it is possible to identify actions of a particular group (or their combination) for differentiated implementation on the lands of various agro-technological groups. The use of these satellite systems in modeling soil losses following current standards is one of the modern multifunctional tools for assessing the manifestations of erosion processes. It allows studying the soil, erosion dynamics, prospects for renewal or implementation of new erosion measures [23].

In general, studying erosion by modeling different scenarios of its manifestations land use management can be considered one of the most common and promising areas in recent decades [4, 5, 28, 30].

That is why the main purpose of our research is to assess the potential soil losses as a result of modeling of surface runoff according to the current DSTU 7904: 2015 "Soil quality. Determination of potential threat of erosion under the influence of rains" [7] in different agricultural technical conditions: under black fallow, under field crop rotation without taking into account the effect of forest shelterbelts, under field crop rotation taking into account the effect of shelterbelts, under soil protective crop rotation. The works were planned to determine how they correspond to the minimum allowable soil losses recommended for the region.

MATERIALS AND METHODS

The study of potential manifestations of erosion processes and possible soil losses in the conditions of various crop rotations and limited functioning of shelterbelts was carried out within a separate field with partially functioning forest belts of contour-ameliorative agro-landscape in Bahmutsky district of Donetsk region in 2021.

Soil type - Chernozem ordinary slightly-eroded low-humificated with light loam composition on loess-like loam. The humus content in the arable layer (0–30 cm) – 4.5–4.7%. The reaction of the soil solution is 6.5-6.9 units. Gross reserves of nutrients in the arable layer: nitrogen - 0.24–0.34%; phosphorus - 0.13%; potassium - 1.52%.

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The obtained terrain data were processed and interpreted by analyzing STRM and other time-varying satellite images using GIS programs such as ARC-GIS®, QGIS®.

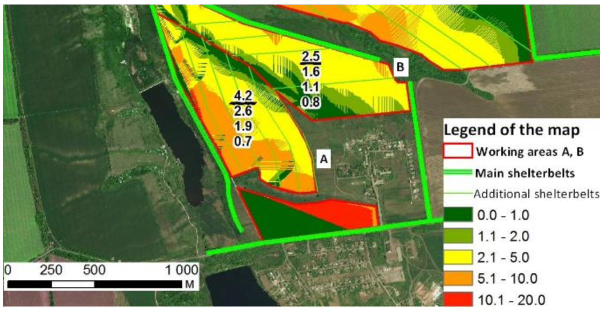
Topographic maps with an appropriate scale M 1:10 000 were used as a cartographic basis.

GIS technics and approaches to calculate potential soil losses were based on M. F. Hutchinson's works that allowed establishing geomorphological parameters of the studied area by constructing a digital terrain model, followed by calculating steepness and slope length values [14, 15, 16, 17, 18]. The other data related to hydrological and soil indicators, responsible for determining the amount of potential loss, were established according to GIS reference data and other literature sources [19, 20, 21, 25, 31]. Mathematical modeling was performed according to the current DSTU standard in Ukraine, and it included the following scenarios for the use of the work area in the research system: 1) black fallow (open soil surface); 2) field crop rotation (excluding the influence of forest shelterbelts); 3) field crop rotation (taking into account the impact of forest shelterbelts); 4) soil-protective crop rotation. The modeling of potential soil losses provided for the use as a predictive model of soil losses due to water erosion under the influence of rain equation C. Ye. Mirtshulava (described in DSTU 7904-2015), that included parameters: the density of the soil structure; the average frequency of the pulsation velocity; weighted average diameter of waterproof units; runoff coefficient; average rainfall intensity; slope angle degree; a coefficient that takes into account the deviation in the movement pattern of the slope runoff from the movement of an equal layer of water accepted in the calculation scheme, defined as the coefficient of furrowing; roughness factor; slope length; rainfall duration; indelible (permissible) speed at the height of the protrusions of the roughness; free fall acceleration; water density; density of the solid phase of the soil; porosity of structural soil particles.

RESULTS AND DISCUSSIONS

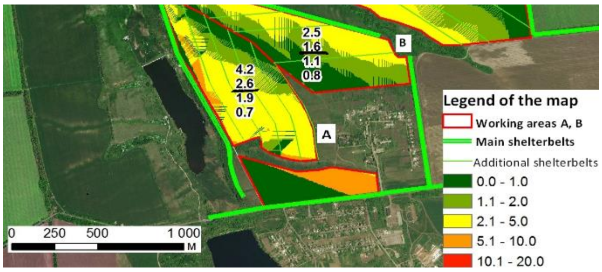
This section presents the result of the potentially possible soil losses simulation from the slope in the research system under the conditions of its use under four scenarios of use (black fallow, field crop rotation (excluding the impact of forest shelterbelts), field crop rotation (taking into account the impact of shelterbelts), soil protective crop rotation according to the valid DSTU) obtained a number of values presented in two columns for two fields - working areas in the research system (AB).

Map 1 presents the results of modeling potential soil losses under conditions of their use under black fallow.



Map 1. Potential soil losses after using the working area in the research system for black fallow
Source: Authors' results.

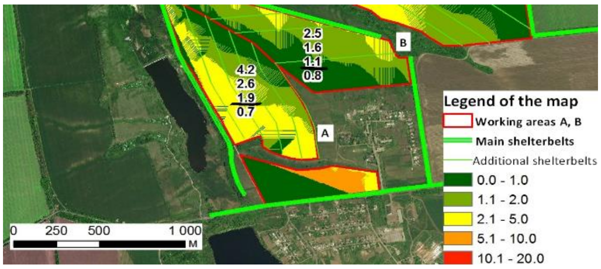
Soil losses from water erosion are the largest because when using the field for black fallow, the field surface is entirely exposed to water denudation and is not protected by any vegetation. In our case, for field A (yellow and orange), it is 4.6 t/ha, and for field B (primarily yellow) it is 2.5 t/ha per year. Along the left edge of field A, the concentration of surface runoff is recorded, followed by its accumulation below this field (red color). The area to outline the runoff build-up is characterized by the value of potential soil losses ranging from 10 to 20 t/ha annually.The following Map 2 presents the results of modeling potential soil losses from erosion with the provision of field crop rotation on two plots, represented by: black fallow, winter wheat, corn dredge, spring barley, sunflower. Thus, in this crop rotation, two crops (wheat, barley) represent cereals of continuous sowing, corn dredge and sunflower - technical row crops with the wide row spacing. Black fallow represents a technical link of crop rotation, during which the field surface remains exposed to water erosion. (Fig. 2). In this case, soil losses resulting from modeling this type of land use reach 2.6 for field A (mostly yellow coloring) and 1.6 t/ha annually for field B (yellow and green colorings).



Map 2. Potential soil losses after using the working area in the research system for field crop rotation (excluding the influence of forest shelterbelts)
Source: Authors' results.

When using the slope area for field crop rotation, preconditions are created for the manifestation of water erosion processes under technical row crops with a wide row spacing (sugar beet, corn for corn, sunflower). However, since their share in crop rotation does not exceed 20 %, the field can be considered protected. The soil losses in the area with runoff accumulation below field A at the level of 5-10 t/ha per year pasted with orange color.

The following Map 3 presents the results of modeling the potential annual soil losses under the conditions of joint soil protection action of field crop rotations and forest reclamation measures in the form of field protective forest shelterbelts on the respective research area.



Map 3. Potential soil losses after using the working area in the research system for field crop rotation (taking into account the impact of forest shelterbelts)
Source: Authors' results.

Under the implementation of this scenario, it can be seen that the amount of eroded soil decreases (both due to the correct selection of agro background in crop rotation (which provides scattering and delay of runoff in the middle of the working area) and due to effective retention of runoff outside the field.

Soil losses are less than in the previous map and are 1.9 t/ha annually for field A (yellow and green colorings) and 1.1 t/ha annually for field B (primarily green coloring).

The last and most effective scenario for the use of the slope area in the research system was the introduction of soil-protective crop rotation with perennial grasses share increase to 60% and leaving the rest of the field for continuous sowing. The surface of the field is then maximally covered with vegetation and protected from water and wind erosion. Annual soil losses then do not exceed 0.7 t/ha for field A (green and dark green colorings) and 0.8 t/ha per year for field B (primarily green coloring). The simulation results of this scenario are presented in Map 4.

Map 4. Potential soil losses after using the working area in the research system for soil-protective crop rotation
Source: Authors' results.

This can be explained by a more powerful soil protection component of forest reclamation measures in the form of field protective forest shelterbelts, presented in greater larger numbers and at a smaller distance from each other. Annual soil losses below field A in the location of surface runoff accumulation are within 10 t/ha annually. This scenario of field use is characterized by the greatest soil protection effect and can be considered as rehabilitation for these areas under conditions of erosion intensification due to increased rainfall or unsatisfactory quality of the surface vegetation in crop rotation. The expected excess of soil losses was observed when using both working plots for black fallow with no vegetation (scenario 1) and using plot A for field crop rotation (scenario 2). For this area, under conditions of local manifestation of erosion processes after the application of black fallow, a "rehabilitation" period is recommended (scenario 4).

The comparison of the obtained results of modeling of potential soil losses under different scenarios of use with the allowable minimum losses (up to 2.0 t/ha) produced obtained a number of values presented in Table. 1.

Table 1. Options for possible use of working areas A and B with recommendations for further use depending on potential soil losses

Description of possible working sites use scenarios	Gradation of soil losses due to allowable values	Potentially possible soil losses from the field, t/ha
1	2	3
Fully open soil surface for winter crops (black fallow)	A: Unacceptable excessive B: Unacceptable excessive	4.2 2.5
Field crop rotation whiep winter wheat, spring barley, corn (for grain), sunflower	A: Unacceptable excessive B: Maximal allowable	2.6 1.6
Preliminary version of field crop rotation with additional effect of forest shelter belts	A: Maximal allowable B: Average allowable	1.9 1.1
Field rotation without black fallow but with perennial grasses for 1-3 years	A: Minimal allowable B: Minimal allowable	0.7 0.8

Source: Authors' results.

Despite finding potential soil losses within acceptable limits, it is recommended to maintain forest reclamation measures in the form of field forest belts in proper functional condition (scenario 3).

Deterioration of soil protection properties of forest belts can lead to more significant values of soil decline from the working areas, which are already within the limits.

In order to compensate for the proportion of nutrients washed away from the soil under the conditions of local manifestation of erosion processes in all working areas (scenarios 2 and 3), it is also recommended to involve perennial grasses in crop rotations instead of technical row crops. This measure will help reduce the effects of erosion and keep soil losses from the site on a minimal level.

CONCLUSIONS

The use of working plots A and B under black fallow (the first scenario) expectedly led to the excess of permissible soil losses in both areas, modeled according to the current DSTU in Ukraine. Exceeding the allowable losses from erosion also occurred in section A under the conditions of its use for field crop rotation (second scenario). Under the conditions of use of plots for soil protective protection crop rotation and in the conditions of functional compliance of forest belts (scenarios three and four), soil losses in both plots remain within the norm. In order to quickly manage the erosion situation on the slopes in the research system, it is recommended to apply a "rehabilitation" period with the introduction of soil-protective crop rotation after the application of black fallow (scenario 4). Otherwise, as a result of the concentration of surface runoff from both sites in the lower part of the landfill there is a high probability of increasing soil losses to the level of more than 10 tons annually.

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DIAGNOSIS OF FINANCIAL STATE AND BANKRUPTCY THREATS OF AGRICULTURAL ENTERPRISES OF LVIV REGION IN ANTI-CRISIS MANAGEMENT SYSTEM

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Abstract

The difficult economic situation in Ukraine today is the main motivating factor for studying problems and developing possible solutions. Since Ukraine is an agrarian country, in our research we justified the need to take into account risk factors in the agricultural sector by diagnosing the financial situation using models to assess the likely crisis and bankruptcy. The article highlights the advantages and disadvantages of using discriminant models developed by both foreign and domestic scientists. The main drawback is the maladaptation to the industry factor. The shortcomings of the diagnosis of financial state for agricultural enterprises are also identified. In order to develop measures to prevent bankruptcy, recommendations for improving the financial state of agricultural enterprises on the example of Lviv region cluster analysis was used. The article states that the need to diagnose the financial condition of the enterprise is systematic and requires a comprehensive assessment using various methods, techniques and methods of analysis, as it is one of the most important characteristics of the results of agricultural enterprises, which is determined by the interaction of all components of the financial relations of the enterprise, the totality of all production and economic factors. The combination of financial indicators and risk assessment, which have the greatest impact on the life of agricultural enterprises, thanks to a comprehensive approach will increase the accuracy of assessing the prospects of the financial state of agricultural enterprises.

Key words**:** *diagnostics, crisis, bankruptcy, anti-crisis management, discriminant model, cluster analysis, financial management, financial stability*

INTRODUCTION

The main feature of the economy is stability and balance in all its processes and phenomena. From the standpoint of agricultural enterprises, stability means as the ability to achieve goals and expected results under the influence of factors that cause temporary deviations in their activities within acceptable limits.

In an unstable economy, the number of enterprises that lose financial capacity is increasing significantly, which leads to the rapid emergence of a crisis in agricultural enterprises.

All companies, regardless of their field of activity, must identify the first signs of possible crises in a timely manner, assess the likelihood of a financial crisis and respond quickly to possible threats of change in management. However, there is currently no generally accepted methodology for assessing or "diagnostic protocol" the probability of a financial crisis. In our opinion, the problem is not only that such a methodology should be based on risk assessment, which is difficult to measure, but also that it cannot be multipurposal.

Many agricultural companies have financial problems and are in danger of bankruptcy [6, 7] and for avoiding failure, management anti-crisis measures are required [9, 10, 12].

In this context, the paper aimed to make an analysis of financial state and bankrupcy threats of agricultural companies from Lviv Region, Ukraine based on the use of various models to assess probable crisis and bankruptcy.

MATERIALS AND METHODS

In recent years, the following economists have covered the issue of assessing the financial stability of the enterprise in their works: O. Arefieva, V. Andriychuk, I. Bilomistna, I. Blank, A. Voronkova, M. Golder, O. Gudz, M. Demyanenko, J. Conant, Ya. Kolesnik, L. Ligonenko, O. Ostrovska, A. Podderyogin, I. Sokyrynska, G. Springate, G. Tisshaw and others. In our opinion, A. Matviychuk's model is the most adapted model of bankruptcy diagnostics and forecasting of crisis situations in the agrarian sphere. This model is a "model for assessing the axiological (subjective) probability of bankruptcy" of Ukrainian enterprises in the form of a discriminant function [5]. But conducted research has shown that the scientific literature reveals only some aspects of the diagnosis of financial condition without determining its impact on the economic security of the enterprise.

The main purpose of this study is to substantiate the need to take into account risk factors in the agricultural sector by diagnosing the financial situation on the example of a few agricultural enterprises: SE «RF «Obroshyne», LLC «Agro Frutika Byshkiv», PAF «Bilyi Stik», SE «RF «Radekhivske», LLC «Danuta», Farming household «Agrotem» and Farming household «Povernennia», using models to assess probable crisis and bankruptcy: Beaver coefficient, Altman's five-factor model, Lis's model, Taffler's model, Springate's model, Tereshchenko's model, and Matviychuk's model.

RESULTS AND DISCUSSIONS

The term "diagnosis" translated from Greek means recognition, identification of signs, knowledge of marks: recognition of phenomena by their symptoms [2, p. 93].

Ya. Kolesnik in his research notes that diagnosing of financial condition is a mandatory component of financial management for any agricultural enterprise [4, p. 71].

The application of integrated analysis according to the models of probability of bankruptcy is the first stage of diagnosis of the crisis from the standpoint of the internal environment. At the same time, it should be noted that discriminatory models and calculations performed in accordance with them of the propensity of agricultural enterprises to the crisis carried out in accordance with them cover only certain indicators, so they do not provide comprehensive information on the full range of possible causes of bankruptcy. In addition, constants are subjective, as their reliability depends on the specifics of the industry, country, region, research period and other internal and external factors. That is, all models are devoid of signs of universality, because according to none of them we can not unequivocally state that the agricultural enterprise is a potential bankrupt. At the same time, the use of bankruptcy probability models jointly allows at the initial stage of diagnosis to average the obtained results and determine the agricultural enterprise that is likely to be threatened with bankruptcy.

Summarizing the information presented in Table 1, PAF «Bilyi Stik» according to any of these models is not threatened with bankruptcy. Thus, this result can be considered as plausible. The second position on financial stability is occupied by Limited liability company «Danuta», and the third – farming household «Povernennia». Other agricultural enterprises during the period under study, in various manifestations show the threat of crisis appearance. At the same time, the aggravation of the crisis should be noted for farming household «Povernennia» and SE «RF «Radekhivske». Despite the smaller number of bankruptcy threats for LLC «Agro Frutika Byshkiv», this agricultural enterprise should be considered as potentially bankrupt due to its unprofitability, which has led to the predominance of negative values of integrated indicators of discriminant models of bankruptcy probability. At the same time, the described patterns persist throughout all four years of the study. We can assume that in the external and internal environment of the surveyed agricultural enterprises there were no unforeseen events that could dramatically affect the financial condition. That is, the course of economic activity was equable given the situation that has formed in previous periods.

Based on the absence of threats of bankruptcy in all surveyed agricultural enterprises according to the model of Matviychuk, which is adapted to the conditions of the domestic economy, we can say that the agricultural sector is not critical. At the same time, due to the diametrically opposed values of integrated indicators according to separate discriminant models for LLC «Danuta» (2019, Tereshchenko's model), FH «Povernennia» (2017 and 2018, Taffler's model), FH «Agrotem» (2019, Lis's model), the presented calculations and generalized results cannot be considered absolutely accurate. For the most part, we have an initial vision of the situation, which can be considered as crisis for LLC «Agro Frutika Byshkiv» and FH «Agrotem».

Table 1. Matrix of values of integrated indicators according to discriminant models of bankruptcy probability

Model	Agricultural enterprise						
	SE «RF «Obroshyne»	LLC «Agro Frutika Byshkiv»	PAF «Bilyi Stik»	SE «RF «Radekhivske»	LLC «Danuta»	Farming household «Agrotem»	Farming household «Povernennia»
2017 year							
Beaver coefficient		-		T		T	+-
Altman's five-factor model	T	-	+-	+-	+-	T	
Lis's model	T	-		T		T	
Taffler's model		T		+-	+-	T	T
Springate's model	T	-		T		T	
Tereshchenko's model		-		+-	+-	T	
Matviychuk's model		-					
Number of threats	3	1		3		6	
2018 year							
Beaver coefficient		T		+-		T	+-
Altman's five-factor model	T	+-	+-	T	+-	T	
Lis's model	T	-		T		T	
Taffler's model		+-		T		T	T
Springate's model	T	T		T		T	
Tereshchenko's model		T				T	
Matviychuk's model		-					
Number of threats	3	2		4		6	1
2019 year							
Beaver coefficient	+-	T		T	+-	T	
Altman's five-factor model	T	+-	+-	+-	+-	T	
Lis's model	T	-					
Taffler's model	+-	T		+-		T	+-
Springate's model	T	T				T	
Tereshchenko's model	+-	-		+-	T	+-	
Matviychuk's model		-					
Number of threats	3	3		1	1	4	
2020 year							
Beaver coefficient	+-	-		T		T	+-
Altman's five-factor model	T	-	+-	+-	+-	T	+-
Lis's model	T	-		T		T	
Taffler's model	+-	T		+-	+-	T	
Springate's model	T	-		T		T	
Tereshchenko's model	T	-		T		+-	
Matviychuk's model		-				T	
Number of threats	4	1		4		6	

□ – there is no threat of bankruptcy; - – the calculated integrated indicator of the model does not make sense, because of its negative value; +- – financial stability is violated; T – threat of bankruptcy.

Source: formed by the authors according to statistical reports and [8].

Along with the manifestations of the crisis, the detection of signs of violation of financial stability also requires an immediate response from the management of the agricultural enterprise. To stabilize the financial situation, prevention the crisis through the preservation of financial balance, agricultural enterprises are forced to adopt and implement a system of anti-crisis management. At the same time, great importance is attached to preventive measures, which focus on identifying early symptoms of the crisis and developing measures to prevent bankruptcy. We agree that the main task of anti-crisis management, from a functional standpoint, should be considered timely and effective use of financial mechanism, special management functions and tools to prevent crisis and bankruptcy, as well as ensuring the financial recovery of the enterprise [1, p. 172].

Therefore, we consider it appropriate to abandon the already proven practice of using elements of financial state. Instead, we will cluster the surveyed agricultural enterprises based on the calculated integrated indicators according to discriminant models of bankruptcy probability.

The purpose of using cluster analysis in our study is to divide the surveyed agricultural enterprises into clusters, i.e. groups with homogeneous characteristics of financial state according to the values of integrated indicators according to discriminant models of probability of bankruptcy.

Therefore, based on ease of use, it was decided to use for clustering the method of distances. It should be noted that LLC «Agro Frutika Byshkiv» is not included in the rating process due to the prevalence of negative values of integrated indicators of bankruptcy probability. Taking into account this fact, LLC «Agro Frutika Byshkiv» can be considered as potential bankrupt.

According to the proposed method in the context of models for detecting the probability of bankruptcy, the distance from the reference point to the specific values of the indicators of the surveyed agricultural enterprises being assessed. The closer the agricultural enterprise is to the benchmark, the smaller its distance to the benchmark and the higher the rating. The highest rating is given to an agricultural enterprise with the minimum value of a comprehensive assessment [3, p. 109-111]. Thus, the following formula was used to calculate the values of the complex rating assessment of the surveyed agricultural enterprises:

$$Kj = \sqrt{(1-x_{i\,j})^2 + (1-x_{2\,j})^2 + \ldots + (1-x_{nj})^2}\ , \qquad (1)$$

where: x_{ij} – standardized indicators of the j-th agricultural enterprise, which are determined by the ratio of the actual value of the integrated indicator for a particular discriminant model of the probability of bankruptcy with the reference by the formula:

$$x_{i\,j} = ai_j \,/\max a_{ij}\ , \qquad (2)$$

where: max a_{ij} – is the reference value of the integrated indicator.

Thus, the results of the rating of agricultural enterprises on the integrated indicators of discriminatory models of bankruptcy probability give grounds to claim that PAF «Bilyi Stik» operates stably, in FH «Povernennia» – a mild stage of the crisis, in SE «RF «Obroshyne», SE «RF «Radekhivske» and LLC «Danuta» – the middle stage of the crisis, in FH «Agrotem» – a protracted stage of the crisis, and LLC «Agro Frutika Byshkiv» – a potential bankrupt. It is obvious that PAF «Bilyi Stik» effectively uses its production potential, it is characterized by signs of diversification of production.

The application of the hierarchical approach in cluster analysis occurs in several stages. Instantly we prepare the data for clustering. In our case, as already mentioned, this is the average value of the integral indicator of discriminant models of bankruptcy probability (Kjc) (Table 2). The next step is to calculate the Euclidean distance between each mean value of the integrated indicator for the studied farms. At the final stage, we combine the studied agricultural enterprises into clusters by visualizing the obtained Euclidean distance values.

The Euclidean distance *d(AB)* between the points A and B located on the line is defined as the square root of the square of the difference of their X coordinates:

$$d(AB) = \sqrt{(xB - xA)^2}\,, \qquad (3)$$

where: *xA* та *xB* – average values of comprehensive assessment of agricultural enterprises on integrated indicators of discriminant models of bankruptcy probability.

Formula 3 ensures that the distance between the two values of the complex estimate is a positive value, ie the distance between A and B is equal to the distance between B and A. Thus, Table 3 presents the values of Euclidean distances between the indicators of the average comprehensive assessment of enterprises on the integrated indicators of discriminant models of probability of bankruptcy.

Table 2. Comprehensive rating assessment of agricultural enterprises according to integrated indicators of discriminant models of bankruptcy probability

Enterprise	Year								**average *Kjc***	**ranking**
	2017		2018		2019		2020			
	Kj	ranking	*Kj*	ranking	*Kj*	ranking	*Kj*	ranking		
SE «RF «Obroshyne»	2.11	4	2.13	5	2.22	5	2.30	5	2.19	5
LLC «Agro Frutika Byshkiv»	-	7	-	7	-	7	-	7	-	7
PAF «Bilyi Stik»	0.35	1	0.4	1	0.67	1	0.28	1	0.43	1
SE «RF «Radekhivske»	2.22	5	1.95	3	2.14	4	2.15	4	2.12	4
LLC «Danuta»	2.08	3	2.05	4	2.02	3	1.93	2	2.02	3
Farming household «Agrotem»	2.33	6	2.35	6	2.38	6	2.36	6	2.36	6
Farming household «Povernennia»	1.77	2	1.77	2	1.75	2	1.95	3	1.81	2

Source: calculated by the authors.

Table 3. Matrix of distances of the average complex estimation of agricultural enterprises on integrated indicators of discriminant models of probability of bankruptcy

Enterprise	**Euclidean distances**					
	SE «RF «Obroshyne»	PAF «Bilyi Stik»	SE «RF «Radekhivske»	LLC «Danuta»	Farming household «Agrotem»	Farming household «Povernennia»
SE «RF «Obroshyne»	0	1.76	0.07	0.17	0.17	0.38
PAF «Bilyi Stik»	1.76	0	1.69	1.59	1.93	1.38
SE «RF «Radekhivske»	0.07	1.69	0	0.1	0.1	0.31
LLC «Danuta»	0.17	1.59	0.1	0	0.34	0.21
Farming household «Agrotem»	0.17	1.93	0.1	0.34	0	0.55
Farming household «Povernennia»	0.38	1.38	0.31	0.21	0.55	0

Source: calculated by the authors.

The dendrogram is an effective visualization of the hierarchical clustering of the studied agricultural enterprises according to the average value of the complex assessment. The constructed dendrogram is made in the form of nested groups and shows a hierarchical relationship between the formed clusters - the higher the column, the greater the distance between the clusters.

Thus, on the basis of hierarchical

agglomerative methods (Agglomerative Nesting, AGNES), the studied agricultural enterprises were consistently merged by reducing the number of clusters. The basic principle of the algorithm is that initially all objects are separate clusters. Then, one cluster was formed with the smallest Euclidean distances between agricultural enterprises according to the studied indicator. It includes SE «RF «Radekhivske», LLC «Danuta» and FH «Agrotem». In the next stages, the consolidation of facilities continues until all agricultural enterprises form one cluster. In doing so, we were guided by specific rules of grouping: the nearest neighbor or single connection, the most distant neighbors or full connection.

Thus, our cluster analysis based on the "nearest neighbor" principle formed two clusters, the distance between which is equal to P=1.38, and during the analysis based on the "most distant neighbors" principle, two clusters were obtained, the distance between which is equal to P=1.93.

The results of the hierarchical classification of objects are presented in the Figures 1 and 2.

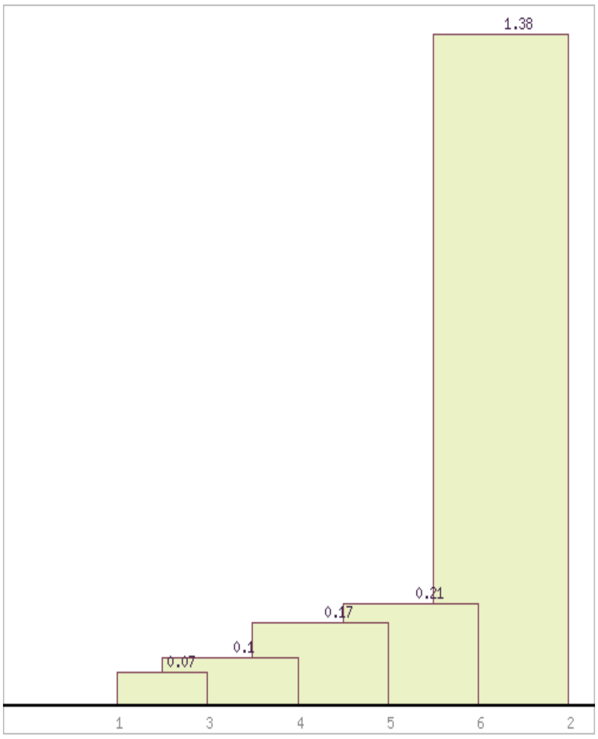

Fig. 1. Dendrogram of clustering of agricultural enterprises by the average value of the integrated indicator of discriminant models of probability of bankruptcy ("nearest neighbor" principle)
Source: Own design and result.

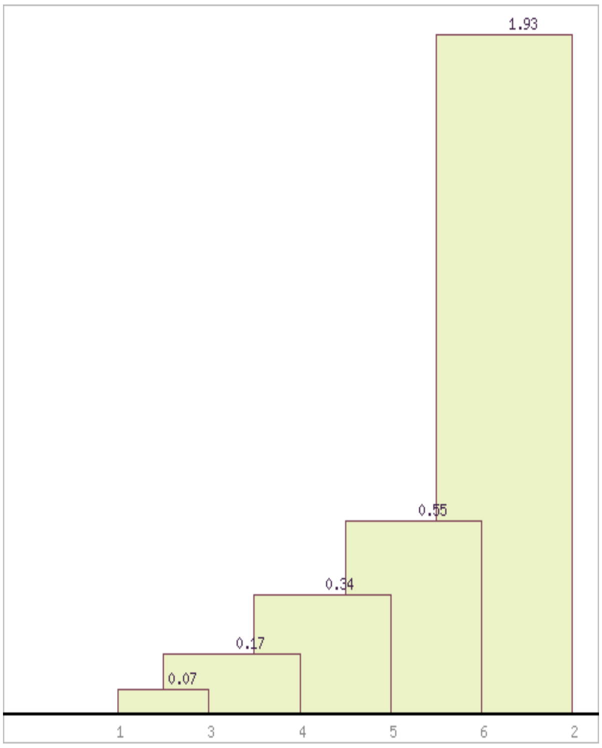

Fig. 2. Dendrogram of clustering of agricultural enterprises by the average value of the integrated indicator of discriminant models of probability of bankruptcy ("most distant neighbors " principle)
Source: Own design and result.

According to Table 3, it is obvious that the similarity between farms is marked by a smaller Euclidean distance. Conversely, the greater Euclidean distance indicates significant differences between farms by the studied indicator.

We see that the shortest distances were formed between SE «RF «Radekhivske», LLC «Danuta» and FH «Agrotem».

Obviously, they will form a separate cluster. Instead, the distance of PAF «Bilyi Stik» to all other agricultural enterprises is the largest.

At the same time, this approach provides less analytical skills in elucidating the preconditions for crises, i.e. the factors that provoked volatile liquidity, business activity, profitability, and so on. In this regard, it is advisable to use the data in Table 3 for grouping in terms of formed clusters (Table 4). This, in turn, will identify specific problem areas and identify specific objects of anti-crisis management influence.

This situation is observed in relation to the average value of the coefficients of turnover of inventories, the turnover of receivables and the profitability of operating costs. At the same time, the results of the calculations cannot be questioned. Obviously, the importance of other factors in the models of discriminant analysis of the probability of bankruptcy is greater. This affected the redistribution of the impact of the values of these indicators on the place of the studied agricultural enterprises in specific clusters.

Thus, the results of cluster analysis are obvious and visual. The large number of clusters for a relatively small number of clustering facilities is largely due to differences in agricultural enterprises in size, form of ownership, scale of production capacity, specialization, and therefore the scale of the crisis.

Table 4. Grouping of average values of coefficients of financial state of agricultural enterprises in the context of formed clusters

Coefficient	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Normative value
Liquidity ratios						
Immediate (absolute) liquidity ratio	0.07	0.02	0.04	0.30	1.12	over 2
Total coverage ratio (current liquidity ratio)	0.41	2.22	2.94	11.11	16.07	0.2 – 0.25
Intermediate coverage ratio	0.47	2.46	3.05	14.60	19.13	in the range of 0.7 – 0.8
Level of operational solvency	17.23	34.28	3.31	109.23	25.44	above 0
Coefficients of financial stability						
Coefficient of financial stability	0	0	0	0.03	0	over 2
Coefficient of provision with own funds	0.12	0.01	0.02	0.03	0.08	0.2 – 0.25
Coefficient of financial independence (autonomy)	-1.82	0.62	0.91	0.31	0.97	in the range of 0.7 – 0.8
Debt ratio	2.15	0.49	0.09	0.70	0.03	0.5
Financial leverage ratio	0	0.68	0	2.19	0	less than 1
Accounts payable to receivables ratio	23.56	25.46	11.41	24.64	0.34	about 1
Coefficients of business activity						
Working capital turnover	1.48	2.46	1.91	1.37	1.24	
Inventory turnover	2.26	3.08	4.75	1.39	1.40	3.6
Accounts receivable turnover	8.72	41.51	48.16	6.69	6.36	4.8
Operating cycle duration, days	215	165	92	324	320	
Accounts payable turnover	0.42	3.95	4.77	0.94	14.83	4.8
Duration of the financial cycle, days	-759	-199	-6	-65	296	
Cost-effectiveness (profitability) ratios						
Net return (loss) of equity	0.13	0.05	0.01	0.74	0.15	
Return on assets	-0.20	0.02	0.01	0.21	0.14	> 0.14
Profitability of turnover (sales)	-0.40	0.04	0.02	0.25	0.21	> 0.3
Profitability of operating costs	-0.17	0.48	0.01	6.42	0.25	
Economic profitability	-0.31	0.04	0.02	0.33	0.29	

Source: calculated by the authors.

Despite the fact that LLC «Agro Frutika Byshkiv» was excluded from the clustering process due to the negative values of the integral coefficients of discriminant models, we decided to allocate this agricultural enterprise as a potential bankrupt to a separate unit cluster with the subsequent formation of anti-crisis management measures for the deep recovery of its financial condition.

LLC «Agro Frutika Byshkiv» is characterized by growing losses, shortage of current assets, which leads to a deep crisis and recognition of potential bankruptcy. A characteristic feature of LLC «Agro Frutika Byshkiv» to be classified as potential bankrupt is the negative value of equity, throughout the study period, as well as the violation of the balance of receivables and payables (Table 4).

Individual clusters are also formed from enterprises that are in both mild and medium stages of the crisis, as well as an agricultural enterprise that operates stably.

CONCLUSIONS

The anti-crisis management subsystem in the management system of an agricultural enterprise with the help of appropriate tools facilitates the timely detection of negative phenomena in the activities of these enterprises. The method of identifying the probability of a crisis is based on the diagnosis of financial condition based on the calculation of financial ratios and discriminant analysis to identify the propensity of agricultural enterprises to bankruptcy.

The application of the anti-crisis management subsystem of agricultural enterprises of common models of discriminant analysis of the probability of crisis and diagnosis of financial state involves ease of calculation and the ability to diagnose both internal and external users of information. At the same time, some models for diagnosing the probability of crisis are not adapted to modern conditions of transformation of the Ukrainian economy, do not take into account the specifics of agricultural activities, features of domestic accounting and tax system, variability of tax legislation, significant impact of inflation and price disparity on the level of profitability of agricultural enterprises, etc. In particular, a common feature of the models of Altman, Lis, Taffler and Springate is the focus on diagnosing the financial state of enterprises in the United States and Western Europe. Therefore, these models can be used as additional diagnostic tools in parallel with modern domestic models of Tereshchenko and Matviychuk.

According to the authors [11, p. 593], every agricultural producer should strive for vertical integration into business and create added value. Because, at the very least, it will help them diversify their risks and survive difficult times.

Most of the studied agricultural enterprises are characterized by different stages of the crisis. Even at the stage of a mild crisis, agricultural enterprises are sensitive to the effects of negative internal and external factors.

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DEFINITION AND CLASSIFICATION OF WASTE IN THE AGRICULTURAL ENTERPRISES' BUSINESS ACTIVITY

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Abstract

The work dwells on the nature of waste as a social phenomenon and defines the term 'waste' from the standpoint of their further use to achieve economic effect. In order to combine the diversity of all components that characterize certain waste features within specific economic conditions, an economic classification of wastes has been developed, that makes it possible to identify areas of effective waste management. It was developed an effective economic mechanism for waste management, which would improve the socio-economic efficiency of public production.

Key words: *waste, agro-industrial production, management, pollution, classification of waste*

INTRODUCTION

The agro-industrial complex is a strategically important branch of Ukraine's economy, which accounts for about 17% of gross domestic product. This can be explained by the fact that Ukraine has high-quality land resources: chernozems account for 60% of the total area of the country. Favourable climatic conditions also contribute to the effective development of agricultural production.
One of the problems of agro-industrial waste is its danger to the environment. Agro-industrial complex proves to be one of the key generators of waste in Ukraine. The constant increase in agrobusiness production shows that serious attention needs to be paid to developing the methods of agricultural waste collection, processing and disposal with minimal pollution.
At the same time, the production of agricultural goods and their processing given the insufficient technological support generate large-scale volumes of waste, the calculation and identification of which do not meet current requirements. The National Waste Management Strategy [1] distinguishes this type of waste among others and aims at its prevention, efficient use and recycling, urging the need to reconsider existing approaches to the development of agro-industrial production as well as the sustainable development of agricultural landscapes [10, 11]. It should be noted that agricultural products processing is accompanied by waste generation in the course of both its production and consumption, while the responsibility for their disposal falls largely on local authorities and local governments. Agricultural enterprises do not comply with the corresponding waste disposal obligations, causing exorbitant damage to the environment and harm to the health of local population.

MATERIALS AND METHODS

The issue of waste in the agro-industry is reflected have been researched in the works of such scholars as: Yu.K. Boroday, V.S. Gonchar, Yu.V. Kersanyuk, A.A. Murakhovskaya, L.I. Stadnik, N.A. Khizhnyakova, L. Filonenko and others.

These authors studied the aspects of waste management, and in particular, sustainability of their disposal.

The main objective of this work is to develop the agro-industrial waste classification, taking into account their impact on the environment as well as determining the economic nature and notion of waste as a social phenomenon within the management system.

RESULTS AND DISCUSSIONS

In order to look into waste issues it is necessary to define certain terminology. In a broad sense, waste is all that people throw out onto the planet as a result of farming, obtaining energy and other life-sustaining activities. There are objective reasons to agree that waste form a kind of "ecological footprint" to be left by each person during the lifetime [6, 7].

Waste management is one of the most acute and complex problems in the world. In Ukraine, the amount of accumulated waste in designated places has increased tendentiously in recent years, as no due attention has been paid to its recycling. In 2019, the volume of solid household waste amounted to 441,516.5 thousand tons, leading to the deterioration of the environmental situation and the increase in the number of fly dumpings in every region of the country [1]. The dynamics of waste generation by types of economic activity is given in Table 1.

Table 1. Dynamics of waste generation by types of economic activity, thousand tons

Waste producers	Years of observation					2019 in % relation to 2010
	2010	2015	2017	2018	2019	
Total	**425,914.2**	**312,267.6**	**366054,0**	**352,333.9**	**441,516.5**	104
From economic activity	**419,191.8**	**306,214.3**	**360196,0**	**346,790.4**	**435,619.8**	104
Agriculture, forestry and fisheries	8,568.2	8,736.8	6188,2	5,968.1	6,750.5	78
Mining activity and quarrying	347,688.1	257,861.9	313738,2	301,448.9	390,563.8	112
Manufacturing industry including:	50,011.7	31,000.5	32176,7	315,23.2	30,751.8	61
Food production	7,245.4	4,222.2	6446,5	5,818.4	5,581.4	77
Beverage production	1,522.2	939.2	394,2	447.4	342.0	23
Production of chemicals and chemical products	2,679.0	703.3	1242,9	1,227.8	1,199.5	43
Production of basic pharmaceutical products and pharmaceuticals	615.4	10.8	12,5	11.5	15.4	2,5
Metallurgical production	32,844.2	20,725.6	21980,0	21,799.3	21,515.3	66
Supply of electricity, gas, steam and air conditioning	8,641.0	6,597.5	6191,7	6,322.7	5,959.2	69
Water supply; sewerage, waste management	1,698.7	594.2	408,7	397.4	411.8	24
Construction	329.4	376.2	493,8	378.8	188.7	57
Other types of economic activity	2,254.7	1,047.2	998,7	751.3	994.0	57
From households	**6,722.4**	**6,053.3**	**5858,0**	**5,543.5**	**5,896.7**	44

Source: State Statistics Service of Ukraine URL: http://www.ukrstat.gov.ua/ [13].

Based on the above indicators given in Table 1, compared to the previous year, the volume of waste generation in the mining industry increased by 12%, in agriculture, forestry and fisheries it decreased by 22%, and in the processing industry it decreased by 39%.

Insufficient financial support of waste management measures, neglect by production enterprises to fulfil their obligations as to supporting products in their further disposal, inadequate control over the implementation of relevant operations, etc. are the main causes of environmental degradation that requires an integrated problem solution through the development of effective waste management mechanism.

Despite all efforts undertaken in more or less developed countries to address these problems, today environmental degradation is not just slowing down, but is rather progressing and becoming a real security threat. This issue is illustrated in the Protecting Europe's Environment report, which states that "economic growth and consumption have proved to be a much stronger determinant of waste generation than all initiatives and measures to prevent it" [3, 9]. In the course of material benefits production companies use natural resources and enter into collaborations in order to produce, distribute, exchange and consume goods. The synthesis of these phases provides a certain reproduction cycle. The reproduction cycle begins with the production phase, where resources are being used and transformed to create benefits, satisfying social needs. At the same time, this production process is associated with a large volume of waste. The distribution phase actively distributes both the production factors as well as the results to which waste is a component.

The exchange stage presupposes the redistribution of the received national product share in the necessary goods and services. With no proper level of exchange development, there's no way that production, and therefore consumption, can develop. During the consumption phase, goods are transformed into consumer goods or labour items. Thus, consumption is the last phase of the reproduction process, the moment of goods assignment, but at the same time the start of a new production process. The classification of waste by source of their origin thus affects the manner in which they are recorded and evaluated for accounting and monitoring purposes, as well as the identification of further measures to be undertaken in their relation. The company's financial performance depends on the chosen waste management measures and the tax consequences in the course of its activity.

Table 2. Current state standards in the field of waste management

No.	Name	Enacted/ Effective as of
DSTU – 4462.0.01:2005	'The Nature Conservancy. Waste management. Terms and definitions"	First time/ 2006-07-01
DSTU – 4462.0.02:2005	"The Nature Conservancy. Complex of standards in the field of waste management"	First time/ 2006-07-01
DSTU – 4462.3.01:2006	"Environmental protection. Waste management. Procedure for of operations"	First time/ 2007-07-01
DSTU – 4462.3.02:2006	"Environmental protection. Waste management. Packaging, labeling and disposal of waste. Rules of transportation of waste. General technical and organizational requirements".	First time/ 2007-07-01
DSTU – 3911-99 (ГОСТ 17.9.0.1-99)	"The Nature Conservancy. Waste management. Identifying waste and submission of information data on waste. General requirements".	First time/ 2001-01-01
DSTU – 3910-99 (ГОСТ 17.9.0.1-99)	"The Nature Conservancy. Waste management. Classification of waste. Procedure for denomination on the genetic basis and the reference to classification categories".	First time/ 2001-01-01
DSTU – 2195-99 (ГОСТ 17.9.0.2-99)	"The Nature Conservancy. Waste management. Technical passport of waste. Structure, content and rules of change".	To replace DSTU – 2195-93 (GOST 17.0.0.05-93) /2001-01-01
DSTU – 3052-95	"Resource Saving. Procedure for establishing parameters of resource saving in the documentation for products".	/1997-01-01

Source: DSTU DK 005-96. Waste Classifier. K.: Derzhstandart of Ukraine, 1996 [2].

Table 2 shows current state standards, which identify the terms and definitions, regulate the naming procedure, and recognize the transfer of waste data.

Classification of agro-industrial waste (Fig. 1) based on safety level affects the organization of tax accounting in terms of the need to determine the rate of environmental tax for operations related to hazardous waste, that is, waste that threatens the environment and human health. Waste can be disposed of by means of own capacities or involve recycling companies specializing in this activity.

Given the method of disposal chosen by the enterprise, this will depend on the expense items reflected in the accounting system, as well as on the need to purchase additional equipment for waste recycling that utilize these methods.

Depending on their properties waste can be recycled biologically, thermally, mechanically or chemically. For this purpose, the company must carry out waste analysis by means of recycling and taking into account whether their own or attracted funds are involved. Lake take a closer look at the abovementioned classifications: 1) based on source of origin: waste from main and auxiliary industries; 2) based on disposal method: by means of own capacity or involving recycling services; 3) based on recycling method: mechanical, biological, chemical; 4) based on safety level: safe, hazardous. The most important industries are characterized by large volumes of waste. Waste processing and recycling within the conditions of scientific and technological advances is a constantly increasing alternative to natural resources.

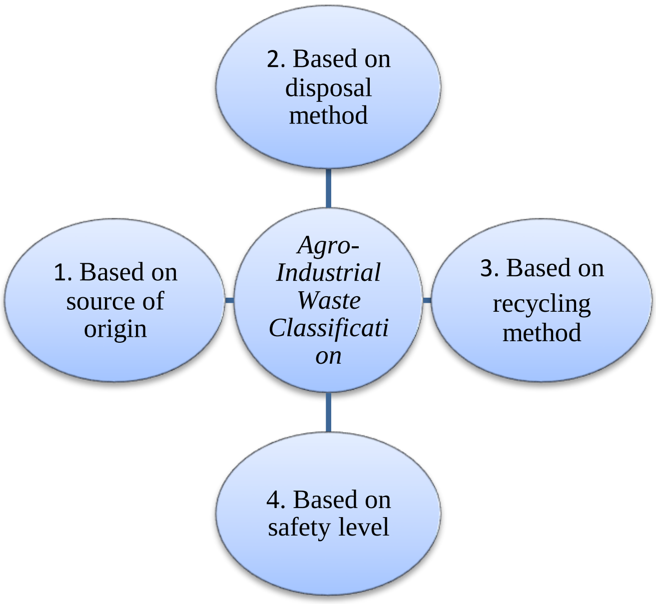

Fig. 1. Classification of agro-industrial waste
Source: DSTU DK 005-96. Waste Classifier. K.: Derzhstandart of Ukraine, 1996 [2].

This can be explained by the fact that the most available raw material deposits are gradually depleting, thus creating the need to develop new, more distant deposits with worse mining conditions that require additional investments. As a result, the cost of materials and extracted resources is increasing, making it necessary to look for resource equivalents - secondary raw materials, which can save up significant production expenses [8, 4].

Moreover, with the continued growth of production output in industrialized countries, the consumption of secondary raw materials is highly dependent on the availability of material resources. Being an alternative to material support for industrial growth, their lack leads to the increasing use of secondary resources.

The environmental dimension of the problem is particularly important, since most production areas generate waste that adversely affects the environment. If such waste accumulates, the problem of its placement (storage) worsens, which means that we are looking at additional investments to be allocated to the organization of landfills and industrial sites. It is worth mentioning that one of the priority areas for minimizing the accumulation of industrial waste is to return it into production aiming at extracting valuable components as well as using it for recycling.

Recycling of waste as a material resource solves a number of crucial economic problems. However, due to various, mostly organizational and economic reasons, the industry accumulates heterogeneous wastes. Therefore, first of all it is necessary to clarify the nature of the term ‘waste’ that can be done by defining its characteristics.

Today, there is a large number of definitions of the term ‘waste’ in scientific literature, most of which relate primarily to the issue of material origin, not focusing attention to their further use by a certain enterprise (company) where they were generated or found. This means that such definition does not have the potential to stimulate further waste recycling. Therefore, it is possible to conclude that the definition of ‘waste’ has certain drawbacks, with the lack of economic content being the most important one, and as such denies it to be a resource for further use. The definition should thoroughly outline the main properties, features and characteristics of waste, since it forms the basis for methodological approaches to the effective management of waste, the choice of disposal methods and the implementation of resource regeneration measures at all stages of reproduction. Given the aforementioned, we can formulate a definition that focuses on motivating economic entities to attract waste into production and then reuse it to achieve economic effect.

The intensification of agro-industrial production has led to the accumulation of waste, accompanied by its decomposition and the expansion of the land areas on which they are located. The potential environmental quality problems associated with agro-industrial production are largely influenced by the production processes, recycling methods as well as waste use by farmers and the processing industry [12, p. 44].

In our opinion, agro-industrial waste should be understood as substances or materials arising in the course of business activity which have completely or partially lost consumer properties, although they can be reused as raw materials in future production, provided that appropriate technologies are in place as well as organizational and economic prerequisites exist to neutralize their negative impact on the environment and human health.

Enterprises generate a lot of waste across various sectors of the economy, making it difficult to account for, plan, control and choose methods for efficient waste management. Due to a number of reasons Ukraine and other countries lack of a universally recognized scientific classification of industrial waste, which would broadly encompass their diversity. Existing waste classifications are substantially varied and unilateral, characterized by indistinct characteristics and duplication, etc. This complicates information perception and impedes the development of an effective waste management mechanism. Therefore, at the very first stage, it is necessary to improve the classification based on identification of existing types and categories of waste.

Classification is widely used in science as it establishes a certain order and divides the objects in question into groups in order to organize them and make information review more accessible. Classification is a multi-level, branched distribution. It should be noted that the principle of toxicity is often chosen as the basis for the primary classification. However, such a classification does not provide for an economically reasonable and rational consideration of disposing different types of waste. It is possible to provide the most complete information on waste, but not to define a hazard class, according to the national waste classifier DC 005-96, which provides information support to address a wide range of public waste based on accounting which is harmonized with international systems.

Waste classification is crucial for investigation of their characteristics and

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establishing certain links between them in order to determine the best management methods and plan organizational and technical measures for waste utilization. Based on the analysis of drawbacks, we have developed and proposed the classification of waste that combines the diversity of all components that characterize specific features of waste management under certain economic conditions (Fig. 2). Let's now have a closer look at waste types. In terms of utilization all generated waste can be classified as real and potential secondary resources. Real secondary resources include waste that is currently used on the farm to produce goods at or outside the plants generating such waste. Real secondary resources are divided into three categories according to their consumer characteristics: high-quality secondary raw materials, secondary-quality raw materials and waste, which are difficult to dispose of. The first category of waste includes high-quality secondary raw materials, the processing of which under local conditions allows producing in demand goods, and ensures high profitability (industrial waste in the form of by-products, scrap, ferrous and non-ferrous metals). Medium-quality secondary raw materials, the processing of which allows to produce in demand goods, but where the sales revenue roughly corresponds to collection expenses, primary treatment and recycling of waste, include raw materials containing cardboard, waste paper, mixed waste paper, polymers, textile waste, worn tires. Waste subject to significant processing are associated with recycling costs that given the current economic conditions exceed the income from their utilization (waste from the raw materials extraction and enrichment, the metallurgical and chemical industries, the recycling of which in order to obtain valuable components is unprofitable; moisture-resistant waste paper and traditional paper; highly contaminated polymer waste).

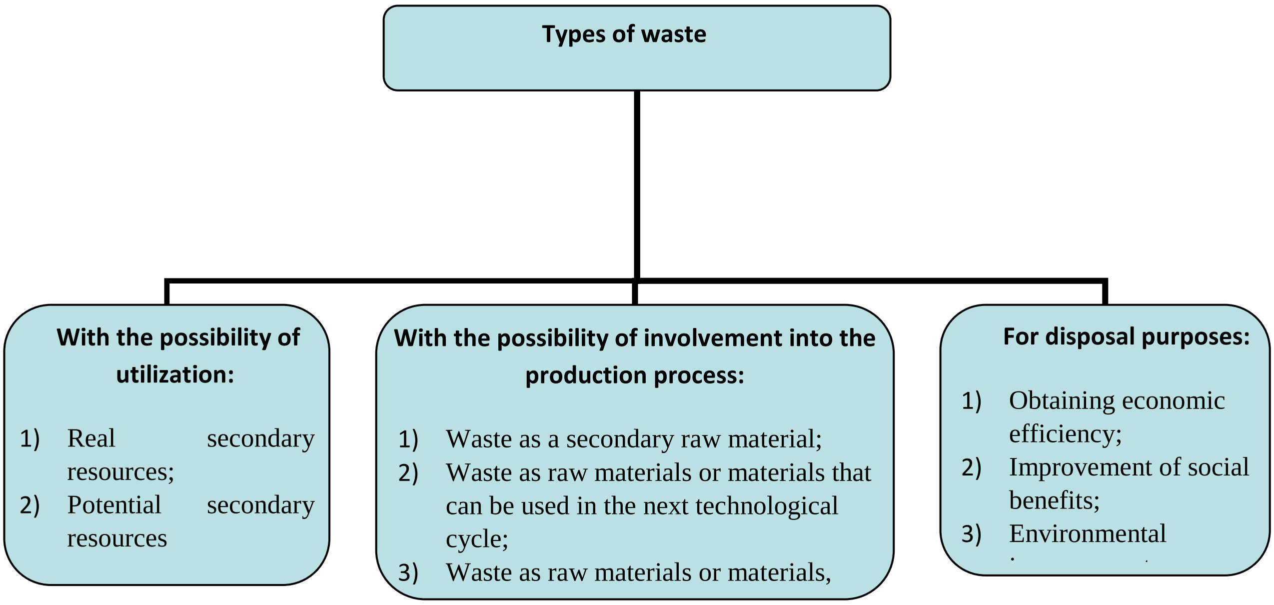

Fig. 2. Classification and types of waste
Source: State Statistics Service of Ukraine URL: http://www.ukrstat.gov.ua/ [13].

Potential secondary resources include waste that is not currently used due to the lack of organizational and technical measures as to their utilization, no capital investment into recycling or the absence of consumer demand. In practice, there is a need to group waste for their further disposal. Achieving economic benefit is critical for business when we speak about making a decision on waste management, as it presupposes cost-benefit comparison. Determination of the economic consequences following such measures is based on the comparison of costs associated with their implementation and the economic benefit as far as the participants are concerned. In addition, the economic benefit of the waste management operations can be illustrated based on the size of annual economic losses from pollution, which these operations aim to avoid. The economy is closely connected with the improvement of the social status, aimed at society development, in particular improving the quality of people's life, which is characterized by such indicators as living standards, promoting good health, improving working conditions and much more. The social effect in the field of material production is characterized by the increase in production, profits, labour savings and maintaining of social work, that means the reduction of work duration. Another factor of importance is improving the environmental situation in order to prevent or reduce potential environmental harm from industrial waste pollution as well as to enhance the environment [14].

The combined effect is aimed at both achieving economic impact as well as positive social and environmental consequences. Partial environmental effect is reflected, for instance, in the improved economic performance: the savings due to the possibility of reusing waste and reducing production waste, recording of pollutant emissions which is possible with the help of advanced technologies, as well as the economic savings due to reducing costs allocated for improvement of the environment, the external environment and the reduction in fines for violating environmental legislation.

For example, GOODVALLEY-Ukraine farm conducts sustainable agriculture, in particular cultivating fields, producing fodder, breeding pigs and producing its own high-quality products in full-cycle production. In other words, the farm is a food brand operating under the principles of sustainable agriculture, which is constantly working to reduce emissions based on calculations and control in accordance with UN climate projects (UNFCCC), namely, Joint Implementation, Joint Implementation of CDM/Clean Development Mechanism. Reporting, control procedures and the use of methods for calculating and reducing produced emissions are reviewed annually by TÜV heinland, an independent accredited auditor, which conducts an on-site audit and issues a certificate of net emissions. At GOODVALLEY-Ukraine farm, CO_2 emissions comprise 2.4 kg per kilogram of meat, compared to the average indicator for Denmark and the world of 2.8 kg CO_2 and 5.2 kg CO_2 per kilogram of meat, respectively. This has been achieved at the farm by replacing the sources of major CO_2 emissions with more sophisticated alternatives. In Ukraine, the farm has established 29 waste processing stations in the neighboring villages and concluded cooperation agreements with waste recycling companies [5].

The main focus of the classification criteria for distributing waste is drawn to the degree of participation in the process of waste production as a secondary raw material. Thus, the criteria define three groups: 1) waste as a secondary raw material used as an additive or a complete substitute of primary raw materials and materials (waste paper, building materials, etc.); 2) waste as raw materials or materials that can be used in another process cycle; 3) waste as raw materials or materials, characterized by fundamentally new properties, lacking in primary raw materials.

Revenues and expenses associated with the processing flow into the enterprise where financial and economic performance is created. It is possible to research this process by determining the method of influence. Direct consequences arise when it is assumed that income will be derived directly from third parties. In some cases, however, this category may result in losses due to transportation costs, waste removal costs or disposal costs. Indirect consequences arise when waste is used in subsequent stages of production, that is, reducing the cost of the raw materials involved. Extraction and processing of valuable waste components during recycling includes their distribution into complex and single-component based on the variety of useful substances. Waste containing two or more useful components is complex. Single-component waste consists of a useful component and impurities, the removal of which is associated with additional costs. The reuse of single-component waste allows ensuring the availability of necessary material resources in the production process, and waste containing multiple useful components makes it possible to differentiate production, which in its turn increases the competitiveness of the company.

CONCLUSIONS

As a result of the study, it was shown that waste occupies a central place in the system of managing and reproducing the national product. The work dwells on the nature of waste as a social phenomenon and defines the term 'waste' from the standpoint of their further use to achieve economic effect. In order to combine the diversity of all components that characterize certain waste features within specific economic conditions, an economic classification of wastes has been developed, that makes it possible to identify areas of effective waste management. At the same time, it is necessary to develop an effective economic mechanism for waste management, which would improve the socio-economic efficiency of public production. The gap between the accumulation of agro-industrial waste and measures to prevent its reuse, recycling and disposal exacerbates the environmental crisis and slows down the development of the state's economy. Ukraine urgently needs a reform of the legal and economic system to regulate the use of waste, in particular in the field of agriculture, as one of the key spheres of our economy, taking into account world and European experience. The interdependency between the efficiency of agro-industrial production and the potential deterioration of environmental quality is becoming more pronounced due to the increasing intensity of agro-industrial production methods. All negative environmental impacts can be significantly reduced or completely eliminated by changing production technologies in the agro-industrial complex, especially upon the launch of waste-free agro-industrial production. This shall maintain a balance between agro-industrial production and the environmental conditions, ensuring a sufficient number of agricultural and food products, acceptable income to the producers of such products, as well as an optimal state of the environment for the population.

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DEVELOPING A MONITORING SYSTEM OF AGRICULTURAL ENTERPRISES' PROPENSION TO BANKRUPTCY

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Abstract

Methodological tools for developing a system for monitoring agricultural enterprises' activities based on forecasting their resilience to bankruptcy have been improved. In contrast to the existing methodological tools, the author's proposals are based on decomposing the priority of monitoring objects, clarifying the logic of relationships between indicators that characterize these objects, and applying probit-analysis to identify changes in the values of factors that cause a decrease in agricultural enterprise resilience to bankruptcy. The practical value of the improved methodological tools is in the possibility of its application by managers of agricultural enterprises to predict their resilience to bankruptcy. Considering the forecast is based on grading integrated monitoring objects because of their priority, the proposed tools allow identifying causal links in judgments about expectations of changing management rationality in an enterprise and an enterprise's compliance with sustainable development values under the influence of enterprise resilience to bankruptcy.

Key words**:** *enterprise management, resilience, bankruptcy, development, monitoring.*

INTRODUCTION

In recent years, the agricultural business has been characterized by positive dynamics of development. This is expressed in: (i) growing exports (in 2019, compared to 2017, the export of agricultural products increased by 4.34 billion dollars, in 2020, the exports were already 22.199 billion dollars [22], [20]). In 2017-2020, the share of agricultural products in the total volume of Ukrainian exports grew steadily and was at average 42% [22]; (ii) diversifying the export structure of agricultural products (the list of marketable products produced in the agricultural sector exceeds two dozen. The greatest demand is observed for fats and butter, milk and dairy products, poultry eggs, natural honey, products of processing vegetables, fruits or other parts of plants); (iii) growing budget expenditures to support the agricultural market (in 2017-2019 – 38.8 billion UAH, the annual growth is 1 billion UAH [26]. In the budget for 2020, 5 billion UAH were allocated to support the agro-industrial complex activities [32], [31]).

Despite this, it should be recognized that the conditions for carrying out business activities in the agricultural sector are quite difficult. Firstly, price competition is high in both domestic and foreign markets. It is aggravated by the influence of the weather factor, fluctuations in fuel prices, changes in export quotas, the breadth of supply of agricultural products, and so on. Secondly, the demand for agricultural products that meet international quality standards, in particular regarding their safety and environmental friendliness, is constantly growing in the markets.

As a result, for agricultural enterprises, in the context of the need to increase the cost of ensuring environmental friendliness and environmental safety of agricultural products, the need to develop a monitoring system, which would allow identifying, analyzing and predicting phenomena and trends that are critical for avoiding bankruptcy, including ensuring financial resilience and profitability is being updated.

Meeting this need is quite problematic since forming such multifunctional monitoring systems requires the application of software adapted to a specific enterprise. Developing such software is associated with significant costs, which will inevitably affect the cost of finished products. In addition, rational applying such software requires well-trained analysts on an agricultural enterprise staff. There is no doubt that only major players in the agricultural business will be able to overcome these difficulties. As for small and medium-sized agricultural enterprises, they need to have multifunctional monitoring algorithms that reflect the values of sustainable development and allow them to make timely reasoned decisions that will contribute to their resilience to bankruptcy.

Thus, the problem is to improve the methodological tools for developing a system for monitoring agricultural enterprises' activities based on predicting their resilience to bankruptcy in the context of professing the values of sustainable development.

The results of the analysis of the dynamics of the number of documents indexed in the Scopus, containing the term "bankruptcy" in the title over the past 30 years (Fig. 1), indicate a high level of publishing activity in the world, which is increasing over time. In total, 3,682 documents were indexed in Scopus, 28.6% of which were published over the past five years, which indicates the urgency of the problem.

In the scientific literature, much attention is paid to various aspects of monitoring enterprises' activities. In general, the author's works are devoted to clarifying the concept of "activity monitoring" [7], [10], [25], indicators, methods and technologies of monitoring [21], [23], as well as its functionality and information content for making managerial decisions [5].

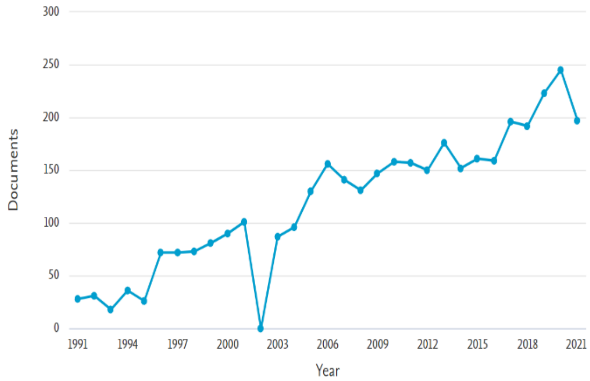

Fig. 1. Dynamics of the number of documents indexed in the Scopus, containing the term "bankruptcy" in the title, 1991-2021
Source: built on the basis of Scopus.

Based on the scientific literature critical analysis, it is revealed that the choice of indicators and monitoring methods depends on the enterprise managers' information needs. These needs are formed under the influence of many factors, among which the most important are: types of economic activity of the enterprise, priority goals of the enterprise, problems of a managerial and engineering-technological nature that arise at the enterprise, the level of development of the management system and corporate culture. Taking into account these factors, each enterprise should build an individual system of indicators, according to the values of which it is possible to make managerial and other decisions. Many authors, the experts in the field of agribusiness such as J. Grabara et al. [9], N. Bulavinova et al. [6], O. Kravchenko et al. [14], L. Pronko et al. [27] note that in the current conditions, the systems for monitoring agricultural enterprises' activities should be based on the sustainable development values. Another group of the researchers is V. Kuzoma and S. Pavliuk [17], R. Hyde et al. [13], E. Domenech et al. [8], M. J. Ramos Fraqueza et al. [28], X. Li [36], L. Kucher et al. [16], [15], A. Sumets et al. [33] notes that it is necessary to take into account the principles that underlie the HACCP system, which is especially important to the exporters of agricultural products. The same opinion, but slightly broader, is supported by A. Honcharov and S. Honcharova [12]. The authors argue that monitoring a company's activities should go beyond the factors of the internal environment. They claim that the quality characteristics of the products offered to the market are directly related to the consumers' market needs. This indicates the need of monitoring changes in market preferences, including new trends in the field of food and raw material safety. It should be recognized that enterprise security is an end-to-end monitoring object for most business entities. In the context of security monitoring, the scientific literature also pays considerable attention to risks. For example, S. V. Selishchev [29], investigating the possibilities of optimizing internal audit procedures of enterprises, proposed an applied approach to monitoring continuity risk assessment. Also dealt with a similar topic is I. Sysoieva et al. [35] who brilliantly described the technology of audit actions in the context of identifying risks associated with economic crimes and fraud. D. Zatonatsky [37] investigated the nature of insider risks and proposed a system for monitoring them that can be easily automated. In fact, one of any monitoring system purposes is timely detection of threats and risk assessment. In many modern scientific papers, the technologies of automated threat monitoring and risk assessment are carefully described. In this direction, the scientific heritage of such researchers such as A. Syrotynska et al. [34], E. Asnina [3], A. Shamsuzzoha [30], E. S. Borges [5], I. M. Gavrilko [11], O. Bogma et al. [4]

One of the trends in forming a system for monitoring enterprises' activities is the gender factor consideration. For example, K. Andriushchenko et al. note: “for each business entity there are individual combinations of resources forming the asymmetry of resources and increase the level of enterprise competitiveness...” [2]. These authors argue that the gender factor can significantly affect enterprise competitiveness, and therefore, if necessary, it should be monitored and adjusted.

Thus, the conclusion is that the objects of monitoring systems are multi-vector. In general, the indicators that characterize these objects are designed to inform management entities, on the one hand, about possible threats and associated risks, and, on the other hand, about the opportunities (potential) for obtaining additional benefits. Implementing this purpose by monitoring systems requires taking into account the provisions of the sustainable development concept, which generally reduces the selfish interests of agribusiness and the consumer interests of a society to a common denominator.

MATERIALS AND METHODS

The purpose of the study is to improve the methodological tools for developing a system for monitoring agricultural enterprises’ activities based on forecasting their resilience to bankruptcy. To achieve this purpose, it is necessary to:

- clarify the structure of monitoring systems for agricultural enterprise activity and specify its development directions;
- justify the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy;
- reveal the essence of methodological and applied tools for monitoring an agricultural enterprise propensity to bankruptcy.

During the research, systematic, structural and integration methodological approaches were applied, as well as general scientific principles of cognition of reality, namely consistency, functionality, and casualty. This allowed clarifying the structure of monitoring systems of agricultural enterprises' activities, specify the directions of its development, and justify the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy. To reveal the essence of the methodological and applied tools for monitoring an agricultural enterprise propensity to bankruptcy, the methodological tools of set theory, as well as the method of probit analysis were used.

RESULTS AND DISCUSSIONS

The structure of a monitoring system for agricultural enterprise activity and its development directions. Based on the review of scientific literature and empirical data of agricultural enterprises, there are grounds to assert that enterprise monitoring systems have the following structure:

- components of a monitoring system, that is, goals and criteria for identifying their achievement; monitoring objects; indicators with whose values monitoring is carried out; monitoring methods; information sources; monitoring subjects;
- monitoring system functions, namely, analytical, informative, predictive;
- monitoring system levels, namely, strategic, tactical, and operational.

From a structural approach view, the monitoring system subjects are the drivers of identifying promising directions for developing the monitoring system of an agricultural enterprise. This is because, in a dynamic competitive environment, the information needs of management entities are constantly changing. As a result, under the influence of accumulated experience and as new methods of processing and interpreting management information are mastered, the demand for its significance and speed of obtaining objectively increases. This indicates that the priority areas for developing the monitoring system of an agricultural enterprise are monitoring subjects and methods of obtaining and processing information related to them. The subject of monitoring is within the object. It characterizes a specific side of the object, for example, if the object of monitoring is economic efficiency, then the subject may be its balance over time, resilience, the sufficiency of the efficiency level in comparison with competitors, etc.

Taking into account the above-mentioned it should be recognized that within a particular enterprise, objects and monitoring objects constitute a certain set of components, in which there are both independent and common elements. To prove this thesis, it is necessary to formalize the types of objects and their subjects to a certain extent. Thus, according to the research results, it was revealed that the integral objects of monitoring systems of agricultural enterprises are the following:

- economic efficiency of an enterprise's activities;
- managerial rationality in an enterprise;
- compliance of an enterprise's activities with the sustainable development values.

In turn, local objects are divisions of the enterprise, types of its activities, projects being implemented, and individual operations. Timeliness, sustainability, safety, quality, and balance should be highlighted among the monitoring subjects.

Justifying the exceptional importance of monitoring an agricultural enterprise propensity to bankruptcy. Among the selected objects and subjects, there are ones that are priority and secondary, or causal and consequential. Thus, any agricultural enterprise is a business entity that carries out business activities at its own risk to make a profit. Profit maximization is a selfish purpose of the enterprise, its main, primary priority. In turn, in order to get its growth constantly and avoid managed and unmanageable threats of an internal and external nature, the enterprise is forced to rationalize management processes permanently and coordinate its own goals with the goals of a society, in particular, regarding the quality and safety of the created product offer. That is, enterprise economic efficiency is the primary object of monitoring, and other integral objects are secondary, those that serve to ensure the implementation of the main purpose by the enterprise, namely, profit maximization.

Given this, it makes sense to prioritize and monitor items. Performing this task requires taking into account the fact that two indisputable criteria for the economic efficiency of an enterprise's functioning are its profitability and financial stability. The proper level of financial stability and profitability values of an enterprise characterizes its resilience to bankruptcy. Consequently, an enterprise that is not resilient to bankruptcy is economically inefficient. Logically, it follows that monitoring an enterprise for enterprise resilience to bankruptcy is extremely important since it reflects information the state of primary and secondary integral monitoring objects depends on.

Methodological and applied tools for

monitoring an agricultural enterprise propensity to bankruptcy. In accordance with the code of Ukraine on bankruptcy procedures No. 2597-VIII of 14.08.2021, bankruptcy is the debtor's inability recognized by an economic Court to restore its solvency through rehabilitating and restructuring procedure and to repay creditors' monetary claims not otherwise than through applying the liquidation procedure. In turn, insolvency is the inability of the debtor to fulfill monetary obligations to creditors after the due date, not otherwise than through applying the procedures provided for in the above–mentioned Code. As you can see, the key indicator of the enterprise monitoring system that characterizes its resilience to bankruptcy is the solvency coefficient. Mostly, it is calculated as the ratio of the enterprise's equity to total liabilities. Ideally, equity should be greater or equal to total liabilities. Identification by the monitoring system of the critical value of the solvency coefficient is direct evidence that the enterprise is on the verge of bankruptcy. The task of the monitoring system is to identify signs of a decrease in the enterprise resilience to bankruptcy. This task can be performed because of monitoring those indicators that characterize the enterprise financial stability and profitability. For example, in addition to the solvency ratio, the total coverage ratio and profitability of production should also be monitored, as well as their variables, i.e. factor indicators that affect solvency, liquidity, and profitability. The logic of relationships is as follows:

$$\left.\begin{array}{l}K_v \wedge Z_s \Rightarrow \bigcup_{x=1}^{2} P_x ; A_p \wedge Z_p \Rightarrow \bigcup_{y=1}^{2} L_y ; P_o \wedge V_v \Rightarrow \bigcup_{z=1}^{2} R_z ; \\ \because \bigcup_{x=1}^{2} P_x \cap \bigcup_{y=1}^{2} L_y = \left\{ Z_p \mid Z_p \in \bigcup_{x=1}^{2} P_x \wedge Z_p \in \bigcup_{y=1}^{2} L_y \right\} \therefore \left(\bigcup_{x=1}^{2} P_x \cap \bigcup_{y=1}^{2} L_y \right) \wedge \bigcup_{z=1}^{2} R_z \Leftrightarrow \bigcup_{\Omega=1}^{6} S_\Omega ; \\ K_v \wedge Z_s \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{x=1}^{2} P_x \in \bigcup_{\Omega=1}^{6} S_\Omega , K_v \wedge Z_s \in \bigcup_{x=1}^{2} P_x ; \\ A_p \wedge Z_p \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{y=1}^{2} L_y \in \bigcup_{\Omega=1}^{6} S_\Omega , A_p \wedge Z_p \in \bigcup_{y=1}^{2} L_y ; \\ P_o \wedge V_v \in \bigcup_{\Omega=1}^{6} S_\Omega \Leftrightarrow \exists \bigcup_{z=1}^{2} R_z ; \in \bigcup_{\Omega=1}^{6} S_\Omega , P_o \wedge V_v \in \bigcup_{z=1}^{2} R_z , \end{array}\right\} \quad (1)$$

where K_v – the volume of the enterprise's own capital; Z_s – the volume of an enterprise’s total liabilities; $\bigcup_{x=1}^{2} P_x$ – a set of the indicators that characterize an enterprise’s solvency; A_p – the volume of an enterprise’s current assets; Z_p – the volume of an enterprise’s current liabilities; $\bigcup_{y=1}^{2} L_y$ – a set of indicators that characterize an enterprise's liquidity; P_o – the volume of profit after tax; V_v – the volume of production costs; $\bigcup_{z=1}^{2} R_z$ – a set of indicators that characterize an enterprise’s production profitability; $\bigcup_{\Omega=1}^{6} S_\Omega$ – a set of indicators that characterize an enterprise's resilience to bankruptcy.

Thus, the set $\bigcup_{\Omega=1}^{6} S_\Omega$ depends on a set of factor indicators $\bigcup_{x=1}^{2} P_x$, $\bigcup_{y=1}^{2} L_y$ and $\bigcup_{z=1}^{2} R_z$.

Identifying the deterioration of their values may in the future worsen the value of the solvency, liquidity, and profitability coefficients and, as a result, reduce the enterprise's resilience to bankruptcy.

Due to the individual work specifics of each agricultural enterprise, its resilience to bankruptcy formed under the influence of the above factors, differ from each other. Given this, it is necessary to determine the value of the average values of factor indicators and their standard error. The established variation series of minimum values of factor indicators that cause changes in enterprises' resilience to bankruptcy reflect the individual enterprises’ sensitivity to these factors. The performed studies allow stating that in the variation series the particle distribution of minimal changes in factor indicators is close to normal. The area above the abscissa axis is bounded by the normal distribution curve. It reflects the number of enterprises that have detected a change in their resilience to bankruptcy under the influence of a minimum change in the values of factor indicators. The normal distribution curve is symmetric to a straight line perpendicular to the abscissa axis and passes through a point $\bar{x}$ (the value of the average value of a particular factor indicator). Given this, this straight line divides the entire area bounded by the normal distribution curve into two equal parts. As a result, the average values of changes in all factor indicators that affect the enterprises' resilience to bankruptcy occur in 50% of the studied agricultural enterprises. Those average values that cause an increase in resilience to bankruptcy are denoted as P_{50}, and those values that cause the reverse reaction are denoted as Z_{50} [18].

Based on the methodological tools presented in the works [18], [1], [19] note that when $x = -1$ the perpendicular set from this point to the left of it is an area equal to approximately 16% of the total area bounded by the normal distribution curve, and with $x = +1$ to the right of the perpendicular is an area of approximately 84%. That is, a change in the values of factor indicators, which is less than one standard deviation from P50, causes a change in resilience to bankruptcy in 16% of agricultural enterprises, and a change in the values of factor indicators, which is more than one standard deviation from P50, causes a change in resilience to bankruptcy by 84% agricultural enterprises. Let's denote these changes as P_{16} and P_{84} or, respectively, Z_{16} and Z_{84}.

Taking into account the above-mentioned it is possible to predict enterprise resilience to bankruptcy based on probit analysis in Excel-97, in particular using the Accute_LD_Calc specification. In this case, probit analysis is a quantitative analysis of experimental data based on studying the relationship between the logarithms of the number of factor indicators studied in the experiment and probits corresponding to the observed effects-changes in enterprises' resilience to bankruptcy. A probit is a probabilistic unit calculated by the formula [18], [24]:

$$Y = \frac{x - P_{50}}{\sigma} + 5, \qquad (2)$$

where: Y – probit; X – any number of factor indicators studied in the experiment; P_{50} – the value of an unambiguous resilience of an agricultural enterprise before bankruptcy for 50% of the studied enterprises; σ is the standard deviation.

In Formula (2) $\frac{x - P_{50}}{\sigma} \sim n$ and $n = b_0 + b_1 x$, In case of replacement n for the right side of formula (2) $\frac{x - P_{50}}{\sigma} + 5$, P_{50} can be defined [18], [1]:

$$P_{50} = \frac{5 - b_0}{b_1}. \qquad (3)$$

In this case, the standard deviation will be expressed as the ratio $1/b_1$.

Based on formula (2) for P_{50} (Z_{50})-$Y=5$, P_{16} (Z_{16})-$Y=4$, P_{84} (Z_{84})-$Y=6$.

Since the dependence between factor indicators and probits is linear, it is written as follows:

$Y = b_0 + b_1 x$, accordingly, $x = \frac{Y - b_0}{b_1}$,

where

$$b_1 = \frac{\sum_{i=1}^{N} x_i y_i z_i \cdot \sum_{i=1}^{N} z_i - \sum_{i=1}^{N} x_i z_i \cdot \sum_{i=1}^{N} y_i z_i}{\sum_{i=1}^{N} z_i \cdot \sum_{i=1}^{N} x_i^2 z_i - (\sum_{i=1}^{N} x_i z_i)^2}, b_0 = \frac{\sum_{i=1}^{N} y_i z_i - b_1 (\sum_{i=1}^{N} x_i z_i)}{\sum_{i=1}^{N} z_i \cdot},$$

where: x_i – *and*- the value of the number of factor indicators; y_i – *and*- the value of the probit effect (state of the agricultural enterprise) that corresponds to the corresponding number of factor indicators; z_i – *and*- the value of the probit weight coefficient corresponding to y_i; N – number of experiments.

Monitoring with probit analysis allows identifying the relationships between the values of factor indicators that affect the solvency, liquidity, and profitability and the enterprise's resilience to bankruptcy. Performing this task requires a certain formalization of the state of an agricultural enterprise, that is, the gradation of these states by the levels of resilience to bankruptcy. Probit analysis assumes unambiguous characteristics of the resulting parameters, so they can be exclusively positive or negative, which corresponds to 1, or 0. Using the method of chain substitutions and the principle of constructing the Harrington scale, the following gradation of an agricultural enterprise’s state by the levels of resilience to bankruptcy is performed (Table 1).

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Table 1. The gradation of an agricultural enterprise's state by levels of resilience to bankruptcy

States	State symbols	State gradation levels
Illiquid (0), solvent (1), profitable (1)	1	Bad
Liquid (1), insolvent (0), profitable (1)	2	
Liquid (1), solvent (1), non-profit (0)	3	
Liquid (1), insolvent (0), non-profit (0)	4	Very bad
Illiquid (0), solvent (1), non-profit (0)	5	
Illiquid (0), insolvent (0), profitable (1)	6	
Illiquid (0), insolvent (0), non-profit (0)	7	Critical

Source: own calculations.

Let's apply probit analysis using empirical data of a number of small agricultural enterprises MP "Supiy", FG "Vayak", FG "Ranok", FG "Galagropolis", LLC "Farm "Losfort", LLC "Farm "Razdolnoye", LLC "Farm "Obriy", LLC "Farm "LLC-temp", LLC "Farm "Kolos", LLC "Farm "Norma", SGP LLC "Kalina", SGP LLC "Ukraine-sich" (Table 2).

Using the Accute_LD_Calc specification in Excel-97, the number of facts for identifying factor indicators that caused negative values of the resulting indicators was calculated. Thus, the average value of changes in factor indicators, which leads to a decrease in the enterprises' resilience to bankruptcy, is Z50 = 8.7763≈9. When changing the factor values to the left relative to equal to Z16 = 5.5643≈6, and when changing to the right – Z84 = 11.9883≈12.

Table 2. Average results of identifying the effect values in probits and weight coefficients of probits

The ordinal numbers of the experi-ments	The number of factor indicators that caused the identification of negative (0) characteristics of the resulting indicators	Research results		Effect value in probits	Weighting factor of probits
		The number of businesses with the detected effect	The total number of businesses in the group		
1	1	0	12	2.97	1
2	2	0	12	2.97	1
4	3	0	12	2.97	1
4	4	0	12	2.97	1
5	5	1	12	3.61	2.3
6	6	3	12	4.33	4.1

Source: own calculations.

CONCLUSIONS

Monitoring systems for agricultural enterprises are multifunctional and have a decomposition structure, in particular in terms of monitoring objects. This is due to the large number of monitoring objects, which are divided into integral and local. In addition, it is argued that among the integral monitoring objects there are primary and secondary ones, which are correlated as causal and consequential. It is proved that the economic efficiency of the enterprise's activities is primary among the integral objects of monitoring. Despite the fact that economic efficiency can be monitored for various subjects, the information about the enterprise's resilience to bankruptcy is still the most informative. This resilience is directly dependent on the indicators of an enterprise's liquidity, solvency, and profitability. Because of that, the identification of signs that indicate a change in an enterprise's resilience to bankruptcy is a sufficient basis for forming sound judgments about the expected changes of management rationality in the enterprise and an enterprise's activities' compliance with the values of sustainable development.

It is argued that it is advisable to develop monitoring systems for agricultural enterprises in the direction of expanding monitoring subjects and methods of processing and interpreting management information. On the example of empirical data of agricultural enterprises, using probit analysis, it is proved that the monitoring of factor indicators affecting primary monitoring objects allows predicting future changes in these primary objects and, thus, forming reasonable judgments about the expected changes in secondary monitoring objects.

Further research should be carried out in the direction of deepening the parameterization of integral monitoring objects, namely, creating conditions to measure isotonic distances between parameters characterizing these objects. This will allow clustering parameters and making predictive dendrites.

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MODELING OF THE OPTIMAL LEVEL OF INTENSITY OF CROP PRODUCTION AT THE REGIONAL LEVEL

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Abstract

The paper studied the impact of the level of production intensity on productivity and profitability of crop production in agricultural enterprises of the regions of Ukraine. In order to answer the question of how to increase crop yields and financial returns of lands in the face of climate change, we built graphic-analytical models of dependence of the yield (productivity) of basic agricultural crops from the size of operating (production) expenses per 1 ha of harvested area in agricultural enterprises of the Ukrainian regions. The results of the analysis showed that the real increase in the yield of analyzed crops is directly related to an increase in the level of intensity, expressed by the value of expenses per 1 ha of harvested area. The paper employed the correlation and regression analysis for quantifying tightness and mathematical description of the relationship, in particular, the dependence of the yield of winter wheat grain, corn for grain, sunflower, soy, rape and potatoes from the size of production expenses per 1 ha harvested area. The predicted optimal level of intensity was determined, taking into account the action of the economic law of diminishing returns.

Key words: *financial support, intensification, sustainable intensification, intensity, optimization, costs.*

INTRODUCTION

The Ukrainian agricultural sector is characterized by an increase in the level of production intensity in recent years, but the achieved level remains lower than the average for the EU countries. Many studies often the argument is made that given the existence of the considerable yield gap (is the difference between the optimal yield and the actual yield of best practice), Ukrainian agricultural enterprises might be able to substantially increase total crop production [4; 7; 19; 20]. However, in this context, one of the main problems and barriers of agricultural enterprises was and remains the deficit of working capital for the full implementation of agricultural technologies and capital investments for updating and expanding fixed assets. This deficit is estimated by experts at 20–25 bln USD per year. This deficit did not allow Ukraine to significantly increase crop yields and reach the production level of 100 million tons of grain, impedes the development of capital-intensive directions of production, limits the development of the processing and food industries [1].

At the same time, no less important is the action of law of diminishing returns. In agriculture the law of descending return consists in that every next unit of costs results in an all less return as an additional volume of products and additional profit, operates clearly, then there is a necessity of such level of intensity of production, and, accordingly, and level of costs, that provides the achievement of maximal economic effect at the optimal indexes of costs [16]. This question is lately investigated by N. Kondratyuk [6], A. Kucher [7], N. Lialina [8], O. Lushnikova [9], D. Parmacli et al. [10], O. Oliynuk, V. Makohon, H. Badalov et al. [13; 14; 15; 16], D. Shuyan, M. Bozhko [19; 20], S. Vynohradenko [25].

The evolution and synthesis of the concept of sustainable development and the concept of intensification has led to the emergence and development of the concept of "sustainable intensification", which has been actively studied in recent years. In particular, the

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following issues are in the focus of attention of scientists: conceptualising fields of action for sustainable intensification [26]; sustainable intensification of agricultural production [5; 11; 18] and its role in adapting to climate change [2]; agricultural innovations for sustainable crop production intensification [12; 21]; farming systems for sustainable intensification [22]; opportunities for sustainable intensification in European agriculture [17]. One of the components of sustainable intensification in the agrarian sector is the sustainable intensification of land use, which includes, in particular, land protection and soil fertility reproduction [3; 23] in the context of the sustainable development [24]. This paper studied the impact of the level of production intensity on productivity and profitability of plant growing.

MATERIALS AND METHODS

The data of the State Statistics Service of Ukraine on the main economic indicators of agricultural enterprises at the regional level were used as an information base in this article. The study used the following methods: economic-statistical and monographic (for study of the intensity of cultivation of the main types of crop products); grapho-analytical (for the visual representation of the identified dependencies); correlation and regression analysis (for quantifying tightness and mathematical description of the relationship); analysis, synthesis, abstract-and-logical (formulation of conclusions).
In order to answer the question of how to increase crop yields and financial returns of lands in the face of climate change, at the first step we constructed graphic-analytical models of dependence of the yield (productivity) of basic crops from the size of operating expenses per 1 ha of harvested area in agricultural enterprises of Ukrainian regions. At the second step, a correlation analysis was carried out and the developed regression equations were analyzed. The predicted optimal level of intensity was determined at the third step, taking into account the action of the economic law of diminishing returns.

RESULTS AND DISCUSSIONS

This section presents the results of assessing the impact of intensity of crop production on the yield of winter wheat grain (Fig. 1), corn grain (Fig. 2), sunflower (Fig. 3), soy (Fig. 4), rape (Fig. 5) and potatoes (Fig. 6) in agricultural enterprises of the regions of Ukraine. The constructed models mainly confirmed the hypothesis based on the assumption that the decisive role in the formation of the yield belongs to the sum of operating (production) expenses per hectare; this dependence is formed under the influence of the economic law of diminishing returns.

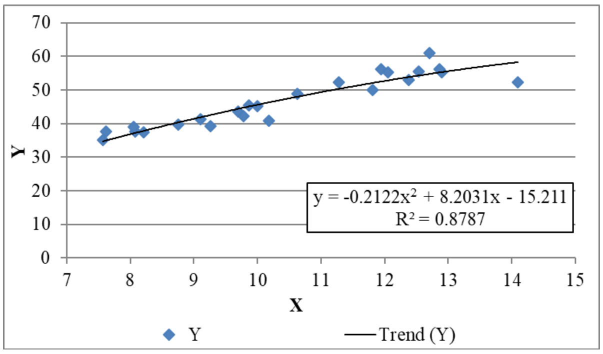

Fig. 1. Graph of the dependence of the yield of winter wheat grain (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

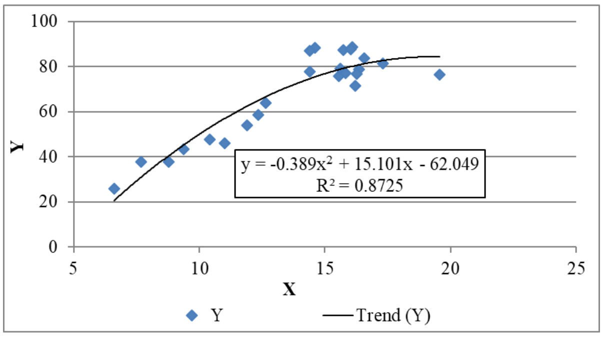

Fig. 2. Graph of the dependence of the yield of corn grain (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

The graphical representation of the influence of the sum of costs per hectare on crop yields showed the polynomial nature of the dependence, which is mathematically described by parabolas of the second order. The regression equations show that the increase in the amount of costs per 1 thousand UAH per hectare of harvested area of winter wheat contributed to the increase in yield by 8.20 c/ha, while the rate of increase in yield slowed by 0.21 c/ha, which led to a decrease in yield after achieving a certain amount of costs. The pairwise correlation coefficient is 0.937, which indicates a very close direct relationship between the sum of costs per hectare and the yield of winter wheat. The coefficient of determination shows that the variation in the yield of winter wheat by 87.9% depended on the variation in the amount of costs per hectare.

It was established that the increase in the amount of expenditures by 1,000 UAH per hectare of harvested corn area for grain contributed to the increase in yield by 15.10 c/ha, while the rate of increase in yield slowed down by 0.40 c/ha. The coefficient of pairwise correlation is 0.934, which, again, indicates a very close direct relationship between the amount of costs per hectare and the corn yield. The coefficient of determination shows that the 87.3% variation in maize yield depended on the variation in the amount of costs per hectare.

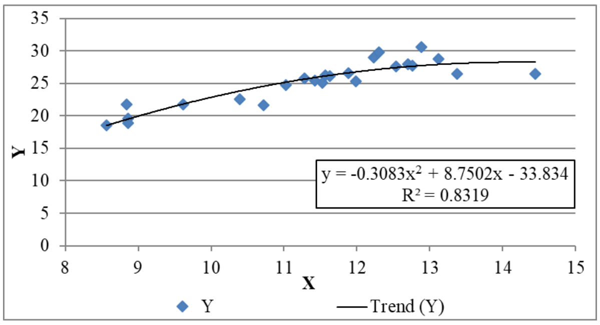

Fig. 3. Graph of the dependence of the yield of sunflower (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

It is established that the increase in the amount of costs by 1 thousand UAH per hectare of harvested area contributed to the increase in yield of sunflower by 8.75 c/ha, soybeans – by 2.80 c/ha, rapeseed – by 3.69 c/ha, while the rate the increase in sunflower yield slowed down by 0.31 c/ha, soybeans by 0.01 c/ha, and rapeseed by 0.10 c/ha. The coefficient of pairwise correlation is 0.912 for sunflower, 0.738 – for soybean, and 0.661 – for rapeseed, indicating a direct very close and noticeable relationship between the sum of costs per hectare and the yield of these crops. The coefficient of determination shows that the variation in yield of sunflower by 83.2%, soybean by 54.5%, rapeseed by 43.7% depended on the variation in the amount of costs per hectare.

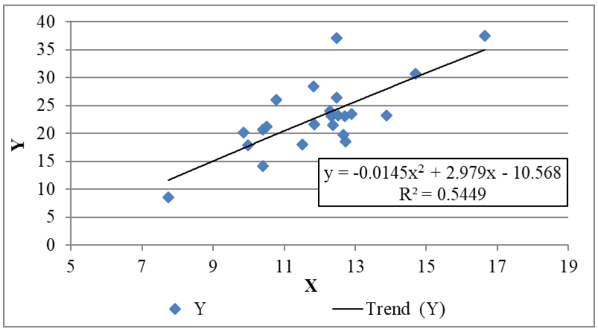

Fig. 4. Graph of the dependence of the yield of soy (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

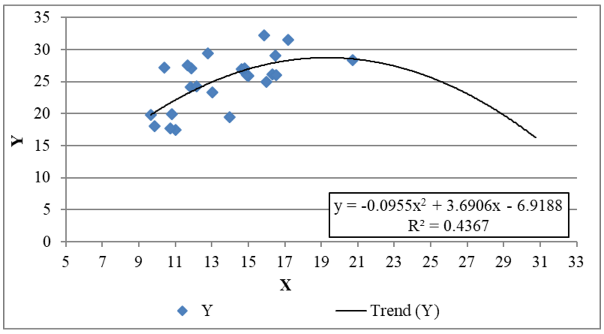

Fig. 5. Graph of the dependence of the yield of rape (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

Thus, the constructed equations of the dependence of the yield of winter wheat, corn, sunflower, soybean and rapeseed on the sum of costs per hectare indicate a clear manifestation of the law of diminishing returns. The dependence of the yield of potatoes from the size of production costs per 1 hectare harvested area most accurately describes the logarithmic function. The coefficient of pairwise correlation is 0.708, which indicates a noticeable direct relationship between the size of costs per hectare and the yield of potatoes. The coefficient of determination in our case shows that the 50.1% variation in yield of potatoes depended on the variation in the amount of costs per hectare.

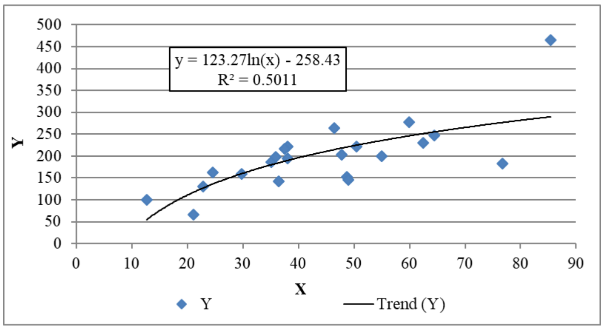

Fig. 6. Graph of the dependence of the yield of potatoes (Y, centner/ha) from the size of production costs per 1 hectare harvested area (X, thousand UAH) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

In turn, we note that the yield significantly influenced the amount of income and profit per hectare (Fig. 7-10), but the nature of the dependence and the degree of closeness of the relationship was different for specific crops.

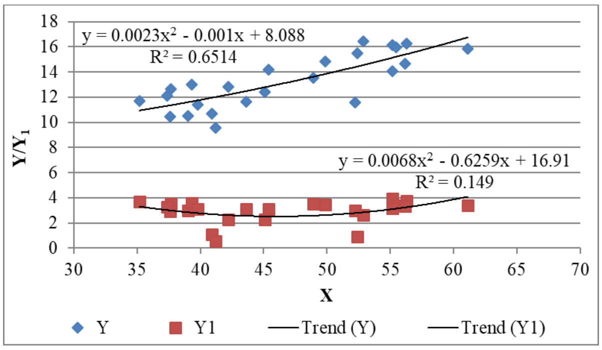

Fig. 7. Graph of the dependence of the income (Y, thousand UAH/ha) and profit (Y1, thousand UAH/ha) from the yield of winter wheat grain (X, centner/ha) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

It was found that the increase in yield by 1 c/ha contributed to the increase in income per hectare of soybeans by 1320 thousand UAH, rapeseed – by 0.895 thousand UAH, potatoes – by 0.335 thousand UAH, while the rate of increase in soybean income slowed by 0.011 thousand UAH/ha, rapeseed – by 0.004 thousand UAH/ha, potatoes – by 0.0002 thousand UAH/ha.

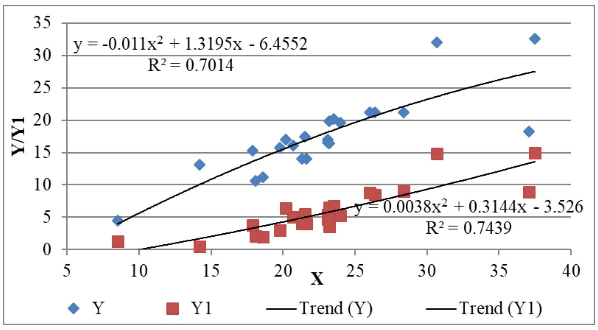

Fig. 8. Graph of the dependence of the income (Y, thousand UAH/ha) and profit (Y1, thousand UAH/ha) from the yield of soy (X, centner/ha) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

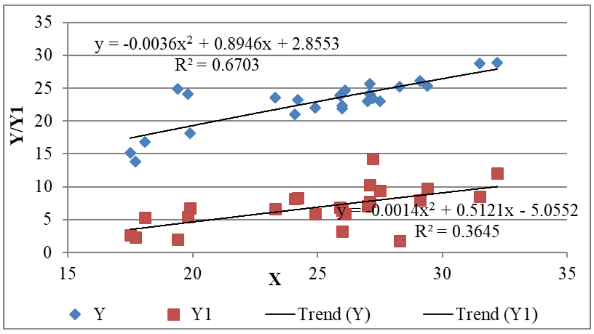

Fig. 9. Graph of the dependence of the income (Y, thousand UAH/ha) and profit (Y1, thousand UAH/ha) from the yield of rape (X, centner/ha) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

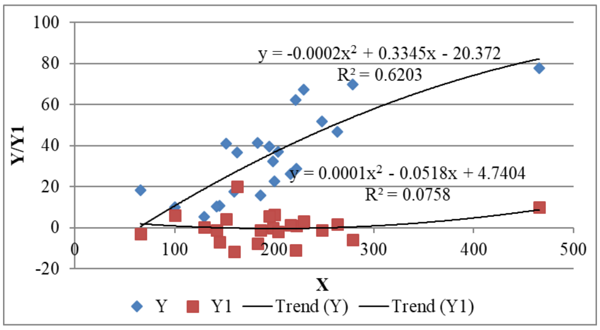

Fig. 10. Graph of the dependence of the income (Y, thousand UAH/ha) and profit (Y1, thousand UAH/ha) from the yield of potatoes (X, centner/ha) in agricultural enterprises of the regions of Ukraine, 2016
Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

The pairwise correlation coefficient is 0.837 for soybeans, 0.819 for rapeseed, and 0.788 for potatoes, indicating a direct close relationship between crop yields and income per hectare. The coefficient of determination shows that the variation in income per hectare of soybean by 70.1%, rapeseed by 67.0%, potatoes by 60.2% depended on the variation in yield of these crops. The profit per hectare in this case depended less on crop yields, which is associated with other factors shaping its size.

Using the developed regression models, we determined the optimums of the function of the dependence of crop productivity from the size of operating expenses in investigated agricultural enterprises of Ukrainian regions and developed the forecast of optimal costs per 1 hectare for 2022 (Table 1).

Table 1. Actual and predicted value of the optimum of the function of dependence of crop productivity from the size of production costs in agricultural enterprises of the regions of Ukraine

Crops	Optimum of functions, 2016 year		Actual values in agricultural enterprises of Kharkiv region, 2016 year		Forecasted value of optimal costs for 2022 year, thsd. UAH/ha*
	Operating (production) costs, thsd. UAH/ha	Yield, c/ha	Operating (production) costs, thsd. UAH/ha	Yield, c/ha	
Winter wheat	19.3	64.1	9.9	45.4	34.3
Corn grain	19.4	84.5	12.4	58.8	34.5
Sunflower	14.2	28.3	12.2	29.0	25.2
Rape	19.3	28.7	9.6	19.8	34.3

*Calculated taking into account the aggregate expenditure index (177.7%) for crop production in 2017-2021. For 2021, the cost index is taken for 9 months (January-September).

Source: calculated and built by the authors based on data of the State Statistics Service of Ukraine.

According to forecast, the optimal (under average farming conditions at the meso level) operating expenses for 2022 will account for winter wheat 34.3 thsd. UAH/ha, corn grain – 34.5, sunflower – 25.2, rape – 34.3 thsd. UAH/ha. These costs will ensure the achievement of yields of these crops, respectively, at the level of: 64.1 c/ha, 84.5, 28.3 and 28.7 c/ha. The results can be used at the regional level of management to make decisions to improve the financial support to optimum level. At the micro level, there is a need for additional research.

Comparing the results of our research with the existing works [14; 15; 16; 19; 20], it should be noted that, in general, they do not contradict each other and complement and develop them, in particular, in terms of managing the sustainable intensification of crop production at the regional level, taking into account certain predicted optimal levels of intensity. Thus, it was established that:

(i) agricultural enterprises of Ukraine have significant reserves for increasing crop yields to the optimal level, which mainly corresponds to the average indicators of the EU countries;

(ii) real growth in crop yields is directly related to an increase in the level of intensity, expressed by the value of costs per 1 hectare of harvested area;

(iii) since production costs have not reached the maximum level, it is proposed to increase them to optimal values with simultaneous optimization of their structure, which will significantly increase economic efficiency and competitiveness;

(iv) a significant problem of increasing the level of intensity is the action of the law of diminishing returns, which entails a decrease in the payback of additional costs and ultimately limits the amount of profit per hectare. In the EU countries, high levels of production intensity are partially offset by budgetary subsidies;

(v) in Ukraine, overcoming the law of diminishing returns should be linked to the introduction of innovative technologies that optimize (minimize) the costs of enterprises while increasing crop yields.

CONCLUSIONS

Using the constructed graphic-analytical models, we can conclude that the productivity of crop production in agricultural enterprises in the regions of Ukraine was formed under the conditions of the economic law of diminishing return. Yet it is worth noticing that the effect of this economic law was not found in potato production, which is probably due to the relatively low level of expenses per hectare. It was found that real growth in crop yields is directly related to an increase in the level of intensity, expressed by the amount of expenses per 1 hectare of harvested area.

It is proposed to increase production costs to optimal values with simultaneous optimization of their structure, which will significantly increase economic efficiency and competitiveness. According to forecast, the optimal (under average farming conditions at the meso level) operating expenses for 2022 will account for winter wheat 34.3 thsd. UAH/ha, corn grain – 34.5, sunflower – 25.2, rape – 34.3 thsd. UAH/ha. Overcoming the law of diminishing returns in Ukrainian crop production should be linked to the introduction of innovative technologies that optimize (minimize) the costs of enterprises while increasing crop yields.

The obtained results can be used at the regional level of management to make decisions to improve the financial support to optimum level. At the micro level, there is a need for additional research, which will be a promising area of our study in the future.

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FINANCIAL SUPPORT FOR THE SUSTAINABLE COMPETITIVENESS OF LAND USE: TRENDS AND OPPORTUNITIES

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Abstract

The paper studied the trends and opportunities of financial support for the formation of sustainable competitiveness of land use of agricultural enterprises in Ukraine. The results of analysis indicate a significant increase in the nominal volume of financial resources of agricultural enterprises of Ukraine during 2010–2018 (6.2 times), however, the structural ratio between the components of financial resources remained almost unchanged. The increase of all financial resources was carried out mainly in the conditions (and, consequently, due to) of inflationary-devaluation processes, and not a real increase in resources. Thus, the sum of financial resources of agricultural enterprises in US dollar terms increased only 1.82 times, and taking into account the inflation index – only 2.15 times during the analyzed period. A similar situation is also characteristic for the sources of formation of financial resources. It can be predicted further increase the amount of the net profit as the main source of own financial resources. The correlation analysis confirmed the hypothesis that the dynamics of profit is more connected to the variation of the exchange rate and the inflation rate than to the internal factors of the efficiency of agricultural enterprises. in the system of financial support for the formation of sustainable competitiveness of land use, the financial leasing, agricultural insurance and stock market has a significant (untapped) potential.

Key words: *financial resources, sustainable competitiveness, financial leasing, insurance, stock market*

INTRODUCTION

Under the effect of sustainable development issues, competitiveness, which is conditional on a collection of institutions, policies, and factors determining the productivity of economic entities, changes [18]. One of the key determinants of the formation of sustainable competitiveness of land use of agricultural enterprises is financial support. Many studies are devoted to various aspects of the current problem of financing the agricultural sector [2; 11; 13; 14; 16] and amalgamated territorial communities in the context of rural development [10]. The importance of financial support for agriculture for the growth of the sector in Ukraine was established. The key techniques to improve the agriculture sector's investment attractiveness were also substantiated [9].
Scientists study and offer various opportunities for financing agribusiness entities, in particular through the stock exchange [2], credit and investment resources [20], leasing mechanisms [14; 19], state support [22], agrarian insurance [26], etc. The scientific provision for financial support for agricultural enterprises has been expanded by substantiating ideas for improving the state support and credit support mechanisms, as well as establishing their essential components [12]. The approach to determining the optimal amount of credit support for innovation has been developed and tested taken into account the agrobiological, economic and financial aspects of the agriculture [17]. The financial support provided to agricultural producers at the expense of the state budget was examined in terms of programs and regional differences. It was demonstrated that the effectiveness of agricultural enterprise activities under modern management settings was impossible to achieve without an adequate state support mechanism [22].
An important aspect of effective financing of

the agricultural sector is the management of this process. These issues are investigated in particular in the works by O. Hudz [6], O. Oliynuk, V. Makohon, V. Mishchenko et al. [17], N. Tanklevska, V. Miroshnichenko [23], V. Zymovets [27]. At the same time, as scientists do not pay enough attention to the comprehensive study of trends, problems and prospects of financial support of the agricultural sector from the standpoint of forming a sustainable competitiveness of land use., the purpose of this paper was to study the trends and opportunities of financial support for the formation of sustainable competitiveness of land use of agricultural enterprises in Ukraine.

MATERIALS AND METHODS

The data of the State Statistics Service of Ukraine, National Bank of Ukraine, and National commission exercising state regulation in the sphere of financial services market [1; 4] regarding the main sources of financial support and the financial results before taxation of enterprises by the types of economic activity with division into large, medium, small and micro enterprises at the national level, as well as public data of agricultural companies [3; 7; 21; 24; 25] were used as an information base in this article.

The research used the following scientific methods: economic-statistical (for analyze the state and dynamics of financial support); mathematical alignment of time series (for determine trends in financial support); correlation and regression analysis (for identify relationships between indicators of financial support); graphical (for the visualize the trends of the analyzed financial indicators); analysis, synthesis (for identifying the main problems and opportunities of financial support).

At the first stage, there were studied the key trends and problems in the practice of support by financial resources of agricultural enterprises of Ukraine. Secondly, there were studied the own sources of financial support for agricultural enterprises. Thirdly, it was researched the financial leasing and its role in the financial support for agricultural enterprises. In the fourth stage, it was investigated the insurance and its role in the financial support for agricultural enterprises. Finally, in the fifth stage, there were approached some aspects of the stock market and its role in the attraction of funds for public agroholdings.

RESULTS AND DISCUSSIONS

In this section, there are described: condition, problems and justified the prior financial sources which have to be assured to agricultural enterprises in Ukraine in the context of the formation of sustainable competitiveness.

Practice of support by financial resources of agricultural enterprises of Ukraine: key trends and problems.

A significant increase in the volume of financial resources of agricultural enterprises of Ukraine during 2010–2018 was observed as indicated by the achieved analysis (by 293.5 bln UAH, or 6.2 times), however, the structural ratio between the components of financial resources remained almost unchanged (Table 1).

Table 1. Current state and dynamics of the composition and structure of financial resources of agricultural enterprises of Ukraine

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Composition of financial resources, bln UAH									
Total amount of financial resources	56.2	72.0	95.8	109.5	162.5	361.0	1,113.7	388.0	349.7
Including: accounts receivables	49.9	63.4	85.3	98.3	151.5	342.8	1,092.1	365.7	325.9
current financial investment	0.743	0.767	1.539	1.331	1.565	1.396	2.123	2.161	1.876
cash	5.54	7.80	9.01	9.89	9.45	16.77	19.48	20.09	21.95
Structure of financial resources, %									
Accounts receivables	88.8	88.1	89.0	89.8	93.2	95.0	98.1	94.3	93.2
Current financial investment	1.3	1.1	1.6	1.2	1.0	0.4	0.2	0.6	0.5
Cash	9.9	10.8	9.4	9.0	5.8	4.6	1.7	5.2	6.3

Source: formed and calculated by the author according to the data of the State Statistics Service of Ukraine and National Bank of Ukraine [4].

The largest share in the structure of financial resources is accounts receivables, the share of which increased from 88.8 % in 2010 to 93.2 % in 2018. At the same time, the share of current financial investments decreased from 1.3 % in 2010 to 0.5 % in 2018, and the share of cash decreased from 9.9 % in 2010 to 6.3 % in 2018. The most significant changes in the volume and structure of financial resources occurred in 2016, which is associated with a significant increase in other accounts receivables. At the same time, the increase of all these financial resources was carried out mainly in the conditions (and, consequently, due to) of inflationary-devaluation processes, and not a real increase in resources.

Thus, according to the National Bank of Ukraine, the official average annual exchange rate of Ukrainian Hryvnia (UAH) against the US dollar (USD) was (UAH per 1 USD): 2010 – 7.94; 2011 – 7.97; 2012 – 7.99; 2013 – 7.99; 2014 – 11.89; 2015 – 21.85; 2016 – 25.55; 2017 – 26.60; 2018 – 27.20. So, the Ukrainian Hryvnia depreciated over the period 2010–2018 by 3.426 times. According to the State Statistics Service of Ukraine, the official average annual inflation index (consumer price index) in Ukraine was: 2010 – 1.091; 2011 – 1.046; 2012 – 0.998; 2013 – 1.005; 2014 – 1.249; 2015 – 1.433; 2016 – 1.124; 2017 – 1.137; 2018 – 1.098. Thus, the cumulative inflation index for 2010–2018 is 2.880. It follows, that the sum of financial resources of agricultural enterprises in US dollar terms increased only 1.82 times (from 7.078 in 2010 to 12.856 bln USD in 2018), and taking into account the inflation index – only 2.15 times during the analyzed period. A similar situation is also characteristic for the sources of formation of financial resources (Table 2).

Table 2. Current state and dynamics of the composition and structure of sources of financial resources of agricultural enterprises of Ukraine

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Composition of sources of financial resources, bln UAH									
Total sources of financial resources	156.4	199.0	257.3	241.3	329.9	572.9	611.8	693.1	760.3
Including: cash revenue (income) from sales	99.9	127.0	162.6	161.1	213.9	362.3	403.7	454.4	525.1
short-term banking credits	8.2	12.2	15.7	22.3	27.6	27.9	29.1	46.9	54.9
current accounts payable	43.8	55.5	72.6	50.6	72.1	137.0	172.1	186.8	176.1
budgetary funds (state support)	4.6	4.3	6.5	7.3	16.2	45.8	7.0	5.0	4.3
Structure of sources of financial resources, %									
Cash revenue (income) from sales	63.9	63.8	63.2	66.8	64.8	63.2	66.0	65.5	69.0
Short-term banking credits	5.2	6.1	6.1	9.2	8.4	4.9	4.8	6.8	7.2
Current accounts payable	28.0	27.9	28.2	21.0	21.9	23.9	28.1	27.0	23.2
Budgetary funds (state support)	2.9	2.2	2.5	3.0	4.9	8.0	1.1	0.7	0.6

Source: formed and calculated by the author according to the data of the State Statistics Service of Ukraine and National Bank of Ukraine [4].

The total financial resources of agricultural enterprises of Ukraine in 2018 accounted for 760.3 bln UAH, meaning 4.9 times more than in 2010. However, the real (taking into account the inflation index) total amount of sources of financial resources increased only 1.69 times, and in US dollar terms – only 1.42 times during analyzed period. The ratio of the sources of formation of financial resources changed across different stages of the evolution of agricultural enterprises. In the structure of sources of financial resources, the leading positions were held by the following: (i) cash revenue (income) from sales (63.2–69.0 %), and (ii) current accounts payable (21.0–28.1 %); the minor positions were held by the following: (i) short-term banking credits (4.7–9.3 %), and (ii) budgetary funds (state support) (0.6–8.0 %). There was a noticeable increase in the share of cash revenue (income) from sales in the structure of the sources of financial resources, from 63.9 % in 2010 to 69.0 % in 2018. Unlike the previous source, in terms the share of current accounts payable, we identified a downward trend (from 28.0 % in 2010 to 23.2 % in 2018). Besides, we identified a clear trend of increasing the share of short-term banking loans (from 5.2 % in 2010 to 7.2 % in 2018), while reducing the share of state support in the structure of sources of financial resources (from 2.9 % in 2010 to 0.6 % in 2018).

It should be particularly noted the significant share of current accounts payable and accounts receivables. The calculation results indicate that the volume of accounts receivables in 2010 was 13.9 % higher than the current accounts payable; and in 2018, accounts receivable were 85.1 % higher than the current accounts payable of agricultural enterprises. Thus, we can agree with the opinion that the current practice of financial support for agricultural producers is not characterized by complexity and systematicity, it has a number of disadvantages that do not make it possible to satisfy the financial needs of agricultural enterprises [9]. One of the features of accounts receivable at agricultural enterprises is that in conditions of inflation and/or devaluation, the returned funds lose their initial value, since Ukraine does not have a mechanism for indexing receivables in accordance with inflationary processes. The main measures for rational management of receivables: (i) to monitor the status of settlements with customers on deferred (overdue) debts; (ii) if possible, focus on a larger number of buyers in order to reduce the risk of non-payment by one or more large buyers; (iii) to monitor the ratio of receivables and payables: significantly exceeded the first threatens the financial stability and competitiveness of the enterprise and requires the attraction of additional sources of financing; (iv) to apply the method of providing discounts for early payments, which is used in foreign practice; (v) to develop measures to limit the term for settlements on deliveries by reissuing overdue payments on receivables into a commercial loan [6].

Own sources of financial support for agricultural enterprises.

Of course, the formation of own sources (domestic private financial resources) of financial support for agricultural enterprises is associated with their financial results of activities (Table 3).

Table 3. Current state and dynamics of the formation of own sources of financial support for agricultural enterprises in Ukraine

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Financial results before taxation, bln UAH	17.3	25.3	26.8	15.0	21.5	102.0	90.1	68.6	67.2
Enterprises which got profit before taxation: percentage to total number	69.8	83.4	78.5	80.3	84.8	89.0	88.4	86.8	86.7
financial result, bln UAH	22.2	30.3	33.7	26.3	51.7	127.6	102.8	89.0	93.4
Enterprises which got loss before taxation: percentage to total number	30.2	16.6	21.5	19.7	15.2	11.0	11.6	13.2	13.3
financial result, bln UAH	4.8	4.9	6.8	11.2	30.2	25.6	12.7	20.4	26.2
Net profit (loss), bln UAH	17.3	25.3	26.7	14.9	21.4	101.9	89.8	68.3	66.9
Enterprises which got net profit: percentage to total number	69.6	83.5	78.6	80.3	84.7	88.9	88.4	86.7	86.7
financial result, bln UAH	22.1	30.2	33.6	26.2	51.7	127.5	102.5	88.7	93.1
Enterprises which got dead loss: percentage to total number	30.4	16.5	21.4	19.7	15.3	11.1	11.6	13.3	13.3
financial result, bln UAH	4.8	4.9	6.8	11.3	30.3	25.6	12.7	20.4	26.3
Profitability level of all types of activity, %	17.5	19.3	16.3	8.3	9.3	30.4	25.6	16.5	13.5
Profitability level of operating activities, %	24.5	24.7	22.8	11.7	21.4	43.0	33.6	23.2	18.5

Source: formed by the author according to the data of the State Statistics Service of Ukraine [4].

Mathematical leveling of dynamic series for 2010–2018 and parameters of obtained equations indicate the general trend to increase of financial results before taxation, net profit and percentage of agricultural enterprises which got net profit (to total number). For example, in Ukrainian agricultural enterprises the average annual increase of financial results before taxation totaled 9.04 bln UAH (R^2 = 0.535), net profit – 9.01 bln UAH (R^2 = 0.533) and percentage of enterprises which got net profit (to total number) – 1.77 % (R^2 = 0.625). The coefficients of determination for these trends suggest that the actual data of investigated dynamic series by an average of 73.1 %, 73.0 and 79.1 % respectively coincide with the estimated (theoretical) data, calculated on the chosen trend line. Therefore, with the appropriate level of probability it can be predicted further increase the amount of the net profit as the main source of own financial resources. In contrast to the previous case, in the dynamics of financial results in US dollar terms there are no clear growth trends, since for linear equations coefficients of determination were significantly lower, indicating that their nonlinear dynamics (Table 4).

Table 4. Current state and dynamics of formation of own sources of financial support for agricultural enterprises in Ukraine (in US dollar terms)

Indicators	Year								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Financial results before taxation, mln USD	2,181.4	3,180.1	3,359.6	1,878.9	1,807.9	4,668.0	3,527.3	2,579.2	2,469.5
Enterprises which got profit before taxation percentage to total number	69.8	83.4	78.5	80.3	84.8	89.0	88.4	86.8	86.7
financial result, mln USD	2,790.0	3,797.4	4,214.0	3,285.6	4,351.9	5,840.2	4,023.0	3,345.3	3,434.6
Enterprises which got loss before taxation percentage to total number	30.2	16.6	21.5	19.7	15.2	11.0	11.6	13.2	13.3
financial result, mln USD	608.6	617.3	854.4	1,406.7	2,544.0	1,172.2	495.8	766.2	965.1
Net profit (loss), mln USD	2,173.0	3,170.3	3,345.2	1,868.0	1,801.0	4,664.2	3,515.3	2,566.8	2,458.8
Enterprises which got net profit percentage to total number	69.6	83.5	78.6	80.3	84.7	88.9	88.4	86.7	86.7
financial result, mln USD	2,782.7	3,787.0	4,201.5	3,277.4	4,345.5	5,836.4	4,011.6	3,333.7	3,424.1
Enterprises which got dead loss percentage to total number	30.4	16.5	21.4	19.7	15.3	11.1	11.6	13.3	13.3
financial result, mln USD	609.7	616.7	856.3	1,409.4	2,544.5	1,172.2	496.3	766.9	965.3

Source: author's calculations based on the data of State Statistics Service of Ukraine [4] using the official exchange rate of Ukrainian Hryvnia to USD set on by the National Bank of Ukraine.

If in national currency the amount of profit increased 3.9 times, then in the US dollar terms – only 13.2 % during the analyzed period. Therefore, it is logical to assume that the change in the amount of profit in the dynamics is more correlated with the change in the exchange rate and the level of inflation than with the internal factors of the efficiency of agricultural enterprises. Correlation analysis confirmed this hypothesis, in particular it is determined that the amount of profit in national currency has a high direct correlation relationship with the official exchange rate of Ukrainian Hryvnia to USD ($r = 0.876$), official average annual inflation index ($r = 0.611$), and moderate relationship between the level of devaluation and inflation ($r = 0.409$). A positive trend is the reduction in the share of unprofitable enterprises (from 30.4 % in 2010 to 13.3 % in 2018), but a negative trend is a decrease in profitability level of all types of activity (from 17.5 % in 2010 to 13.5 % in 2018).

Another important own source of financial resources for sustainable competitiveness is the equity capital, during 2010–2018 it increased significantly (by 396.2 bln UAH, or 5.2 times); however, the real (taking into account the inflation index) sum of the equity capital increased only 1.79 times, and in US dollar terms – only 1.51 times (Table 5).

Table 5. Current state and dynamics of equity capital of agricultural enterprises in Ukraine at the end of the year, bln UAH

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Equity capital – total	95.3	127.6	152.1	162.0	170.1	282.3	377.0	443.1	491.5
Including: registered capital	22.4	24.2	27.3	30.2	30.5	33.6	40.1	43.8	54.4
additional capital	25.2	29.2	30.1	29.6	31.2	36.8	46.3	48.8	59.4
reserve capital	8.0	10.3	12.5	14.2	15.2	18.7	24.4	28.6	32.8
undistributed profit (pending loss)	37.2	62.2	80.2	85.4	90.1	189.7	262.4	318.5	340.6
unpaid capital and disposed capital	2.5	1.7	2.0	2.6	3.1	3.5	3.8	3.4	4.3

Source: formed by the author according to the data of the State Statistics Service of Ukraine [4].

In the structure of equity capital, the leading positions were held by the following:

(i) undistributed profit (39.0–71.9 %), (ii) additional capital (11.0–26.4 %), and (iii) registered capital (9.9–23.5 %); the minor positions were held by the following: (i) reserve capital (6.5–8.9 %), and (ii) unpaid capital and disposed capital (0.8–2.6 %). The most significant increase (9.2 times) is characteristic for undistributed profit – the average annual increase is 40.85 bln UAH (R^2 = 0.906), accordingly, its share almost doubled. The calculations indicate an increase in ratio of accounts receivables to equity capital: from 0.524 in 2010 to 0.663 in 2018.

Financial leasing in the financial support for agricultural enterprises.

From the point of view of the formation of sustainable competitiveness of Ukrainian agricultural enterprises, financial leasing is a promising source of financing (Table 6).

Table 6. Current state and dynamics of the volumes of financial leasing for agricultural enterprises in Ukraine

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of financial leasing contracts, thsd. units	5.1	10.9	10.8	11.1	8.9	4.1	9.1	7.7	10.3
Value of financial leasing contracts concluded during the reporting period, total, bln UAH	4.9	11.3	14.7	31.6	7.2	6.2	9.8	13.0	22.2
Value of existing financial leasing contracts at the end of the period, total, bln UAH	30.5	33.6	41.5	67.1	58.6	26.3	23.2	22.8	25.2
including: value of existing financial leasing contracts concluded with agricultural enterprises, bln UAH	4.0	4.7	7.9	9.4	11.2	6.6	5.6	5.5	5.3
percentage to value of existing financial leasing	13.1	14.0	19.0	14.0	19.1	25.1	24.1	24.1	21.0

Source: formed and calculated by the author according to the data of the National commission exercising state regulation in the sphere of financial services market.

The total number of financial leasing contracts in Ukraine in 2018 was 10.2 thsd. units, which is 2.0 times more than in 2010. The total value of financial leasing contracts concluded during the reporting period in 2018 was 22.2 bln UAH, which is 4.7 times more than in 2010. Simultaneously, we identified a polynomial trend in the dynamics of change of total value of existing (current) financial leasing contracts at the end of period. Nevertheless, the value of existing financial leasing contracts concluded with agricultural enterprises in 2018 was 5.3 bln UAH, which is 32.5 % more than in 2010, but half as much as in 2014. We identified a trend of increasing the share of value of existing leasing contracts concluded with agricultural enterprises in total value (from 13.1 % in 2010 to 21.0 % in 2018), which indicates the growing importance of this source of funding.

State participation in the revitalization of financial support for agricultural enterprises via financial leasing is implemented through National Joint-Stock Company «Ukragroleasing». In 2017, «Ukragroleasing» purchased 246 units of machinery and equipment in the amount of 150.8 mln UAH for their subsequent transfer to leasing. As a result of the conclusion of 189 leasing agreements 210 units of machinery were transferred to lessees with a total value of 107.5 mln UAH. As we know, «Ukragroleasing» provides services of financial leasing on the following conditions: prepayment in the amount of 15 % of the contractual value of the leased object; commission payments from the agreed value of the leasing objects are one-time (2–7 %), annual (19–23 %); leasing period is 12–45 months; the frequency of leasing payments depends on their components (the main payment is made monthly and/or quarterly, the commission – monthly) [14].

We agree that the main areas of improvement of business activity of «Ukragroleasing» are: (i) enhancement of terms of the leasing services towards the reduction of commission and reducing the list of required paperwork; (ii) improving the quality parameters and expanding the list of technique and equipment that are leased; (iii) individual work with clients and active involvement of small agribusiness, including family farms [8].

Insurance in the financial support for agricultural enterprises.

Agricultural insurance has significant (untapped) potential in the system of financial support for the formation of sustainable

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competitiveness of land use of agricultural enterprises (Table 7).

Table 7. Current state and dynamics of the volumes of agrarian insurance for agricultural enterprises in Ukraine

Indicators	Years								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of contracts	1,217	2,710	1,936	1,722	1,392	1,062	793	957	1,207
Area, thsd. ha	553	786	727	869	732	689	700	661	974
Insurance amount, mln UAH	N/d	N/d	N/d	N/d	3,055	3,969	6,240	5,933	6,675
Amount of premium, mln UAH	72.1	136.3	130.4	135.4	72.8	77.7	157.0	204.3	208.8
Insurance subsidy, mln UAH	0	0	0.086	0	0	0	0	0	0
Level of payments, %	50.9	28.0	41.0	9.7	7.6	12.9	44.2	4.9	4.2
Average premium rate, %	3.8	3.7	3.8	3.1	2.4	2.0	2.5	3.4	3.1
Insurance amount, mln USD	N/d	N/d	N/d	N/d	256.9	181.6	244.2	223.0	245.4
Amount of premium, mln USD	9.1	17.1	16.3	16.9	6.1	3.6	6.1	7.7	7.7

Note. N/d – no data.
Source: formed by the author according to the data [1, p. 8].

The positive aspect is that the insured area in 2018 was 974 thsd. ha, which is 1.8 times more than in 2010, however, the number of contracts remained almost unchanged. The insurance amount in 2018 was 6,675 mln UAH, which is 2.2 times more than in 2014. The amount of premium in 2018 was 208.8 mln UAH, which is 2.9 times more than in 2010. However, the amount of premium in US dollar terms is decreased by 15.4 % during analyzed period due to the hryvnia devaluation.

The three-level analysis (territorial, sectoral and institutional levels) of agrarian insurance gives grounds to state that there are positive trends. However, issues concerning the expansion of the agrarian risk insurance coverage, activating the business activity of the insurance market participants for balancing their existing insurance interests, possible sources of insurance payments diversification and the growth of insurance companies capitalization still need improvement [26].

Stock market in the attraction of funds for public agroholdings.

A powerful external source of financial support for large public Ukrainian agricultural holdings is the issue of securities and their placement on international stock exchanges (Table 8).

Table 8. Current state of attraction of financial resources by the largest agroholdings of Ukraine through world's stock exchanges

Company name	Registered office	Stock market	Date of IPO	Currency	Capitalization three months after IPO, mln USD	Share price three months after IPO, USD	Free float as of IPO date, %	Capitalization, mln USD 2017*	Capitalization, mln USD 2019**
Agrogene-ration	Paris	Euronext	March 2010	N/d	72.1	2.1	17.9	N/d	N/d
Agroliga	Nicosia	New-Connect	February 2011	PLN	45.5	81.0	16.7	7	6
Agroton	Nicosia	WSE	November 2010	PLN	312.8	41.0	42.4	35	21
Astarta	Amster dam	WSE	August 2006	PLN	147.3	17.5	14.6	444	159
Avangardco	Limassol	LSE	May 2010	USD	17.8	12.8	22.5	42	18
IMC	Luxembourg	WSE	May 2011	PLN	101.0	9.2	24.0	83	127
Kernel	Luxembourg	WSE	November 2007	PLN	933.8	35.5	36.0	1,466	1,105
KSG Agro	Luxembourg	WSE	May 2011	PLN	103.8	19.9	34.8	10	3
MHP	Luxembourg	LSE	May 2008	USD	1,745.7	15.8	22.3	1,086	1,105
Milkiland	Amsterdam	WSE	December 2010	PLN	461.6	42.0	27.2	14	3
Ovostar	Amster dam	WSE	June 2011	PLN	111.0	59.9	25.0	192	179
Ukrproduct	Jersey	AIM	February 2005	GBP	47.8	63.5	27.2	2	3

Note. N/d – no data. * As of 27.06.2017; ** As of 24.12.2019.
Source: formed by the author according to the data of the public sources [5; 21; 25].

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So, more than 10 Ukrainian agroholdings place their stocks and bonds on the stock exchanges (mainly London, Frankfurt, Warsaw and Paris), using such two tools as Initial Public Offering and depository receipts, which give them opportunity to gain competitive advantages and increase the market value of their businesses. According to Ukrainian Agribusiness Club (UCAB), as of March 2019, in comparison to the end of last year, the total market capitalization of Ukrainian public agricultural companies has decreased – down to 2.83 bln USD (from 2.96 bln USD). The agroholding KERNEL is the leading company with of 1.10 bln USD, but since the beginning of the year it shows a weak negative tendency in its market capitalization (Fig. 1) [7].

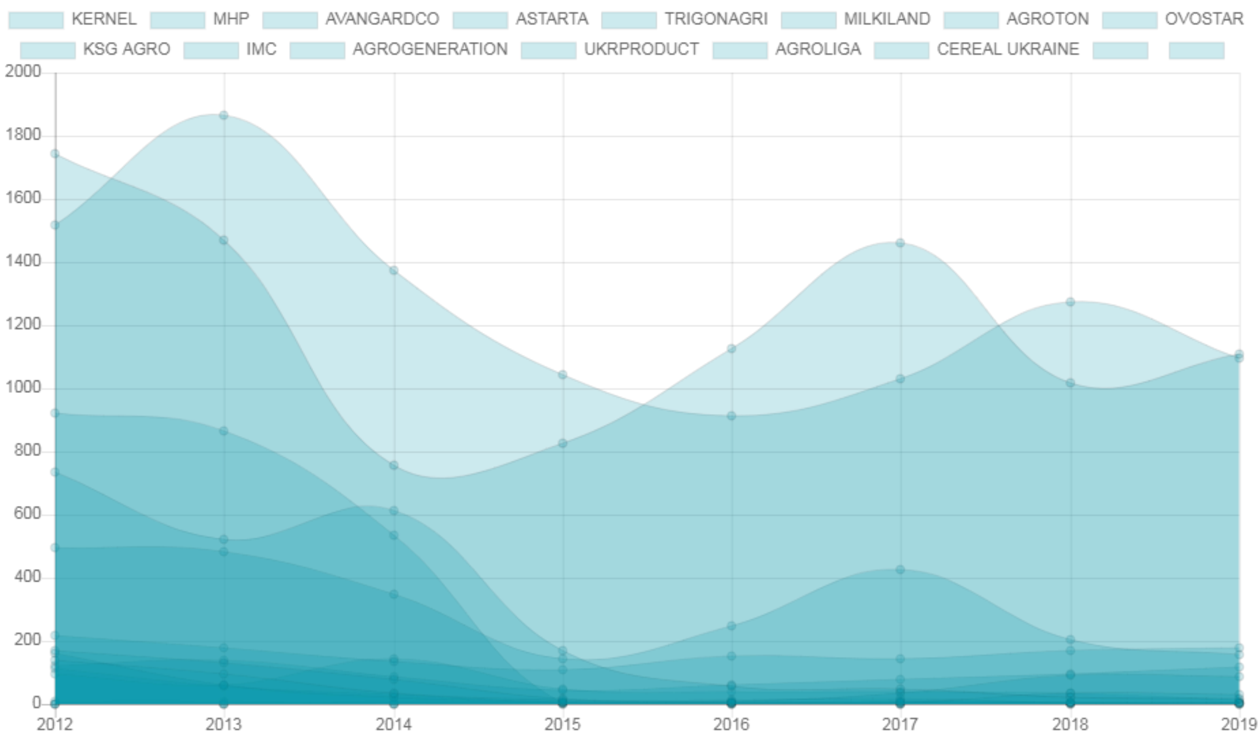

Fig. 1. Capitalization of Ukrainian publicly listed agroholdings
Source: Investments & finances [7].

Additional benefits of access to foreign stock exchanges are the access to credit resources of foreign banks, whose cost (usage fee) is 2.0–2.5 times lower than Ukrainian banks. Ukrainian banks also provided loans to agroholdings on much more attractive terms than other agricultural enterprises. As an alternative way of attracting financial resources, agroholdings have chosen to enter the Eurobond market, cooperate with the European Bank for Reconstruction and Development and other international financial companies [15].

The decrease in market capitalization of agroholdings is due to a number of macro-financial and political shocks, in particular, hryvnia devaluation, loss of a land bank and production capacities located in the occupied territories. However, due to relative macro-financial stabilization and improving conditions on the world markets, there was a gradual restoration of investor confidence, which was reflected in the increase in the price of shares of agroholdings [27, p. 20].

It is worth noting that despite political uncertainty farmers remain optimistic. So, for example, a survey of agricultural producers conducted in February 2019 on the agricultural business climate in Ukraine, demonstrates its further improvement (Fig. 2). Since the end of 2017, the indicator has been growing steadily and has now reached the mark of 46.3 points. Most likely, this improvement is the result of stable monetary policy and declining inflation [3].

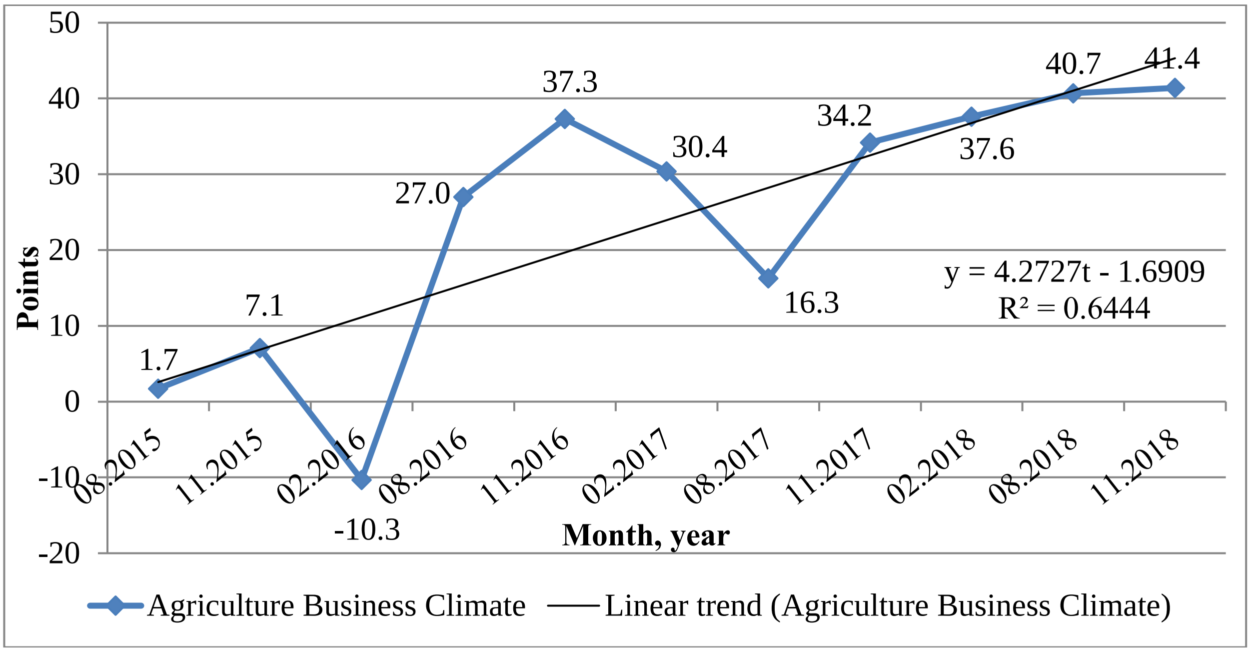

Fig. 2. Dynamics of the Agrarian Business Climate Index in Ukraine
Source: UCAB, author's calculations based on the data of the UCAB [24].

Unfortunately, nowadays, attraction of funds through exchanges is available only for Ukrainian large agroholdings, and for small and medium-sized agricultural enterprises this source of financial support is not yet available. In the context of expanding funding opportunities of small and medium-sized agricultural enterprises through the stock exchange it may be useful European experience, in particular the key features of the newly formed SME market in Bulgaria called «BEAM SME growth market» [2]. It is possible to attract and use other sources of financial support.

CONCLUSIONS

The results of the dynamic analysis indicate a significant increase in the nominal volume of financial resources of agricultural enterprises of Ukraine during 2010–2018 (6.2 times), however, the structural ratio between the components of financial resources remained almost unchanged. At the same time, the increase of all financial resources was carried out mainly in the conditions (and, consequently, due to) of inflationary-devaluation processes, and not a real increase in resources. Thus, the sum of financial resources of agricultural enterprises in US dollar terms increased only 1.82 times, and taking into account the inflation index – only 2.15 times during the analyzed period. A similar situation is also characteristic for the sources of formation of financial resources.
Mathematical leveling of dynamic series for 2010–2018 and parameters of obtained equations indicate the general trend to increase of financial results before taxation, net profit and percentage of agricultural enterprises which got net profit (to total number). With the appropriate level of probability, it can be predicted further increase the amount of the net profit as the main source of own financial resources. The correlation analysis confirmed the hypothesis that the amount of profit in the dynamics is more correlated with the change in the exchange rate and the level of inflation than with the internal factors of the efficiency of agricultural enterprises. If in national currency the amount of profit increased 3.9 times, then in the US dollar terms – only 13.2 % during the analyzed period. Another important own source of financial resources for sustainable competitiveness is the equity capital, during 2010–2018 it increased significantly (5.2 times); however, the real (taking into account the inflation index) sum of the equity

capital increased only 1.79 times, and in US dollar terms – only 1.51 times.

The financial leasing, agricultural insurance and stock market has significant (untapped) potential in the system of financial support for the formation of sustainable competitiveness of land use of agricultural enterprises. Substantiation of directions of use of this potential can be one of perspective directions of researches, as well as other external sources of financial support for the formation of sustainable competitiveness of land use of agricultural enterprises.

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A THEORETICAL APPROACH TO MEASURING ENVIRONMENTALLY SUSTAINABLE GROWTH OF AGRICULTURE

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Abstract

In recent years, the economic growth has resulted in the depletion of natural resources and degradation of ecosystems. Therefore, the environmentally sustainable growth was accepted, as a new mode for economics, that prevents environmental deterioration and loss of biodiversity. The idea of environmentally sustainable growth has been widely discussed not only by experts in environmental economics, but also in the international and national policy scene. However, the measurement of environmentally sustainable growth still remains a challenge, especially in agriculture. In this paper, available academic literature is reviewed and summarized to provide a theoretical baseline for creating a measure of environmentally sustainable growth of agriculture.

Key words: *environmentally sustainable growth, green growth, agriculture*

INTRODUCTION

Over recent years the concept of environmentally sustainable growth or green growth, or environmentally sustainable economic growth, or ecologically sustainable growth has attracted much attention not only in the international but also in the national policy scene. The guidelines for environmentally sustainable growth we can follow since 1987 in Brundtland report. Although Jacobs [16] claimed that a term was rarely heard before 2008. Several steps of the concept of environmentally sustainable growth can be distinguished.

First step - the need of new era of economic growth that provides the right kind of growth. Starting with 1987 it has been increasingly recognized that growth should be not only forceful but at the same time environmentally and socially sustainable. Once the world's population continues to grow fast, to meet the projected food demands, diet shifts, and increased biofuel consumption, the world agricultural production alone needs to double by 2050, unless there occur dramatic changes in agricultural consumption patterns [42; 43]. These environmental pressures if not addressed and tackled, will undermine the world's ability to meet these demands. Therefore, to meet the world's future of food and biofuels demand and environmental sustainability needs, agricultural production must increase significantly, while the environmental footprint of agriculture must shrink dramatically, i.e. sustainable intensification of agricultural production, lower specialization of agroecosystems, and lower or balance the use of mineral fertilizers and pesticides per unit area.

Second step - the era of sustainable development concept. Although there is more discussion about right kind of economic growth, but the whole environment continues under pressure (for example, loss of biodiversity, fish stocks, desertification, climate change) [10; 11]. The concept of sustainable development is too broad.

Third step - the beginning of environmentally sustainable growth concept. The Organization for Economic Cooperation and Development (OECD) take responsibility to help countries' policy assess and determination of best practices, which assist in their efforts to respond to the growing policy demands to foster environmentally sustainable growth and develop measures to build sustainable economies [41]. Therefore, measurable environmental and natural resource indicators are needed to promote sustainable growth.

Fourth step the work on environmentally sustainable growth indicators. Internationally comparable data shows a lack in environmentally sustainable growth indicators. Especially, the indicators that show economic growth within the environmental damages [27]. Therefore, new measurement systems of environmentally sustainable growth are under development.

The key issues of environmentally sustainable growth first applied by the 5th Ministerial Conference on Environment and Development in Asia and the Pacific of the Economic and Social Commission for Asia and the Pacific of the United Nations Economic and Social Council in 2005. In this conference, environmentally sustainable growth (author named it as green growth) was proposed as a way to seek for further economic growth with respect to environmental sustainability, without putting significant pressure on environmental capacity and without compromising environment sustainability. Moreover, further economic growth was necessary to reduce poverty in this region. Besides, since 2009 OECD, World Bank and other organizations more and more focused on environmental issues, including environmentally sustainable growth. As a result, various terms such as environmentally sustainable growth, green growth, green economy, green jobs, green economic growth and other are gaining popularity in the political and community space [45].

Previous studies showed that, there is no single recognized and commonly used definition of environmentally sustainable growth. There are several equivalents of this concept, for example, environmentally sustainable growth, green growth, environmentally sustainable economic growth, ecologically sustainable growth, inclusive green growth, genuine green growth, green economy, green new deal, low-carbon growth. Some authors, previously used concepts, used as synonyms, and other – as separate concepts. InterActive Terminology for Europe (IATE) gives preference to concept of environmentally sustainable growth which also is used in this study. Jacobs [16] argues that sustainable environmental growth contributes not only to economic growth but also ensures environmental protection and sustainable use of natural resources. Consequently, the idea of environmentally sustainable growth has emerged as a dominant policy response to environmental crises. However, according to Stoknes and Rockström [35], the notion of environmentally sustainable growth is still notoriously vague and elusive.

Besides, there are noticeable links between the concept of environmentally sustainable growth with the concept of sustainable development. According to Choi [7], first is more practical concept and second – more abstract. Also, Mishra [24] argued that, environmentally sustainable growth is a subset of sustainable development, which gives more attention to the necessary innovation, competition and investment.

Moreover, it is important to emphasize that the most common definition of environmentally sustainable growth focuses on environmental and economic issues [16] and social issues are only the result of the integration of environmental and economic objectives and their implementation [17; 28].

Finally, the definition of environmentally sustainable growth does not explain how green growth can be achieved. According to Stoknes and Rockström [35], there is a lack of simple and clear indicators of whether economic growth at different scales is green enough. This is the relevance of environmentally sustainable growth assessment by the academic literature.

This article aims to provide a baseline for measurement of environmentally sustainable growth of agriculture using the available academic literature review.

MATERIALS AND METHODS

Literature overview method was used in this study to obtain information associated with environmentally sustainable growth and its measures. A literature overview method also obtains a robust conclusion on the measurement of environmentally sustainable growth. According to Snyder [33] literature overviews are foundation for all types of research, due to a literature overview may be the best methodological tool for topic, to provide an overview of a relevant issue or research problem. Keywords were used as a most common method of identifying literature [8]. The keywords used in this paper fell into the following two categories:

Growth related keywords such as environmentally sustainable growth and green growth;

Growth measures related keywords such as green GDP growth, environmentally adjusted multifactor productivity, green multi-factor productivity and green total factor productivity.

In the measurement methodology of the environmentally sustainable growth, terms “total factor productivity” (TFP) and “multifactor productivity” (MFP) often used as synonyms [19; 31]. In this article, both terms are used as synonyms as well.

RESULTS AND DISCUSSIONS

The available academic literature on environmentally sustainable growth highlights that: economic growth reduces natural capital and risks for development are still rising [24]; there is not enough literature about environmentally sustainable economic development, although this development has been a worldwide concern [46]; harmonizing environmental issues for land use with the need to produce more food is an established concern of scientific and policy discourses on sustainable agriculture [12], i.e. literature have been undertaken investigating the relationship between the environment and the economy as whole or its respective sectors [18].

It is recognized that the discussion on environment versus growth continues to the recent day, therefore the environmentally sustainable growth is imperative in further economic growth, that contributes to lower resource use and lower negative environmental impact [3; 36], helps to solve environmental and economic problems [3].

Table 1 illustrate environmentally sustainable growth measurement based on literature review, which distinguish five ways for its measurement. It was determined that environmentally sustainable growth may be measured by single indicators, footprints, adjusted or expanded economic indicators, dashboards or composite indicators.

As mentioned Tilsted et al. [39], typically, claims of environmentally sustainable growth are assessed with respect to decoupling rates, consisting of two metrics: value added (at the national level – gross domestic product, GDP) and national emissions. According to Lundquist [22], decoupling emissions from growth submit a sustainability path where pressure on the environment can be prevented without compromising economic development.

It is widely recognized that environmentally sustainable growth is mostly measured by systems of indicators that shows the progress of the environmentally sustainable growth, for example, dashboards, headline indicators. However, the sets of indicators are not only without hierarchy, but also often measured in different units. Moreover, mostly environmentally sustainable growth is compared in terms of estimating adjusted MFP, which is usually measured through the prism of output and pollution, especially at national level [6; 38; 46]. For example, Tzouvelekas et al., [40] involve emissions as an input in the production process. Authors also measure the contribution from the use of environment in total output growth. Wang et al., [46], estimate the potentials of industrial growth, greenhouse gas (GHG) reduction and energy saving based on the green productivity measurement. Also, the assessment of environmentally sustainable growth takes into account not only pollution but also natural resources [6; 32], therefore the assessment has been extended to include the input of natural capital.

Besides, Table 1 illustrates, that many studies have aimed their attention at measuring the environmentally sustainable growth of the whole economy and there are still a few studies measuring environmentally sustainable growth of agriculture.

Based on literature overview, adjusted economic indicators measure environmentally sustainable growth in monetary terms (one metric) and are better compared with each other, especially at national level.

Table 1. Literature overview on environmentally sustainable growth measurement

Author (s)	**Indicator/ Dimension**	**Research area**
Single indicators		
Antal and van den Bergh [3]	GDP and GHG emissions decoupling rate	whole economy
Ipate et al. [15]	Water exploitation index	whole economy
Footprints (how much the existing biological capacity is used to support economic activities and human needs)		
Vanham and Bidoglio [44]	Water	whole economy
Tian et al. [38]	Environmental and resource	whole economy
Al-Mansour and Jejcic [2]	Carbon	agriculture
Bauwens [5]	Material	whole economy
Adjusted or expanded economic measures (A monetary metric derived by adjusting a conventional economic variable for broader environmental and social sustainability values)		
Tzouvelekas et al. [40]	Total factor productivity growth and the environment	whole economy
Škare et al. [34]	Green GDP	whole economy
Brandt et al. [6]	Green multi-factor productivity growth	whole economy
Baldoni et al. [4]	Farm-level TFP and EI indices	agriculture
Rodríguez et al. [32]	Environmentally adjusted multifactor productivity	whole economy
Hamilton et al. [13]	TFP including natural resources	agriculture
Liu et al. [21]	Green TFP	agriculture
Li et al. [20]	Green GDP	agriculture
Coli and Colucci [9]	Total factor productivity adjusted for GHGs emissions	agriculture
Dashboards (a set of indicators without hierarchy, often measured in different units)		
Lyytimäki et al. [23]	Green growth indicators	whole economy
OECD [28]	Green growth indicators for agriculture	agriculture
Acosta et al. [1]	Natural capital protection	whole economy
Composite indicators (aggregated measure that combine indicators through rescaling the components and weighting, often measured in different units)		
Ou [30]	Green competitiveness analysis index	whole economy
Tamanini [37]	Global green economy index	whole economy
Nahman et al. [25]	Green economy index	whole economy

Source: Own elaboration based on the literature mentioned above.

Although changes in productivity are usually measured as MFP, the environmentally adjusted MFP (one of adjusted economic measure) is a better driver of growth in agriculture than conventional MFP. Table 2 illustrates the comparison between those productivity measures.

Table 2. Comparison between conventional and environmentally adjusted multifactor productivity

	Conventional MFP	**Environmentally adjusted MFP**
Output	Gross value added	Real gross value added (or good output); Pollutant emissions (bad output)
Input	Labour; Capital	Labour; Capital; Natural capital
Elasticity	Inputs elasticity	Inputs elasticity; Bad output elasticity

Source: Own elaboration based on Brant, Schreyer and Zipper [6], Rodríguez, Haščič and Souchier [32].

The disadvantages of conventional MFP versus the environmentally adjusted MFP are follows:

(i)the conventional MFP is a measure of productivity growth where the underlying production function traditionally accounts for the labour and produced capital inputs [32] and do not accounts for nonmarketable inputs and outputs;

(ii) the role of natural capital as a factor input in conventional MFP is generally ignored, although short-term economic growth leads to the loss of natural capital [6; 14];

(iii) the conventional estimates of productivity ignore nonmarketable outputs, i.e. negative and/or positive externalities.

It was established that conventional approach of productivity ignores adverse agricultural production effects on the environment, such as soil erosion, pollution from nitrate leaching, greenhouse gas emissions, etc. [26]. This may result to incorrect policy conclusions and a systematic bias in productivity calculations [4; 29]. Meanwhile, environmentally adjusted MFP measure explicitly accounts for natural capital as an input factor and for negative externalities (or undesirable goods) as an output of the production process [6].

CONCLUSIONS

An increasing number of studies have sought to measure the environmentally sustainable growth of whole economy, but still studies which measure this growth for agriculture are lacking. Most of these studies are based on OECD measurement of green growth indicators and include several indicators helping to measure environmentally sustainable growth in agriculture.

Conventional MFP measure do not take into account those inputs and outputs with environmental externalities in the production process, although, the concept of environmentally sustainable growth emphasis the need to measure them [3; 27].

However, environmental externalities are usually ignored in conventional measurement of MFP in agriculture. Therefore, this issue can be solved by creating a measure of MFP that takes into account natural capital.

Environmentally adjusted MFP not measured yet. However, the OECD organization is exploring ways to include bad output and natural resource inputs in the assessment of MFP in agriculture.

The OECD [28] argue, that there is a lack of agreement among experts on the research for measuring MFP. Moreover, existing researches show heterogeneity of measurements. Besides, all studies are mainly of a methodological approach.

Therefore, the OECD created a network on agricultural MFP and the environment in 2017, where experiences and good practices are shared.

Besides, they seek to develop a comparable system of environmentally adjusted MFP indicators.

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STUDY REGARDING THE EVOLUTION AND SCOPE OF FACILITIES MANAGEMENT, POINTING OUT ASPECTS OF FACILITY MANAGEMENT IN AGRICULTURE

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Abstract

An important part of managerial activities is also the management of facilities. Facility management aims to streamline support processes in companies and reduce operating costs using an appropriate adjusted system. Facility management is an effective way to ensure the core business activities. Thus, the benefit of the facility management can be summarized: reduction of operating costs, competitive advantage, establishment of support processes by a facility manager and so on. In the past, the issue of Facility Management was closely related only to the operation and maintenance of buildings. In practice, it includes various support processes required for the operation of all companies. The study also pursued to evaluate different opinions on the place and role of facility management.

Key words*: *administration, cost, facility management, organization, standard

INTRODUCTION

Facilities management is a relatively new notion for the Republic of Moldova, but it is increasingly asserting itself in the economic life of the country. In fact, it was always present in the activity of any company, except not under the name of Facility management [5].

The primary role of facility management is to maximize the efficiency of the core business. In order to focus on the core business, the organization must refrain from its ancillary activities, but without which the core business will not be able to run successfully. For this it can either manage them internally as part of the organizational structure of the enterprise or externally, representing outsourcing or the company can use a mix of these services.

Such a classification of the use of facilities management is also found in the works of Somorova (2006), “the form of providing the services of facilities management may be different:

-Integration of the facilities management unit in the organizational structure;

-Outsourcing;

-Partial outsourcing”[10].

If the facilities management department is part of the organization chart, then it will manage all the activities that would facilitate the core business.

Through facility management, the company cooperates with other levels of management by creating systemic links between activities.

The aim is to achieve the strategic, tactical and operational objectives of the company. Based on the general objectives of the enterprise, the facilities management elaborates its own strategic, tactical and operational objectives.

If we refer to the form of provision of facilities - outsourcing, then this form assumes that all facilitation activities are provided under contract, by another company, which becomes responsible for the quality of services provided.

According to the author Somorova V., the most used form of facilities management is partial outsourcing [10]. Thus, support activities are provided by several facility providers and their subcontractors.

The purpose of this paper is to analyze the evolution and scope of facility management.

MATERIALS AND METHODS

To understand the nature and purpose of the facility management concept, it is necessary to know its origin. The paper consists of theoretical research and conclusions, based on the research of literature and theoretical paradigms. The analysis begins with the determination of the basic structure and principles of facility management.

For the first time, facilities are being talked about in the United States. In the 1970's, the concept of facility management was unfamiliar to ordinary people and not even to managers [1]. In May 1980, a meeting of facility providers was held, attended by 47 facility managers, resulting in the establishment of a new association - the National Facility Management Association (NFMA). Twenty-seven of the 47 participants became members.

This Association had its own regulations, plans and members. One year later, in 1981, an annual conference was held in Houston, attended by 27 members and 87 listeners. During this conference, the association was renamed the ”International Facility Management Association” (IFMA) [3]. This step has resulted in the dynamic development of facility management. Since then, IFMA has been a member of affiliated organizations or organizations around the world.

In 2003, the Dutch Institute for Standardization recommended to the CEN/ TC Technical Committee 348 Facility Management that a European standard on facility management be developed. This Committee, following three years of cooperation with national standardization bodies, developed this Standard, which was approved in September 2006.

The European Facility Management Standard covers the operational, tactical and strategic level of services provided for business support activities. Its aim is to improve the competitiveness of the European market, to improve the efficiency of facilities management, to improve the transparency of tendering procedures, to improve the quality of results and to develop new programs and support systems.

The Technical Committee selected two main themes in the creation of the facility management standard [2, 6]:

-standardization in terminology;

-definitions of facility management.

The aim was to establish terms and definitions relevant to facility management and to define specific terms that should be used in contracts between service facility management, customer service facilities and facility management [13, 14].

The priority objective of the standard in this area was to focus on the scope of facility management services and to identify procurement options, as well as to promote reciprocal trade between companies from different countries in the European market and to establish a clear link between customer and supplier. facility management.

The benefits of managing the European facility are economic and legislative [9].

RESULTS AND DISCUSSIONS

For the first time, facility management began to be used in Europe in the 1990s in countries such as France, the United Kingdom, the Benelux and the Scandinavian countries. About five years later, the term spread to German-speaking countries. Each of these countries has set up its own association for facility management [13].

One of the first countries in Europe to establish a national facility, the International Association of Facility Management (IFMA), was United Kingdom. It operates in companies that offer a wide range of facility management services. It focuses on building management, asset management, space planning and design, maintenance, labor protection, relocation for various organizations and cleaning services [14].

The first research in the field of the study of the evolution of facility management in Europe was carried out by Maliene, Alexander and Lepkova in 2008. They mention that in the case of France, there is no complex concept of facility management and the profession of facility manager is not described. specifically [2].

Researchers Bartosova Viera and Valaskova Katarina (2018) in their paper "Facility Management in a Global Society" note that the French facilities management market focuses on the provision of real estate services, while the facility management in Italy is based on innovation and dynamism [3].

In the early 1990s, foreign investors operating in Hungary organized the first transfer of knowledge in the field of facility management for Hungarian building management. It was a prerequisite for finding the first Hungarian facility management association in 1991. Currently, the management of Hungarian facilities is mainly focused on providing services.

Scandinavian countries use different definitions and forms of facility management depending on the organization and objectives of the country. Management and service organizations use their own definitions of facility management in marketing and promoting their services in local markets. Interestingly, asset management is usually included in facility management services. Based on research conducted by Bartosova Viera and Valaskova Katarina, it can be stated that each Scandinavian country has its own particularities in terms of organizing the management of the facility, as a consequence of local laws and traditions [3].

Of all the Scandinavian countries, in Norway the facility management is the least developed, but at the same time, for many Norwegian companies the quality of services is of major importance.

Sweden has the second largest share of facility management (Denmark is the first in the ranking) according to its degree of development. In recent years there has been a significant leap in the management of the facility. Many globally known organizations have not joined the Finnish or Norwegian markets, but have merged with Swedish companies.

A few years later, the management of the facilities spread to the surrounding countries. The first country in the ex-communist space, where the facility management association was established, was Hungary. Here, in 1998, the National Union of Facility Managers (HUFMA) was created. A little later, in 2000, the Czech Republic joined IFMA, which in 2018 had about 18,000 members in 60 countries around the world, with about 130 branches.

In the Czech Republic, the offer of separate, individually specialized services such as protection, repairs, cleaning, catering has been promoted. But over time, providers of complex facilities have appeared on the Czech market. These services were quite close to the management of the integrated facility.

Referring to the history of the emergence of facility management, according to Vyskočil and Kuda (2011), Baden-Fuller et al. (2000), "facility management, as a field, is related to the history of the development of individual secondary services." [4, 14] (Table 1).

Table 1. Development of the Facility Management

Own sources	Contractual service	External sources	Integrated facility management	Infrastructural management
1970-1980	1980-1990	1990-1995	1996-1998	2000-present
cleaning	cleaning guarding catering maintenance land	contractual services + postal services telecommunication IT, print, FM administration	external services + training property project management consulting	capital suggestion construction equipment accounting integrated FM

Source: Bartosova V., Valaskova K. (2018) [3].

Analyzing at what stage of development is the management of facilities in the Czech Republic, then, according to the researcher Somorova, is in the third stage of development (external sources).

There are many providers in the market that offer facility services at a high quality and at a favorable price level. Most facility companies are becoming integrated facility management companies. Czech companies prefer to order a full service [10].

When the facility management moves to a higher level, it is clear that the facility provider is beginning to cooperate with the business facility manager and thus a team is formed that can provide strategic information at any time, which helps to move to the next level of the service provider. facility management complexes. The company that provides a complex of facilities management services not only offers the grouping of the given services, but also cooperates with a team of well-established experts and facility managers.

First, the group of people assesses the current state of the company and then finds appropriate solutions and ways to improve. In addition, the company providing the support services has the technical facilities to carry out all the necessary activities [3, 6].

Most experts in the field mentioned that up to 90% of manufacturing companies use outsourcing of facility management. This allows them to make big savings [3, 4].

In Slovakia, the concept of facility management has slowly reached the consciousness of the Slovak population due to a growing number of foreign companies and corporations. These large companies have brought to the Slovak market not only capital but also the managerial know-how of support services.

Currently, the application of facility management is quite demanding for several reasons. It is known that about 20 years ago, facility management began to be used in Central European countries. It was the period of the global economic crisis, but according to the statistics, relatively good results were obtained in the development of the facility management [3].

The development of the facility management in Slovakia was closely linked to the Slovak Institute for Technical Standardization, which issued a new standard of the facility STN EN 15221 Management in 2007. The new European standard has allowed organizations to trade internationally.

The single European standard for facility management is an important factor for the future development of facility management in the European Union. The "Slovak Association for Facility Management (SAFM)" was established in Slovakia in 2009. Its basic purpose is to introduce and support the management of the facility in the decision-making process and management at all levels of an organization: strategic, tactical and operational. It also provides exchange of experience and information between facilities management specialists.

Slovakia is one of the countries that lags behind other European countries in terms of facility management [3].

Facilities management also plays a key role for the agricultural sector

According to researchers Don Jones of Purdue University, Brian Holmes of the University of Wisconsin and Ted Funk of the University of Illinois: “The facilities (structures) as well as the equipment (tractors, tools, machines, implements, etc.) of an agricultural holding plays an important role in the productivity and profitability of the farm. Facilities and equipment are usually seen as investment and labor savings, but can become a source of financial ruin for the farm.” [11].

One of the roles of facility management in agriculture is to ensure that agricultural equipment works when needed. Machines used in agricultural processes must be ready for operation on time - otherwise there could be significant losses for the farm as a whole. In addition, food processing and storage facilities must be kept safe, clean and structurally sound to ensure that the farm product is safe for consumption. [12].

Another argument in favor of facility management is the maintenance of agriculture. Farmers often maintain their equipment on their own. This means having some knowledge in the field, such as: knowledge of how machines work and how often machines need to be maintained.

In reality, agriculture involves a lot of unskilled labor, and as such, farmers often have very little formal training when it comes to the maintenance of agricultural machinery. Thus, accidents and injuries can occur as a result of improper maintenance practices.

Lately, most organizations are turning to companies that provide certain facilities, especially complex ones. Haidel International Project Management is an independent organization, established in January 2000, with the aim of providing clients, especially in agriculture, with consultants with experience in the field. This company is currently present in the market of several international locations [7].

Haidel International has established strong relationships with other key industry and agribusiness partners and provides comprehensive management development and operation services to facilitate the owner in order to ensure profitability and business expansion plan.

This company facilitates agricultural producers in adopting new ideas or technologies [7].

The concept of facility management is very poorly implemented in the economy of the Republic of Moldova. The implementation of facilities management in the country's agricultural sector could overcome some of the chronic problems facing the agricultural sector, especially in addressing the issues of sustainability and the provision of quality services.

For the Republic of Moldova, the trend of sustainable development of the economy in general and of agriculture in particular is quite current. The goal of sustainable development is to ensure the development of society without diminishing the prospects of future generations.

The emphasis on sustainable agriculture is a reflection of the widespread agricultural and environmental problems. The issue of sustainable development of agriculture in developing and developed countries varies. This variation depends on the agro-ecosystem capabilities, governance and management systems in the country [9].

In the approach to facility management, all elements must be taken into account. These should involve the development of strategic objectives and a business plan for the facility management function, with appropriate reference to agricultural development.

The facility management approach should include:

1.The need of the population in agricultural products.

2. Identify and establish an efficient and easy-to-manage process to meet the needs of agricultural products.

3.Establishing the appropriate resources needed to supply agricultural products.

4.Identifying the source of funds to finance the production strategy and its implications on the marketing strategy.

5.Establish a budget, not only for the short-term strategy, but also for a long-term value for money.

6.Achieving an efficient control of the facilities management regarding the development of agriculture [8].

CONCLUSIONS

Facility management is an area that is developing very dynamically. Many companies refuse their own support services in favor of professionals, so that they can only carry out their core business. The trend in recent years in the European market is that companies prefer large providers of facilities, due to the greater supply of services, which they are able to offer.

Up to 90% of manufacturing companies use outsourcing of facility management and this allows them to make big savings as mention the experts.

Currently, the most common situation is when companies implement facility management in full operation. The facility manager takes over the support services from the current providers and optimizes their functions.

Facility management focuses on support activities aimed at reducing costs, increasing management efficiency and improving quality.

Agriculture is one of the most sensitive sectors of the economy of the Republic of Moldova. In order to alleviate and correct the blockages that affect the development of the agricultural sector to the new demands, concentrated efforts are required at the level of state institutions and the business community.

Agriculture in the Republic of Moldova is of utmost importance because more than 30 percent of the population works in this field, the conditions are favorable, also this field has a significant contribution in the formation of the gross domestic product. In many parts of the country, agriculture is on the brink of subsistence: productivity is very low, product competitiveness is modest, and products are sold at very low prices.

The main lever for maintaining and sustainable economic growth of the agricultural sector remains the renewal of technology, using the opportunities of technical-scientific progress, able to increase the technical level of production and competitiveness of agricultural entities, in terms of implementation, adequate facilities management.

Thus, in the author's opinion, the implementation of facilities management becomes a strategic priority of farmers at the current stage.

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INCREASING THE COMPETITIVENESS OF AGRICULTURAL ENTERPRISES IN CONDITIONS OF ECONOMIC RISKS

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Abstract

The article investigates the theoretical foundations of agricultural enterprises competitiveness in today's conditions, based on statistical data, an analysis of their activities is carried out. The production intensification mechanism of competitive agricultural products is substantiated. The issue of introducing innovations to improve the quality of agricultural products as the main component of competitiveness is considered. It is the innovation infrastructure that will promote the development of agricultural enterprises, strengthen their competitive advantages and increase competitiveness. Strategic directions of the enterprises competitiveness increase on the basis of an information platform creation of providers' activity for the purpose of innovative maintenance of the agricultural enterprises are offered. The author's approach to the study of agricultural enterprises competitiveness problem in conditions of economic risks is presented in the article and the directions of its solution are stated.

Key words: *agricultural enterprises, competitiveness, production intensification, economic risks, innovation, information provider*

INTRODUCTION

Competitiveness is the foundation of a stable position in the market of agricultural entities, minimizes the impact of dynamism and instability of the environment, determines the optimal number of consumers and the best sales channels, reduces commercial risk, ensures efficient operation and high financial and economic performance. Due to competitiveness agricultural formations have the opportunity to increase production, to use all resources efficiently and rationally, especially land, as the main means of production in the industry and the priority of national wealth, to introduce modernized technologies, use modern agricultural machinery and equipment, even on lease, test new crops, which are resistant to diseases and pests, to improve the professional abilities of workers in the field on the basis of international experience and scientific developments of domestic agricultural scientists. The competitiveness of products has a positive effect on the competitive position of the enterprise, which, in turn, forms a good image of agriculture as an industry and determines its alternative position in the world market.

Many scientists dedicate their work to this issue [1, 7, 8, 9, 10, 15, 17].

From a theoretical point of view, to achieve a high level of products or enterprises competitiveness is quite easy while analyzing the strengths and weaknesses of the industry, as well as its opportunities and advantages.

However, the realities of agricultural enterprises in Ukraine show that such a process is quite complex, lengthy, costly, and sometimes unjustified.

Therefore, today's agricultural producers need new approaches to the formation of competitive positions, determining their advantages through the production of products that will best meet consumer needs, taking into account its quality characteristics, especially for organic products.

It is in the conditions of economic risks the increasing of agricultural enterprises competitiveness is very relevant, important and necessary. This determines the choice of research topic.

MATERIALS AND METHODS

The following methods were used in the article: induction to collect, systematize and summarize information, data and facts related to the activities of agricultural enterprises; deduction and abstract-logical for a theoretical explanation of agricultural enterprises competitiveness increasing importance in conditions of economic instability; synthesis for the presentation of the research problem as a holistic system, which is formed in a combination of components or constituent subsystems; statistical and economic research for processing of statistical data of agricultural enterprises, their analysis and comparison; graphic for economic entities performance indicators presentation in the dynamics and structural; monographic for the manifestation of causal links in the activities of enterprises that receive both high and low economic indicators that affect the formation of competitiveness of both products and the enterprise itself; calculation and design – for forecasting economic processes and production planning, which are associated with increasing of agricultural enterprises competitiveness.

Legislative acts of Ukraine, official data of the State Statistics Service of Ukraine, works of domestic and foreign scientists, personal observations of the authors became information resources for the research.

RESULTS AND DISCUSSIONS

The competitiveness of agricultural enterprises and the agro-industrial complex in general is formed under the influence of a huge number of factors that create the conditions for functioning, contribute or worsen them. For example, factors are divided by such features as: natural (land, plants, animals, fertility, natural resources, climate) and artificial (machinery, machinery, equipment, inventory), general (network of roads, railways, transport, advertising, exchanges) and specialized (production technology, strategy and image of the enterprise, agricultural techniques, seasonality and duration of production), basic (natural resources, capital, location of production facilities, simple labor) and developed (skilled labor, developed infrastructure, innovation, modernized technologies) [11]. However, alternative factors influencing the competitiveness of both products and enterprises are product quality, price and demand.

In addition, the formation of competition in agricultural production is significantly influenced by: state support of farmers, material and technical base, rational specialization and organization of production, staffing, quality of agricultural products, both finished and raw materials, marketability and low costs [12].

It can be added that the generation of competitive advantages by agricultural enterprises leads to a reduction in the cost of production and improve its quality according to European standards. After all, modern market conditions require agricultural producers to produce quality agricultural products, the basis of which is the rational use of production potential on the basis of organizational and economic improvements.

Table 1. Agricultural production value by agricultural products and Ukrainian farms at constant prices, 2016, UAH million

Indicator	Year			
	2018	2019	2020	2020 to 2018, %
Enterprises				
Agricultural products, total	437,999	449,806	395,718	90.3
crop products	367,689	376,789	323,199	87.9
livestock products	70,310	73,017	72,519	103.1
Households				
Agricultural products, total	233,295	231,176	216,404	92.8
crop products	161,659	161,916	150,179	92.9
livestock products	71,636	69,260	66,225	92.4
TOTAL				
Agricultural production value	671,294	680,983	612,121	91.2
Crop production value	529,348	538,706	473,377	89.4
Animal production value	141,946	142,277	138,744	97.7

Source: Statistical information of the State Statistics Service of Ukraine [13].

An enterprise that is intended to produce competitive agricultural products must have the ability to acclimatize to external change, using a special economic mechanism, which can be described as a mechanism for intensifying production activities. Because competition takes place in conditions of economic risks which are associated with political and economic instability, effective demand decline, inflation, irrational production structure, unacceptable foreign economic policy, and so on. Such negative phenomena in the country's economy have led to the fact that many companies not only reduced their production, but became unprofitable, went bankrupt or closed down altogether.

Production of agricultural products in Ukraine decreased in 2020 compared to 2018 in all categories of farms by 8.8%, including crop production – by 10.6%, livestock – by 2.3% (Table 1).

Based on the data from Table 1, its was determined the structure of agricultural production value by farm type in the analyzed period (Table 2).

Table 2. Structure of agricultural production value by farm category and agricultural sectors (%)

Indicator	Year 2018	2019	2020	2020 - 2018, +, -
Enterprises				
Agricultural products, total	65.2	66.1	64.6	-0.6
crop products	54.8	55.3	52.8	-2.0
livestock products	10.4	10.7	11.9	+1.5
Households				
Agricultural products, total	34.8	33.9	35.4	+0.6
crop products	24.1	23.8	24.5	+0.4
livestock products	10.7	10.2	10.8	+0.1
TOTAL				
Agricultural production value	100	100	100	-
Crop production value	78.8	79.1	77.3	-1.5
Animal production value	21.2	20.9	22.7	+1.5

Source: Own calculation based on Statistical information of the State Statistics Service of Ukraine [13].

We see that crop production in all categories of farms amounted to 77.3%, and livestock – 22.7% of the total value of agricultural products, including the ratio in enterprises is 52.8% and 11.9%, and in households – 24.5% and 10.8% in 2020.

Also, the structure of production value by farm category in the year 2018-2020 is shown in Fig. 1.

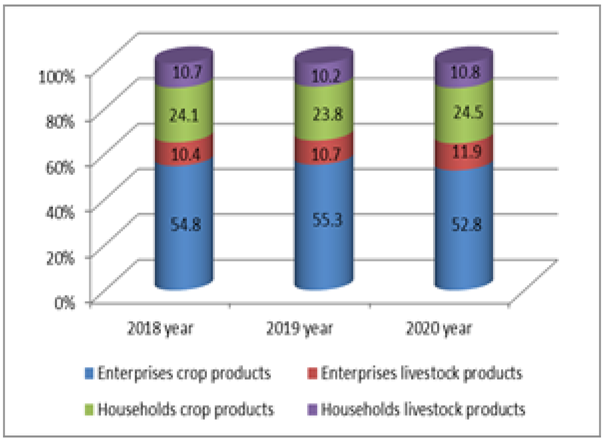

Fig. 1. The structure of agricultural production in terms of farms categories, Year 2018-2020 (%).
Source: Own calculation based on Statistical information of the State Statistics Service of Ukraine [13].

It is also worth noting that the level of performance indicators of enterprises, including competitiveness, is directly affected by the size of agricultural land (Table 3).

Table 3. Grouping of enterprises by area of agricultural land in use in 2020

Indicator	number of enterprises: units	number of enterprises: share, %	land area: ha	land area: share, %
Land area, total	40,754	100	21,250,626	100
Including area				
up to 5.0 ha	2,125	5.2	6,885	0.03
5.1 – 10.0 ha	2,013	5.0	15,747	0.07
10.1 – 20.0 ha	3,261	8.0	50,669	0.2
20.1 – 50.0 ha	10,023	24.6	375,606	1.8
50.1 – 100.0 ha	5,234	12.8	378,186	1.8
100.1 – 500.0 ha	9,296	22.8	2,277,598	10.7
500.1 – 1,000.0 ha	3,225	7.9	2,322,783	10.9
1,000.1 – 5,000.0 ha	4,950	12.2	10,413,239	49.0
more than 5,000.0 ha	627	1.5	5,409,913	25.5

Source: Own calculation based on Statistical information of the State Statistics Service of Ukraine [13].

The data in Table 3 show that enterprises with an area of up to 10 hectares account for 10.2% of their total number and occupy only 0.1% of the total area of all lands in the country. Enterprises with an area of more than 5,000 hectares occupy 1.5%, and the share of their total area is 25.5%. The largest share – 24.6% is occupied by enterprises with an area of 20 to 50 hectares, and the highest share of land – 49% have enterprises that own land from 1,000 to 5,000 hectares.

Also an important aspect in the production of agricultural products is its full implementation, meeting domestic needs, especially in crop production to preserve the seed fund. Equally important is taking into account of natural crop losses (unfavorable natural conditions – excessive rainfall, drought, technical reasons, risky situations), which farmers try to prevent or minimize. Unfortunately, it is almost impossible to get rid of them completely. But there is an option – to insure the future harvest. Undoubtedly, fluctuations in demand and competitiveness of agricultural products are affected by various risks, especially economic, so they must be competently avoided or minimized through appropriate ways, effective and acceptable methods. The occurrence of internal and external risks in the activities of agricultural enterprises have significant negative consequences, for example, production risks reduce the competitiveness of the enterprise and its products; market and economic risks reduce the financial and economic performance of enterprises and investment attractiveness; natural risks lead to failure to obtain the planned harvest; financial risks lead to debt, loss; ecological risks worsen the quality of land and products; social risks are associated with low productivity, unproductive costs, etc. [14].

Therefore, the introduction of an effective mechanism for intensifying the production of competitive agricultural products is a reliable and significant factor in the comprehensive improvement and increase of enterprises economic efficiency. Interpretation of the mechanism as a process is to take specific actions to achieve the goal. Let's remind that the overall goal of each business is minimization of costs and maximization of profit.

The mechanism of competitive agricultural products production intensification is interpreted as a set of appropriate methods, levers and tools for the implementation and expanded reproduction of the components of the agricultural enterprise potential, as well as achieving the strategic goal. The process of forming a mechanism to intensify the production of competitive products through principles, functions, forms and structural elements, taking into account the regulatory framework should ensure the process of functioning of this mechanism through methods, levers, tools and criteria and build a further strategy for agricultural development in general on this bases. It should be noted that such an approach to agricultural development should include innovative modernized technologies, modern agricultural techniques, foreign experience in agricultural production, high professionalism and environmental standards for the quality of products and food products made from it.

Of course, the competitiveness of agriculture as a specific industry has its axioms, namely: a set of interdependent factors and the level of potential opportunities that affect long stay of an agricultural enterprise with strong competitive advantages in the market; the ability of the business entity to improve constantly its production, namely, to create new competitive advantages, even under the influence of external conditions and risky situations; a chance for the company to achieve the planned result through the implementation of properly constructed and selected strategies.

If we give a description of each of the above postulates, it is expedient to highlight the following: factors which are used in agricultural production are specific and limited, for example, land, soil, its fertility, is a renewable natural resource, but only if it is used rationally and carefully and the with minimum influence on the environment; plants have their own growing season, so accelerate the rate of cultivation and maturation is almost impossible even in very favorable climatic conditions, in addition, the use of growth stimulants is prohibited by law and impairs plant quality, harms the ecosystem and is dangerous to human health and life; improvement of the agricultural production process, its modernization, intensification will be carried out by agricultural enterprises only when clear legislation and state regulators will support the industry by financing, providing opportunities for tax holidays, expanding sources of investment in agricultural development; thanks to the "iron" and also highly motivating state support, the agricultural producer will clearly build the strategy of its activities with the help of professional competencies of employees, enterprise management functions and organization of the production process, which, in turn, will provide production process based on high economic results such as profit and level of profitability.

By the way, agricultural products are characterized by specific features. They have limited storage period, require heat treatment, temperature and appropriate packaging. Therefore, it is important to add that the production process itself and its scale cannot ensure high competitiveness of the industry and its products. This can be realized comprehensively due to the logistics of product promotion, marketing mechanism, well-established communications with the market and market infrastructure.

It should be noted that today's consumer is very demanding and demanding of products, especially food, so quality standards, differentiation and diversification of products are important and influence consumer choice and demand. After all, from an economic point of view, the needs of customers are unlimited, and the resources and products offered by manufacturers are limited. As a result, the manufacturer chooses the alternative that, in terms of economic benefits, suits him best, but also takes into account consumer demand and competitive advantage and market position in the short or long term. Therefore, the competitiveness of agricultural products is also affected by the diversification of consumer needs and it is difficult to interest them by standard products.

Thus, the formation of the competitiveness of agricultural enterprises should take into account a set of components: providing agricultural producers with modern equipment; creation of the newest technologies in plant growing and animal husbandry; financing of agricultural production and providing financial support to producers of seed material, research institutions, variety testing stations; training of highly qualified personnel; taking into account the specifics of agricultural production in the regions; improving pricing policy; market segmentation and product differentiation; logistics of agricultural products promotion; marketing communications; networking, international experience and cooperation based on the exchange of information, technology, innovation; effective management system; investment and innovation support of the industry [3].

These components of the production process form the competitiveness not only of the industry but also of the enterprise as a whole. It is also appropriate to take into account the fact that the entity seeks to constantly increase its competitive advantage by using innovations and expanding investment attractiveness through the production of new or improvement of old products. Of course, the strategy of diversification of agricultural products has appropriate limitations related to area size, climatic conditions, use of machinery, tillage, etc., but improving the quality of agricultural raw materials and finished products, improving agricultural practices, production methods, modernization of machinery and Strengthening the environmental standards of agricultural production is within the power of every company that seeks to achieve high competitive positions in the market.

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Innovative processes in the modern market space are dominant not only for agricultural enterprises, but also for other economic entities. After all, innovations are the result of production and sales increasing, they lead to overall costs lowering, increase financial and economic indicators, including the level of profitability, capital adequacy, productivity, expanded reproduction of agricultural enterprises and improve socio-economic development of villages and the rural population well-being.

To increase the competitiveness of agricultural enterprises, we propose to apply the following measures in stages, namely: 1. development of innovative projects. 2. approbation, application and testing of innovations. 3. reproduction of innovative projects. 4. introduction of innovations in production processes. 5. comparing of performance with previous periods.

Innovations are primarily related to the introduction of new plant varieties that are resistant to pests, diseases and environmental conditions. But, taking into account European product quality standards, it is advisable for companies to implement a set of innovations gradually.

Based on the content analysis of the works of scientists, we propose the following innovations classification (Figure 2).

It should be noted that the introduction of innovations in the agricultural process of enterprises should take into account the characteristics of the industry, which are not inherent in other sectors of the economy. But, regardless of the activity, the essence of innovation is not to change the type of product, but only in its qualitative improvement and improvement of consumer characteristics. Thus, the fundamental goal of innovative implementations in agriculture is to ensure environmental friendliness and quality of products for consumers and efficiency – for businesses themselves.

This innovative infrastructure will promote the development of agricultural enterprises, strengthen their competitive advantages and increase the competitiveness of products not only in the domestic market but also abroad.

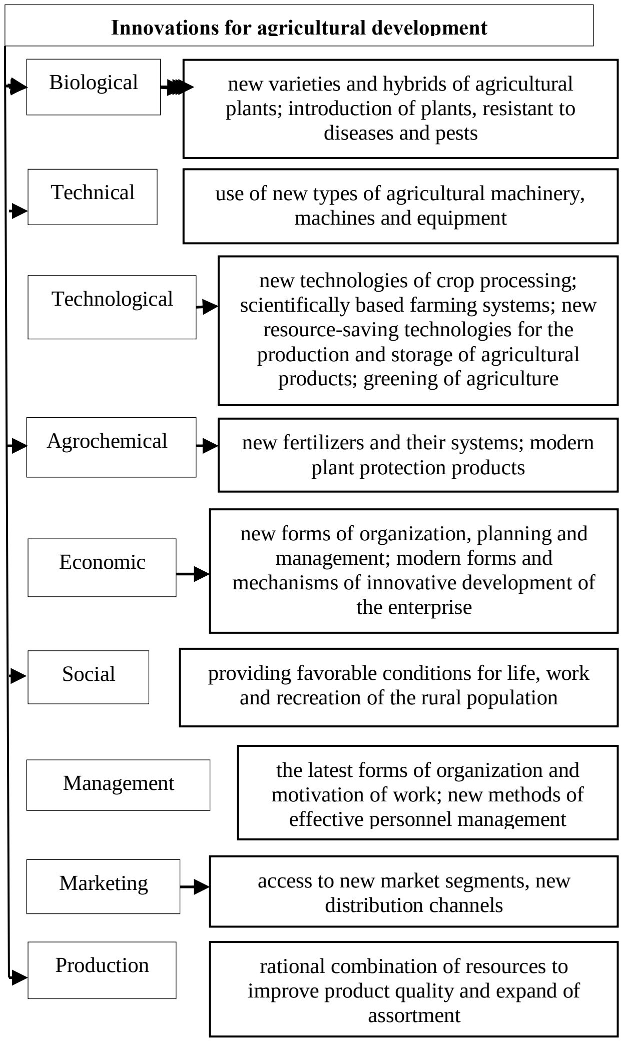

Fig. 2. Implementation of innovations to increase the competitiveness of agricultural enterprises.
Source: Compiled based on [2, 4, 6, 16].

Entire networks of research institutions and institutes, as well as the Ministry of Agrarian Policy and Food of Ukraine should develop innovations for agribusiness entities. Unfortunately, we have to state the fact that only 5-10% of agricultural entities use innovations [18]. Logically, the main reason for such a low share of innovation among enterprises is the lack of investment or lack of financial resources for such projects, as well as underdevelopment of systematic information about the market of innovative technologies, unfinished relationship between farmers and producers of innovation (research institutes, schools, integrated associations, specialized business structures) and credit and financial institutions (banks, credit unions, leasing companies).

At present, many agricultural enterprises find it difficult to organize such a connection, beneficial relations and effective interaction between innovators and financial institutions. Therefore, it is advisable to offer another component of the relationship – innovation service providers (advisory services), which should provide complete information and organize acceptable innovative products and technologies in the commercialized process of production of agricultural enterprises. Specialists of advisory services, who will act as intermediaries between the main participants in the innovation process – agricultural enterprise, financial institution and producer of innovations, must meet the relevant requirements, namely to have in-depth knowledge of agricultural techniques and practical skills to assess efficiency and risks and their minimization associated with innovation and investment projects. In addition to the requirements for providers, they must perform a number of functional responsibilities that are directly related to the innovation of agricultural enterprises, the main of which are: advising farmers on new technologies, providing recommendations for innovative improvement of their economic process; conducting a technological audit of an agricultural enterprise to determine the optimal portfolio of innovations; analysis of the financial condition of the agricultural enterprise, development of business plans and investment projects with economic justification of the effectiveness of innovation; search for sources of funding for the acquisition and development of each innovation; assessment of the effectiveness of innovation (economic, social and environmental), etc. In order for the mechanism of interaction of all components of innovation implementation processes to work fully, it is necessary to systematize the relevant information on all participants in the transfer of innovative technologies for agricultural enterprises. Such systematization of information requires the creation of regional information platform centers, which should be part of a single virtual national network for the transfer of innovative technologies [5]. This system should provide a broad information and innovation base not only for the formation but also for the maintenance of competitive advantages by agricultural enterprises.

CONCLUSIONS

Modern market conditions require agricultural producers to produce quality products based on the rational use of production potential on the basis of organizational and economic improvements. The introduction of an effective mechanism for intensifying the production of competitive products is a reliable and significant factor in the comprehensive improvement and increase of economic efficiency of enterprises. Further development of agriculture should include innovative modernized technologies, modern agricultural techniques, foreign experience in agricultural production, high professionalism and environmental standards for the quality of products and food products from it. We believe that the formation and functioning of the mechanism of production intensification should take place in stages with the implementation of tasks which belong to the relevant component of this mechanism. Innovations in agriculture are related to the introduction of new plant varieties that are resistant to pests, diseases and environmental conditions. But, taking into account European product quality standards, companies should use a range of innovations. At present, many agricultural enterprises find it difficult to organize beneficial relationships and effective interaction between innovators and financial institutions. Therefore, it is advisable to offer another component of the relationship – innovation service providers (advisory services), which should provide complete information and organize acceptable innovative products and technologies in the commercialized process of production of agricultural enterprises. Specialists of advisory services, who will act as an intermediary between the main participants in the innovation process – the agricultural enterprise, financial institution and producer of innovation, must meet the relevant requirements and perform functional responsibilities.

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STUDY ON THE IMPLICATIONS OF THE APPLICATION OF THE SPECIFIC TAX ON THE PROFITABILITY OF ECONOMIC ENTITIES IN TOURISM AND PUBLIC FOOD

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Abstract

In this article we aim to present how the application of the specific tax in tourism and food influences the profitability of economic entities in this field. The research methodology involved the study of the literature, the accounting regulations regarding the specific tax and the analysis performed for a number of 10 economic entities that apply these regulations. The study was based on quantitative and qualitative research that involved the collection of information provided by the financial statements, but also other information obtained based on a questionnaire applied to the entities in the study sample. The calculation methodology provided in Law 170/2016 on the establishment of the specific tax was also used. Following this research, we aimed to highlight both the way of applying the specific taxation within the entities in the field subject to analysis, but also the way in which this system influences the registered financial performance. At the same time, there were identified the advantages and disadvantages of its application. Based on the results obtained during the research, the conclusions were formulated regarding the efficiency of the application of the calculation system of the specific tax in the units with tourist and food profile.

Key words**:** *specific tax, tourism, public catering, profitability*

INTRODUCTION

Tourism is one of the most important sectors of activity in the field of services within a country, contributing on the one hand to their development and on the other hand to the development of the entire economy, both due to jobs and income generated, but also due to contribution to the state budget [7]. The development of this sector of activity is influenced by the possibility of making investments, the existence of infrastructure, etc. so that the quality of the services offered can ensure the satisfaction of the needs of consumers of tourist products [14].
At the level of Romania, given that GDP has grown continuously from 2015 to 2019 (the increase being about 48%), the contribution of tourism to GDP formation was over 2.7% for the period 2016-2019 (Figure 1). The decline in 2020 was due to the impact that the Covid-19 pandemic had on this sector of activity [3]. Therefore, tourism can be one of the important sources of income growth and contribution to GDP formation [8].
Over time, solutions have been sought to encourage, on the one hand, the achievement of these objectives, and, on the other hand, the promotion of the activity of collecting taxes and taxes resulting from the activity in this sector. Fiscal measures are one such example.
In 2016, Law 170/2016 introduced the specific tax in tourism and food, the applicability of which came into force starting with 2017 and which partially replaced the profit tax for some of the categories of taxpayers. The specific tax can be applied in parallel with the profit taxation system, in the situation where the economic entity carries out other categories of activities that do not fall under the specific tax [2, 12]. Also, for those entities that, although they have registered in the articles of incorporation the activities mentioned in the law, but which do not carry them out, there is no obligation to apply this taxation system [13].

"The NCEA codes for which Law 170/2016 establishes the obligation to apply the specific tax are the following: 5510 - Hotels and other similar accommodation facilities"; "5520 - Accommodation facilities for holidays and short periods;" "5530 - Caravan parks, campsites and camps;" "5590 - Other accommodation services;" "5610 - Restaurant;" "5621 - Event catering activities;" "5629 - Other catering services;" "5630 - Bars and other beverage service activities" [1].

If the specific tax is related to several activities carried out by the same legal entity, either in the same unit or through several units, then it is determined by adding the tax specific to each activity, and then for each of those units in part [4, 6]. Only in terms of hotel complexes, a single tax is calculated regardless of the number of activities carried out.

If there are companies that pay profit tax, which carry out both activities for which they owe specific tax, but also other categories of activities, then they will pay both profit tax and specific tax [9].

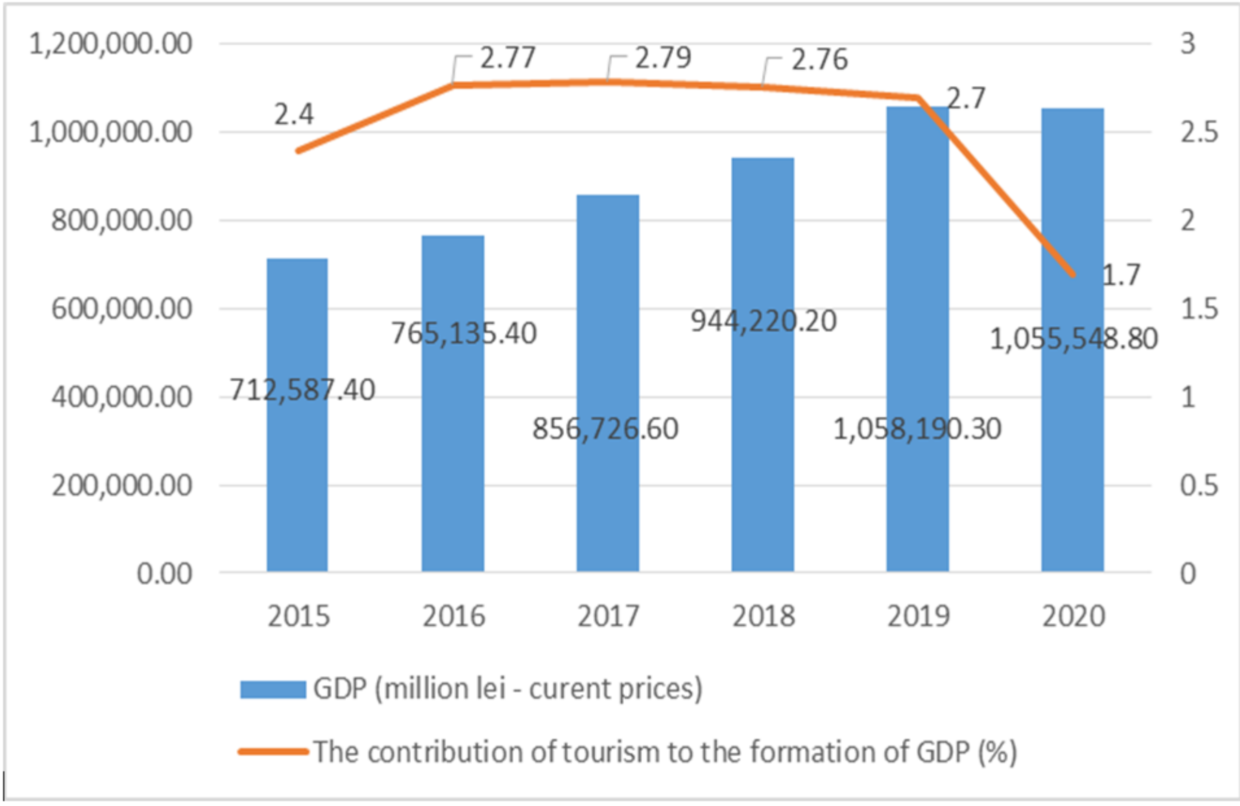


Fig. 1. The contribution of tourism to GDP formation
Source: own processing [10, 11].

MATERIALS AND METHODS

According to Law 170/2016, the method of calculating the specific tax is influenced by a series of variables, which depend on the NCEA. These variables refer to: the value of the standard tax, the variable referring to the locality line; variable related to the usable area; seasonality coefficient; technical space adjustment coefficient.

"The determination of the specific tax is made as follows [5]:

Annual specific tax / unit = k x (x + y x q) x z

where:

k - the value of the standard tax;

x - variable depending on the rank of the locality;

y - variable depending on the commercial / service / business area;

z - coefficient of seasonality;

q - 0.9 and represents an adjustment coefficient for ethnic space".
"The value of the standard tax is 1,400 lei for the NCEA codes 5610 - Restaurants; 5621 - Event catering activities and 5629 - Other catering services. For the NCEA code 5630 - Bars and other beverage service activities, the value of the standard tax is 900 lei".
"For NCEA codes 5510 - Hotels and other accommodation facilities, 5520 - Accommodation facilities for holidays and short periods, 5530 - Caravan parks, campsites and camps and 5590 - Other accommodation services, the calculation formula of the specific tax is as follows:

Annual specific tax/unit = k x number of accommodation places [5]

where:
k - standard specific tax (lei/accommodation/ year)".
"The seasonality coefficient refers to the period of functionality of an accommodation unit of one year and has the value 0.45 for Bucharest and the 8 poles, 0.35 for municipalities and cities, 0.30 for tourist resorts of national interest and 0.10 for tourist resorts of local interest, villages and communes.
The variable depending on the rank of the locality varies between 0.4 in the case of communes and 16, in the case of zone A in Bucharest".
The variable depending on the surface has values between 2 (for entities with usable areas up to 30 m) and 105 (for entities with usable areas larger than 801 m) [12].
Starting from the methodology of calculation of the specific tax and based on the information taken from the financial statements, as well as other information regarding the activity carried out by the tourist entities, both the value of the specific tax due by the companies applying this system and the value of the profit tax were calculated which would have been due in the absence of the adoption of Law 170/2016.

RESULTS AND DISCUSSIONS

The case study analyzes the size of the specific tax paid by a number of 10 Romanian companies for 2019. We mention that the years 2020 and 2021 were years in which companies in the field of HoReCa benefited from various tax facilities given the impact that the Covid-19 pandemic had it on business in this area.
The 10 companies are located in different areas of the country, meet the condition of falling into the category of economic entities paying specific tax and have calculated and transferred to the state budget the tax resulting from activities in the field of tourism and public catering (Table 1).
The data underlying the calculations were collected based on the information resulting from the financial statements of the entities, as well as those from the management accounting.

Table 1. Data on the sampled companies

Company	City	NCEA Codes
Company 1	Bucharest	5510; 5610; 5630
Company 2	Bucharest	5510; 5610; 5630
Company 3	Brasov	5510; 5610; 5630
Company 4	Constanta	5510; 5610
Company 5	Targoviste	5510; 5610
Company 6	Bucharest	5610
Company 7	Brasov	5610
Company 8	Bucharest	5610
Company 9	Constanta	5630
Company 10	Sibiu	5630

Source: Own calculation.

Of the 10 companies analyzed, 5 of them carry out several activities included in the category of those for which the specific tax is determined. Thus, 3 of them have 3 NCEA codes that fall into this category, 2 of them each have two NCEA codes specific to the flat tax, and the remaining 5 carry out public catering activities through restaurants and bars.

Starting from the values recorded by the variables “x”, “y” and “z”, as well as from the values of the two coefficients “k” and “q”, the tax specific to the activities carried out was calculated, and the results were centralized in the Table 2.

Table 2. Specific tax

Company	NCEA Code	K	x Variable	y Variable	z Variable	q	Area / No. accommodation places	Accommodation days	Specific tax
Company 1	5510	513					438	360	221,616
	5610	1,400	16	75	0.45	0.9	342	360	51,884
	5630	900		10	0.45	0.9	120	360	3,595
Total									**277,095**
Company 2	5510	308					972		287,073
	5610	1,400	14	80	0.45	0.9	422	350	51,953
	5630	900		14	0.45	0.9	136	350	4,893
Total									**343,920**
Company 3	5510	308					268		80,283
	5610	1,400	13.5	38	0.45	0.9	184	355	29,228
	5630	900		10	0.45	0.9	98	350	3,495
Total									**113,005**
Company 4	5510	513					148	220	45,762
	5610	1,400	14	38	0.45	0.9	194	220	18,303
Total									**64,065**
Company 5	5510	224					162	360	35,791
	5610	1,400	9	29	0.35	0.9	135	360	16,963
Total									**52,754**
Company 6	5610	1,400	17	38	0.45	0.9	186	350	30,930
Company 7	5610	1,400	13	47	0.45	0.9	224	360	34,362
Company 8	5610	1,400	15	47	0.45	0.9	208	360	35,604
Company 9	5630	900	17	16	0.45	0.9	186	180	6,271
Company 10	5630	900	15	14	0.45	0.9	124	360	11,025

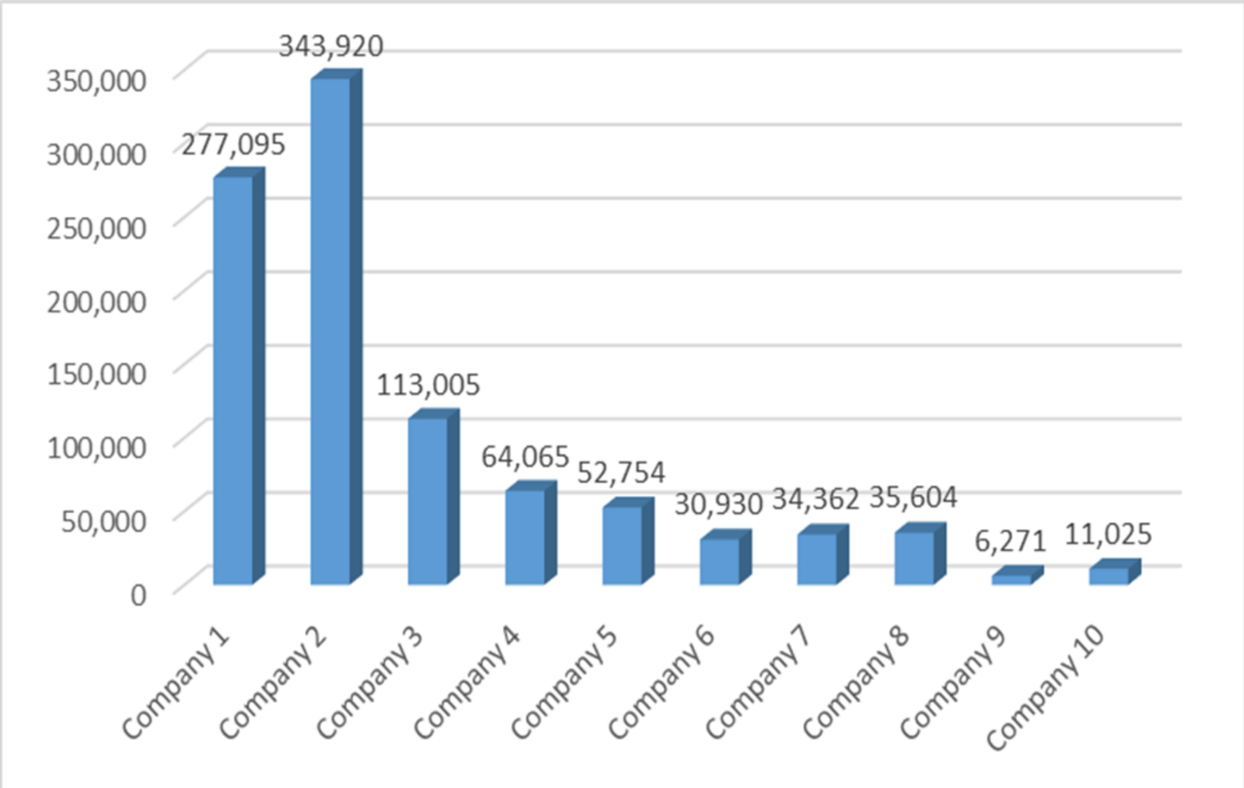
Source: own processing.

Of the 10 companies analyzed, the highest specific tax is the one calculated for company no. 2, which carries out both accommodation and catering activities through its own restaurant and a bar. The company is located in Bucharest and has a number of 972 accommodation places. The usable area of the restaurant is 422 m^2, and that of the bar is 136 m^2. Thus, we find that the high value of the specific tax is directly proportional to the large number of accommodation and the area, therefore to the volume of activity that the entity can carry out. On the 2nd place is also a company located in Bucharest, which carries out all 3 types of activities and which is on the 2nd place and in terms of the values of the variables according to which the specific tax is determined.

The lowest specific tax was registered by the company no. 9, located in Constanta, which has a single NCEA code, being a bar. The usable area is 180 m^2.

We find that both the location of the business at the locality level, but also in the region influences the size of the calculated specific tax.

The profitability of an economic entity is influenced on the one hand by the value of the profit obtained, and on the other hand by the size of the expenses with the specific profit/ tax. Therefore, the size of the specific tax is one of the elements that are taken into account when determining how to optimize a business, but also how to optimize its tax.



Fig, 2. The situation of the specific tax for the entities in the sample, in 2019
Source: own processing.

The ranking of the analyzed companies, in relation to the size of the specific tax calculated, according to the type of activity carried out, is presented in Figure 2.

Thus, we find that the size of this tax is influenced not only by the volume of the activity carried out, but also by the seasonality or the rank of the locality.

CONCLUSIONS

The analyzed information showed that for those companies that have serving spaces such as restaurants, the specific tax/m^2 is higher in terms of percentage, for those of them that have smaller areas, compared to those that have larger areas.

In the case of companies that carry out activities through bars, the value of the specific tax decreases with the decrease of the owned area. It is observed that this value decreases even more as the rank of the locality decreases.

We find that the tax specific to the accommodation activity increases in direct proportion to the increase in the number of accommodation places. In the case of those accommodation units that practice seasonal tourism, the value of the tax is adjusted according to the number of days of accommodation.

It is found that those tourist units that carry out several categories of activities are advantageous, that is, those that offer both accommodation and bar and restaurant services.

In practice, however, thereare many particular cases that complicate the way of calculating and taxing the income registered by the entities in this field of activity.

The introduction of the specific tax aimed at applying a flat tax for companies in the field of tourism and public catering, this measure being part of the legislative changes in the fiscal field. At the same time, there were increases in the turnover ceiling, which led to an expansion of the number of companies in the field of micro-enterprises. The applied system has an impact both on the taxation of companies' revenues, but also on budgetary revenues and on the added value created by the activity carried out.

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USING SENSORY ANALYSIS AND SENSORY MARKETING AS MODERN MEANS OF SATISFYING CONSUMER PREFERENCES

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Abstract

The world is constantly changing, both in terms of consumption habits, consumption patterns or consumer attitudes. Therefore, producers must pay much more attention not only to the products obtained, but also to the way in which these products are promoted and reach these consumers. That is why the marketing techniques had to keep up with these changes and which led to the separation of new promotion channels and new ways of promotion, all with the aim of increasing sales. In this paper we aim to discuss sensory marketing that starts from the data provided through sensory analysis tests that aim to either identify sensitive points that appear in technological schemes or extend the life cycle of products, in the end, they aim at both consumer satisfaction and ensuring profit for producers. The research methodology involved reviewing the literature, collecting information through questionnaires to which the valid answers belonged to a number of 127 respondents. The data processing was done using descriptive statistical methods and the Likert scale, and the interpretation of the data allowed us to draw conclusions about how the relationship between sensory analysis and sensory marketing could be used so that the results are used as efficiently as possible.

Key words*: *sensory marketing, sensory analysis, consumer, profitability

INTRODUCTION

Both marketing and sensory analysis are the so-called "moments of truth". There are times when the manufacturer can see if the products he gets and wants to sell are accepted and appreciated by the consumer. If marketing is the first of these moments, sensory analysis is certainly the second moment, depending on which consumer makes the decision to buy or give up a product. Therefore, sensory analysis identifies consumer preferences that can contribute to the improvement of manufacturing technologies, the development of new products or the anticipation of the success or failure of a product before its launch into production and before its release on the market. At the same time, based on the decisions taken, the lifespan of some of the products can be extended [5].

In order to obtain the desired results, a combination of the two fields is needed, their modernization because the traditional methods drag modernized with the modernization of consumers, with the change of their generations and consumption habits [4]. Starting from the features of consumers, marketing must be based on personalizing the relationship with them, on their individuality, on stimulating the senses, thus becoming a psychological or sensory marketing, the notion of sensory brand is not a recent one, it appeared in the '40s advertising began to use visual images, so to use the sense of sight [9, 3]. Therefore, sensory marketing appeals to one of the 5 senses (sight, hearing, smell, taste, tactile sense) or a combination of these senses, thus replacing logic and aiming to create a reflex reaction or emotional association with a certain brand or with a product [2, 6, 7].

The use of sight in sensory marketing is based on colour, graphics, image, text, light; hearing use is based on thematic music and sound effects; the use of smell involves the use of aromas and perfumes; the use of tactile sense on the possibility of testing the products, of

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touching them; the use of taste involves trying samples.
There are many such examples, the orange colour associated with the Orange brand, the pumpkin smell associated with Starbucks coffee, the use of touch sense to recognize an iPhone, certain musical fragments associated with brands (ex. Jumbo), etc.
Specialty studies show that in 90% of cases the choice of products is made starting from the colour associated with them or from the way in which a colour is associated with a brand or a product. Although there is a direct link between colour and colour perception (red means emotion, blue reliably, etc.), modern marketing tries to overcome these stereotypes and find a brand identity [5].
Scent marketing is also a way of sensory marketing that cannot yet pass in the online environment and which tries to create attachment to the brand and which consists in providing a signature that distinguishes products from others on the market. It is likely that solutions to print these thematic, environmental and online promotion scents will soon be found through the use of flavour dispersers, which will be able to contribute to increasing the attachment to a certain brand, and will strengthen companies' strategies development by using emotional factors in their marketing strategies.
In this context, the purpose of the paper was to analyze the connection between sensory analysis and sensory marketing used in the specific scientific researched destined to assess consumer preferences.

MATERIALS AND METHODS

Establishing the relationship between sensory analysis and sensory marketing involved the study of literature, articles published in databases such as Web of Science, Google Scholar and Science Direct, and other sites dedicated to the topic, in order to perform an analysis detailed and for formulating conclusions and recommendations in order to increase the efficiency of the promotion and marketing of goods.
The study was based on a survey conducted through an online questionnaire answered by 127 random respondents who are customers of mall stores in Bucharest. The questionnaire had 10 questions with both multiple answers and hierarchical questions, which aimed to determine how the different elements of sensory marketing influence the behavior of consumers of non-food products.
The questionnaire also included demographic data regarding the respondents (sex, age, education, income, environment).
The research in this paper was based on the application of the questionnaire of the group of respondents, on the analysis of the data and on their interpretation.
In order to establish the information regarding the demographic data, the frequencies and the percentage were calculated. For the calculation of the monthly income, but also of the age, we used the quadratic mean deviation and the statistical mean, which were calculated based on the following formulas:

$$\delta 2 = \sum_{i=1}^{n} \frac{(xi-\bar{x})2}{n-1}$$

$$\bar{X} = \frac{\sum_{n=1}^{n} \mathrm{xi}}{\mathrm{n}} \qquad [1, 10]$$

The Likert rating scale, with 4 ratings, is used to measure buyers' preferences, which is a forced scale, but which offers non-overlapping options that offer open answers [8]. Although it generally uses from 5-7 steps of appreciation, other values can be used.
For the uniform distribution, descriptive statistics and the chi-square test were used both in the data analysis and their comparison in order to formulate the conclusions.

RESULTS AND DISCUSSIONS

The sample to which the online questionnaire was applied on how the elements of sensory marketing influence purchasing decisions included a number of 127 people for whom the answers were validated.
The questions contained in the questionnaire were the following:
(1) Does the light and design of the shop windows influence your purchasing decision?
(2) How do you feel when the light and design of the windows are attractive?

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(3) Can you associate an environmental scent with a brand?
(4) Do you prefer a strong ambient odor or a subtle odor?
(5) How do you feel when you can associate an ambient smell with a certain brand?
(6) What kind of music do you like in a store?
(7) How do you feel when you hear a favorite song in a store?
(8) Do you use tactile sense when purchasing goods?
(9) What is the order in which the following sensory elements influence your purchasing decisions?
(10) What do you consider to be the factors that influence your purchasing decisions the most?

Socio-demographic features of the respondents

Of the total number of individuals included in the sample, 67% were women and 23% men. Out of the total number of respondents, the majority have university studies (61.17%), followed by those with secondary education (29.65%) and those with secondary education (9.18%).

Regarding the incomes, 37.23% have incomes over 10,001 lei/month, 26.14% have incomes between 5,001 lei - 10,000 lei/month, 20.92% have incomes between 2,501 lei - 5,000 lei, and 15.71% have lower incomes of 2,500 lei/month.

Analyzing the residence environment, we find that 57% of buyers come from urban areas, 34% from suburban areas, and 9% from rural areas.

Regarding the frequency of visiting mall stores, 48% of respondents answered that they visit them once a week, 33% 2-3 times a week, and 19% occasionally (Table 1).

Questions 2, 5 and 7 had four answer options regarding how the respondents feel about the hypotheses tested: excited, relaxed, happy or indifferent.

Regarding the way in which consumer behavior is influenced by the atmosphere of the store, to the question "How do you feel when the light and the design of the windows are attractive?" it is found that out of the 127 respondents, the largest share of those in the age group between 18-35 years, that is, 48% said they enjoyed it, and 30% of them felt exciting or were not impressed by the presence of lights. In the age group between 36-55 years, 40% feel enjoy, and 26% feel relaxed. In the age group between 56-65 years, the largest share of respondents feel relaxed (32%) and none of them feel excited. These results are shown in Table 2.

Table 1. The socio-demographic characteristics of the consumers

	Frequency	Percentage
Gender		
Female	85	67.02
Man	42	32.98
Age		
18-35	44	34.87
36-55	47	36.96
56-65	22	17.14
Over 65	14	11.03
Education level		
Gymnasium	12	9.18
Secondary	38	29.65
University	78	61.17
Monthly income level (lei/month)		
>2,500	20	15.71
2,501-5,000	27	20.92
5,001-10,000	33	26.14
over 10,001	47	37.23
Residence environment		
Urban	73	57.12
Periurban	43	33.68
Rural	12	9.20
Frequency of visits		
Once a week	61	48.21
2-3 times a week	42	33.17
Occasionally	24	18.62

Source: Own calculation.

Table 2. How do you feel when the light and design of the windows are attractive?

	Age				**Total**
	18-35	36-55	56-65	Over 65	
Exciting	5	7	4	0	**16**
Relaxing	13	12	7	4	**36**
Enjoy	21	19	6	5	**51**
Nothing	5	9	5	5	**24**
Total	**44**	**47**	**22**	**14**	**127**

Source: own processing.

Therefore, the visual experience of the group of respondents is appreciated as enjoy for 39%, relaxed for 25%, and 23% are indifferent (Table 3).

Table 3. Correlation of the tested hypothesis regarding the light and the design of the showcases

	Age			
	Frequency	Percent (%)	Valid percent (%)	Cumulative percent (5)
Exciting	**16**	12.5	12.6	12.6
Relaxing	**36**	25.0	25.2	37.8
Enjoy	**51**	39.1	39.4	77.2
Nothing	**24**	22.7	22.8	100.0
Total	**127**	99.2	100.0	
System	**1**	0.8		
Total	**128**	100.0		

Source*:* own processing

When asked how customers feel when they can associate a brand with the environmental smell, for the age group between 18-35 years, the highest percentage (45%) feel enjoy, 25% relaxed and 16% they are different (Table 4).

Table 4. How do you feel when you can associate an ambient smell with a certain brand?

	Age				**Total**
	18-35	36-55	56-65	Over 65	
Exciting	6	5	2	1	**14**
Relaxing	11	22	6	3	**42**
Enjoy	20	11	5	4	**40**
Nothing	7	9	9	6	**31**
Total	**44**	**47**	**22**	**14**	**127**

Source*:* own processing.

What is found is that for the age groups between 56-65 and over 65 the association of the brand with an environmental smell is no longer perceived as important, but rather relaxing for 27% of respondents in the group 56-65 years or enjoy for 29% of respondents over 65 years.

Table 5. Correlation of the tested hypothesis regarding the environmental smell of a brand

	Age			
	Frequency	Percent (%)	Valid percent (%)	Cumulative percent (5)
Exciting	**14**	10.9	11.0	11.0
Relaxing	**42**	32.8	33.1	44.1
Enjoy	**40**	31.3	31.5	75.6
Nothing	**31**	24.2	24.4	100.0
Total	**127**	99.2	100.0	
System	**1**	0.8		
Total	**128**	100.0		

Source: own processing.

The experience of associating the brand with the environmental smell is enjoyable for 32% of the respondents and relaxing for 33% of them. The percentage of those who are indifferent at the time of association is quite high (24%). However, this can also be based on the individual ability of the respondents to perceive certain smells or to associate them with a certain brand (Table 5).

Table 6. How do you feel when you hear a favorite song in a store?

	Age				Total
	18-35	36-55	56-65	Over 65	
Exciting	7	16	4	1	**28**
Relaxing	13	12	6	2	**33**
Enjoy	21	12	8	5	**46**
Nothing	3	7	4	6	**20**
Total	**44**	**47**	**22**	**14**	**127**

Source: own processing.

When respondents were asked about how they feel when there is ambient music in a store, for those in the 18-35 age group it is found that this is important given that 93% they feel excited, happy or relaxed. For the 36-55 age group, those who try these hemorrhages represent 85%, for those in the 56-65 age group the percentage is 89%, and for those over 65, the percentage is 57%. Therefore, the presence of ambient music greatly influences the customer when entering a store (Table 6).

Table 7. Correlation of the tested hypothesis regarding ambient music

	Age			
	Frequency	Percent (%)	Valid percent (%)	Cumulative percent (5)
Exciting	**28**	21.9	28.3	22.0
Relaxing	**33**	25.8	26.0	26.0
Enjoy	**46**	35.9	36.2	36.2
Nothing	**20**	15.6	9.4	15.7
Total	**127**	100.0	100.0	100.0
System	**1**	0.8		
Total	**128**	100.0		

Source: own processing.

Out of the total number of respondents to the interview question regarding the state created by the presence of ambient music at the time of shopping, almost 36% of respondents feel happy, 26% feel relaxed, 22% excited, and 16% are indifferent (Table 7).

For questions number 1, 3 and 8, the Likert scale of appreciation was used, and the answer options were: very much, much, very little and not at all.

When asked how the design of shop windows, light, atmosphere can influence purchasing decisions or attract the attention of visitors, 22% of respondents considered that these aspects influence them a lot, 10% quite a lot, and 37% are quite influenced. Little or not at all, the motivation being that when they want to purchase a certain known or desired product they do not let themselves be influenced by the environment.

The distribution of the respondents' answers to question 1 "How do you feel when the light and design of the windows are attractive?"
is highlighted in Figure 1. It reflects that most of the consumers (41%) are impressed " a lot" by what they can see in the shops windows. Also, 22% are very much impressed, 21 % are very little impressed and 16% are not at all impressed. This is an important result for the shop owners who has to think how to arrange the shop windows in a more attractive manner to impress the potential clients to visit the shop and identify and buy the products they are interested to.

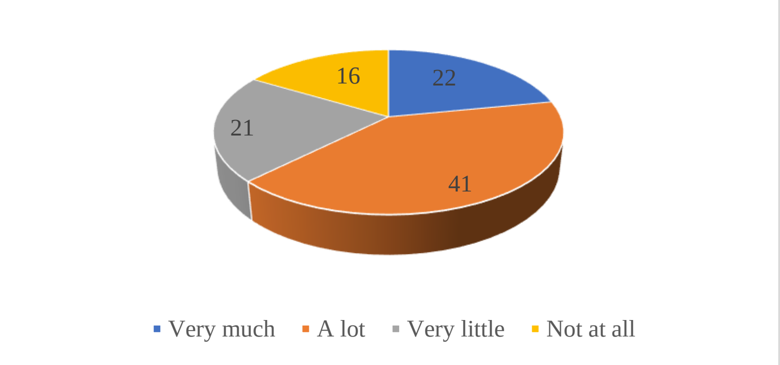

Fig. 1. Distribution of the respondents' answers to question 1 "How do you feel when the light and design of the windows are attractive?"
Source: own processing.

When asked about the possibility of associating a brand with an environmental smell, 20% of respondents were able to associate this smell very well, and quite well they were able to associate 42% of them. Almost 38% of the respondents could not achieve this association or managed quite hard to achieve the association, but this is related to the individual's ability to perceive smell or olfactory memory. Therefore, olfactory sensory marketing can use the ability of buyers to associate a scent with a particular brand, precisely to create customer loyalty (Figure 2).

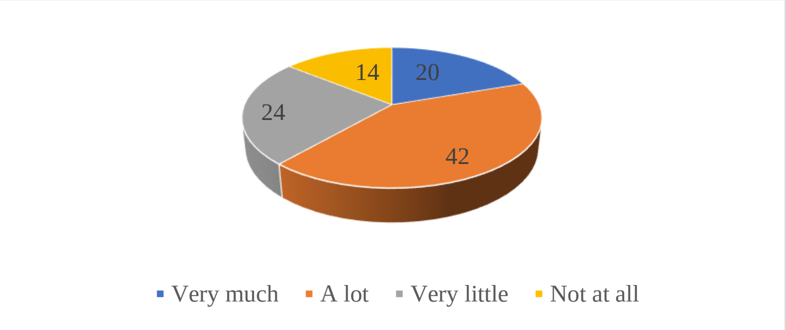

Fig. 2. Distribution of the respondents' answers to question 3 " Can you associate an environmental scent with a brand?"
Source: own processing.

When asked how tactile sense influences purchasing decisions, 35% of respondents (21% very little and 14% not at all) considered that this aspect influences their purchasing decision quite little or not at all, considering that a large part of the purchased goods does not allow this due to the packaging, but 65% of buyers are influenced by the possibility of touching non-food products at the time of purchase (Figure 3).
These answers could led to an improvement of the marketing strategy applied by shop owners in the sense to increase the importance of information written on packages in order to develop consumers' curiosity or to convince them to purchase a product. This is especially important for packaged goods.
In case of other products, like clothing, footware, leather goods, household appliances, electronics, cars etc, clients could touch the products and use their tactile sense to identify what they like or dislike to that product.
In fact, while a client is looking for a good to buy it is very important to touch it, to try it, to feel its texture, fineness/harshness etc which are features closed connected to product quality.

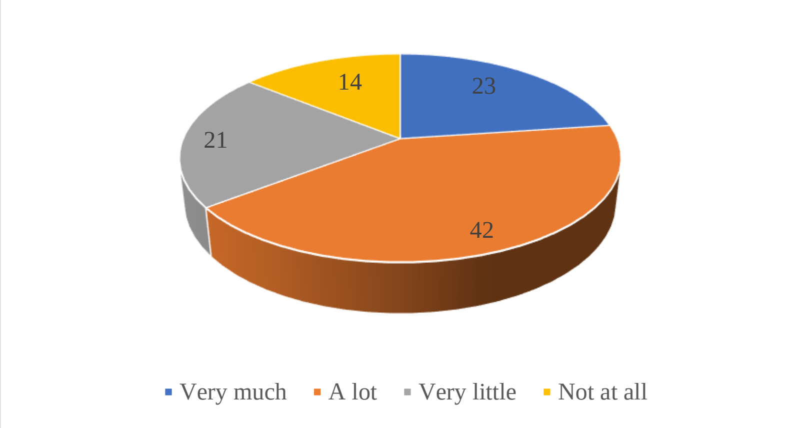

Fig. 3. Distribution of the respondents' answers to question 8 "Do you use tactile sense when purchasing goods?"
Source: own processing.

Question 4 was a closed-ended question that measured consumers' preferences regarding the ambient smell in a store. Thus, 84% of the respondents preferred a subtle smell, and 16% a strong smell. As age groups, mainly in the category of consumers who prefer a strong smell, young people aged 18-35 were included.

When asked about the musical style that buyers want to represent ambient music, this style also depends on the age and preferences of the respondents. Thus, 18% of them prefer classical music, most of them belonging to the 56-65 age group (23%), followed by only 1.5 percentage points of the 36-55 age group. Regarding the preferences for pop music, it is preferred by the majority of respondents (44%). Compared to the favorite music category by age groups, we find that 39% of those aged 18-35 prefer the pop style, 46%, from the group 36-55 years, 50% from the age group 56-65 years and 42 % of those over 65 years of age. Rhythmic music is preferred by 15% of respondents, and 68% of them are between 18-35 years old. Relaxation music is preferred by 23% of respondents, distributed as follows: 28% aged between 18-35 years, 34% aged between 36-55 years, 17% aged between 56-65 years and 21% with over 65 years old. Therefore, the choice of ambient music in order to influence the purchase decision can be made depending on the age of buyers, but also gender, because of the 18% attributed to lovers of classical music 15% are women and 3% are men, of the 44% who prefer pop music 31% were women and 11% men, of the 15% respondents who prefer rhythmic music 8% were women and 7% men, and of the 23 percent owned by those who prefer relaxation music 14% were women and 9% men, given the share of the sample. However, if we refer to the number of respondents, by categories of musical preferences, we see that 74% of women prefer classical music compared to 26% of men, 71% of respondents who prefer pop music are women, compared to 29% men, 53% of those who prefer rhythmic music are women compared to 47% men and 62% of respondents who prefer relaxing music are women, compared to 38% men.

The last question was about the factors that could influence their purchasing decisions. If 62% of the respondents considered that the objective reasons influence their comparison decisions, the remaining 38% answered that often the ambiance or emotional state influences their purchase decision. In terms of gender, out of the 79 respondents who are influenced by emotions or environment in shopping, 82% were women and 18% men, and of the 48 respondents who do their shopping based on objective needs 38% are women and 62% are men.

CONCLUSIONS

Sensory marketing consists in identifying consumers' emotions, in measuring and understanding them, in identifying new markets in order to capitalize on their potential and creating brand loyalty.

The use of sensory marketing is made starting from measuring consumers' preferences by using sensory analysis methods, objective and subjective that take into account both the physical and chemical characteristics of products, but also their sensory aspects.

Taking into account the results of surveys, case studies and research, marketing can exploit consumer preferences depending on age, gender, etc. so that the best channel for promoting products can be found in order to satisfy consumer preferences, given the achievement of a high level of sales, which from the point of view of trade translates into increasing profit and profitability of the activity carried out.

The present study thus allowed us to find that consumers' preferences are largely influenced by sensory experiences. The strongest influence has the olfactory sense that not only convinces the consumer, but also reminds memories according to which the purchase decision is made.

At the same time, buying decisions are influenced by factors such as: age, training environment, income, mood, personality, lifestyle, which means that future studies should take into account as many aspects as possible influence consumer preferences.

Market research must be as complex as possible, as innovative as possible so that it can contribute to improving the relationship between consumer and producer.

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COMPENSATORY PAYMENTS GRANTED BY MEASURE 11 - ORGANIC AGRICULTURE IN VÂLCEA COUNTY (2015-2020)

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Abstract

In this paper we intend to provide an updated situation on the land used in organic agriculture system and registered in the database of the Agency for Payments and Intervention for Agriculture - Vâlcea County Center, during the campaigns for submitting single payment applications, related PNDR framework 2014-2020. The amounts granted as financial support for the implementation of Measure 11 - organic agriculture are also highlighted in terms of value. Compared to the areas that benefited from support through Measure 11, it was observed an increase during the studied period from 10.56 ha in 2015 to 6,054.98 ha in 2020, areas that include several categories of land uses: arable land, permanent crops and permanent pastures. As for the number of farmers who have accessed this form of support, it has increased from 3 in 2015 to 37 at the end of 2020. The average value of payments - expressed in euro - at the farmer level registered an increasing trend, starting from 2,138.21 euros in 2015 and reaching a maximum of 16,625.58 euros in 2020, with a total of payments of 615,146.67 euros related to this measure in Vâlcea County, in the year 2020.

Key words**:** *organic agriculture, arable land, permanent crops, compensatory payments amount*

INTRODUCTION

Through the National Rural Development Program (NRDP) 2014-2020, a specific measure of organic farming was implemented, financed by the European Agricultural Fund for Rural Development (FADR), respectively: Measure 11 - organic agriculture. The measure is one of the main used tools for minimizing water pollution in sustainable land management systems which aimed the fertilizer management, crop protection management, water management and land erosion protection management [6]. The practice of organic farming brings many benefits to the rural environment at EU level, elements highlighted in numerous studies on: the integration of economic aspects with those of environmental protection [1, 7]; the production and promotion of authentically traditional foods both in terms of taste and nutritional quality of ingredients [4, 10] thus leading to a projected growth in the EU's Common Agricultural Policy for the organic food market [5].

Farmers, as owners of agricultural land used for organic farming, benefit from compensatory payments, following the conclusion of voluntary annual/multiannual commitments aimed at compensating: additional costs and loss of income generated by the implementation of extensive management measures on agricultural land, designed for achieving environmental objectives (biodiversity conservation, water and soil protection); additional costs and loss of income resulting from the application of organic farming practices; the additional costs and loss of income that farmers suffer due to natural and specific constraints in areas with an impact on agricultural production [9].

The current context of support policies defined at the level of the European Union is extremely favorable for the development of organic agriculture in Romania as well.

Accessing programs through which payments are granted to certified organic farmers or which are in the conversion period had registered an increasing trend in last years in all regions of the country [3], including Vâlcea County. The use of agricultural land, starting from the categories of use [11], is achieved through field crops, vegetables and fodder plants - arable land, vineyards and orchards (including nurseries) - permanent crops, natural pastures and hayfields - natural meadows.

Vâlcea County, located in the South-West of Oltenia Development Region, has an agricultural area of 242,856 ha, of which arable land of 86,857 ha, vineyards and vineyards nurseries of 3,622 ha, orchards and orchards nurseries of 12,952 ha, natural pastures of 106,894 ha and natural grasslands of 32,531 ha [12].

MATERIALS AND METHODS

The work involved an adequate documentation, by completing the field phase - travel to APIA Vâlcea headquarters, consulting the database [2] and procuring the related data, but also by going through the office phase - processing the data extracted from the records of the institution mentioned above. In order to achieve the goals of paper, based on the discussions with the specialized staff, we collect a series of information related to: land areas (by categories of use) that benefited from support through Measure 11 - Organic farming; the number of farmers who benefited from these measures; the amount of financial support (euro). For the inclusion in the time horizon of PNDR 2014-2020, the situation specific to the interval 2015-2020 was analyzed. Thus, in addition to the specific annual indicators (land areas, number of farmers and the level of compensatory payments), we also added a synthetic indicator - the average value of payments per farmer. Related to the terminology used, it should highlight that this is specific to the institution where the documentation was carried out. It should be noted that, in order to determine the amount of the payments at the farmer's level, we started from the land areas, their use and the specific financial values of the packages associated with sub-measures 11.1. - areas under conversion and 11.2. - ecologically certified areas [8], for which the land has been framed. Comparison was used as a method of analysis.

RESULTS AND DISCUSSIONS

Table 1 present the areas of arable land who received compensatory payments.

Related the arable land areas that received support, except for the first year of the studied time interval 2015 (0.22 ha) and the year of 2017 (66.73 ha) when the surface was below 100 ha, there are areas of 129.95 ha in 2018, 298.84 ha in 2016, 324.33 ha for 2019 and respectively 1,156.38 ha for 2020.

In the same interval there is a marked diversification of the crops for which a compensatory amount has been granted. Thus, starting in 2015 with maize and counting in 2016 with winter wheat, maize, sunflower, medicinal and aromatic plants, alfalfa and other fodder plants. In 2017 there are new crops as fresh annual vegetables, but corn, sunflower and alfalfa have disappeared. The crops variety is more present in the following years and continues with maintenance of the nomenclature of crops in 2018 compared to 2017 and the transition to autumn oats, peas, tomatoes in solariums, medicinal and aromatic plants, alfalfa, trefoil, other fodder plants and perennial leguminous mixtures with perennial grasses used as fodder in 2019.

In 2020 we observe that the biggest areas were occupied by alfalfa and trefoil which represent the majority areas from the total of 1,156.38 ha. Also, sorghum and common sainfoin appear, but peas and solarium tomatoes disappear during this year as crops who received financial support.

Table 1. Arable land (ha)*

SPECIFICATION	Year					
	2015	2016	2017	2018	2019	2020
Winter wheat	-	48.9	0.44	0.44	-	-
Oat	-	-	-	-	54.7	13.5
Maize	0.22	40.5	-	-	-	-
Sorghum	-	-	-	-	-	2.85
Pea	-	-	-	-	15.2	-
Sunflower	-	198	-	-	-	-
Fresh vegetables	-	-	2.09	2.09	-	-
Solarium tomatoes	-	-	-	-	0.12	-
Medicinal and aromatic plants	-	7.07	10.5	7.42	7.42	7.42
Alfalfa	-	2.4	-	-	24.9	472
Trefoil	-	-	-	-	23.9	79.5
Common sainfoin	-	-	-	-	-	1.05
Other forage crops	-	1.97	53.7	120	194	576
Perennial leguminous mixtures with perennial grasses used as fodder	-	-	-	-	4.09	4.06
Total	**0.22**	**298.84**	**66.73**	**129.95**	**324.33**	**1,156.38**

Source: *alphanumerical data from Agency for Payments and Intervention for Agriculture - Vâlcea County Center.

Table 2 lists the areas for permanent crops. For 2015, there are areas with apples and quinces for which financial support was obtained (9.3 and respectively 0.67 ha). In 2016, in addition to these two species (with identical areas as in the previous year) there are also plum tree and other fruiting shrubs (0.93 and respectively 9.57 ha).

Table 2. Permanent crops (ha)*

SPECIFICATION	Year					
	2015	2016	2017	2018	2019	2020
Young orchards that do not bear fruit	-	-	-	3.89	4.13	7.18
Apple tree	9.30	9.30	9.30	9.93	9.63	9.63
Plum tree	-	0.93	8.98	60.61	60.13	61.64
Quince tree	0.67	0.67	0.67	0.67	0.67	0.67
Walnuts and hazelnuts	-	-	-	8.41	23.75	23.75
Other fruit trees	-	-	1.31	1.92	1.92	2.61
Blueberry	-	-	-	0.1	0.1	0.1
Other fruiting shrubs	-	9.57	9.38	9.38	9.38	21.54
Vineyards for wine	-	-	8.68	8.33	8.23	8.23
Vineyards financed thru the reconversion program	-	-	12.4	12.38	12.38	12.38
Total	**9.97**	**20.47**	**50.72**	**115.62**	**130.32**	**147.73**

Source: * alphanumerical data from Agency for Payments and Intervention for Agriculture - Vâlcea County Center.

In 2017 there is a more pronounced diversification of the species for which the compensatory payment was obtained (apple - 9.30 ha, plum - 8.98 ha, quince - 0.67 ha, other fruit trees - 1.31 ha, other fruit bushes 9.38 ha, vineyards producing grapes for wine - 8.68 ha and vineyards in reconversion program - 12.4 ha). For the years of 2018, 2019 and 2020, payments were granted (in addition to those specified in 2017) for the young orchards do not bear fruits, nuts and hazelnuts, respectively blueberry. Thus, we are discussing of areas between 0.1 ha and 60.61 ha for currants and plums in 2018; 0.1 ha and 60.13 ha for the same species in 2019; 0.1 ha and 61.64 ha for blueberry and plums in 2020.

It is noteworthy that the vineyards had shares between 13.95% and 17.91% for the years 2020 and respectively 2018. The total area increases of 2.05 times in 2016 compared to 2015 (20.47 and respectively 9.97 ha), of 2.48 times in 2017 (50.72 ha) compared to the previous year, of 2.28 times in 2018 (115.62 ha) compared to 2017, and of 1.13 times for years 2019 and 2020 (130.32 and 147.73 ha) compared to previous years.

The area of permanent meadows included in Measure 11 is presented in Table 3. At county level, the permanent meadows had subsidized areas of 0.37 ha in 2015, 0.84 ha for 2016 (of 2.27 times - in dynamics), 10.88 ha in the case of 2017 year (of 12.95 times), after which for the period 2018-2020 there are marked significant increases of the areas at 816.49 ha (of 75.04 times), 1,065.26 ha (of 1.30 times) and respectively 4,750.87 ha (of 4.46 times).

Table 3. Permanent meadows and pastures (ha)*

SPECIFICATION	Year					
	2015	2016	2017	2018	2019	2020
Permanent communal meadows used individually - exploited by grazing	-	-	-	505	1,331	1,429
Permanent meadows commonly used - mixed exploitation	-	-	-	207	-	-
Permanent meadows used individually - mixed exploited	0.37	0.84	10.5	103	112.8	271.8
Pastures used individually - exploited by grazing	-	-	-	-	2,615	3,046
Meadows used individually - exploited by mowing	-	-	0.38	1.49	6.09	4.07
Traditional orchard exploited extensively thru grazing	-	-	-	-	0.37	-
Total	**0.37**	**0.84**	**10.88**	**816.49**	**1,065.26**	**4,750.87**

Source: * alphanumerical data from Agency for Payments and Intervention for Agriculture - Vâlcea County Center

This situation is generated, in particular, by the access to payment of the areas related to the communal permanent meadows used individually, exploited by grazing and to the pastures used individually and also exploited by grazing.

It is noted that in the first two years of the specified interval they had access to payment only permanent meadows used individually - mixed exploitation.

In 2017, the meadows used individually - exploited by mowing, are also included in the financing program. For the year of 2018 are also accepted areas of permanent communal meadows used individually and commonly.

In the case of 2019 there are not included for payment program the permanent meadows shared use - mixed exploited, but there is the traditional orchard exploited extensively thru grazing, while at the level of 2020 year we found that did not include for payment the areas related to permanent shared use - mixed exploited, respectively the traditional orchard exploited extensively thru grazing.

If we take into account the information presented above (Tables 1, 2 and 3), we find a total county area, which benefited from support through Measure 11 according to Figure 1.

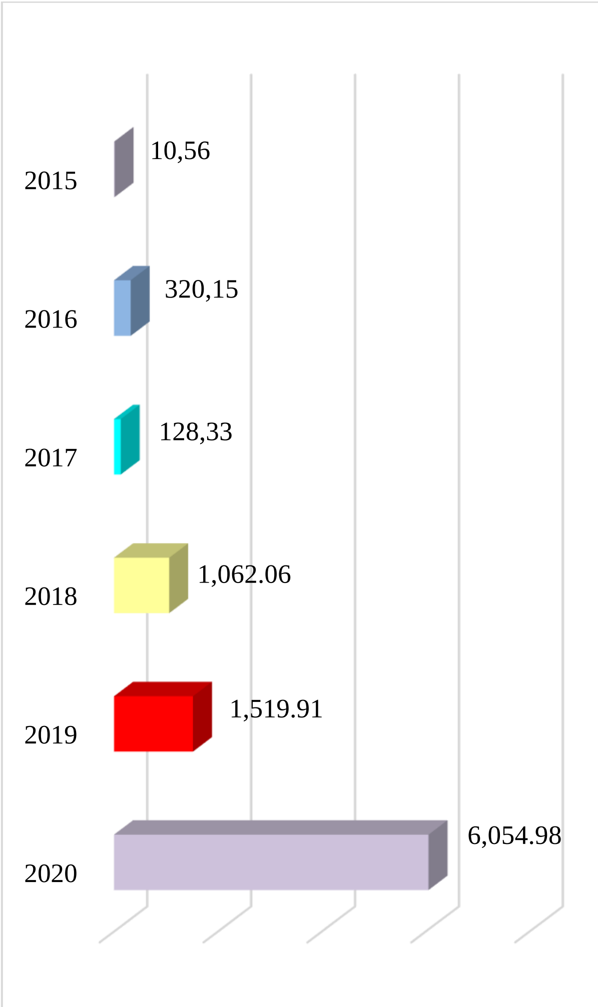

Fig. 1. Total area that received payments (ha)
Source: Own calculation.

The evolution of the surfaces was fluctuating. There was an increase of 30.32 times in 2016 compared to 2015 (320.15 ha and respectively 10.56 ha); a decrease of 59.92% in the case of 2017 (128.33 ha) compared to 2016, then there is a spectacular increase in 2018 year compared to the previous term of the dynamic series (of 8.27 times - area of 1,062.06 ha), a trend that moderates in 2019 year (1,519.91 ha - overtaking 1.43 times related 2018 year), but which is accentuated again for 2020 (6,054.98 ha - exceeding of 3.98 times in the situation of previous year).

If we refer to the farmers who received support, there is an increase in their number during the analyzed period (Figure 2).

The increases were more pronounced in 2016 and 2019 (the number of farmers doubled compared to previous years) and less pronounced in 2017 (+ 42.87% compared to 2016), 2018 (+ 30% compared to the previous year) and 2020 (+ 48% compared to 2019).

Table 4 list the level of payments distributed in Vâlcea County, for the interval 2015-2020.

The total value of the support increased, from one year to another, as follows: of 2.30 times in 2016 (14,731.91 euro) compared to 2015 (6,414.63 euro); of 2.92 times in 2017 (43,078.74 euro) compared to 2016; of 2.32 times in 2018 (100,088.70 euro) compared to 2017; of 2.20 times for 2019 (220,150.56 euro) compared to 2018 and of 2.79 times at the level of 2020 (615,146.67 euro) compared to the specific situation of 2019.

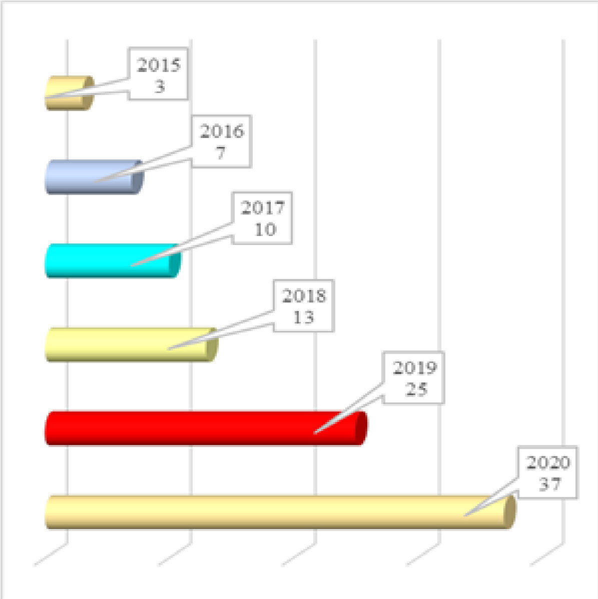

Fig. 2. Number of farmers who received support
Source: alphanumerical data APIA Vâlcea [2].

Table 4. Value of compensatory amount (euro)

SPECIFICATION	Year					
	2015	2016	2017	2018	2019	2020
Total/year*	6,414.63	14,731.91	43,078.74	100,088.70	220,150.56	615,146.67
Average amount/farmer**	2,138.21	2,104.56	4,307.87	7,699.13	8,806.02	16,625.58

Source: * alphanumerical data from Agency for Payments and Intervention for Agriculture - Vâlcea County Center [2]; **own calculation.

The level of average amount/farmer (as a synthetic indicator) varied from 2,104.56 euro in 2016 to 16,625.58 euro in 2020.

The trend of evolution of the average value on the farm decreases in 2016 compared to 2015 by 1.58%, after which there is an ascending trend more or less accentuated from year to year (of 2.05 times in 2017, of 1.79 times in 2018, of 1.14 times in 2019 and of 1.89 times in 2020).

CONCLUSIONS

Under the NRDP, Measure 11 supports the necessity to maintain biodiversity, protection and rational use of natural resources, especially the quality of water resources. The main objectives of the measure, namely to promote the biodiversity of agricultural land, to reduce the environmental impact of agricultural production and to promote the production of healthy food, are an essential step for positive change at national and regional level to promote a healthy diet. The most important aspect resulting from the data presented is the fact that organic farming in Vâlcea County has a positive dynamic evolution, largely due to the compensatory payments granted by the measures carried out by NRDP program.

The practice of organic farming is a chance for the rural environment, contributing to sustainable development by increasing employment, avoiding the depopulation of the rural areas.
It is clear that the local specificity defines the mode of action of farmers. For farmers in Vâlcea County, the implementation of Measure 11 can be the basis for the development of family farms, with main activity in animal husbandry, large areas of permanent grassland and meadows, included in the system of organic farming, allowing the development of real organic farms, combining local practical knowledge with the opportunity offered by European funds.

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ASSESSMENT OF SOIL QUALITY LIMITATIVE FACTORS. A CASE STUDY: SECAŞ, TIMIŞ COUNTY, ROMANIA

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Abstract

The paper aims, as the main purpose, at assessing the limiting factors of the soil quality in the perimeter of the Commune of Secaş, Timiş County, Romania. To achieve the aim pursued, we identified the main limitative factors of agricultural productivity and soil degradation processes. These were introduced in the database using modern methods, namely the GIS technique, for each soil unit, with "space" representations thereof. The soil surfaces on which each factor and/or degradation process is manifested and which is of particular practical importance in assessing soil quality were calculated automatically. The method used allows one to highlight the soils identified by various maps and cartographic representations. Most of the results were obtained from field work and calculations in the office and laboratory, supplemented by those from O.S.P.A. Timisoara and from literature. The importance of this study materialized in a complex database comprising all soil units in the studied perimeter, limiting factors specific to this area and degradation processes, as well as the establishment of fertility classes, i.e., the quality of existing soils in the studied area. The study highlights that the soils of the Commune of Secaş falls into grade III and IV fertility (quality).

Key words*: *cartographic representations, limitative factors, soil, quality, evaluation

INTRODUCTION

Agriculture plays an important role in preserving natural resources and landscapes. During the centuries, agriculture has contributed to the creation and preservation of a variety of landscapes and habitats. However, agricultural practices may have adverse effects on the environment. Soil degradation, water, soil and air pollution, habitat fragmentation and wildlife destruction may be the result of inappropriate agricultural practices [1], [9].

Soil is a complex, dynamic, living resource that plays many vital functions: food production and other types of biomasses, storage, filtration and transformation of substances, including water, carbon, and nitrogen [12], [8].

Soil is subjected to a series of degradation processes. Some of these processes are closely related to agriculture: water erosion, wind erosion and agricultural soil preparation works; compaction; decrease of the amount of organic carbon in the soil and soil biodiversity; salinisation and nitration; and soil contamination (with heavy metals and pesticides or excessive amounts of nitrates and phosphates) [7], [13]. The damage caused by soil erosion materialises in: loss of organic matter, soil structure degradation, soil surface compacting, low water infiltration, low water supply for the ground water layer, surface soil loss, nutrient removal, increase in coarse materials in the soils, stringing and gutter formation, plant uprooting, and decrease of soil productivity [14], [22].

Soil degradation processes involve the need to protect, maintain, and improve soil quality. Soil properties, as well as soil genesis factors such as climate, land use, or soil management determine the degree of soil degradation [18], [24].Certain agricultural systems and practices target one or more soil degradation processes and can contribute to better protection and preservation of soil resources.

The Commune of Secaş is located in north-eastern Timiş County, about 60 km from Timisoara, and occupies a total area of 5.767 ha, of which 5,006 ha have an agricultural destination [8], [21]. The natural framework of the locality was highlighted on the basis of the information in literature, complemented by field observations and by drawing up working maps [6], [13]. All these maps help us faster, clearer and easier soil identification in the studied area, and especially, to easier identify on the map all factors and degradation processes, maps and information that will benefit both locals and stakeholders and also future generations [3], [23].

In this context, the purpose of the paper was to assess the limiting factors of the soil quality, agricultural productivity and degradation processes in the perimeter of the Commune of Secaş, Timiş County, Romania.

MATERIALS AND METHODS

In order to achieve a detailed analysis of the factors that have contributed to the identification and description of soils and the achievement, due to GIS, of a multitude of representative materials, pedological maps containing a series of data on the soils studied, the limiting factors and the processes of degradation that limits soil quality were realised [1], [4], [20].

Part of the pedological data was obtained from the O.S.P.A. Timisoara archive, from the Secaş City Hall and from the field trips [21], [17].

For each soil unit, a series of features were identified, such as: name, area (automatically calculated with a program), degradation processes (limitative factors grouped according to their intensity) and quality class for arable use [5].

In the cartographic representation of limitative factors and of soil degradation processes, those degradation factors and processes specific to soils in the analysed area are presented [11], [19]. Data were introduced into the database for each soil unit, the "space" representations of these characteristics being thus obtained [2], [15], [16].

Spatial representations of the soil units were achieved using GIS techniques because they have multiple advantages compared to classical representation and mapping methods, of which the most important are: the net quality of cartographic representations, the possibility of automatic measurement of parameters like the area and the possibility of using data and representations in spatial analyses along with other digital data [10], [25].

RESULTS AND DISCUSSIONS

Soil quality in the investigated area is influenced by a series of limitative factors and/or degradation processes represented by some soil and/or environmental factors, which, through their action, lead to reducing fertility potential and, implicitly, to soil yielding capacity on which they exercise their action.

The spatial distribution of these factors and/or processes is presented below on the basis of GIS techniques. In this respect, the analysed factors limiting the quality of soils in the area and processes observed on the ground are:

a) The unevenness of the land displayed as a limiting factor on a share of 96.2% of the total area, the intensity of this factor being represented in Fig. 1.

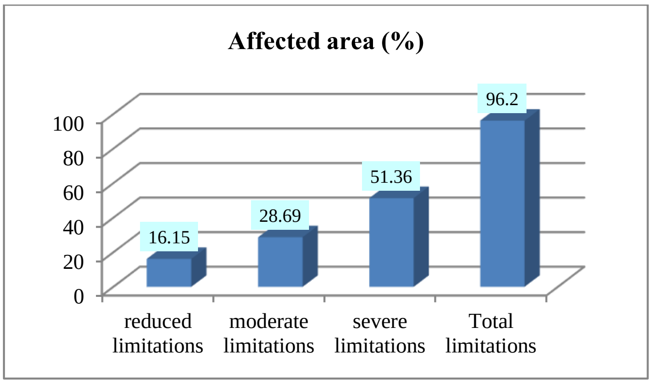

Fig. 1. Intensity of land unevenness
Source: Own calculation.

Therefore, the non-uniformity of the land affects the quality of soils in a very large proportion, the area analysed overlapping a hill region, with lands of different degrees of declivity.

The spatial distribution of the land affected by different intensities of unevenness is represented in Fig. 2.

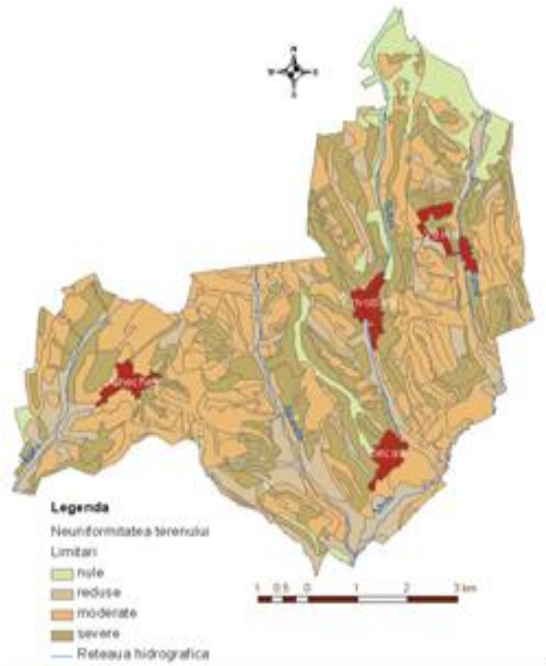

Fig. 2. Soil grouping according to land unevenness
Source: Own determination.
Legend, Land unevenness, *Limitations (top to bottom): null; reduced; moderate; severe; hydrographic network*

Limitations with severe intensities correspond to hill areas with higher altitudes, but as the altitude decreases, the intensity of unevenness decreases.

b) Acidic soil reaction limits the yielding capacity of 41.12% of soils, the largest share (38.83%) being that of reduced limitations (Fig.3).

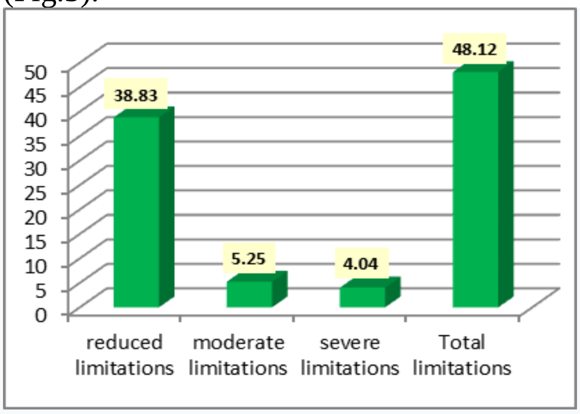

Fig. 3. Intensity of soil acidity
Source: Own calculation.

The space distribution of the soils whose quality is limited by acid reaction is shown in Fig. 4.

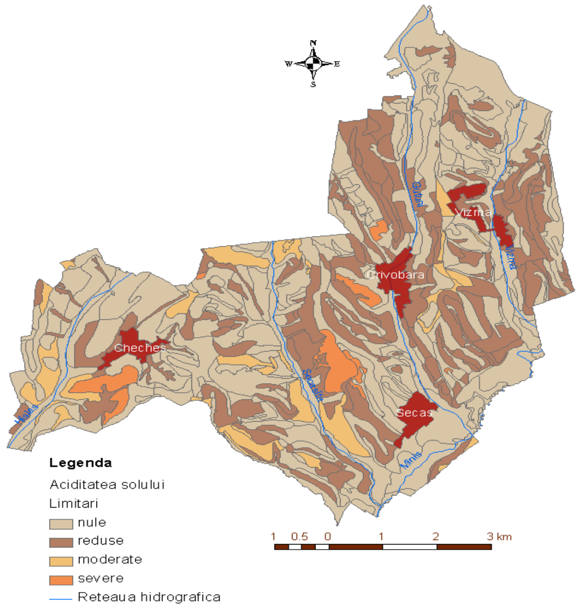

Fig. 4. Soil grouping according to acidic reaction
Source: Own determination.
Legend, Acidic soil reaction, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

Unfortunately, at an area of 4.04% of the analyzed area, the limitations are severe in terms of soil acidity. In this context, it is important to carry out works to correct the acid reaction of the soils, such as the application of calcium carbonate amendments.

c) Humus reserve, a particularly important indicator in assessing soil quality, characterises 89.88% of the analysed soils. The intensity with which this factor acts is shown graphically in Fig. 5.

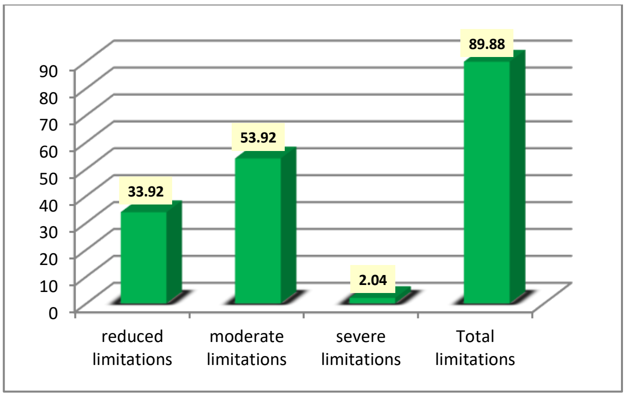

Fig. 5. Intensity of humus reserve
Source: Own calculation.

Soils, depending on humus reserve, are spatially "located" in Fig. 6.

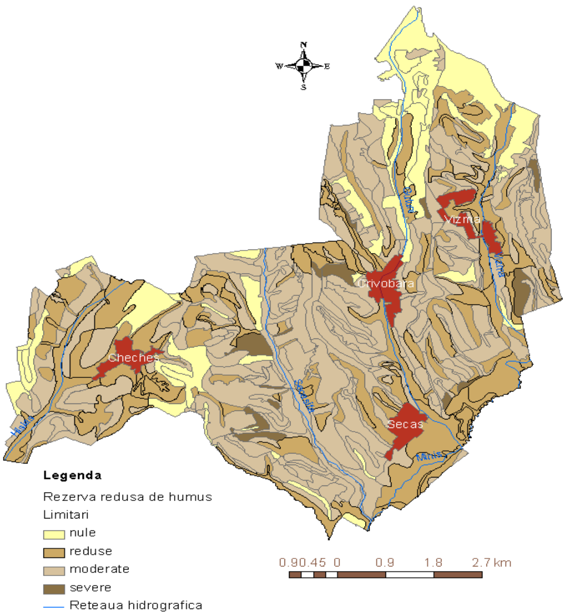

Fig. 6. Soil grouping according to humus reserve
Source: Own determination.
Legend, Low humus reserve, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

d) Landslides limit the production capacity of soils in Secaș to 70.01% of the surface. (Fig.7).

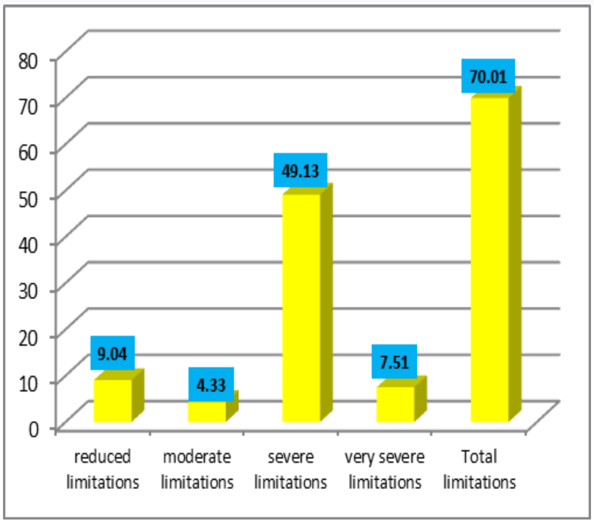

Fig. 7. Intensity of landslides
Source: Own calculation.

The lands most affected are by severe limitations, namely 49.13% of the surface. Out of the total of 70.01% of the lands affected by these landslides, on 7.51% there are very severe limitations. The territorial distribution of soils affected by landslides with different degrees of intensity is represented in Fig. 8.

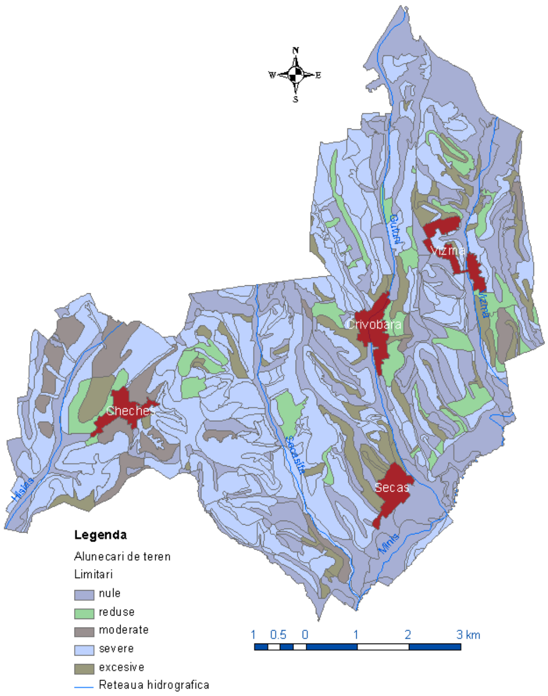

Fig. 8. Grouping of soils depending on landslides
Source: Own determination.
Legend, Landslides, *Limitation (top to bottom): null; reduced; moderate; severe; excessive; hydrographic network*

e) Land bearing capacity is manifest on 67.6% of the territory analysed with reduced limitations on 43.8% of the land limitations and with moderate limitations on 23.8% of the land (Fig. 9).

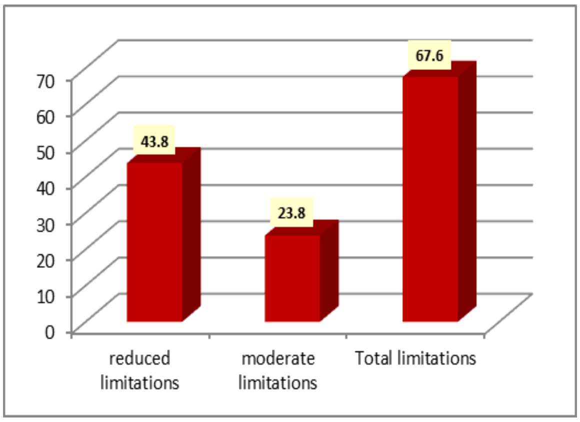

Fig. 9. Intensity of limitations depending on land bearing capacity
Source: Own calculation.

Regarding the Intensity of the limitations depending on the load-bearing capacity of the land, the Secaș locality has low and moderate limitations. does not have big problems,

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because the soils have low and moderate limitations.

Soil distribution according to land bearing capacity is represented in Fig.10.

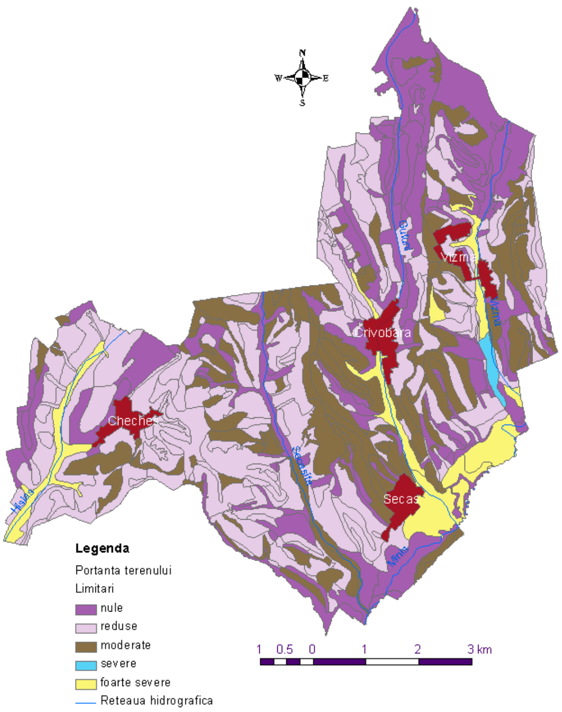

Fig. 10. Soil grouping depending on land bearing capacity
Source: Own determination.
Legend, Land bearing capacity landslides, *Limitation (top to bottom): null; reduced; moderate; severe; very severe hydrographic network*

f) Surface erosion, including erosion risk, affects 79.14% of the total area, the highest percentage being caused by severe limitations, i.e., 39.29%, followed by moderate limitations, by 28.53%.

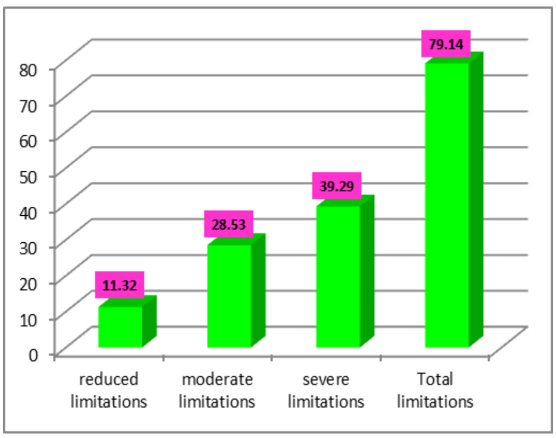

Fig. 11. Intensity of surface erosion
Source: Own calculation.

The territorial distribution of soils affected by erosion is represented in Fig. 12.

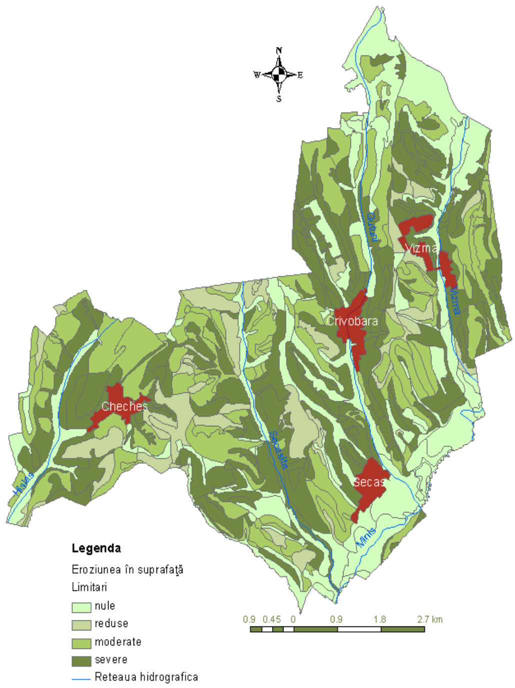

Fig. 12. Soil grouping depending on surface erosion
Source: Own determination.
Legend, Surface erosion, *Limitation (top to bottom): null; reduced; moderate; severe; hydrographic network*

Under the action of limiting factors and/or degradation processes in the research area, soils are classified in different quality classes as shown in Fig. 13.

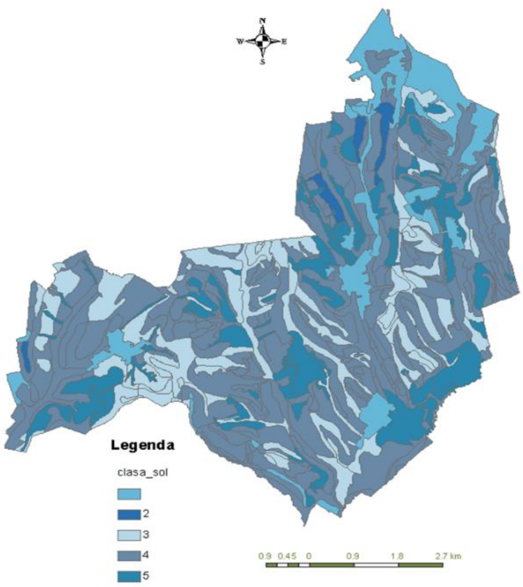

Fig. 13. Soil quality
Source: Own determination.
Legend, Soil_quality *(top to bottom):* 1, 2, 3, 4, 5.

As shown in the map presented above, grade III and IV quality soils predominate in the "arable" use category, a consequence of the physical-geographical conditions specific to the study area.

CONCLUSIONS

Considering the evaluated "limitations", we have found that soils in the study area are different both from a unit of relief to another and from one type of soil to another, their fertility potential being expressed by quality grades.

Soil erosion is a natural process, the main factors that determine this process are: intense rains, topography, low content of organic materials in the soil, percentage and type of vegetation cover. However, this process is intensified and accelerated by human activities, such as soil work techniques and improper harvesting practices, changes in hydrological conditions, deforestation and marginalization or abandonment of land. Improper land management is the main cause of soil compaction. A too large livestock number in a particular land area, improper use of heavy machinery in agriculture and soil work when it is too wet are factors that lead to soil compaction. Wet soils are not strong enough to withstand weight, and this leads to compaction.

The main limitations were conditioned by the existence of one or more limitative factors and degradation processes observed on the ground, namely:

1. *Land unevenness* on 96.2% of the studied area, with severe limitations on 28.69% of the area;

2. *Soil acidic reaction* on 41.12% of the area, with moderate limitations on 5.25% and severe limitations on 4.04% of the area, respectively;

3. *Humus reserve* on 89.23% of the area, with moderate limitations on 33.92% and severe limitations on 2% of the total area analysed;

4. *Landslides* on 70.01% of the analysed area, with severe limitations on 49.13% of the area, one of the factors that mostly limit soil quality in the area;

5. *Land bearing capacity* on 67.6% of the studied area;

6. *Soil surface erosion*, another major limiting factor, on 79.14% of the area, with severe limitations on 39.29% of the area, followed by moderate limitations on 28.53% on the area.

Following the assessment of the limitative factors and of the degradation processes, we have found that the analysed soils used as "arable" are *medium quality*, i.e., *grades III and IV fertility (quality)*.

In this situation, measures are required to increase soil fertility, namely its quality, depending on the specific needs of the field, so that they can classify in higher fertility categories. In this respect, we propose fertilization measures to increase the humus reserve by applying organic fertilizers (manure), given that over 89.88% of the land have a low content in humus. To correct the acidic reaction on acid pH land (41.12% of land) we propose amendments (calcium carbonate).

Soil structure can be improved with organic matter, thus reducing the predisposition of soil to compaction, erosion, landslides and desertification.

Also, practicing soil non-hazardous cultivation agricultural farming systems (*mixed cultures* – cultivation of two or more cultures in alternative rows, *subsoiling* – aerating compacted soil layers deeper than the ploughing, without overturning them, and *working the land along level curves* – to increase soil infiltration capacity and slows down water drainage, giving water the time to infiltrate the soil) can contribute to a better protection of soil resources.

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DANUBE COUNTIES OF THE SOUTH-MUNTENIA DEVELOPMENT REGION, ROMANIA, IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract

Measuring sustainable development is a hot topic in specialized studies. The aim of this study is to compare the Danube counties of the South-Muntenia Development Region in terms of sustainable development. For this, several indicators of sustainable development have been selected. The indicators were analyzed by calculating and comparing averages and average growth rates. Depending on the averages of the analyzed indicators and compared to the other three counties, Teleorman County ranks first. Depending on the average growth rates of the analyzed indicators and compared to the other three counties, Călărași County ranks first. However, the average growth rates are low and even negative and denote the fact that the Danube counties of the South-Muntenia Development Region face different problems in the management of sustainable development.

Key words: *Danube counties, South-Muntenia Development Region, sustainable development*

INTRODUCTION

In the current age, also called the age of speed, the development of economic activities is accelerated by the evolution of technology. Out of the desire to evolve as quickly as possible, to make a profit and prosperity, humanity tends to ignore the consumption of resources, falling into a certain trap of selfishness. Thus, irrational resource consumption and selfishness are opposed to sustainable development. The importance of this concept derives from the fact that it involves meeting the needs of the present generation as well as meeting the needs of the next generation, taking into account that meeting the needs of future generations depends on how the needs of the present generation have been met. In order to ensure that the present generation is developing sustainably and that it offers posterity the opportunity to meet its own needs, the goals of sustainable development have been developed [26] and several indicators for measuring them. The methods for presenting and analyzing sustainable development indicators are diverse, starting with analysis through dynamic indices [1] and ending with the use of indicators in the creation of composite indices [5, 13].

Sustainable development is a concept that emerged in the twentieth century against the background of the awareness of the negative effects that human activities have on the environment. However, the concept of sustainable development is not limited to the environment, as this dimension is supplemented by two more, namely the social dimension and the economic dimension. The most widely defined definition of sustainable development in the world is the one published in the report entitled Our Common Future, which was prepared by the World Commission on Environment and Development. Thus, according to the World Commission on Environment and Development [28], sustainable development is "the ability of present generations to meet their own needs without compromising the ability of posterity to meet their own needs."

Based on the above definition, it can be deduced that the current generation has a debt to the next generation in terms of resource consumption, because the needs are met by consuming different resources. As a result, the present generation is obliged to adhere to rational consumption and to avoid wasting resources. Rational consumption and the avoidance of waste of resources will ensure the possibility of posterity to meet and meet their own needs.

In addition to the definition given by the aforementioned commission, there have been other definitions given by various researchers. Thus, sustainable development could also mean "achieving a higher and more evenly distributed level of well-being, within ecological limits" [31]. It can be deduced from the above definition that the way in which resources are consumed is not important, as long as certain environmental limits are met. In other words, from a sustainable point of view, the highest level of well-being is the one that does not exceed the ecological limits and not the one that exceeds these limits. Moreover, the previous definition does not include the concept of future generations, from which it can be deduced that a consumption within ecological limits of the present generation will give the chance to the next generation to benefit from the same resources. In other words, related to the term welfare, sustainable development means "increasing the quality of life of present generations without compromising the interests of posterity" [4].

Hummels and Argyrou [12] pointed out that the definition given by the World Commission on Environment and Development is somewhat vague. As a result, they proposed redefining the concept of development as follows: "sustainable development is development that meets the needs of this generation, respects the limits of the planet and does not compromise the ability of posterity to meet their own needs without exceeding the same limits of the planet" [12]. The previous definition highlights the central elements of the concept of sustainable development, namely the present generation, the planet or, better said, the resources of the planet, and the next generation. Moreover, the above definition emphasizes a particularly important thing, namely that resources are limited. That is why it is considered that “sustainable development does not consume resources, but uses and reuses them endlessly” [9]. In other words, sustainable development is a complex concept that also involves actions to recycle waste, reuse resources and increase the capacity of resources to regenerate.

Being such a complex term and with consequences in the future, the development of objectives and measurement indicators was absolutely necessary. As a result, there have been several stages in the development of sustainable development goals, and in 2015, the United Nations developed 17 sustainable development goals, relating to: 1. Poverty; 2. Hunger; 3. Good health and well-being; 4. Quality education; 5. Gender equality; 6. Clean water and sanitation; 7. Clean and accessible energy; 8. Decent work and growth; 9. Industry, innovation and infrastructure; 10. Reducing inequalities; 11. Sustainable communities and cities; 12. Sustainable production and consumption; 13. Climate action; 14. Underwater life; 15. Earth life; 16. Peace, justice and strong institutions; 17. Partnerships for goals [26]. The objectives set by the United Nations are valid globally. Following an analysis of national voluntary reports on sustainable development goals, the World Tourism Organization and the United Nations Development Program [29] have highlighted that the closest links to tourism are Objectives 8, 12 and 17. In other words, tourism contributes mainly to sustainable development by: creating new jobs, promoting and supporting sustainable production and consumption through sustainable forms of tourism and by creating partnerships involving a multitude of stakeholders.

Sustainable development indicators are closely linked to sustainable development goals. Thus, in 2017 was established a global framework of targets and indicators for the 17 Sustainable Development Goals for 2030 [27]. The European Commission has also set a number of indicators to monitor European progress on sustainable development, the latest report being that of 2021 [10]. Another set of indicators of sustainable development is developed by the OECD – Organization for Economic Co-operation and Development [24]. It should be noted that indicators of

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sustainable development can be used and adapted in studies, depending on the areas of activity and their characteristics, such as agriculture [6, 11], tourism [14, 15], construction [21, 30], public health [7] and other areas of activity. In other news, sustainable development has a very wide applicability and the measurement indicators can be adapted, in the sense that they are not standardization for a particular field of research or for a particular area or region.

The South-Muntenia Development Region is composed of the counties of Argeș, Călărași, Dâmbovița, Giurgiu, Ialomița, Prahova and Teleorman. The predominant form of relief is the plain, but there are also mountains, hills and plateaus. Most of the houses in this region are in rural areas. Between urban and rural areas are differences regarding population, its natural movement, age, education level and living standard [20]. School infrastructure and the health system are poorly developed in rural areas of this region [16]. In the field of tourism, the counties of Argeș, Dâmbovița and Prahova stand out. There are several watercourses in the region, including the Argeș and Ialomița rivers, the Danube river. Of the seven counties, only the counties of Călărași, Giurgiu, Ialomița and Teleorman have the privilege of hosting the waters of the Danube river [23]. Thus, out of the seven counties that make up the South-Muntenia Development Region, only the counties of Călărași, Giurgiu, Ialomița and Teleorman can have the title of Danube counties.

From the point of view of social and technological development, the Danube counties of the South-Muntenia Development Region are among the most disadvantaged counties in Romania, according to an index of social and technological disadvantage, calculated for all counties in the country in 2021 [17]. Thus, the causes that led to the fact that the Danube counties of the South-Muntenia Development Region are among the most socially and technologically disadvantaged counties are: the higher number of the elderly population than the number of young (the highest value of this indicator is found in Teleorman County), the infant mortality rate (the highest value of this indicator is found in Călărași County), the rate of employees in agriculture (the highest values of this indicator are in Teleorman counties), the unemployment rate (the highest values of this indicator are found in Teleorman, Mehedinți, Călărași and Ialomița counties), the area inhabited by one inhabitant (Călărași County has the second lowest value of this indicator), the number of doctors per 1,000 inhabitants (in Călărași, Ialomița and Giurgiu counties there are less than 1.2 doctors per 1,000 inhabitants), the length of the sewerage network (Teleorman, Vrancea and Călărași counties have the lowest values of this indicator), the number of passengers using public transport (the second lowest value of this indicator is found in Teleorman County, and the third lowest value is found in Giurgiu County), research and development expenses (Ialomița County recorded zero expenses), the number of computers in schools – the four Danube counties of the South-Muntenia Development Region are among the first seven counties with the lowest values of this indicator [17]. Behind the numbers is the profile of these counties or the reality within these counties, more precisely the fact that the productivity of an employee in these counties must be extremely high to support the local economy, given that the population is aging. The large number of agricultural workers shows that the Danube counties of the South-Muntenia Development Region have an agrarian character, and employment opportunities are relatively low, which means that development is also somewhat limited to the agricultural sector, and the shortage of jobs generates unemployment and the search for jobs in localities outside the county of residence. The small number of doctors, compared to the number of inhabitants, makes it impossible for many citizens to benefit from specialized medical consultations, which can lead to deteriorating health and exhaustion of medical staff. Poor sewerage infrastructure makes it impossible for citizens to enjoy decent living conditions, and the small number of people using public transport indicates that transport infrastructure is not developed or that citizens prefer to use their own means of transport, which leads to the consumption of significant quantities of fuels and, implicitly, to the increase of the quantities of noxious substances. The small number of computers in schools limits the ability of students to benefit from current teaching-learning methods and to acquire the digital skills needed for the present era. The previous study [17] focuses on comparing all counties based on the index of social and technological disadvantage. Other studies focus on comparing counties, given their membership in different macro-regions. Thus, according to a study conducted in 2014 [8], the Danube counties of the South-Muntenia Development Region and the counties of Argeș, Dâmbovița, Prahova, Ilfov and Bucharest form one of the macro-regions. Also, the main variables of sustainable development for this macro-region are the number of graduates, the built area and the activity rate [8]. While Teleorman County scores well in terms of the variable entitled built area and a less good score on the variable entitled number of graduates, Călărași, Giurgiu and Ialomița counties score poorly in the case of both variables. Thus, based on the variable entitled built area, Teleorman County becomes a "regional main pole" [8]. The variable entitled the built area, in Teleorman County, satisfies rather the economic component of sustainable development and less the environmental component, since by increasing the areas on which buildings that have different purposes (of living, factories, offices, etc.) are built, the area of green spaces is reduced and the overcrowding of localities can be installed. Moreover, in the case of variables entitled number of graduates and the rate of activity, the favourable case would be that they recorded values as high as possible, because from an economic point of view, the performance of a better trained and prepared person is higher than that of an unprepared person, i.e. the local/national economic level increases to the extent that the number of active persons is higher than the number of inactive people.

Other studies [22] show the comparison of counties based on a connecting element, such as the Danube river. Thus, all the Danube counties were compared regarding the vulnerability to climate change, and by the Cluster method, a cluster was obtained consisting of the four Danube counties of the South-Muntenia Development Region [22]. Following the comparison of the Danube counties regarding the vulnerability to climate change, it was obtained that the exposure of the Danube counties of the South-Muntenia Development Region to hydro-climatic factors is low to average, although Ialomița and Teleorman counties are more prone to flood risk [22]. Also, in the four counties the modern factors of production are used to a small extent, the counties are dependent on agriculture, they have quality soils, but the capacity to adapt to hydro-climatic factors is the lowest, compared to the other Danube counties. At the same time, regarding the infrastructure and the level of literacy, the four Danube counties of the South-Muntenia Development Region have the lowest values compared to the other Danube counties [22].

In terms of sustainable development, some authors [9] consider that among the variables to be analyzed are: the rate of establishment of companies, the amount of drinking water and natural gas distributed to the population/household consumers, the share of street length in urban areas that benefit from sewerage in the total length of city streets, the number of libraries, school dropout, the average number of primary and secondary school students related to a teacher, the costs of measures to reduce unemployment. The sustainable development index, built on the variables mentioned above, showed that the counties of Călărași, Teleorman and Giurgiu are on the last places in terms of sustainable development, at least at the level of the South-Muntenia Development Region, and Ialomița County ranks fourth [9]. In other words, based on the sustainable development index, calculated using the variables entitled, the rate of establishment of companies, the amount of drinking water and natural gas distributed to the population/household consumers, the share of street length in urban areas that benefit from sewerage in the total length of city streets, the number of libraries, school dropout, the average number of primary and secondary school students related to a teacher, the costs of measures to reduce unemployment, the ranking of the four Danube counties of the South-Muntenia Development Region is as follows: Ialomița, Călărași, Teleorman and Giurgiu [9].

Indicators that measure sustainable development actually measure the goals of sustainable development. Based on 90 indicators it was constructed an index of sustainable development goals, in order to measure the achievement of sustainable development goals at local and regional level [3]. For this index was used a scale from 0 to 10, in which 10 is the highest value of sustainable development. Moreover, the values obtained were concentrated in four intervals. As a result, the index of achieving the objectives of sustainable development at county level took values between 2.49–3.16, 3.17–3.80, 3.81–4.46, 4.47–5.96 [3]. Following the calculations, the four Danube counties of the South-Muntenia Development Region: Călărași, Giurgiu, Ialomița and Teleorman, fall within the smallest range. Also, Teleorman County ranks last nationally [3]. In other words, in the counties in the shortest range, the objectives of sustainable development are the least achieved.

Based on these results, it can be admitted that in the four Danube counties of the South-Muntenia Development Region there are concerns about achieving the objectives of sustainable development, but these concerns are at an early stage, and the hierarchy of counties in terms of sustainable development may differ depending on the variables analyzed.

MATERIALS AND METHODS

This paper is a descriptive study, whose purpose is to compare from a statistical point of view, the Danube counties of the South-Muntenia Development Region, through the perspective of the indicators/variables of sustainable development. As a result, the analyzed counties were Călărași, Giurgiu, Ialomița and Teleorman.

The data series were taken from the database of the National Institute of Statistics, more precisely the TEMPO Online statistical database [18]. The data used were presented in the form of time series. The chosen analysis period was between 2007 and 2020, because 2007 is a reference year for Romania, namely the accession to the European Union, and 2020 is the last year for which data were recorded in the aforementioned database.

Due to the fact that in the mentioned database there are statistics under construction, regarding the objectives of sustainable development, indicators of sustainable development have been selected that correspond to those objectives. Due to the fact that there are no statistical records for all indicators of sustainable development, corresponding to the period and counties analyzed, the following indicators (variables) were treated: Land area with soil erosion improvement and erosion control works – LASEIECW, Area of land with irrigation works – ALIW, The amount of chemical fertilizers used in agriculture – ACFA, The amount of natural fertilizers used in agriculture – ANFA (these indicators are related to Objective 2 of sustainable development, namely Zero Hunger); Number of beds for continuous hospitalization – NBCH (this indicator is related to Objective 3 of sustainable development, namely Health and well-being); Classrooms, School workshops – SW (these indicators are related to Objective 4, namely Quality Education); Population connected to sewage treatment systems – PCSTS (this indicator is related to Objective 6 of sustainable development, namely Drinking water and sanitation); Length of public roads – LPR (this indicator is related to Objective 9, namely Industry, Innovation and Infrastructure); Length of modernized city streets – LMCS (this indicator is related to Objective 11, namely Sustainable Cities and Communities); The rate of natural population growth – RNPG (this indicator is related to Objective 16, namely Peace, Justice and Strong Institutions). Abbreviations of variable names were used to analyze data series using the SPSS program – version 20.

The data analysis was performed by comparing the averages and the average growth rates of the aforementioned variables, reported at the level of Călărași, Giurgiu, Ialomița and Teleorman counties. Usually, the normal distribution of the series is checked to compare the averages, but due to the fact that the analysis period is short, the normal distribution may be redundant. Thus, the averages were found using the SPSS program, through the Compare Means command [25]. For the calculation of the average growth rate, denoted by R, the average dynamic index, denoted by I, was used. In this respect, the two formulas used were [2]:

Average dynamic index:

$$(\mathrm{I}) = (n-1)\sqrt{\frac{y_n}{y_1}}$$

where:
n = the total number of values/records
y_n = the last value of the data series
y_1= the first value of the data series.

Average growth rate (R) = $(Ix100) - 100$

RESULTS AND DISCUSSIONS

Following the calculation of the averages and average growth rates, it can be admitted that in Teleorman and Călărași counties, the concerns for achieving Objective 2 of sustainable development – Zero Hunger, are stronger than in Giurgiu and Ialomița counties. As a result, the average land area with works to improve soil erosion and combat soil erosion is higher in Teleorman County, compared to Călărași, Giurgiu and Ialomița counties. Also, the average growth rates are constant in the case of Călărași, Giurgiu and Teleorman counties, while in Ialomița county there is an average annual decrease of the average land area with works to improve soil erosion and combat soil erosion with 6.81%. With regard to the average area of land with irrigation works, the situation is similar to that of the average area of land with works to improve soil erosion and combat soil erosion in the case of average growth rates, while in the case of the average, the hierarchy is as follows: Călărași County, Teleorman County, Ialomița County and Giurgiu County. In other words, the average surface of the lands arranged with irrigation works is higher in Călărași county, compared to Teleorman, Ialomița and Giurgiu counties.

Concerns about achieving the goal of Zero Hunger in sustainable conditions could also be highlighted by the amount of chemical and natural fertilizers used in agriculture. Both in the case of chemical fertilizers and in the case of natural fertilizers, the average quantities used in Teleorman County are higher than in the case of Călărași, Ialomița and Giurgiu counties. In the coming years, this may change, as in the case of both categories of fertilizers, the highest growth rates are recorded in Călărași County. The positive aspects of this situation are that the average growth rate of the amount of natural fertilizers is higher than that of chemical fertilizers in Călărași County and that in Teleorman County, the average rate of increase in the amount of chemical fertilizers is negative (decreases in the amount of chemical fertilizers). Thus, considering the Zero Hunger objective and the analyzed variables, Teleorman County ranks first in three of the variables, depending on the averages.

In the case of this paper, the objective Health and well-being is represented by the variable entitled number of beds for continuous hospitalization. And in the case of this variable, Teleorman county ranks first both in the average number of beds for continuous hospitalization and in the average growth rate, compared to Călărași, Giurgiu and Ialomița counties. In other words, this shows a major interest in the permanent increase in the number of beds for continuous hospitalization. It is also noteworthy that, in terms of the average number of beds for continuous hospitalization, Călărași County ranks second, but in terms of growth rate ranks last, compared to Teleorman, Ialomița and Giurgiu counties.

In the field of education, the counties with greater concerns are the counties of Teleorman, Ialomița and Călărași. In this paper, the objective of Quality Education is represented by the variables entitled the number of classrooms and the number of school workshops. Thus, the highest average number of classrooms is found in Teleorman County, and the highest average number of school workshops and the highest average growth rate of school workshops is found in Ialomița County. This indicates that in the county of Ialomița there are permanent concerns for increasing the number of school workshops. In the case of Teleorman County, the concerns are more intense in terms of maintaining the current average number of classrooms and less intense in terms of its growth, as in Teleorman County, the average growth rate of the number of classrooms is the lowest, compared to the counties of Călărași, Ialomița and Giurgiu. Rather, more intense concerns for the increase in the number of classrooms are found in Călărași County, because the average growth rate of the number of classrooms is the highest, compared to Ialomița, Giurgiu and Teleorman counties.

The fact that natural resources are limited is well known throughout the world. In this sense, the solution could be to reuse and recycle resources. Water can be reused through treatment processes. In the four Danube counties of the South-Muntenia Development Region, the highest average number of people connected to sewage treatment systems is in Teleorman county. However, in Teleorman County there is the lowest average growth rate of the population connected to sewage treatment systems, and the highest average growth rate is in Ialomița County. In fact, Ialomița County ranks second in terms of the average number of people connected to sewage treatment systems, and the last place is occupied by Giurgiu County.

Regarding the concerns for public roads, Teleorman and Ialomița counties hold the leading places, compared to Călărași and Giurgiu counties. As a result, the highest average length of public roads is in Teleorman County, and the highest average length of modernized city streets is in Ialomița County. It is noteworthy that Ialomița County ranks last in terms of average length of public roads and first place in the average rate of increase in the length of modernized city streets. Also, the lowest average growth rate of the length of modernized city streets is held by Teleorman County. The capitalization of the various resources and the development of economic activities depend on the transport infrastructure. More than that, transport infrastructure is essential for development, which means that modernized public roads and city streets must be a top local priority.

The responsibility of the present generation is not only to ensure that future generations have the opportunity to benefit from the same resources and to meet their own needs, but also to ensure the existence of future generations.

Table 1. Average dynamics indices (I) and Average growth rates (R) of the sustainability indicators

Variables	Călărași		Giurgiu		Ialomița		Teleorman	
	I	R (%)	I	R (%)	I	R (%)	I	R (%)
LASEIECW	1	0	1	0	0.9319	-6.81	1	0
ALIW	0.9992	-0.08	0.9992	-0.08	0.9984	-0.16	0.9992	-0.08
ACFA	1.0203	2.03	1.0007	0.7	1.0108	1.08	0.9984	-0.16
ANFA	1.1973	19.73	0.8931	-10.69	0	0	1.0239	2.39
NBCH	0.9884	-1.16	0.9952	-0.48	0.9976	-0.24	0.9992	-0.08
Classrooms	1.0160	1.6	1.0114	1.14	1.0141	1.41	1.0006	0.06
SW	0.9602	-3.98	0.9650	-3.5	0.9839	-1.61	0.9537	-4.63
PCSTS	1.0101	1.01	1.0273	2.73	1.0322	3.22	1.0052	0.52
LPR	0.9992	-0.08	1.0022	0.22	1.0003	0.03	1.0015	0.15
LMCS	1.0022	0.22	1.0387	3.87	1.0037	0.37	0.9976	-0.24
RNPG	1.0922	9.22	1.0322	3.22	1.1566	15.66	1.0245	2.45

Source: Own calculation on the basis of data from Tempo on line data base 2007-2020, NIS [18].

As a result, the non-existence of the beneficiary of sustainable development shows that the efforts made to ensure sustainability are useless. Thus, natural growth is a particularly important variable in the context of sustainable development. Unfortunately, in all four Danube counties of the South-Muntenia Development Region, the natural growth rate is negative. There is a contrast with this variable, more precisely, the fact that the lowest average negative rate of natural increase is found in Ialomița County and the highest average rate of increase of the negative rate of natural growth is also found in Ialomița County, and the highest average negative rate of natural growth is meets in Teleorman county and the lowest average growth rate of natural growth is also found in Teleorman county. It is also known that for the continuity of generations, the natural growth must be at least zero, and in the most favorable case to be positive, and at the level of the South-Muntenia Development Region, more than half of the variation of the natural growth is influenced by the risk of poverty and social exclusion [20].

Considering the analyzed variables (11 variables) and the two indicators (average and average growth rate), Teleorman County has the highest probabilistic chances to hold the first place based on averages, compared to Ialomița, Călărași and Giurgiu.

Table 2. Averages levels for the main chosen indicators reflecting sustainable development

Variables	MU	Călărași	Giurgiu	Ialomița	Teleorman
LASEIECW	ha	2,827	2,637	453.79	6,382
ALIW	ha	360,548.71	169,754.21	209,361.21	237,879.64
ACFA	tons	265,971.93	138,221.57	261,998.79	393,957
ANFA	tons	3,748.71	2,609.07	321.36	5,054.29
NBCH	beds	1,202.93	823.21	857.43	1,925.21
Classrooms	number	1,537.57	1,325.79	1,526.71	1,879.21
SW	number	58.50	28.36	61.07	45.21
PCSTS	persons	72,768.57	59,481	72,776.50	84,989.64
LPR	km	1,337.50	1,167	1,163.50	1,544.21
LMCS	km	333.57	216.93	492.43	367.86
RNPG	%	-4.27	-6.65	-3.08	-9.43

Source: Own calculation on the basis of data from Tempo on line data base 2007-2020, NIS [18].

Thus, the ranking of the four counties according to averages, in the period 2007-2020, is as follows: Teleorman, Ialomița, Călărași and Giurgiu. From a probabilistic point of view, depending on the average growth rates, Călărași County has the highest chances to hold the first place. Thus, the ranking of the four counties according to the average growth rates, in the period 2007-2020, is as follows: Călărași, Teleorman, and Giurgiu and Ialomița occupy the third place.

CONCLUSIONS

Given that the indicators of sustainable development have a very wide applicability, the indicators analyzed in this study came from several fields, such as agriculture, health, education, infrastructure and demography. Following the calculation of the average growth rate, negative growth rates (decreases) were obtained at the level of all four Danube counties of the South-Muntenia Development Region, more precisely in the case of the variables entitled the surface of the lands arranged with irrigation works, the number of beds for continuous hospitalization, the number of school workshops, the natural growth. This highlights some of the issues that exist in the four counties that need to be addressed through quick and effective measures. These issues include the productivity of agricultural land, the agglomeration of the existing hospital units, the decrease of the resident population knowledgeable by trades, the aging of the population. Also, in general, the average growth rates of the analyzed variables are very low. The fact that some average growth rates are negative and others are very low are consistent with the results of other studies [3, 8] which showed that the Danube counties of the South Development Region Muntenia ranks last in terms of sustainable development. Thus, the ranking of the four counties based on the averages and the average growth rates of the analyzed variables denotes the way in which these variables of sustainable development were managed locally in the period 2007-2020.

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IDENTIFICATION OF FATTY ACIDS IN GRAPE AND TOMATO POMACE – SUSTAINABLE VALORIZATION OF AGRICULTURAL WASTE

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Abstract

Food industry generates large quantities of waste material containing significant amounts of biologically active compounds such as polyphenols, dietary fibers, essential fatty acids etc. Wine industry creates grape pomace during wine manufacturing, whereas tomato derived products industry (ketchup, tomato puree, canned tomatoes, tomato juice, and tomato sauce) produces tomato pomace. Both food wastes contain fruits' seeds as source rich in fatty acids. The aim of this study is to identify fatty acids that are containing in aforementioned types of food waste and to demonstrate the alternative food waste applications other than animal feed. Fatty acids were analyzed using gas chromatography. Grape pomace is richer in linoleic and palmitoleic acid and ω-6 fatty acid in comparison with tomato pomace. Tomato pomace is richer in ω-3 fatty, stearic, palmitic and oleic acids. Grape pomace holds up higher quantity of PUFA and CLA, but lesser amount of SFA and MUFA and cis isomers of oleic acid than tomato pomace.

Key words: *by-product, fatty acid profile, grape pomace, sustainable, tomato pomace*

INTRODUCTION

Roughly, one third from world's annual food production (1.3 metric billion tons) is food waste [25]. European Union countries are given plans to be implemented for proper management with this type of waste, in order to decrease it up to 30% until 2025 and up to 50% until 2030 [7]. Due to the current inefficiency in food economy, there is a constant loss in productivity, energy and ecosystem. Circular Economy encompasses reuse, recovery and recycle of existing materials, briefly, the waste becomes resource at a certain point [14]. It helps in amelioration and optimization of the sustainability of Western food system. According to Rana et al., 2021 [19] valorization of agro industrial waste through green and biotechnological processes is feasible approach for its reduction. Wine and tomato industries generate large and bulky waste, which is challenging to manage. Grape pomace (GP) is a by-product of the wine industry. This waste contains skin, seeds and stalks (Fig. 1a) [24]. Tomato pomace (TP) is a by-product of tomato derived products industry and contains seeds and skin (Fig. 1b) [3].

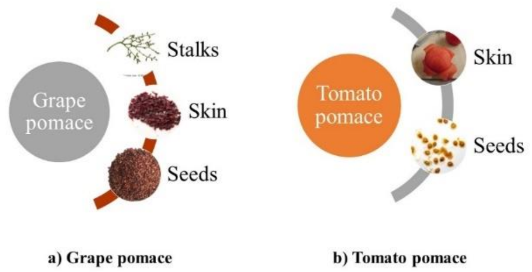

Fig. 1. Constituents of grape and tomato pomace
Source: Own design.

In our previous work, the chemical composition of grape pomace was estimated. [18]. According to many authors, GP by-product is an excellent source of dietary fibers

[11], phenolic compounds [4] and lipids [13]. Moreover, GP has high antioxidant activity [10], whereas grape seed oil is plentiful in linoleic and oleic acids [1]. The chemical composition of grape pomace is grape variety and level of ripeness dependent among other factors [1]. Once tomatoes are transformed in puree, juice, sauces and ketchup, the generated waste is called tomato pomace that is composed of seeds, peels and a little quantity of pulp [26]. Due to the good chemical composition of tomato, tomato waste is characterized as an excellent source of lycopene, dietary fibers, proteins and lipids. This chemical composition relies on the proportion of peels and seeds in the tomato pomace, since the peels are richer in dietary fibers, lycopene and phenols, while the seeds generally contain lipids and proteins [17]. According to the scientifically available information, the dietary fiber content in TP is in the range of 39.11 and 68.04 g per 100 g DM, the protein content is in the range of 16.00 and 24.67 g per100 g DM, the amount of minerals lies between 2.88 and 5.29 g per 100 g DM, while the amount of lipids varies between 2.00 and 16.24 g per 100 g DM [9, 12, 20, 21]. Grape pomace is abundant in unsaturated fatty acids (UFA), linoleic and oleic in particular, which make up more than 68% from the total content of fatty acids [5]. The essential oil of tomato seeds can be used in daily nutrition due to its high nutritional value. This tomato seed oil extract is high in content in palmitic, linoleic, arachidic, oleic and stearic acids, whereas the content of unsaturated fatty acids (UFA) accounts for approximate 80% [17]. Due to the high lipid quantity in GP and TP, the aim of this paper was determine the fatty acid profile and highlight the most important fatty acids. In this manner, we can validate the potential alternative use of these types of food waste as a source of functional foods, nutraceuticals and cosmetics formulation. Their further use will contribute for sustainable agro food waste development.

MATERIALS AND METHODS

Preparation of grape and tomato pomace

Grape pomace was collected after separating the grape juice from the red grapes. The residuals (stalks, seed and skin) were placed on stainless steel pans and were dried for 48 hours at 60 ºC in the UFE 500 oven (Memmert GmbH, Schwabach, Germany). Afterwards the dry grape pomace was ground using an IKA MF10 grinder (IKA®-Werke GmbH & Co. KG, Staufen, Germany). Tomato pomace (seeds and peels) was collected after extracting the juice from technological mature tomatoes. It was dried at 45 ºC in UFE 500 oven (Memmert GmbH, Schwabach, Germany), and subsequently pulverized on an IKA MF10 grinder (IKA®-Werke GmbH & Co. KG, Staufen, Germany). Both types of pomace were placed in vacuum bags and vacuum stored at a temperature of 4ºC.

Lipid extraction form grape and tomato pomace

For the lipid extraction, 25 g from the grape pomace powder and 10 g from tomato pomace powder were used. Static extraction was performed employing chloroform and methanol as an extracting solvent in ratio 1:2. The extraction process was repeated twice. The whole extract was transferred in separating funnel, while water was added for phase separation. After the separation of the aqueous phase, the non-polar phase was transferred into vacuum evaporator, followed by complete drying and evaporation of the extracting solution [6].

Identification of fatty acid profile of grape and tomato pomace

Identification of fatty acids in grape and tomato pomace was performed using gas chromatograph Shimadzu-2010 gas chromatograph (Kyoto, Japan). The assay was performed with a CP7420 capillary column (100 m x 0.25 mm i.d., 0.2 m, Varian Inc., Palo Alto, CA), with carrier gas-hydrogen and make-up gas-nitrogen. A five-stape gas chromatographic oven program has been used.

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Statistical analysis

The presented values are the mean values from three replicates. To determine least significant difference Fisher's test was employed ($p < 0.05$), using the software XL STAT 2019 (Addinsoft Inc. Long Island City, NY, USA).

RESULTS AND DISCUSSIONS

In the food industry, the oil extracted from grape and tomato seeds can be promoted as cheaper oil compared to other types of oil, representing a new source of nutrition in humans' diet at the same time [17, 22]. Nevertheless, tomato pomace contains extensive quantities of lipophilic bioactive compounds (carotenoids and unsaturated fatty acids). Therefore, this food waste can be utilized as a source for manufacturing high quality extracts [23]. Mainly, the fatty acid content in grape and tomato pomace comes from the occurrence of the seeds in the pomace itself. The seeds are highly valued due to the good nutritional characteristics of the extracted oil from them, which are high in unsaturated fatty acids (oleic and linoleic) [5]. In Fig. 2, the quantities of stearic, palmitic, palmitoleic, oleic, linolenic and linoleic fatty acids in grape and tomato pomace are presented. The highest content of unsaturated fatty acids present in pomaces were oleic and linoleic acids. According to Lu et al., 2019 [17] oil extract from tomato seeds had the highest linoleic acid content. The quantity of palmitic acid in tomato pomace was higher than the one in grape pomace. Jin et al., 2019 [13] presented results for the palmitic acid content varying between 7.81 and 10.6 g/100 oil and steric acid content in the range between 2.51 and 6.12 g/100 g oil in their investigation of fatty acids identification in grape pomace produced from different varieties of red grapes. The amount of palmitoleic acid in grape and tomato pomace was estimated to be 0.39 and 0.35 g/100 g oil, respectively, while stearic acid can be found in capacity of 3.75 g/100 g oil in grape pomace and 5.98 g/100 g oil in tomato pomace.

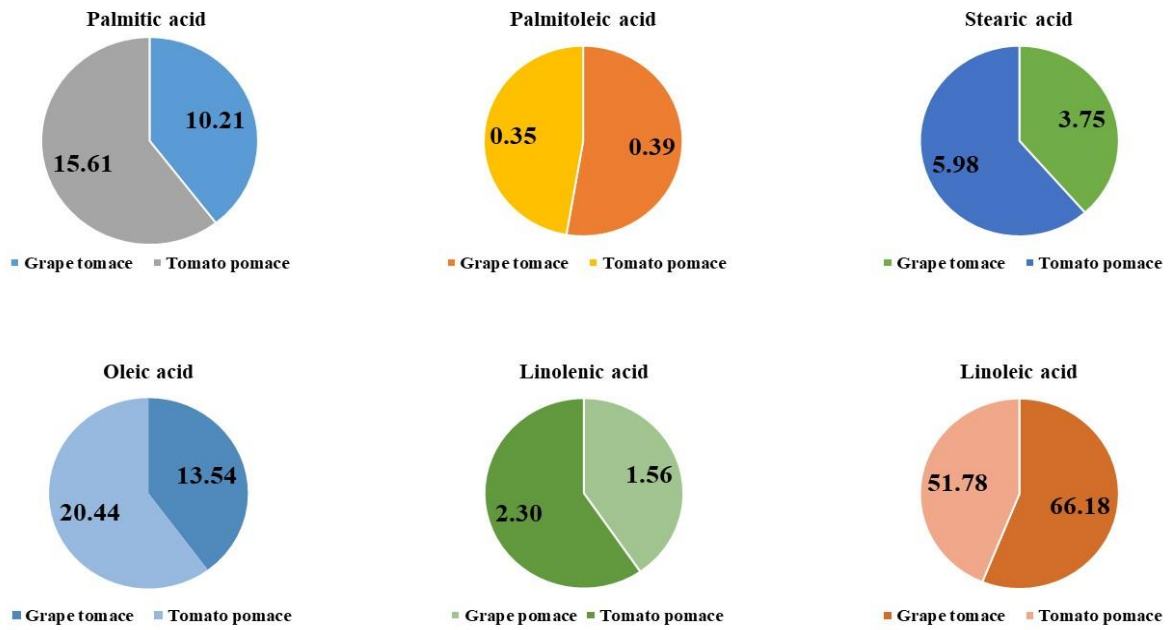

Fig. 2 Different fatty acids (g/100g oil) in grape and tomato pomace
Source: Own design.

According to Beres et al., 2017 [5] saturated stearic fatty acids in grape seeds were present in quantities of 3-6%. α-linolenic acid as a part of essential fatty acids has a role of precursor for long chain fatty acids [22]. This fatty acid is present in quantities of 1.54 g/100 g oil in grape pomace, while in tomato pomace the concentration is higher (2.30

g/100g oil). According to Lazos et al., 1998 [15] tomato pomace is a good source of fatty acids: linoleic, oleic, and palmitic acids present in different ratios, dependant of tomato varieties producing the pomace, the degree of ripeness, and climate conditions during cultivation.

The values of different groups of fatty acids present in the grape and tomato pomace are demonstrated in Table 1. The ANOVA for different groups of fatty acids highlighted significant differences among the two pomaces (grape and tomato) types. The total amount of saturated fatty acids (SFA) in our grape pomace was 14.78% in comparison to 21.97% in tomato pomace.

Table 1. Total groups of fatty acids (%) present in grape and tomato pomace

	Grape pomace	Tomato pomace
Saturated fatty acids (SFA)	$14.78^{e}\pm0.01$	$21.97^{c}\pm0.02$
Monounsaturated fatty acids (MUFA)	$15.38^{d}\pm0.01$	$22.00^{c}\pm0.02$
Polyunsaturated fatty acid (PUFA)	$68.81^{a}\pm0.07$	$55.02^{a}\pm0.05$
Conjugated linoleic acid (CLA)	$0.22^{h}\pm0.00$	$0.15^{g}\pm0.00$
ΣΩ-3 fatty acid	$1.77^{g}\pm0.00$	$2.95^{f}\pm0.00$
ΣΩ-6 fatty acid	$66.84^{b}\pm0.06$	$51.92^{b}\pm0.05$
Σn-6/Σn-3	$37.78^{c}\pm0.01$	$17.58^{e}\pm0.00$
Cis isomers of oleic acid	$14.36^{f}\pm0.01$	$21.02^{d}\pm0.02$

The means are calculated from three repetitions. Values in the same row with different letters are significantly different (p<0.05) following Fisher`s LSD test.

Source: Own results.

Fernandes et al., 2013 [9] determined 14.94% SFA in the seeds of the grape variety Tinta Barroca that is in accordance with our results. In addition, Aksoylu Özbek et al., 2020 [2] discovered 18.06% SFA in tomato pomace acquired from tomatoes cold pressing and their subsequent drying. The quantity of monounsaturated fatty acids (MUFA) in GP was 15.38% and in TP was 22.00%.

In the study of Aksoylu Özbek et al., 2020 [2] the fraction of monounsaturated fatty acids (MUFA) in tomato pomace was 28.84%, while the same fraction was reported in quantities in the range of 14.19 - 21.29% by Fernandes et al., 2013 [8]. These literature data are in accordance with our findings. The amount of monounsaturated fatty acid (MUFA) in grape and tomato pomace was estimated as 15.38% and 22.00%, respectively. In the study of Fernandes et al., 2013 [8] the content of PUFA fraction evaluated in the seeds of different grape varieties was in the range of 63.64% to 73.53% which was significantly higher than our results. In contrast to our results, Aksoylu Özbek et al., 2020 [2] reported 53.10% PUFA in tomato pomace. The occurrence of conjugated linoleic acid (CLA) was determined in grape pomace (0.22%) and in tomato pomace (0.15%). It is assumed that CLA has positive effects on cardio metabolic risk factors, while its positive impact on glycemic index, arteriosclerosis and cancer are already proven with experimental methods [16]. Modern lifestyle differs from what human genetic structure is created. The studies show enormous changes in the nutrition, especially in the type and quantity uptake of essential fatty acids and antioxidants from food [16]. ω-3 and ω-6 are essential fatty acids likewise found in food waste. The total amount of ω-3 fatty acid in GP was 1.77%, while its content in TP was 2.95%. In addition, the quantity of ω-6 fatty acids in GP and TP was found to be 66.84% and 51.92%, respectively. The ratio between essential fatty acids in GP and TP was 37.8/1 and 17.6/1, respectively. Today's human nutrition evolved from nutrition in which ω-6/ω-3 ratio was approximately 1 to a nutrition with ω-6/ω-3 ratio in the range of 15/1 and 16/1. The agribusiness and modern agriculture promote the reduction of ω-3 fatty acids and increase of ω-6 fatty acids. All this causes imbalance of the characteristic food from the past [16]. Cis isomers of oleic acid in grape and tomato pomace was 14.36% and 21.02% respectively.

CONCLUSIONS

Grape and tomato pomace are by-products from the food industry, which have large quantities of biologically active compounds (polyphenols, dietary fibers, vitamins) in their content. They also contain big quantities of fatty acids due to the presence of the fruit seeds in both types of pomace. From the fatty acid profile of both pomaces, it can be concluded that GP is richer in linoleic acid and ω-6 fatty acid in comparison to TP. On the other hand, TP has a higher content of palmitic, stearic, oleic and ω-3 fatty acids then GP. When the comparison is in terms of different groups of fatty acids, grape pomace has more PUFA and CLA in its content than tomato pomace. The latter is richer in SFA, MUFA and cis isomers of oleic acid.

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RESULTS ON THE INFLUENCE OF PLANTING DISTANCE AND MEASUREMENT DATE, ON SPAD VALUES IN *PRIMULA OFFICINALIS* HILL. SPECIES

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Abstract

The aim of this research was to measure the amount of chlorophyll leaf content of the Primula officinalis Hill. Species during the vegetation period. Evaluations were made using the chlorophyll meter SPAD 502 (Chlorophyll Meter SPAD 502), with three determinations in dynamics. At each variant repetition / row, three uniform plants in size were analyzed, with each plant performing three readings on three different leaves, resulting a total number of 729 readings and 243 analyzed plants on the occasion of each determination. The SPAD 502 measuring device allows quick and easy measurement of leaf chlorophyll concentrations, without damaging the analyzed plant leaf. The amount of chlorophyll in a plant shows how healthy that plant is. Estimating the concentration of chlorophyll leaf content in real time can be used to determine the optimal period of administration of nutritional supplements as well as their quantity, thus ensuring higher quality yields. Chlorophyll Meter SPAD 502 measuring device is used to determine the plants' vegetation period and at the same time, based on the obtained results, the optimal harvesting time can be determined.

Key words*: *Chlorophyll Meter SPAD 502, Primula officinalis Hill

INTRODUCTION

This paper aims to study some physiological plant aspects, to determine the concentration of chlorophyll in the leaves of *Primula officinalis* Hill., during vegetation period, using the Chlorophyll Meter SPAD 502 device.

According to Richards [11], the genus *Primula* has its genetic centers, mainly in the temperate or subalpine areas of the northern hemisphere, with the main center of species diversity in the Sino-Himalayan region and secondarily in the large mountain ranges of the Circumboreal region.

Primula is the largest genus of Fam. *Primulaceae*, and the heterogeneity of morphological and cytological characters has led different authors to conclude that many, if not most of the remaining genera, are derived members of it [10].

From a taxonomic point of view, species *Primula officinalis* Hill. is classified as follows: Kingdom: *Plantae*; Subregnum: *Viridiplantae*; Order: *Primulales*; Family: *Primulaceae;* Genus: *Primula*; Species: *Primula officinalis* Hill. or *Primula veris* L. [15].

Genetically, *Primula officinalis* Hill. $2_n = 22$.

Phylogenetically, framed in *Querco-Fagetea, Arrhenatheretea* [7], [2].

Primula officinalis Hill. ("cowslip" or "cowslip primrose" in popular language) is a well-known endemic plant, it grows spontaneously in Romania, on poor, calcareous soils, with southern exposure, at a certain altitude. Being an endangered species, due to irrational harvesting, it is necessary to cultivate it in areas of natural plant growth [9].

main morphological characteristics and active substances in the vegetative and generative organs of the species *Primula officinalis* Hill.: the root is a cylindrical rhizome 10-15 cm long, 0.5 cm thick, thin, white-yellow, contains 5-10% triperpenic saponins (primrose, primic acid A and other saponins), heterosides (primveroside, primulavezoride), volatile oil (0.1-0.25%), starchy substances, enzymes, etc.; the stem is cylindrical, 15-30 cm height, erect, hairy, without leaves, finished with inflorescence; the leaves are arranged in a basal rosette, are ovate, with a crenate or wavy edge, 12-15 cm long and 5 cm wide, with prominent ribs on the underside, green on the upper side and gray-green on the underside, contain ascorbic acid (vitamin C), beta-carotene, etc.; the inflorescences are arranged in umbels, 6-18 at a time, on type 5, persistent calyx, gamopetal corolla, golden-yellow, contain saponins and flavones; the fruits are denticulated capsules, with a length of 6-10 mm, have a persistent calyx [14], [7].

In Romania, *Primula officinalis* is found in hilly forested areas, on pastures and alpine meadows, up to almost 2,300-2,400 meters height, according to chronological map attached below (Fig.1), regarding the presence of *Primula officinalis* Hill. Species in our country [13].

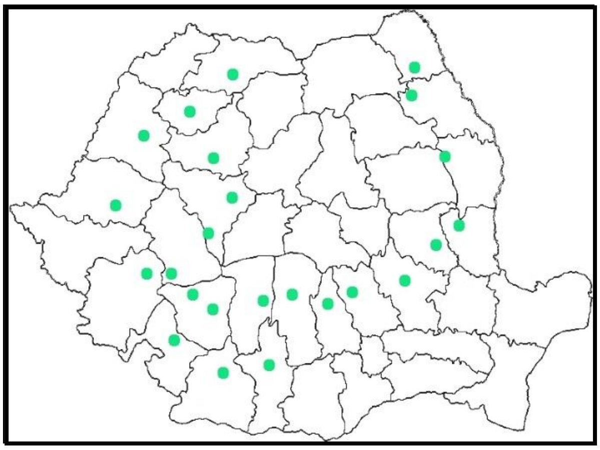

Fig. 1. Chronological map of *Primula officinalis* Hill. Species on the territory of our country
Source: [13].

The SPAD-502 chlorophyll meter is a portable, nondestructive, lightweight device designed to estimate foliar chlorophyll [12].

This meter records optical density measurements at two wavelengths, converts them into digital signals, and then into a SPAD value [4].

Chlorophyll meters have been used to estimate leaf chlorophyll content, and therefore nitrogen (n) status and fertilization requirements for several crops. A field study was conducted in 1995 and 1996 to evaluate the potential of chlorophyll (SPAD) meter readings to determine switchgrass n concentration and herbage yield. Meter readings were taken on the top most fully expanded leaves of switchgrass grown on a free draining sandy clay [6].

Recent studies have demonstrated the use of a hand-held chlorophyll meter (SPAD 502 meter, Minolta Corp, NJ) for evaluation of N sufficiency or management strategies. This technique is based on the fact that leaf chloroplasts contain 70% of leaf N and, as a result, chlorophyll content is well correlated with N content [16].

The SPAD-502 chlorophyll meter is a portable, nondestructive, light-weight device designed to estimate foliar chlorophyll [12].

The chlorophyll meter SPAD-502 is for simple, rapid and non destructive estimation of chlorophyll content in tomato leaves [3]. Studies of Madakadze et al. [6], showed that the relationship between N concentration and SPAD readings was linear (r^2=0.62–0.93; $p<0.01$) for the cut systems. Except for the 1st cut under the 4 week harvest regime, there were positive correlations between dry matter yield and SPAD meter readings (r^2=0.58–0.96; $p<0.01$). These results indicate that SPAD meter readings can be used to measure N concentration and/or monitor N availability for seed production, and when N is the limiting factor, to estimate yield of switchgrass (*Panicum virgatum* L.)

MATERIALS AND METHODS

In order to highlight the biological aspects of the plant, the aim was to determine the concentration of chlorophyll in the leaves of *Primula officinalis* Hill. synonymous with *Primula veris* L., where non-invasive measurements were made using the portable device Chlorophyll Meter SPAD 502.

The researches were carried out at The National Institute of Research and Development for Potato and Sugar Beet

Brașov, Technology and Good Practices in Agriculture Department, Laboratory of Medicinal and Aromatic Plants. The biological material, on which the researches were made, was brought in the spring of 2016 from the spontaneous flora of Brașov County; this study focused on aspects of biology and technology regarding the introduction into the culture of the species *Primula officinalis* Hill. being part of the author's doctoral thesis.

The experiment was bifactorial, set according to the model of randomized blocks, in three repetitions, being established by seedling in the fall of 2016, with the aim of determining the optimal nutrition space for the species *Primula officinalis* Hill.

Factor A – distance between rows with the following graduations: 25 cm, 50 cm, 75 cm;

Factor B – distance between plants per row, with the following graduations: 10 cm, 25 cm, 50 cm;

Interaction with 10/25 density is considered the Control of this research.

Experimental device: the surface of the plots from the factor a_1 = 4.5 m^2; the surface of the plots in factor a_2 = 9 m^2; the surface of the plots in factot a_3 = 13.5 m^2; total experimental surface including paths (27 m^2 * 3 + 13.5 m^2 * 2) = 108 m^2; number of plants on plots - b_1; (2 m/10 cm) = 20 * 9 = 180 * 3 = 540; number of plants on plots - b_2; (2 m/25 cm) = 8 * 9 = 72 * 3 = 216; number of plants on plots - b_3; (2m / 50 cm) = 4 * 9 = 36 * 3 = 108; total number of plants per experiment: 540 + 216 + 108 = 864 [8].

SPAD-502 PLUS Chlorophyll Meter can measure relative content of chlorophyll, non-destructive to leaves. Measured datum will be displayed in trend graph. It can be used to enhance the utilization rate of nitrogen fertilizer [1].

Chlorophyll content is an indicator of plant health and can be useful to optimize the time and amount of application of additional fertilizers, ensuring higher crop yields and superior quality. It is an easy-to-use device, being at the same time very useful to food industry because it can be used both by farmers during harvest, for determing the optimal time for harvesting, but it can also be used in cold warehouses, to determine the state of vegetables and fruits' full growth. SPAD 502 Plus measuring device quantifies subtle changes or new prospects in plant health long before they are visible to the human eye.

The device has a high level of precision: for values between 0-49, 0 error; for values between 50-99, errors less than 0.1 [5].

Advantages of using the Chlorophyll Meter SPAD-502: non - invasive method; the measurement is done in real time (less than 2 seconds); the measuring area is very small, 2 mm x 3 mm, which allows the analysis of small leaves, and the thickness of the leaves can have dimensions up to 1.2 mm; it is water resistant and can be used in adverse weather conditions. SPAD value: the relative chlorophyll content index indicated by the device has values between -9.9 and 199.9 [5].

Working method: turn on the device and calibrate by holding the two flaps between which the leaf is to be inserted in contact, until the value 0 is indicated; the leaf is inserted in locations intended for these, between the two flaps, so that this also completely covers the measuring window; press with your finger to close the measuring end, holding it closed until you hear a sound, when the result is displayed on the screen and stored automatically [5].

Measurement principle: The measured values with the SPAD 502 Plus Chlorophyll Meter correspond to the amount of chlorophyll present in the leaf. They are calculated based on the amount of light transmitted by the leaf in the two wavelengths, in which the absorption is different. The leds in the lighting system emit red and infrared waves. The light passes through the sample and passes through the receiver, which transmits the light into analog electrical signals. These signals are then amplified and converted to digital signals by the A / D converter [5].

RESULTS AND DISCUSSIONS

Three determinations in dinamics were made, using the SPAD 502 Chlorophyll Meter. At each variant/ repetition/ row three uniform plants were analyzed, three readings on three different leaves were made, resulting in a total of 729 readings and 243 analized plants on each measurement.

The SPAD 502 Device was calibrated before use by pressing the measuring head, after which the actual reading was performed by inserting the leaf into the measuring area. The values were read approximately two seconds after closing the measuring cap.

The choice of leaves for reading was made following a visual control on all leaves/ plants, choosing three plants from each variant/repetition/row.

Results on SPAD values were statistically processed by analyzing the variance and interpreted by the "t" test for the user significance thresholds p 5%, p 1% and p 0.1%.

Assessing the measurement date on SPAD values (Table 1) from *Primula officinalis* Hill. leaves in 2018, there is a slight decrease in the values measured on 03.05.2018 by 0.17 units compared to the first measurement considered as a control; the measurements made on 11.05.2018 indicate an average value of 45.73, distinctly significantly positive, with a difference of 2.48 from the control.

Table 1. The influence of measurement date on SPAD values in *Primula officinalis* Hill. leaves experimental year 2018

No.	Date	SPAD average values	Value (%)	Difference	Signif.
1	25.04.2018	43.26	100.0	0.00	MT
2	03.05.2018	43.04	99.6	-0.17	-
3	11.05.2018	45.73	105.7	2.48	**
DL 5%				1.47	
DL 1%				2.43	
DL 0.1%				4.54	

Source: own calculation.

Table 2. The influence of measurement date on SPAD values in *Primula officinalis* Hill. leaves experimental year 2019

No.	Date	SPAD average values	Value (%)	Difference	Signif.
1	25.04.2019	35.92	100.0	0.00	Mt.
2	13.05.2019	40.69	113.3	4.77	*
3	20.05.2019	42.98	119.6	7.06	**
DL 5%				3.16	
DL 1%				5.23	
DL 0.1%				9.80	

Source: own calculation.

In 2019, SPAD values gradually increased, at the same time with the senescence of the plants, the highest SPAD value (42.98) being registered on 20.05.2019, distinctly significant compared to the control variant (Table 2).

SPAD values showed a great state of plant health, falling within the parameters at which the measuring device has 0 error.

Studying the influence of planting distance on SPAD values in *Primula officinalis* Hill. leaves, can be observed the fact that measured values increase both in the variants planted at a distance between rows of 50 cm and in those planted at 75 cm, with very significant values compared to the control variants, planted at a distance of 25 cm between rows (Table 3).

Table 3. The influence of planting distance on SPAD values in *Primula officinalis* Hill. leaves experimental year 2018

No.	Distance between rows	SPAD average values	Relative value(%)	Difference	Signif.
1	25	41.51	100.0	0.00	MT
2	50	46.43	111.9	4.92	***
3	75	44.13	106.3	2.62	***
DL (p 5%)				1.15	
DL (p 1%)				1.61	
DL (p 0.1%)				2.28	

Source: own calculation.

The influence of planting distance (Table 4) on SPAD values, in 2019, registered a vegetation state of the plants with very significant differences at planting distances of 75 cm between rows, reaching an average of 3.37 units higher values than the 25 cm between rows variant

Table 4. The influence of planting distance on SPAD values in *Primula officinalis* Hill. leaves experimental year 2019

No.	Distance between rows	SPAD average values	Relative value(%)	Difference	Signif.
1	25	38.53	100.0	0.00	Mt.
2	50	39.16	101.6	0.62	-
3	75	41.90	108.7	3.37	***
DL (p 5%)				1.64	
DL (p 1%)				2.30	
DL (p 0.1%)				3.25	

Source: own calculation.

From the data in Table 5, where results of interaction between planting distance and SPAD measurement fom 2018 were presented, resulted that planting distance of 50 cm between rows had the highest values, regardless of the measurement date, with very significant values, compared to the control planted at a distance of 25 cm between rows.

Table 5. Interaction between planting distance and SPAD measurement date in *Primula officinalis* experimental year 2018

No.	Planting distance (cm)	Date of measurement	SPAD average values	Relative value (%)	Differ. ±	Signif.
1	25	25.04.2018	40.93	100.0	0.00	MT
2	50		45.43	111.0	4.50	***
3	75		43.40	106.0	2.47	*
4	25	03.05.2018	41.37	100.0	0.00	MT
5	50		45.23	111.3	3.87	***
6	75		42.67	103.1	1.30	-
7	25	11.05.2018	42.23	100.0	0.00	MT
8	50		48.63	115.2	6.40	***
9	75		46.33	109.7	4.10	***

DL (p 5%) 1.99
DL (p 1%) 2.80
DL (p 0.1%) 3.95

Source: own calculation.

In 2019, the results of the interaction between planting distance and the date of SPAD measurements were significant at both planting distances: 50 and 75 cm (Table 6).

Table 6. Interaction between planting distance and SPAD measurement date in *Primula officinalis* experimental year 2019

No	Planting distance (cm)	Date of measurement	SPAD average values	Relative value (%)	Difference±	Signif.
1	25	25.04.2019	35.50	100.0	0.00	MT
2	50		33.07	93.1	-2.43	-
3	75		39.20	110.4	3.70	*
4	25	13.05.2019	39.13	100.0	0.00	MT
5	50		40.20	102.7	1.07	-
6	75		42.73	109.2	3.60	*
7	25	20.05.2019	40.97	100.0	0.00	MT
8	50		44.20	107.9	3.23	*
9	75		43.77	106.8	2.80	-

DL (p 5%) 2.84
DL (p 1%) 3.98
DL (p 0.1%) 5.63

Source: own calculation.

The following conclusions can be drawn from the table of comparisons of the interaction between the SPAD measurement date and the planting distance: in the case of variants planted at 25 cm between rows, the differences are insignificant for both analyzed data; the variants with graduations of 50 cm between rows present insignificant values on 03.05.2018 and significant values on 11.05.2018; the same meanings are registered in the case of the variants with 75 cm between rows, compared to the control variant analyzed on 25.04.2018 (Table 7).

Table 7. Interaction between SPAD measurement date and planting distance to *Primula officinalis* experimental year 2018

No.	Date	Distance between rows	Average SPAD	Values (%)	Differ. ±	Signif
1	25.04.2018	25cm	40.93	100.0	0.00	MT
2	03.05.2018		41.37	101.1	0.43	-
3	11.05.2018		42.23	103.2	1.30	-
4	25.04.2018	50cm	45.43	100.0	0.00	MT
5	03.05.2018		45.23	99.6	-0.20	-
6	11.05.2018		48.63	103.1	2.93	*
7	25.04.2018	75cm	43.40	100.0	0.00	MT
8	03.05.2018		42.67	98.3	-0.73	-
9	11.05.2018		46.33	106.8	2.93	*

DL (p 5%) 2.17
DL (p 1%) 3.26
DL (p 0.1%) 5.25

Source: own calculation.

Comparing the interaction between measurement date of SPAD values and the planting distance in 2019, it is found that on 20.05.2019 all planting variants registered significant differences in planting distances of 25 and 75 cm between rows and very significant in the variant planted at 50 cm between rows (Table 8).

In conclusion, the distance of 50 cm and 75 cm between plants, gives them an optimal space for photosynthesis and the ability to show their true productive potential.

Table 8. Interaction between SPAD measurement date and planting distance in *Primula officinalis* experimental year 2019

No.	Date	Distance between rows	Average SPAD	Values (%)	Differ. ±	Signif.
1	25.04.2019	25cm	35.50	100.0	0.00	MT
	13.05.2019		39.13	110.2	3.63	-
3	20.05.2019		40.97	115.4	5.47	*
4	25.04.2019	50cm	33.07	100.0	0.00	MT
5	13.05.2019		40.20	121.6	7.13	**
6	20.05.2019		44.20	133.7	11.13	***
7	25.04.2019	75cm	39.20	100.0	0.00	MT
8	13.05.2019		42.73	109.0	3.53	-
9	20.05.2019		43.77	111.6	4.57	*

DL (p 5%) 3.89
DL (p 1%) 6.05
DL (p 0.1%) 10.29

Source: own calculation.

CONCLUSIONS

The influence of the measurement date on the SPAD values on the leaves of *Primula officinalis* Hill., in 2018, registers a slight decrease of the values measured on 03.05.2018 by 0.17 units compared to the first measurement, considered as a control (25.04.2018); the measurements made on

11.05.2018 indicate an average value of 45.73, this being distinctly significantly positive, with a difference of 2.48 compared to the control. In 2019, the SPAD values increased gradually, with the plants' strength, the highest SPAD value (42.98) being registered on 20.05.2019.

The results of the interaction between planting distance and SPAD measurement date in 2018 show that the variants planted at a distance of 50 cm between rows at the highest values, regardless of measurement date, with very significant values compared to the control planted at 25 cm between rows. In 2019, the results of the interactions between the planting distance and the data of the SPAD measurements were significant at both planting distances (50 and 75 cm).

SPAD measurements on the leaves of Primula officinalis Hill, with high values in the variants whose distance between rows was 50 cm, show a good health of the plants and recommend this planting distance.

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ANALYSIS OF MARKET INTEGRATION OF NIGERIAN TOMATO MARKETS

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Abstract

Poor market integration affects market liberalization and handling of shocks such as covid-19. This study, therefore, investigates the market integration of tomato and its determinants in Nigeria. Johansen co-integration techniques, autoregressive distributed lag, the error correction model, bootstrapping regression and granger causality test were used to achieve the objectives of the study. The results revealed that most tomato markets in Nigeria were not integrated. This shows that tomato prices in most markets in different regions of Nigeria were not well integrated which could affect the transmission of price. From the Granger causality test results, ten tomato producing states Granger caused the demanding states, while only two demanding states granger caused the producing states. The adjustment term (-0.849924) shows that the reversion to long-run equilibrium is at an adjustment speed of 84.9924%. Distance, population and self-sufficiency had a negative influence on tomato market integration while the telephone had a positive influence on tomato market integration. Thus, the distance between two markets, population and self-sufficiency inhibits the flow and transmission of price information among tomato markets across the country which, in turn, lower market integration. The presence of telephone in Nigerian markets enhanced the flow of price information from one market to others and consequently increase market integration. These findings call for upgrading and investing in infrastructure, such as roads, and regulating information and telephone services by the government.

Key words*: tomato market, market integration, determinants, Nigeria, price transmission*

INTRODUCTION

Achieving efficient market integration is a veritable means to facilitate price stability, stimulate production and ensure food availability. The ability of markets to keep a stable price and make food available depends on whether markets are integrated [20]. Market integration is a condition in which commodity prices in multiple marketplaces move in lockstep, allowing for smooth price transmission [24]. It is the process through which interdependence between prices takes place and changes in commodity price in one market affect other markets. Market integration is regarded as a significant driver of price stability, food supply, accessibility and availability [5]. A responsive, integrated and efficient market mechanism is vital to maximizing the resource area in agriculture and encouraging farmers to increase their production [5].

Across African countries, most agricultural markets are inefficient and not well integrated, particularly in Nigeria, the performance of agricultural marketing is weak [2, 21, 22]. Poor marketing system and function lead to several setbacks in agricultural production, causes price fluctuation and forced farmers to sell at any available price due to the perishable nature of the agricultural products which posed them to risk [18]. Thus, integration of agricultural markets is important in developing nations, which mostly relied on primary goods from the agricultural sector for the smooth running of their economy. Achieving market integration and price stability is very critical for vegetable crops because of their perishable nature and the need to have an efficient marketing system to reduce wastage. This is particularly important for tomato in which about 45% of fresh tomato produced annually was lost in 2017 [26]. In fact, a significant portion of the income of tomato farmers in Nigeria has been lost due to wastage [23].

Poor market integration poses a threat to the agricultural marketing system in Nigeria. For instance, poor tomato market integration is affecting market liberalization and handling of shocks such as flood and COVID-19. An inefficient agricultural marketing system limits agricultural expansion [8]. It also results in poor price transmission and fluctuation in tomato prices. The poor marketing system of tomato increases the extent of post-harvest loss and further spoilage of the crop due to its perishable nature which requires an immediate and efficient agricultural marketing system. This is evidenced as Abimbola [1] found that the gross margin of tomato farmers decreased from 80% to 17% due to post-harvest losses.

There is a need to improve the tomato marketing system, which plays a significant role in households in developing nations, to ensure market integration and stability in tomato price to improve the wellbeing of both producers and marketers in Nigeria. If tomato price is synchronized across Nigeria, it will boost production by encouraging farmers to produce at a large scale all year round. This will further ensure that supply meets up with demand and tomato spoilage will be reduced.

Given the importance of tomato crop and the effect of market integration in stimulating production, efficient marketing and income to farmers, and also to facilitate government policy interventions, there is a need to understand the extent and causes of tomato market integration.

Previous studies on integration of agricultural commodities markets concentrated on cereal, roots and tuber crops [3, 11, 12, 15, 20, 24, 25, 29]. While vegetable crops such as tomato which provide income to many households, serve as means of livelihood in developing nations received less attention, especially in the area of market integration. The available studies [6, 27, 28] only investigate the level of tomato market integration without identifying the factors responsible for the degree of tomato market integration. The studies by Shrestha *et al.* [28] and Baiyegunhi *et al*. [6] covered a few markets and were not conducted in Nigeria. In addition, Baiyegunhi *et al.* [6] used the Augmented Engle-Granger test to test for cointegration in the markets. However, the Augmented Engle-Granger test was considered inferior to the Johansen cointegration test which was adopted in this study. This is because the Johansen cointegration test does not assume apriori that a single vector for co-integration exists but rather measures the number of vectors for co-integration [4]. The present study intended to add to existing literature and fill the gap by identifying the factors inhibiting or enhancing the tomato market integration in Nigeria.

Therefore, this study was poised to examine the market integration of tomato markets in Nigeria. Specifically, the study determines the extent of market integration between different spatial tomato markets; examine the direction of causality of price between the supply and demand states; measure the speed of tomato price adjustment process to the long-term multipliers; and identify the factors which inhibit or enhance tomato market integration in Nigeria.

MATERIALS AND METHODS

The study area is Nigeria. The country has a total land area of 923,768 km^2. Nigeria is an agrarian nation endowed with rich natural resources, suitable weather conditions for agricultural production [17]. Agriculture contributes greatly to Nigeria economy and employs about 70 per cent of the workforce [19]. One of the major vegetable crops produced in Nigeria is tomato [3]. Nigeria is the largest tomato producer in sub-Sahara Africa, 2nd in Africa and 11th in the world, [10]. Tomatoes are mostly farmed in the northern portion of the country and are widely distributed throughout the country. To have a good representation and considering the fact that tomato is marketed and consumed across the country, all the six geopolitical zones in Nigeria were used for this study. Twelve states and the Federal Capital Territory, Abuja, were used for the study.

Secondary data was used in this investigation. Data on monthly tomato price per kilogram in various states from 2016 to 2020 were

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sourced from the National Bureau of Statistics (NBS). This was long enough to measure the market integration as it gives sixty data points or observations. This is, however, considered a large sample and acceptable to conduct research on market integration [6]. Data on other variables were also sourced from NBS.

Data Analysis Techniques

The data for this study were analysed with Augmented Dickey-Fuller model, Johansen co-integration techniques, bivariate Granger causality test, the error correction model (ECM) and the bootstrapping regression model.

Augmented Dickey-Fuller (ADF) Model

Before proceeding with analysing any time series data there is a need to check for the stationarity level of the series to adopt the appropriate model in a view to avoid spurious regression [16]. This would allow understanding the behaviour, nature and order of integration of the series [16]. To test for the unit root properties of the variables ADF test was employed.

This is specified as:

$$\Delta\gamma_t = X_t\,\beta + \delta\gamma_{t-1} + \alpha_i \sum_{i=1}^{p} \Delta\gamma_{t-i} + \varepsilon_t$$

....(1)

where:

Δ = difference operator

γ_t= vector of the n variables (the price of tomatoes from different markets)

X_t= are optional exogenous regressors

β= coefficients

$\sum$ = summation

ρ = number of lags

ε_t= error term

Johansen Cointegration Test

In examining the market integration, the Johansen cointegration test has gained wide recognition and usage. The Johansen Cointegration test was used in this study to examine if tomato markets in spatial locations are integrated. It was, however, used for variables with the same integration order. It is specified as:

$$\Delta У_t = \Pi У_{t-1} + \sum_{t=1}^{p-1} \Gamma_i\,\Delta У_{t-i} + Bx_t + \mathcal{E}_t$$

....(2)

where:

$\Delta У_t$= first difference of an (*n* x *i*) vector of the *n* variables of interest (tomato price).

Π= (*n* x *n*) Coefficient matrix associated with lagged values of the endogenous dependent variable, which has a reduced rank of r<k.

$\Pi У_{t-1}$= lagged values of Y_t

Γ = Matrix of short-term coefficients (n x (k – 1))

Bx_t = Cointegrating vector (n x 1)

$\mathcal{E}_t$ = Vector of white noise residuals (n x 1)

Both the maximum-eigenvalue and trace test statistics from the Johansen cointegration test will be employed.

Autoregressive Distributed Lag (ARDL) Bound Test

The ARDL bound test was used to examine if tomato markets in spatial locations are integrated among variables of a different order of integration. it is specified as:

$$\Delta M_{it} = \alpha_1 + \textstyle\sum_{i=1}^{p} \beta_i\,\Delta M_{i(t-1)} + \sum_{i=1}^{p} \gamma_i\,\Delta M_{j(t-1)} + \varepsilon_{1t}$$

$$\Delta M_{jt} = \alpha_2 + \textstyle\sum_{i=1}^{p} \pi_i\,\Delta M_{i(t-1)} + \sum_{i=1}^{p} \rho_i\,\Delta M_{j(t-1)} + \varepsilon_{2t}$$

....(3)

where:

Δ= difference operator which denotes a k x 1 vector of cointegrated variables (tomato prices in different markets) of order 1.

$M_{i(t-1)}$ = lagged tomato price in the market i.

$M_{j(t-1)}$ = lagged tomato price in market j.

M_{t-1} = lagged tomato price in different markets.

$\varepsilon_{1t}$and ε_{2t} =Error term

Granger Causality Test

Granger causality test proposed by Granger in 1969 is used to examine the causal relationships and direction of causality between variables [16]. To explore the causality between the price of tomatoes in the market *i* and market *j*, the bivariate Granger casualty test was used. Here, the average price of tomato in the major tomato producing states and the average price in low producing states were used. This is to identify the direction of causality among the supply and demand states. The major producing states were used as the supply states while low producing states were used as demand states. The Granger casualty between the price of tomato in spatially located markets (demand and supply states) is specified as:

$$\Delta lnPR_t = \alpha_1 + \sum_{i=1}^{n} \beta_i \, \Delta lnPR_{t-i} + \sum_{i=1}^{m} \delta_j \, \Delta lnPU_{t-j} + r_1 (EC_1)_{t-1} + \varepsilon_t$$

$$\Delta lnPU_t = \alpha_2 + \sum_{i=1}^{n} c_i \, \Delta lnPU_{t-i} + \sum_{i=1}^{m} g_j \, \Delta lnPR_{t-j} + r_2 (EC_2)_{t-1} + \mu_t$$

....(4)

where:

Δ = first difference operator

PR_t = monthly tomato price in the supply market (major producing state)

PU_t = monthly tomato price in the demanding state (low producing state)

ln = natural logarithm transformation

α_1 and α_2 = intercept

β_i, δ_i, g_i, and c_i = coefficient

$\mathcal{E}_t$ and μ_t = error term

n and *m* = numbers of lag lengths

$(EC_1)_{t-1}$ and $(EC_2)_{t-1}$ = error correction terms.

If δ_j is significant but g_j is not, it means that a unidirectional causality exists from the supply market (major producing states) to demand markets (low producing states). Conversely, if only g_j is significant, a unidirectional causality exists from demand market to supply markets. If both δ_j and g_j are significant, there is a bidirectional causality implying that supply markets Granger cause demand markets and vice versa. If both coefficients are not significant, there is no causality running from any of the markets to the other.

Error Correction Model

The ECM was used in measuring the speed of price transmission and adjustment to long-run multiplier or equilibrium. It is specified as:

$$\Delta M_{it} = \alpha_1 + \sum_{i=1}^{p} \beta_i \, \Delta M_{i(t-1)} + \sum_{i=1}^{p} \gamma_i \, \Delta M_{j(t-1)} + \varphi_1 \mu_{t-i} + \varepsilon_{1t}$$

$$\Delta M_{jt} = \alpha_2 + \sum_{i=1}^{p} \pi_i \, \Delta M_{i(t-1)} + \sum_{i=1}^{p} \rho_i \, \Delta M_{j(t-1)} + \varphi_2 \mu_{t-i} + \varepsilon_{2t}$$

....(5)

where:

Δ= difference operator which denotes a k x 1 vector of cointegrated variables (tomato prices in different markets) of order 1.

$M_{i(t-1)}$ = lagged tomato price in the market i.

$M_{j(t-1)}$ = lagged tomato price in market j.

M_{t-1} = lagged tomato price in different markets.

μ_{t-i} = error correction term.

φ_i and φ_j = adjustment speed.

ε_{1t} and ε_{2t} =Error term

Bootstrapped Regression Model

To identify the determinants of tomato market integration, the trace statistics result from the Johansen cointegration analysis for each possible pair of the markets were regressed against some explanatory variables. Considering the fact that the cointegration test statistics which was used as regressand was generated and follows a non-normal (non-standard) distribution. The ordinary least square (OLS) cannot be directly used because the OLS estimator is not normally distributed [13, 14]. To deal with the violations of normality (by OLS) and derive useful parameter estimates, bootstrapping which is a distribution-free method introduced by Efron [9] and used by Goodwin and Schroeder [13] and Ismet et al. [14] was adopted in this study to identify the determinants of tomato market integration. It is specified as:

$$TMI = \beta_0 + \beta_1 Trancost_{1i} + \beta_2 Tele_{2i} + \beta_3 Dist_{3i} + \beta_4 Cont_{4i} + \beta_5 Pop_{5i} + \beta_6 Self_{6i} + \varepsilon_i$$

....(6)

where:

TMI is the tomato market integration

Trancost is the transportation cost. This measures the level of infrastructural facilities such as a good road network, a low transport suggests a good transportation network while a high transportation cost suggests a poor transportation network.

Tele is the telephone density. It is a proxy for the availability of information.

Dist is the distance from one market (state) to the other.

Cont is the contiguity (1 if the state shares a border, 0 if not). This will measure the additional costs involved in tomato marketing cost.

Pop is the population (number of people living in the state).
Self is self-sufficient in tomato (1 if a major tomato producer, 0 otherwise). This measures the level of tomato production in terms of meeting the state demands.
β_0= constant
ε_i = Stochastic error term

RESULTS AND DISCUSSIONS

The unit root property of tomato prices across spatially separated markets in Nigeria were presented in Table 1. The results revealed that tomato prices in Bauchi, Benue, Sokoto, Kaduna, Lagos and Ondo states were not stationary in the level form. They, however, became stationary after the first difference. This means that the variables are order one. While tomato prices in Taraba, Plateau, Enugu, Anambra, Rivers, Cross River states and Abuja (FCT) were stationary at level form. This implies that these variables are order zero.

Table 1. Unit root property of tomato price

Variables	Level	First Difference
Bauchi	-0.803226 (0.8093)	-5.85478 (0.0000)
Taraba	-2.765427 (0.0695)	8.2863 (0.0000)
Benue	-2.549004 (0.1094)	-7.81098 (0.0000)
Plateau	-2.876504 (0.0542)	-7.865429 (0.0000)
Sokoto	-1.77882 (0.3873)	-8.930966 (0.0000)
Kaduna	-1.61370 (0.4692)	-11.8404 (0.0000)
Lagos	-2.28944 (0.1787)	-10.29302 (0.0000)
Ondo	-2.5269 (0.1144)	-7.52985 (0.0000)
Enugu	-4.8996 (0.0002)	-6.4889 (0.0000)
Anambra	-3.50798 (0.0111)	-7.128149 (0.0000)
Rivers	-2.72809 (0.0754)	-9.45669 (0.0000)
Cross River	-3.61088 (0.0084)	-6.72578 (0.0000)
Abuja	-3.13119 (0.0268)	-9.30195 (0.0000)

Note: *, ** and *** denote rejection of the null hypothesis at 10%, 5% and 1% significant levels respectively based on the Mackinnon critical values. P-values of test statistics are in parenthesis.
Source: Data analysis, 2021.

The extent of market integration between different spatial tomato markets in Nigeria

To examine the tomato market integration in different markets across the country, the Johansen cointegration and bound test of the ARDL were used based on the stationary level of tomato prices (variables) in different states. Table 2 presents the result of Johansen cointegration used for variables of the same order. The Maximal eigenvalue test and the Trace test were both employed to determine whether or not the markets were integrated. If the Maximal eigenvalue test and Trace test statistic were more than the 5% threshold criterion, it indicates integrated markets. Tomato marketplaces in Northwest Nigeria were found to be integrated, according to the findings. This implies that tomato prices in northwest Nigeria will effectively be transmitted within the region and any policy implemented in any part of the region will easily be transmitted across the region (northwest Nigeria). This is because market integration information offers specific evidence of market competition, arbitrage efficacy and pricing efficiency [7]. The markets in Northwest and southwest were integrated. This implies that tomato prices were effectively transmitted between the two regions. Thus, price change in the northwest will affect tomato prices in the southwest. In southwest Nigeria, the tomato markets were not integrated. This means that pricing information and movement within tomato markets in southwest Nigeria is not well transmitted. This is because unintegrated markets will communicate wrong price information that could distort marketing decisions by producers and lead to inefficient product movements [13].

The tomato markets in southeast Nigeria were integrated. This means that tomato prices in southeast Nigeria move in lockstep, and price information and signals are easily communicated through markets. Also, tomato markets in south-south and Southeast were integrated. This means that variations in tomato prices in the southeast and south-south were easily transferred, and that changes in tomato prices in either zone would affect the other. In the south-south, tomato markets were merged. This implies that tomato prices within the zone were well transmitted from one market to the other. Thus, a change in price in one state within the south-south region will cause a change in another market within the zone.

Table 2. Tomato market integration across Nigeria (Johansen cointegration results)

Markets		Trace test		Maximal eigenvalue test	
		Statistic	5% C.V.	Statistic	5% C.V.
North west	None	20.37578**	15.49471	14.11304	14.26460
	At most 1	6.262740**	3.841465	6.262740**	3.841465
North west and south west	None	62.55476**	47.85613	35.40631**	27.58434
	At most 1	27.14844	29.79707	14.91918	21.13162
	At most 2	12.22926	15.49471	10.88151	14.26460
	At most 3	1.347754	3.841465	1.347754	3.841465
South west	None	10.64717	15.49471	9.360369	14.26460
	At most 1	1.286799	3.841465	1.286799	3.841465
South east	None	28.21408**	15.49471	20.63318**	14.26460
	At most 1	7.580898**	3.841465	7.580898**	3.841465
South east and south-south	None	70.80281**	47.85613	33.74730**	27.58434
	At most 1	37.05551**	29.79707	17.43129**	21.13162
	At most 2	19.62422**	15.49471	10.11935**	14.26460
	At most 3	9.504867**	3.841465	9.504867**	3.841465
South-south	None	17.43640**	15.49471	12.08200	14.26460
	At most 1	5.354401**	3.841465	5.354401**	3.841465

Source: Data analysis, 2021.

The results of the ARDL Bound test used for variables (tomato price) of different orders were presented in Table 3. The results revealed that tomato markets in northeast Nigeria were integrated as indicated by F-statistics (11.96239) which was greater than the upper and lower limits at all significant levels. This implies that tomato prices in the Northeast market were well transmitted and change in any market will result in a change in other markets. Meanwhile, the tomato markets in northeast and Northcentral were not integrated as evidenced by the F-statistics (1.004137) which was lower than the lower limits at all significant levels. This implies that tomato prices in the markets within the northeast and northcentral were not well transmitted. Goodwin and Schroeder [13] stated that unintegrated markets will communicate wrong price information that could distort marketing decisions by producers and lead to inefficient product movements. Thus, a change in tomato price in the northeast will not affect tomato price in the northcentral, and vice versa. Tomato markets in northeast and Northwest were integrated as indicated by F-statistics (9.048741) which was greater than the upper and lower limits at all significant levels. This implies that tomato prices in the northeast and northwest move together and price signals are easily transmitted. In addition, the northeast and southwest tomato markets were integrated. This means that signals and information on tomato prices may easily be transferred between marketplaces in the northeast and southwest. The tomato markets in the Northeast and southeast were integrated. This implies that tomato prices in the northeast and southeast were well transmitted among the markets. The tomato markets in northeast and south-south were integrated. This implies that tomato price information and signal in the northeast and south-south were well transmitted.

The tomato markets in northcentral were not integrated as indicated by F-statistics (1.537946) which was lesser than the upper and lower bound limits at all significant levels. This result implies that tomato price signals and information in northcentral markets were not well transmitted. In the same vein, tomato markets in the northcentral and northwest were not integrated. This also implies that tomato price information and signals in northcentral and Northwest markets were not well transmitted. Thus, changes in tomato markets in any of the markets in the two zones did not effectively affect tomato prices in other markets.

Table 3. Tomato market integration across Nigeria (Bound test results)

	Test statistic	Value	Sig. level	I(0)	I(1)
North east	F-Statistics	11.96239	10%	3.02	3.51
	K	1	5%	3.62	4.16
			2.5%	4.18	4.79
			1%	4.94	5.58
North east and North central	F-Statistics	1.004137	10%	2.2	3.09
	K	4	5%	2.56	3.49
			2.5%	2.88	3.87
			1%	3.29	4.37
North east and North west	F-Statistics	9.048741	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North east and south west	F-Statistics	6.687093	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North east and south east	F-Statistics	6.907528	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North east and south-south	F-Statistics	7.574823	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North central	F-Statistics	1.537946	10%	2.63	3.35
	K	2	5%	3.1	3.87
			2.5%	3.55	4.38
			1%	4.13	5
North central and north west	F-Statistics	2.973333	10%	2.2	3.09
	K	4	5%	2.56	3.49
			2.5%	2.88	3.87
			1%	3.29	4.37
North central and south west	F-Statistics	5.088846	10%	2.2	3.09
	K	4	5%	2.56	3.49
			2.5%	2.88	3.87
			1%	3.29	4.37
North central and south east	F-Statistics	1.220422	10%	2.2	3.09
	K	4	5%	2.56	3.49
			2.5%	2.88	3.87
			1%	3.29	4.37
North central and south-south	F-Statistics	1.148590	10%	2.2	3.09
	K	4	5%	2.56	3.49
			2.5%	2.88	3.87
			1%	3.29	4.37

Source: Data analysis, 2021.

The tomato markets in North Central and southwest were integrated as indicated by F-statistics (5.088846) which was greater than the upper and lower limits at all significant levels. This implies that tomato price information and signal in northcentral and southwest were well transmitted and any change in tomato price within the two zones will affect other markets in the same zones. The tomato markets in the northcentral and southeast were not integrated as indicated by F-statistics (1.220422) which was lesser than the upper and lower bound limits at all significant levels. This implies that tomato price information and signal were not well transmitted among markets between north-central and southeast. The tomato markets in northcentral and south-south were also not integrated as indicated by F-statistics (1.148590) which was lesser than the upper and lower bound limits at all significant levels. This implies that tomato markets information and signal were not well transmitted between northcentral and south-south tomato markets. The tomato market in the Northwest and southeast were not integrated as indicated by F-statistics (2.134382) which was lesser than the upper and lower bound limits at all significant levels. This also implies that changes in tomato prices were not well transmitted between the tomato market in the Northwest and the Southeast.

Table 4. Tomato market integration across Nigeria (Bound test results) continued

	Test statistic	Value	Sig. level	I(0)	I(1)
North west and south east	F-Statistics	2.134382	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North west and south-south	F-Statistics	1.628250	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
South west and south east	F-Statistics	2.241119	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
South west and south-south	F-Statistics	1.209207	10%	2.37	3.2
	K	3	5%	2.79	3.67
			2.5%	3.15	4.08
			1%	3.65	4.66
North west	F-Statistics	1.665857	10%	3.02	3.51
	K	1	5%	3.62	4.16
			2.5%	4.18	4.79
			1%	4.94	5.58
North east, North central and north west (supply side)	F-Statistics	6.290346	10%	2.08	3
	K	5	5%	2.39	3.38
			2.5%	2.7	3.73
			1%	3.06	4.15
South west, south east, south-south and FCT (demand side)	F-Statistics	1.656574	10%	1.99	3.153
	K	6	5%	2.27	3.28
			2.5%	2.55	3.61
			1%	2.88	3.99

Source: Data analysis, 2021.

The Northwest and South-South tomato markets were not connected. As a result, tomato prices in the Northwest and South-South were not properly communicated. Furthermore, tomato markets in the geopolitical zones of the Southwest and Southeast were not linked. This suggests that tomato prices in the Northwest and South-South marketplaces were not effectively communicated. The Southwest and South-South tomato markets were not integrated. This indicates that tomato prices were not adequately communicated between the southwest and the south-south. In the northwest, the tomato markets were likewise not integrated. This suggests that the signal and information on tomato pricing in northwest markets were not properly integrated. The tomato markets in the supply states (Northeast, Northcentral and northwest) were integrated. This result implies that tomato price signal and information were well transmitted among markets in the tomato supply states. Changes in the price of tomato in one state were well transmitted to other tomato supply states. This could be because the tomato supply states share the same features such as variable climatic conditions and had a similar cost of production. The tomato markets in the demand states (Southwest, Southeast and south-south) were not integrated as indicated by F-statistics (1.656574) which was less than the upper and lower limits at all significant levels. This result implies that tomato price signals and information were not well transmitted among markets in the tomato demanding states.

The direction of tomato price causality between supply and demand states

From the granger causality test results presented in Table 5, ten tomato producing states granger caused the demanding states, while only two demanding states granger caused the producing states. Tomato price in Bauchi state granger causes tomato price in Anambra state. Tomato prices in Bauchi states also granger caused tomato prices in Cross River states. In the same vein, tomato prices in Taraba state granger caused tomato prices in Ondo state. Tomato price in Taraba state granger causes tomato price in Abuja. Tomato prices in Plateau state also granger cause tomato prices in Abuja markets. Furthermore, tomato prices in Sokoto state granger caused tomato prices in Lagos state. Also, tomato prices in Sokoto state granger caused tomato prices in River state. The result further shows that tomato prices in Kaduna state granger caused tomato prices in Enugu state. Tomato prices in Kaduna state also granger caused tomato prices in Anambra state. In addition, tomato prices in Kaduna state granger caused tomato prices in River state. While tomato price in Abuja granger caused tomato price in Benue state and tomato price in River state granger cause tomato price in Sokoto states. These results imply that tomato price in the producing states determine the tomato price in demanding states and the previous price of tomato in the producing states can be used to predict the current price of tomato in the demanding states. This could be because tomato marketers who got the tomato from the producing states will tag a price to it based on the amount sold in the producing states.

In addition, the result revealed that only tomato markets in Sokoto state and Rivers State shows a two-way Granger causality while the majority of the tomato markets did not show a two-way Granger causality.

Table 5. The direction of causality of tomato price between the supply and demand states

	Statistics	Probability	Decision
Lagos price DNGC Bauchi	1.99487	0.1461	A
Bauchi price DNGC Lagos	1.42010	0.2507	A
Ondo price DNGC Bauchi	0.94480	0.3952	A
Bauchi price DNGC Ondo	0.06860	0.9338	A
Enugu price DNGC Bauchi	1.94047	0.1537	A
Bauchi price DNGC Enugu	0.17708	0.8382	A
Anambra price DNGC Bauchi	0.61873	0.5425	A
Bauchi price DNGC Anambra	3.45477	0.0389	R
Cross River price DNGC Bauchi	0.30625	0.7375	A
Bauchi price DNGC Cross River	10.6279	0.0001	R
River price DNGC Bauchi	1.35842	0.2659	A
Bauchi price DNGC River	0.53302	0.5899	A
Abuja price DNGC Bauchi	0.09934	0.9056	A
Bauchi price DNGC Abuja	0.55502	0.5774	A
Lagos price DNGC Taraba	2.19234	0.1217	A
Taraba price DNGC Lagos	1.96075	0.1508	A
Ondo price DNGC Taraba	0.12759	0.8805	A
Taraba price DNGC Ondo	7.78647	0.0011	R
Enugu price DNGC Taraba	0.41423	0.6630	A
Taraba price DNGC Enugu	0.70649	0.4980	A

Anambra price DNGC Taraba	0.21904	0.8040	A
Taraba price DNGC Anambra	1.14515	0.3259	A
Cross River price DNGC Taraba	0.10983	0.8962	A
Taraba price DNGC Cross River	0.40445	0.3259	A
Rivers price DNGC Taraba	1.03990	0.3606	A
Taraba price DNGC Rivers	1.05724	0.3546	A
Abuja price DNGC Taraba	0.67068	0.5156	A
Taraba price DNGC Abuja	3.57293	0.0350	R
NB: DNGC = Does not Granger cause, A = Accept, and R = Reject			
Ondo price DNGC Benue	0.74041	0.4818	A
Benue price DNGC Ondo	0.15291	0.8586	A
Enugu price DNGC Benue	0.66252	0.5198	A
Benue price DNGC Enugu	1.25578	0.2932	A
Anambra price DNGC Benue	0.14536	0.8651	A
Benue price DNGC Anambra	0.81358	0.4487	A
Cross River price DNGC Benue	1.03565	0.3621	A
Benue price DNGC Cross River	0.47648	0.6236	A
River price DNGC Benue	0.17117	0.8431	A
Benue price DNGC River	1.48165	0.2365	A
Abuja price DNGC Benue	3.78474	0.0291	R
Benue price DNGC Abuja	0.66206	0.5200	A
Lagos price DNGC Plateau	1.02930	0.3643	A
Plateau price DNGC Lagos	0.11398	0.8925	A
Ondo price DNGC Plateau	0.15275	0.8587	A
Plateau price DNGC Ondo	1.99447	0.1462	A
Enugu price DNGC Plateau	0.03655	0.9641	A
Plateau price DNGC Enugu	1.04619	0.3584	A
Anambra price DNGC Plateau	0.30929	0.7353	A
Plateau price DNGC Anambra	1.09622	0.3416	A
Cross River price DNGC Plateau	2.29880	0.1103	A
Plateau price DNGC Cross River	0.18687	0.8301	A
Abuja price DNGC Benue	3.78474	0.0291	R
Benue price DNGC Abuja	0.66206	0.5200	A
River price DNGC Plateau	0.22534	0.7990	A
Plateau price DNGC River	0.82969	0.4418	A
Abuja price DNGC Plateau	1.08548	0.3451	A
Plateau price DNGC Abuja	4.36411	0.0178	R
Lagos price DNGC Sokoto	1.97272	0.1492	A
Sokoto price DNGC Lagos	3.64272	0.0329	R
Ondo price DNGC Sokoto	0.39361	0.6766	A
Sokoto price DNGC Ondo	0.01717	0.9830	A
Enugu price DNGC Sokoto	0.59240	0.5566	A
Sokoto price DNGC Enugu	0.83729	0.4385	A
Anambra price DNGC Sokoto	1.50715	0.2309	A
Sokoto price DNGC Anambra	0.67372	0.5141	A
Cross River price DNGC Sokoto	0.14865	0.8622	A
Sokoto price DNGC Cross River	0.28052	0.7565	A
River price DNGC Sokoto	2.63383	0.0812	R
Sokoto price DNGC River	5.52711	0.0066	R
Abuja price DNGC Sokoto	0.09221	0.9121	A
Sokoto price DNGC Abuja	1.52423	0.2272	A
Lagos price DNGC Kaduna	2.35674	0.1046	A
Kaduna price DNGC Lagos	0.31649	0.7301	A
Ondo price DNGC Kaduna	0.61039	0.5469	A
Kaduna price DNGC Ondo	0.04444	0.9566	A
Enugu price DNGC Kaduna	1.03683	0.3617	A
Kaduna price DNGC Enugu	3.19326	0.0490	R
Anambra price DNGC Kaduna	1.99144	0.1466	A
Kaduna price DNGC Anambra	4.02126	0.0237	R
Cross River price DNGC Kaduna	1.31674	0.2766	A
Kaduna price DNGC Cross River	1.42605	0.2493	A
River price DNGC Kaduna	0.82064	0.4457	A
Kaduna price DNGC River	2.86159	0.0660	R
Abuja price DNGC Kaduna	0.02063	0.9796	A
Kaduna price DNGC Abuja	0.08509	0.9186	A

NB: DNGC = Does not Granger cause, A = Accept, and R = Reject
Source: Data analysis, 2021.

The speed of the tomato price adjustment process to the long-term multipliers

As shown in Table 6, the error correction coefficient (CointEq(-1)) was negative and significant, which is a favourable sign. The ECM results were accurate and in line with expectations. The ECM results appeared within the expectation and had correct signs. The adjustment term (-0.849924) shows that the reversion to long-run equilibrium is at an adjustment speed of 84.9924%. This implies that 84.9924% of disequilibrium error in tomato price was corrected within a year and tomato price returns to its equilibrium level in about a year in absence of any other shocks.

Table 6. The speed of tomato price adjustment process to the long-term multipliers

	Coefficient	Standard error	t-statistics	Prob.
CointEq(-1)*	-0.849924	0.081659	-10.40819	0.0000
R-square	0.746280			
Adjusted R-square	0.722344			
S.E. of regression	22.707060			
Log-likelihood	-264.7929			
Durbin-Watson stat	2.255069			
Akaike info criterion	9.179421			
Schwarz info criterion	9.390696			
Hannan-Quinn criterion	9.261894			

Source: Data analysis, 2021.

Factors influencing tomato market integration in Nigeria

Table 7 presents the factors influencing tomato market integration in Nigeria. The result revealed that distance, population, self-sufficiency and telephone had a significant influence on tomato market integration in Nigeria. The coefficient of distance had a negative influence on tomato market integration in Nigeria. This implies that the longer the distance cover from a spatial market to another, the lower the market integration. Thus, distance cover reduces tomato market integration. This is because commodity price is well transmitted when the distance between two markets is short. A longer distance also increases transportation costs which reduces market integration. A similar result was reported by Goodwin and Schroeder [13] that distance deters cattle markets integration in the US. This is also in tandem with Goletti et al. [12] who reported that distance from one market to another influenced rice market integration in Bangladesh.

The population had a negative effect on tomato market integration in Nigeria. This implies that an increase in population in a particular location reduces the tomato market integration. This could be because a tomato producing state with a high population could have enough demand for the product from the state which will lower the moving of the product to other markets in other zones or states and consequently lower price transmission and signals.

Self-sufficiency in tomato production had a negative effect on tomato market integration in Nigeria. This implies that being self-sufficient in tomato production reduces the tomato market integration. This could be because a self-sufficient state can decide the price to sell tomato without necessarily considering the price in other states.

The telephone density had a positive influence on tomato market integration. This implies that the presence of the telephone in Nigerian markets increases the tomato market integration. This is because the telephone enhances the transmission of tomato prices among spatially separated markets. Farmers and marketers can easily ask the price of tomato in other markets via the telephone. This supports the findings of Goletti et al. [12] who reported that telephone density had a positive influence on rice market integration in Bangladesh.

Table 7. Factors influencing tomato market integration in Nigeria

Variables	Coefficient	Standard error	t-statistics	Prob.
Contiguity	-3.424172	1.845185	-1.855734	0.1226
Distance	-0.010891***	0.001566	-6.952738	0.0009
Population	-2.88E-06*	1.15E-06	-2.507132	0.0540
Self sufficiency	-11.88839***	2.137022	-5.563065	0.0026
Telephone	1.38E-06*	6.33E-07	2.180264	0.0811
Transportation cost	-0.024180	0.014439	-1.674632	0.1549
Constant	64.51281	9.395746	6.866173	0.0010
R-square	0.906186			
Adjusted r-square	0.793608			
F-statistics	7.452			
Probability	0.014			

Source: Data analysis, 2021.

CONCLUSIONS

This study analysed the market integration of tomato in Nigeria. Market integration appears to be limited in tomato markets in different regions of Nigeria. Meanwhile, the combination of tomato markets in the supply states (Northeast, Northcentral and northwest) were integrated. Thus, tomato price information and signals were well transmitted among markets in the tomato supply states. The combination of tomato markets in the demand states (Southwest, Southeast and south-south) were not integrated which implies that tomato price information and signals were not well transmitted among markets in the tomato demanding states. The tomato price in the producing states determines the tomato price in demanding states and the previous price of tomato in the producing states can be used to predict the current price of tomato in the demanding states. About 85% of disequilibrium error in tomato price was corrected within a year and tomato price returns to its equilibrium level in about a year in absence of any other shocks. Distance contributed immensely to tomato market integration, the longer the distance the lower the market integration. while telephone enhanced the market integration as it assists to transmit price across regional tomato markets in Nigeria.

The study recommends upgrading and investing in infrastructure such as roads would also enhance tomato market integration. A good road network is equivalent to a shorter distance between spatially separated markets which will reduce time to transmit tomato price information and reduce transaction cost. This would ensure adequate movement of tomato from the surplus or supplying states to the shortage or demanding states. This can be achieved by improving the existing roads and constructing new ones. There is also a need to encourage tomato market price information in Nigeria to enhance market integration and reduce price differences. Information flow about prices, demand and supply of tomato will enhance market integration as it will increase the speed of price transmission. Government can formulate policies that will regulate information services and tomato prices to avoid market exploitation. Provision of tomato price information centre, where tomato daily prices will be disseminated, by the government will also enhance the flow of price information and communication within spatially different markets. The provision of efficient telecommunication networks in the rural areas would also enhance the price transmission of tomatoes in Nigeria.

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THE STUDY OF SOCIO-ECONOMIC CHARACTERISTICS AND COOPERATIVE-PARTNER RELATIONS OF AGRICULTURAL DEVELOPMENT COOPERATIVES

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Abstract

This study aims to evaluate the cooperative-partner relations in Agricultural Development Cooperatives (ADC) in Bursa/Turkey and identify the factors affecting this relationship. There are 313 active ADC in the province of Bursa, with 33,334 partners in total. Primary data was collected by survey. A face-to-face survey was conducted with 408 people determined by simple random sampling method. The data are analysed with SPSS 24 program, and cross-tables are created. 69.1% of the respondents have read the Articles of Association. While 28.4% of their partners are involved in the Board of Directors.,77% have joined the General Assembly. Only 33.1% of the partners had other cooperative partnerships. Although fewer than one-third of the partners have reported increased (27.7%) income, 94.6% reported that they would continue their partnership. The most common activity made by cooperative was the supply of credit with 32%. The educational activities are ranked second (23%). Partners participated in 74.3% of the given education. 78% found the training useful. The research has shown that 46% of the partners did not know what risturn is.

Key words: *agricultural development cooperatives, cooperative movement**,** farmer's organization, partnership*

INTRODUCTION

Agricultural organisations such as cooperatives, producers' associations and growers' associations can be defined as economic organisations established by farmers and protecting the farmers' interests through mutual assistance [17].
Most of the agricultural enterprises in Turkey are not large enough, and they have a weak capital accumulation. Consequently, investments in the enterprise are not at the desired level. The use of modern agricultural technologies and agricultural inputs cannot be achieved. Agricultural enterprises living and producing in rural areas must be organised so that they can use their resources more effectively and efficiently, apply modern agricultural technologies and market their products at a better price [9].
Cooperatives are key to rural development and sustainability and are likely to be the leading actor of social welfare when they use their resources and forces effectively and efficiently [10]. It is a model of development that is not narrow and not top-down, but much wider and bottom-up. Cooperatives should take on the role of reducing economic pressure on the market, as in global markets. Marketing products through the cooperative is essential in terms of neutralising intermediaries and converting production into an economy.
Agricultural cooperatives are highly developed numerically throughout the country. One in five people living in rural areas is a cooperative partner. However, although cooperatives are numerous, they have not been sufficiently effective in supplying the agricultural inputs, developing the knowledge and skills of producers, evaluating and marketing products [11]. Poor management, incapable and ineffective managers lacking investment capital and business volume, legislative and top management problems, and the prominence of political views lead cooperatives to failure.
The attitude and behaviour of partners towards the cooperative directly or indirectly affect the success of the cooperative. It is their

partners who sustain the cooperative. Partners are both customers and owners of cooperatives. The goals of the cooperative and the goals of the partners should be in harmony with each other. If harmony does not exist, it will be difficult for cooperatives to succeed. Progress and sustainability of agricultural organisations, especially agricultural development cooperatives, are only possible if cooperative-partner relations are healthy and consistent. Effective participation of the partners in the management helps to achieve this goal.

Bursa province, located in the Southern Marmara region of Turkey, is one of the leading agricultural production centres with the polyculture agricultural system applied [22]. The organisation of farmers in Bursa is at a reasonably good level, yet, the institutional structures of farmers' organisations are not sufficient in terms of organisation and human resources.

There are 313 active Agricultural Development Cooperatives (ADC) in the province of Bursa, which operates under Law no: 1163, and 3 agricultural unions. In addition, there are four breeders' associations that operate under Law No. 5996. Further, twenty-three producer unions operate under Law No. 5200. ADC has 333 partners, irrigation cooperatives have 6,434, and aquaculture cooperatives have 1,047 partners. A total of 40,815 people are cooperative partners in Bursa province.

It may be possible to make the agricultural potential in Bursa province even more effective through cooperatives in the countryside. Although most cooperatives from agricultural organisations in Bursa do not take an active role for all kinds of reasons (financial situation, administrative problems), it is possible to see successful examples.

There is a growing literature on agricultural cooperatives and ADC. Ari and Ozcelik [3] examined the ADC Implementing the Milk Project in Kastamonu province. Paksoy and Bulut [14] examined the socio-economic characteristics and cooperative-partner relations engaged in dairy cattle farming in Aksaray province. Gencdal et al. [8] compared dairy cattle breeding enterprises with and without ADC partners in Gevas district of Van Province. Yercan and Kinikli [23] analysed the factors affecting the participation of partners in the management of dairy cooperatives in Izmir. Basaran and Irmak [4] evaluated the partnership structure and cooperative activities in agricultural cooperatives in Edirne. Everest and Yercan [7] analysed the trends of cooperative partners participating in cooperative management through the Balikesir Regional Association. Alcicek and Karli [2] investigated the cooperative-cooperative relations in agricultural cooperatives in Burdur province and Topuz and Bozoglu [18] in Samsun province. Sayili and Adigüzel [16] carried out the economic analysis of the partners of team credit cooperative of Tokat province.

The number of studies that analyse cooperative-partner relations for ADC is scarce. This type of study has not been conducted for Bursa province before. This study will reveal the common characteristics of partners and ADC-partner relations in Bursa province.

MATERIALS AND METHODS

This study aimed to identify factors affecting cooperative partner relations of Agricultural Development Cooperatives in Bursa Province. This study was conducted in 2018.

This research consists of two main parts. The first part consists of a literature review. Agricultural organisations in Bursa province, the ministries they are affiliated with, and the laws to which they are subject were examined, numerical data were compiled, and statistical charts were created. Analyses were made using secondary data from the Ministry of Agriculture and Forestry. Agricultural organisations are grouped according to the laws and areas of activity to which they are subject. The relevant data of the Ministry of Agriculture and Forestry are examined in detail and processed in tables. Primary data was collected by survey. ADC partners were preferred because of the breadth of the fields of activity and the vast number of partners for the survey study. A face-to-face survey was conducted with 408 people determined by simple random sampling method among the partners (33,334) of 313 cooperatives selected decisively.

The data obtained from the survey are analysed with SPSS 24 program, and cross-tables are created. The reliability of the data was tested, and Cronbach's Alpha level was found as 0.932. Cronbach's Alpha being (α)≥0.90 confirms that the survey is "highly reliable".

RESULTS AND DISCUSSIONS

Results

The employment rate of women (15-64 years) in Turkey was 38.3% in 2018. Male employment was 78.6% in 2018 [20] Similarly, in ADC, the number of male partners is higher than in women. Of the partners surveyed, 84.2% were men, and 15.8% were women. The youngest of the surveyed partners was 18, and the oldest was over 65 years of age. The average age of the participant was 49.5. The average age of ADC of Kastamonu milk project is 52 Ari and Ozcelik, [3] and 52.16 in agricultural cooperatives in Edirne [4]. Accordingly, the average age in the current study falls within the country-wide data.

A third (33.8%) of the participants are in the 45-54 age group, with a total of two out of three (62.6%) being 45 years of age or older. In Everest and Yercan [7] Balikesir Agricultural Credit Cooperatives (ACC) survey, 33.24 of the partners were 46-55 years old, and 77.93% of the participants were 46 years old and over.

About one-fifth of the partners in the research have less than five years of experience. 24.8% of the partners have 11-15 years, 26.7% have 26 years or more of farming experience. It is fair to say that the partners participating in the study were less experienced than other studies. Yercan and Kinikli [23] indicated the farming experience of the partners as 24.02 years and Ozalp [13] as 19.21 years.

The average household size of Bursa province in 2020 was 3.23 and 3.3 for Turkey [21]. The average number of households in cooperative partners in the current study is 3.43. Everest and Yercan [7] reported the average household size for credit cooperatives in Balıkesir as four people; in a study conducted across Turkey, the average household size of families was 4.6 [15]. Although the proportion of partners in the Bursa may seem to be low compared to other studies, the household population in the western parts of the country is less; and the data coincide with the data of TUIK for Bursa and Turkey.

According to TUIK 2020 results, the rate of high school or equivalent graduates for Bursa province was 22.98%, and the rate of university graduates was 17.32 [19]. Although the distribution of partners is not far from the Bursa provincial average, the proportion of high school graduates, in particular, is relatively lower (16.7%) for partners in the current research.

Table 1. Demographic characteristics of the participants (N=408)

		N	%			N	%
Gender	Male	340	83.3	Marital status	Married	335	82.1
	Female	68	16.7		Single	73	17.9
Age	18-24	24	5.8	Education	Literate	12	2.9
	25-34	69	16.9		Primary School	168	41.2
	35-44	60	14.7		Secondary School	81	19.9
	45-54	138	33.8		High School	68	16.7
	55-64	77	19		Associate Degree	16	3.9
	65 ≤	40	9.8		University	60	14.7
	-	-	-		Master Degree	3	0.7
Household size	1	32	7.8	Farming experience	1-5	76	18.8
	2	60	14.7		6-10	36	8.9
	3	96	23.5		11-15	100	24.8
	4	140	34.4		16-20	44	10.9
	5 ≤	80	19.6		21-25	40	9.9
					26 ≤	108	26.7

Source: Own calculation

Approximately half of the participants (58.78%; 51.57% and (52.4%) were primary school graduates in the Alcicek and Karli [2], Basaran and Irmak [4] and Paksoy and Bulut [14] studies. Nevertheless, the proportion of university graduates in the current research is much higher than the university graduates in the research mentioned above, with 14.7% Alcicek and Karli [2]: 3.82%; Basaran and Irmak [4]: 7.6%; Paksoy and Bulut [14]: 2.4%. The partners' educational levels in the ADC are relatively higher than those of other crop production and livestock cooperatives; the educational levels of the partners are generally low.

This part of the study examined cooperative-partner relationships with the most studied dimensions in the literature, and the findings were summarised in Table 2.

Table 2. Partnership features of the participants

		N	%	SD	σ2
Duration of partnership	0-5	103	25.2	1.580	2.497
	6-10	57	14.0		
	11-15	162	39.7		
	16-20	18	4.4		
	21-25	15	3.7		
	26 ≥	53	13.0		
Income growth after becoming a partner	Yes	113	27.7	.438	.192
	No	164	40.2		
	Partially	131	32.1		
Reading the articles of association	Yes	282	69.1	.463	.214
	No	126	30.9		
Regular participation in the general assembly	Yes	314	77.0	.438	.192
	No	94	23.0		
Serving on the board of directors	Yes	116	28.4	.452	.204
	No	292	71.6		
Partnership with other agricultural organisations	.222	135	33.1	.471	.222
	No	273	66.9		
The intention to continue the partnership	Yes	386	94.6	.226	.051
	No	22	5.4		

Source: Own calculation.

In the current research, the average partnership duration is 15.1 years, and the maximum partnership duration is 40% between 11-15 years, followed by new partners (5 years and less) with 25.2%.

Arı and Ozcelik [3] state that 40.82% of partners in Kastamonu province are members for 11-20 years. Aktoprak [1] found that the partnership period of the Irrigation Cooperative manager in Edirne province was 26.7% of those between 1-10 years and 35.5% of those between 11-20 years. Basaran and Irmak [4] determined the partnership duration as 15.6 years on average in their research. The current research's mean partnership duration and the partnership's distribution by year are in line with recent research.

Reading the *Article of Association*

The Article of Association (AA) is an agreement between the partners and the cooperative regulating the mutual rights and responsibilities and reading and understanding the AA benefits the partner. When partners know their rights and responsibilities, they can better control whether the cooperative is working under the purpose. Knowing the legislation well will allow partners to seek their rights and responsibilities; thus, they will have a stronger desire and take care of the cooperative [11].

"Not reading the contract" is one of the leading problems encountered in practice. Many people sign the document or agreement without reading the text, relying only on the oral statements of the other person or common expectations. Since contracts are usually written in a legal language under legal legislation, many people believe that they will not understand contracts, even if they read them. Members usually join cooperatives through an acquaintance or on a recommendation. In this case, individual assurance may be considered more important than written contracts. In addition, cooperatives are based on volunteerism. Consequently, cooperatives may not be seen as official as other organisations. Members may also consider that they do not have power if they object to contractual clauses.

Of the partners surveyed, 69.1% reported reading the AA. This rate is the highest compared to available research. Sahin et al. [15] stated that 51.0% of the partners in ADC in Turkey read the AA, while Yercan and Kinikli [23] reported this ratio as 42.3%. Ari and Ozcelik [3] reported that the main contract reading rate was 35.05%, In the ACC of Tokat province, only 15.15% of the partners have read the main contract [16].

Often, even highly educated people do not care to read contracts. Yercan and Kinikli [23] confirm this thesis that 72.5% of partners did not see the need to read the contract. 12.5% of partners found the text too long, and the writing was too small. Another 10% have not received the contract. Everest and Yercan [7] similarly reported that 56.34% of farmers did not read the main contract because they did not need to read it. 24.25% did not read it because the contract was too long and its writings were too small, and 11.19% did not read it because they did not receive it.

It is crucial to prepare contracts to cover as many issues as possible related to the cooperative. Nevertheless, this, in turn, results in lengthy contracts, which can be a deterrent for prospective future partners. So there is the need to prepare the general agreement as short and clear so that members will be more willing to read. There is also a need to improve communication between the cooperative management and its prospective partners.

Intention to continue the partnership

Voluntary and free entry are among the basic principles of cooperative decency. In the same way, the partner who wishes can leave the cooperative. Members will continue their membership if they find the activities of the cooperative satisfactory, at least unless they face serious difficulties. 94.6% of the partners surveyed said they would continue the partnership, and 5.4% would prefer to end it (Table 2). Similarly, Ertan and Kaya [6] found that 95% of partners in the Cunur irrigation cooperative were successful.

Partnership with other agricultural organisations

Multiple cooperative partnerships of individuals should be evaluated within the areas of activity of the existing cooperative and the opportunities they offer to members. As the area of activity of the cooperative is expanded, members will prefer other cooperatives to a lesser extent. If the cooperative is established to provide a limited number of products and services, or if members in the region engage in multiple activities, membership in other cooperatives will increase.

Of the partners surveyed, 33.1% had other co-op partnerships (Table 2). Yercan and Kinikli [23] found that the partnership rate for another cooperative in Izmir was 32.4%, and this finding supports the current research. On the other hand, there are studies in which membership in other cooperatives is observed as high. Yercan and Kinikli [23] point out that 73.65% of cooperative partners in Edirne are partners in more than one cooperative. The multiple coop partnership rate in ADC in Bursa is low since they perform input supply and irrigation activities through existing cooperatives.

The details of which other cooperatives the partners are members of are given in Table 3. Accordingly, most of those who have a partnership in another cooperative are also partners in Marmarabirlik. The proportion of partners in Marmarabirlik is 44%, while the second is a partnership with ACC with 29%.

Ari and Ozcelik [3] determined that 36.36% of the cooperative partners they examined were members of the Chamber of Agriculture, and 22.73% were members of the Cattle Breeders' Association 18.18% of them were members of ACC. Yercan and Kinikli [23] emphasised that 82.6% of the partners in another cooperative were partners in the ACC, 15.2% in the agricultural sales cooperative, and 2.2% in the irrigation cooperative.

Table 3. Other agricultural organisations in partnership

	N	%	SD	σ2
Agricultural Credit Cooperative	40	29	1.380	2.140
Another Agricultural Development Cooperative	20	15		
Artisan Redemption Credit Cooperative	10	7		
Marmarabirlik	60	44		
Agricultural Sales Cooperative	6	5		
Total	408	100		

Source: Own calculation.

As revealed in the current research, membership in other cooperatives can vary greatly depending on the region of production, the needs of the producer, and the variety of opportunities offered by the cooperative.

Participation in general assembly

Cooperatives are democratic organisations managed by partners, so partners actively participate in the General Assembly's decision-making process and create policies. Consequently, each partner has the right to vote and also has the right to scrutinise the activities and express his opinion. GA meetings are held every year. These meetings are open to all partners. The high level of participation in the General Assembly (GA) is an essential indicator that the cooperative is democratically governed. The GA is the most critical body of the ADC. The board is where the annual financial situation is discussed, accounts are negotiated, cooperative activities are reviewed, issues are raised and discussed, and management's rights, powers, and responsibilities are determined. GA meetings require a quarter of its members' participation. For this reason, the participation of partners in the GA is vital to carry on the cooperative activities, and it falls under the 'partners' responsibility. Article 21 Clause 'e' of the ADC of Association states that a partner who does not participate in 3 GA meetings in a row is dismissed from the partnership [5].

Research shows that partners participate in the GA at a rate of 77% (Table 2). Although this ratio seems high at first sight, it is necessary to compare it with other research for a more realistic comparison. Kilic and Bozoglu [12] reported that the participation rate of the cooperative partners in the GA was 96%. The Ari and Ozcelik [3] research found the participation rate to the GA meetings approximately 92%, Topuz and Bozoglu [18] 90%, and Sahin et al. [15], on the other hand, revealed it as 80.9%.

Although the participation rate in the current research is not as high as that in the stated research, it is undeniably high and satisfactory overall.

Serving on management board

In addition to the GA, there are two boards in the ADC: Management and supervision. If a partner requests and is elected, he can serve on these boards. The powers and responsibilities of these boards are greater than those of the regular partner [5]. This responsibility can be both a choice and a reason for withdrawal from the partnership. Partners involved in the management are more interested in problems than other partners and make more efforts to develop the cooperative. Therefore, partners serving in the management or wanting to participate in management provide valuable information about their sense of ownership.

Accordingly, 28.4% of the cooperative partners surveyed took part in management boards (management and supervisory boards) (Table 2). This finding coincides with Ozalp’s [13] ratio of members of the board of Directors of livestock Cooperatives of the western Mediterranean region. In this particular study, 35.85% of the partners were on the board of directors at various times.

Partners' willingness to participate in management varies from person to person. Although some partners are very enthusiastic and willing to participate in the GA or the board of directors, some do not want to participate in the meetings. This can vary according to age, education, past experiences, personality traits of the partner. Indeed, the participation in the boards of directors in Turkey is generally low. Yercan and Kinikli [23] reported that 93% of the partners and Everest and Yercan [7] 89.10% of the partners have not served in the management board. Sayili and Adigüzel [16] also determined that 10.61% of the members took part in the board of directors or supervisory board in any period.

Change in the economic situation of its partners compared to previous years

Although cooperatives are not-for-profit entities, the aim of organising and establishing a cooperative is to meet the needs and raise the income level of its partners by using the advantages arising from unity. In order to maintain unity, income growth must be provided after joining the cooperative. In the absence of revenue growth, it will not be easy to convince producers to become partners. The sustainability of the cooperative will be ensured as long as partners and the local community observe the economic impact of being a partner. Cooperatives contribute to profitability increases by providing relatively cheaper input to agricultural enterprises. Cooperatives are also helpful in adopting and implementing effective production methods, providing farmers with a flow of information about new production methods, effective organisation, and personnel management. Thus, it mediates farmers to have a higher and stable income.

However, looking at the research results, the proportion of those who stated that their income increased from the partners surveyed was disappointingly low. Less than a third of partners said their income had increased (27.7%). Those who said income did not increase were 40.2%, while those whose income partially increased accounted for the other third (32.1%). Information on income growth after joining the cooperative is given in Table 2.

Examination of the current research results shows that the income status of the partners varies widely depending on the subject field and types of the cooperative. In a recent study, Alcicek and Karli [2] found that while the rate of shareholders who stated that they had an income increase after becoming a partner in the cooperative was 28.24%, the rate of those who said that there was no income increase was 39.69%. The rate of those who said they were indecisive was 32.6%. Sahin et al. [15] pointed out that 55.1% of the cooperative partners interviewed had positive changes in their income after becoming partners in the cooperative. However, Ari and Ozcelik [3] said that 92.78% of the partners increased their income. Similarly, in Paksoy and Bulut [14] findings, 83.3% of the cooperative partners engaged in dairy cattle farming in Aksaray province confirmed the cooperative playing a role in increasing their income.

Activities of cooperative partners through cooperative

Cooperatives, like other organisations, will ensure the loyalty of their partners and the continuity of the cooperative as long as they perform activities following the needs and expectations of their partners. Information about the activities of ADC partners through the cooperative is given in Table 4. Accordingly, the most common activity was loan supply with 32%. Educational activities take second place. The research showed that the main activity carried out through the cooperative is the credit supply followed by educational work. The primary purpose of establishing cooperatives is to provide cheap input and sell products at the most affordable price.

Table 4. Activities through the cooperatives

Activities	N	%
Loan provision support	128	32
Educational support	95	23
Assistance in product marketing	68	17
State aid support	48	12
Providing cheap product input	30	7
Assistance during the production phase	21	5
Assistance in product processing	13	3
Other	5	1
Total	408	100

Source: Own calculation.

Nevertheless, due to administrative failures, a producer with cash can buy input alternatives from the market for less with their means or sell them to an intermediary at a price higher than the amount set by cooperatives. As a result, producers and sellers' cooperatives cannot work effectively, except for particular examples. Manufacturers do not rely very much on such cooperatives or activities related to production and sale in other cooperatives.

In addition, there is a fragmented agricultural structure in Turkey. Since the fields and property used for production are usually belong to multiple shares, it is impossible to get a loan when a farmer applies with his own means. Even if they can get a loan, this is usually with a very high-interest rate. As a result, agricultural producers see cooperatives as a means of financial credibility and often use them to secure loans and receive state aid. It should also be considered that about a third (29%) of the partners are members of other ACC.

Although universities in the country provide agricultural education, agricultural extension at a lower level has not been fully enabled. A widespread education system that will provide farmers with the education they need in practice has not been put forward. Given that farmers are generally at low levels of education, education through cooperatives is very much needed.

In the same line, Everest and Yercan [7] states that for farmers, the second most important goal of becoming a cooperative partner was "providing cash loans", the third goal was "providing technical information."

The participation level of cooperative partners in education

According to the principle of "education, training and information", cooperatives carry out educational and training activities to develop cooperatives for their partners, managers and staff. It also organises educational and training activities for those not partners in the cooperative to explain the cooperative structure. Educational activities given to partners in various subjects are essential in increasing their knowledge and skill levels, increasing their product knowledge and indirectly their income, and in the long term, in ensuring the success of cooperatives.

In the last part of the study, it was stated that one of the most commonly used services with cooperative means was a high demand for educational services. The current finding supports the previous finding. Partners participated in 74.3% of the given training (Table 5). This finding coincides with available research: Alcicek and Karli [2] stated the participation of ADC partners in educational activities as 75%.

Table 5. The participation level of cooperative partners

	N	%	SD	σ^2
Yes	303	74.3	.530	.281
No	105	25.7		
Total	408	100.00		

Source: Own calculation.

Thoughts on educational activities

A large majority of partners (78%) found the organised training useful. The proportion of those who say" training time is not well adjusted "and" not useful " is pleasingly low. This result shows that the cooperative managers understand the partners' training needs correctly and prepare these training per the actual needs (Table 6).

Table 6. Thoughts on educational activities

	N	%	SD	σ^2
Beneficial	319	78	.438	.192
The topic was not relevant	10	3		
Timing was not convenient	30	7		
Not beneficial	30	7		
No idea	17	4		
Other	7	1		
Total	408	100		

Source: Own calculation.

Training attended by partners

Here, participants could select multiple options because partners are likely to participate in multiple pieces of training. Accordingly, the surveyed partners reported that they participated in "fundamentals of cooperatives" training in the first place, "new production techniques" in the second place, and "personal development, product processing" training in the third place (Table 7).

It is gratifying that partners primarily participate in essential training related to the

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fundamentals of cooperatives, about general principles of cooperatives, their rights and responsibilities so on.

Table 7. Training attended by partners

	%	Popularity
Fundamentals of cooperation	59	1
New production techniques	44	2
Product processing	37	3
Self-development	37	4
Irrigation	27	5
Crop production	24	6
Animal Husbandry	7	7
No relevant training	7	8
Marketing	5	9

Source: Own calculation.

In general, the level of education of farmers and cooperative partners is low, as this study again underlined. We must remember that 70% of the partners surveyed have over ten years of experience. Perhaps because of this height of experience, the fact that partners are interested in new products and production techniques rather than fundamental production issues shows that partners are open to innovation and experiential. Again, the fact that partners demand personal development training in third place is a good indicator of the desire for openness and development.

Knowledge of risturn by cooperative partners

The portion of the profit at the end of the 'operating period' obtained in cooperatives distributed between the partners is called return. Cooperatives are mainly serving their partners for support rather than for profit. However, for various reasons, the surplus of businesses generated at the end of the financial year is distributed between partners according to specific rules. This principle is that the profits are distributed to the partners in the measure of the exchange made from the cooperative. Distribution is based on the idea of preventing members from making unfair profits over each other, rather than sharing between partners.

Research has shown that although the most popular training among partners is 'fundamentals of cooperatives', about half of partners (46%) do not know what risturn is. Alcicek and Karli [2] determined the rate of knowing as 23.66%. It is necessary to keep in mind that many cooperatives do not pay risturn and that there are no risturn-related clauses in the articles of association.

Table 8. Knowledge of risturn by cooperative partners

	N	%	SD	σ^2
Yes	188	46	.720	.519
No	163	40		
Partially	57	14		
Total	408	100		

Source: Own calculation.

CONCLUSIONS

This study aims to evaluate the cooperative-partner relations in ADC in Bursa province and identify the factors affecting this relationship.

A significant part of the participants consists of male partners. The average age was about the average age of the country. However, the partners' educational level of ADC of Bursa province is higher than that of similar cooperatives. Especially the prominence of university graduates is pleasing. Further, it can be seen that those who have ten years and less experience among partners are decently distributed among those who have 26 years and more experience. As a result of the high level of education in cooperatives, the AA reading rate was about 70%. Reading the AA is an indicator of conscious partnership. There was a parallelism between reading the AA and regularly attending the GA. The fact that almost all of the partners (94.6%) were considering continuing the partnership shows that the partners' satisfaction with the cooperative was exceptionally high. Only a third of the partners were also members of other cooperatives. Cooperatives' main goal is to increase partners' income by providing low-cost input, removing intermediaries, and selling consumers directly and at a better price. However, only 27.7% of the partners declared an increase in income after becoming a partner in the cooperative. Low-income increases have been reported in similar studies in the literature. When the reason for the high level of satisfaction level is investigated, despite this low income from cooperatives, it is seen that the partners significantly use the cooperative to provide loans (32%). Other vital benefits were realised by participating in in-house training. Training related to personal development were in high demand. 78% of the partners found the training was valuable. Despite the relatively high educational status of the partners and their participation in training, less than half of them were able to define risturn.

This research provides a general framework regarding the characteristics of Agricultural Development Cooperative partners in Bursa Province. The research results enable relevant authorities to analyse the situation and compare and contrast them with other provinces and other types of cooperatives. The positive aspects of cooperatives (high level of education, participation in the board of directors and the GA, high satisfaction) will be used to support management decisions and develop policies. The more negative situations revealed by the research will allow managers to realise, understand and correct these situations. The research results will guide cooperative managers, local administrators and agricultural policymakers, and other researchers.

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CHICKPEAS - A POSSIBLE NICHE CULTURE FOR ROMANIAN FARMERS

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Abstract

Chickpeas are a culture that is part of the Leguminous family, with multiple uses in human nutrition, as an industrial raw material, in animal feed (not used as green fodder) as well as from agro-technical point of view (good for other cultures due to biological peculiarities). As advantages of culture, it is noted the uniform baking and the existence of the indehiscent pods. The culture presents a productive potential for Romania, between 1,000 and 1,500 kg/ha, under the conditions of use, in production, of local populations and varieties. The study relates to the possibilities of enlargement in the culture of the chickweed as a result of climate change, as the plant is not a demanding one for water consumption, and presents a relatively affordable technology for farmers. In this context, are noted areas cultivated (694.59 ha – average level for the analyzed period), total productions (720.37 t) and average productions (about 1,010 kg/ha), specific to Romania, as well as the quantities of imported product (561.15 t) and Exported (50.56 t) by our country for the time interval 1992-2018. The analyzed timeframe captures both political, economic and social changes, as well as changes under the main climatic parameters, with a rather significant impact on the productive activity of the vegetal sector. Our country is not an important player on the market of this product at European and world level, but the existing conditions may lead to a reduction in the external trade balance, and the proper use of the specific national potential.

Key words**:** *chickpeas, area, total production, average production, export, import*

INTRODUCTION

Chickpea belongs to the *Leguminosae* family. The genus *Cicer* L. of the family *Leguminosae* contains 49 taxa with 40 perennial species and nine annuals, which including the cultivated chickpea, *Cicer arietinum* L. [14].

At global level, chickpea is grown on a surface of 11 million ha. But, the chickpea area is concentrated in South Asia, which holds more than three-fourths of the world chickpea area [9].

The importance of chickpeas is not only due to its use in human nutrition, crops also have fodder, industrial, agrotechnical - technological (good precursor plant for a wide range of crops) and even therapeutic use.

The cultivation have particular importance for food security in the developing world where, because of capacity for symbiotic nitrogen fixation, the seeds of chickpea are the main source of protein for human dietary [12].

The seeds of chickpeas can be consumed in various forms, as a coffee surrogate, roasted or boiled, also in the form of salads, and canned, because of its good digestibility and a high nutritional value [7].

The essential amino acids in Chickpea have significant quantity (except sulphur-containing amino acids) and un-saturated fatty acids such as oleic acid, linoleic acid, campesterol and stigmasterol, beta-sitosterol [6].

The properties of legume proteins (like water binding capacity, foaming and gelation fat absorption) and their gluten-free nature have increased the interest of using legume flours for the creation of novel foods aided for celiac disease patients.

The flour from chickpea, have been used for the formulation of a wide variety of products such as pasta, bakery products and snacks [1].

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Also the chickpea is found in the gluten-free bread formulations [5].
The chickpea can be consumed as food, and in agricultural industry where meets both as roasted chickpea and as an animal food [4].
For the chickpea, the seed size is an important component regarding of yield, and trade [11]. Therefore, seed sizes represent an important breeding objective for the chickpea improvement programs [13].
Reported to other legumes for grains, the chickpea supports drought, because it possesses the capacity of stopping its growth in case of drought and resuming after the first rain [10]. Due to this, we can state that the chickpeas are a culture that can exploit the climate change issues that Romania is currently subject to, at the present time.
The cultivation of the chickpeas can also be analyzed in the context of Romania's accession to the EU, a situation which has been aimed at subsidizing producers in agriculture – the transition from the granting of the area subsidy to the subsidy on the product. In this context, it can be shown that, chickpea producers can obtain current subsidies to the practice of culture, and when they exceed the total area of 15 hectares, they are stimulated to practice protective crops, one of the cultures being chickpeas.

MATERIALS AND METHODS

Through the exploitation of the accessible databases, the documentary phase was carried out, using information on the cultivated area (ha), total production (t), average production (kg/ha), imports (t) and exports (t), then achieving correlates, among some of the above mentioned indicators. A dynamic series of 27 terms has been formed to avoid, as far as possible, the short-term consequences of some of the factors of influence (climate factor) on the aspects analyzed.
To highlight the correlation between: (I) surface (*x*) and total chickpeas production (*y*), (II) surface (*x*) and average production (*y*); (III) average production (*x*) and total chickpeas production (*y*), (IV) total chickpeas production (*x*) and exports (*y*), (V) total chickpeas production (*x*) and imports (*y*), (VI) exports (*x*) and imports (*y*) at national level. The equation used for the correlation coefficient was:

$$r = \frac{\sum (x_i - \overline{X})(y_i - \overline{Y})}{\sqrt{\left(\sum (x_i - \overline{X})^2\right)\left(\sum (y_i - \overline{Y})^2\right)}},$$

where: $\bar{X}$ and $\bar{Y}$ - are the averages for samples, average (matrix1) and average (matrix2).
In the analysis, the values of the correlation coefficient (r) and of the coefficient of determination (R^2) are presented.

RESULTS AND DISCUSSIONS

The data relating to chickpeas, surface area, and total production are shown in Figure 1.
The cultivated area was between 78 ha, at the level of 2009, and 2,127 ha, in the case of 2001. Between 1992 and 2001, an upward overall evolution of the indicator is noted, with some inherent fluctuations (from 170 ha in 1993 to 2,127 ha in 2001, in four years the surface exceeding 1,000 ha – 1996, 1999, 2000 and 2011, in 1995 and 1998 exceeding 500 ha, otherwise the indicator was below this threshold). After the year 2002 to 2009, the surface knows uneven downward tendencies (one year exceeds the level of 1,000 ha – 2002 1,310 ha, two years exceed the threshold of 500 ha – 2004 and 2007 with 834 and 598 ha respectively, the rest of the terms do not reach this level). Since 2010, there is a tendency to recover, the surface evolving upward-fluctuating (the years 2016, 2017 and 2018 registers a more convenient areas – 438, 1,231 and 2,086 ha, in the rest of the years, the indicator not reaching the threshold of 200 ha).
With regard to total production, a somewhat similar evolution of the surface may be observed. Thus from 1992 to 2001, evolution trends are fluctuating upward (growth from 236 t in 1992 to 2,773 t at the level of 2001), between 2002 and 2009 the indicator evolves downward-fluctuating (from 1,047 t in 2002 to 75 t in the case of the year 2009), and between 2010 and 2018 total production knows an upward-fluctuating trend (from 134 t in 2010 to 1,768 t for the year 2017, but for

the other, the level of 200 t is exceeded only in the years 2013, 2016 and 2018 – 224, 554 and 1,765 t).

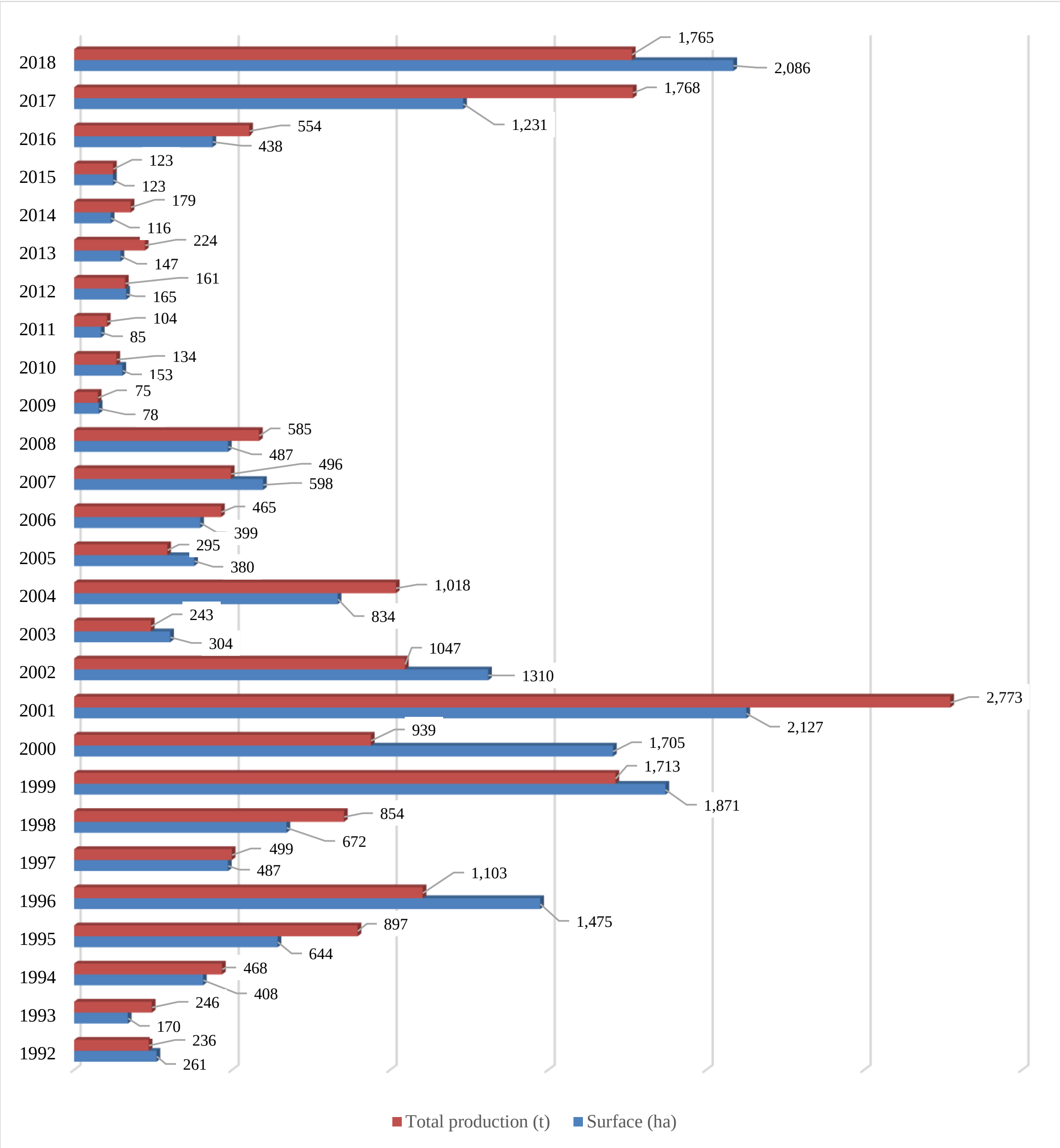

Fig. 1. Dynamics of surface and total production (1992-2018)
Source: http://www.fao.org/faostat/fr/#data/QC, Accesed on 11.12.2020 [16].

The evolution of average production (kg/ha) is presented suggestively through Figure 2.
The indicator has evolved unevenly, from year to year.
Only 4 periods are met for which the indicator maintains its same trend for at least 2 years: 1996 – 1998 increase, 1999 – 2000 decrease, 2008 – 2010 decrease, 2012 – 2014 increase, 2016-2017 increase. The variation limits were 551 kg/ha in 2000 and 1,543 kg/ha for the year 2014 respectively.
In general, we can speak of temporal sequences in which the indicator has not reached the level of 1,000 kg/ha (12 Years – 1992, 1996, 1999, 2000, 2002, 2003, 2005, 2007, 2009, 2010, 2012 and 2018), one year (2015) when average production was 1,000 kg/ha and 14 years with higher levels of 1,000

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kg/ha (1993, 1994.1995, 1997, 1998, 2001, 2004, 2006, 2008, 2011, 2013, 2014, 2016 and 2017).

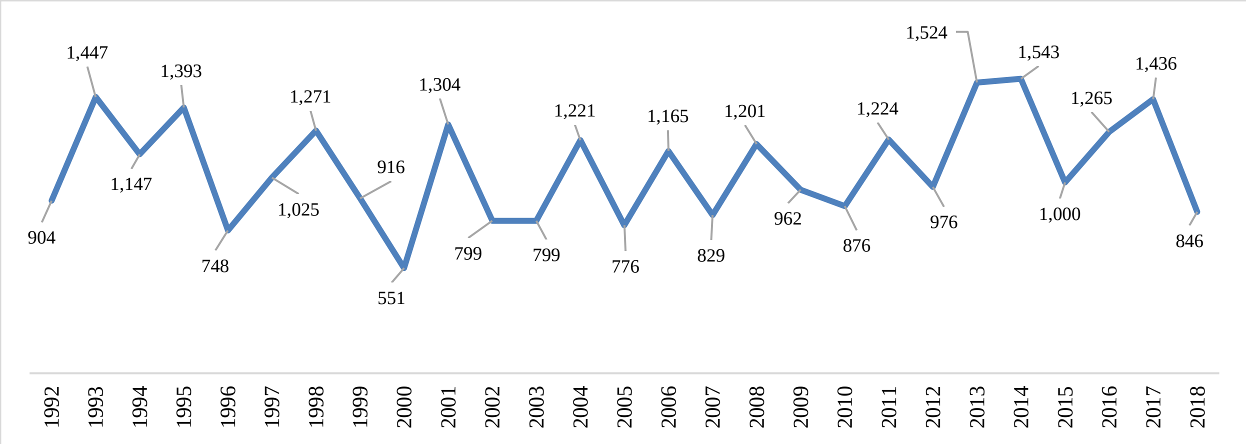

Fig. 2. Average production dynamics kg/ha (1992-2018)
Source: http://www.fao.org/faostat/fr/#data/QC, Accesed on 11.12.2020 [16].

In these circumstances, we can show that Romania has outrun 1.16 and 1.26 times the existing situations at global and European Union level (870 and 797 kg/ha – multiannual averages for the range 1992-2018). The existing correlation between the surface, total production and average production are presented in Table 1.

Table 1. Values of correlation coefficient (r) and determination coefficient (R^2) - for the surface, total production and average production

Correlation	r	R^2 linear function	R^2 polynomial function grade 2	R^2 polynomial function grade 3	R^2 polynomial function grade 4	R^2 polynomial function grade 5
Surface (ha) – total Production (t)	0.91827	0.8432	0.8433	0.8734	0.9229	0.9245
Surface (ha)-average production (kg/ha)	-0.283525	0.0804	0.0826	0.1197	0.3074	0.3128
Average production (kg/ha)-total production (t)	0.02467	0.0006	0.0028	0.0648	0.2117	0.2198

Source: own calculations.

The total area and production are found in a direct correlation resulting from the values of r (0.91827) and R^2 for linear function and polynomial function of grade 2, 3, 4 and 5 (0.8432, 0.8433, 08734, 0.9229 respectively 0.9245), which is highlighted by Figure 2. Starting with the degree 3 polynomial function, an ever-increasing correlation between the two aspects may be considered (Fig. 3). Between the surface and the average production, there is a correlation coefficient of -0.283525, respectively a reduced inverse dependence between the two aspects.
The determination coefficient R^2 has values of: 0.0804, 0.0826, 0.1197, 0.3074 and 0.3128 for linear function and polynomial functions of degree 2, 3, 4 and 5 (Fig. 4).
Consequently, there is a correlation between phenomena, but no mathematical model can be recommended for use.

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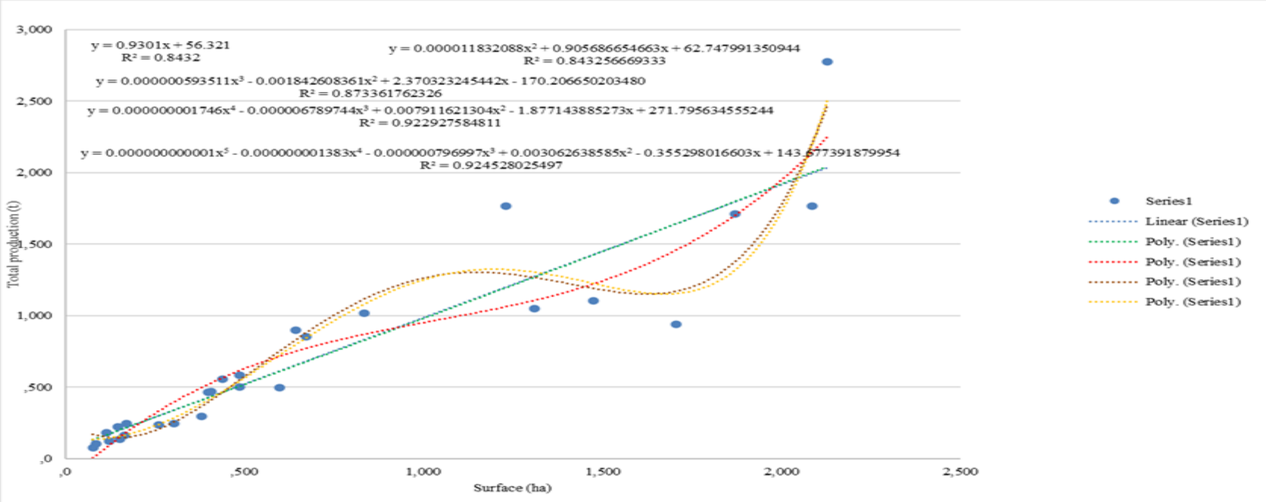

Fig. 3. Correlation between surface (ha) and total production (t)
Source: Own design and calculation.

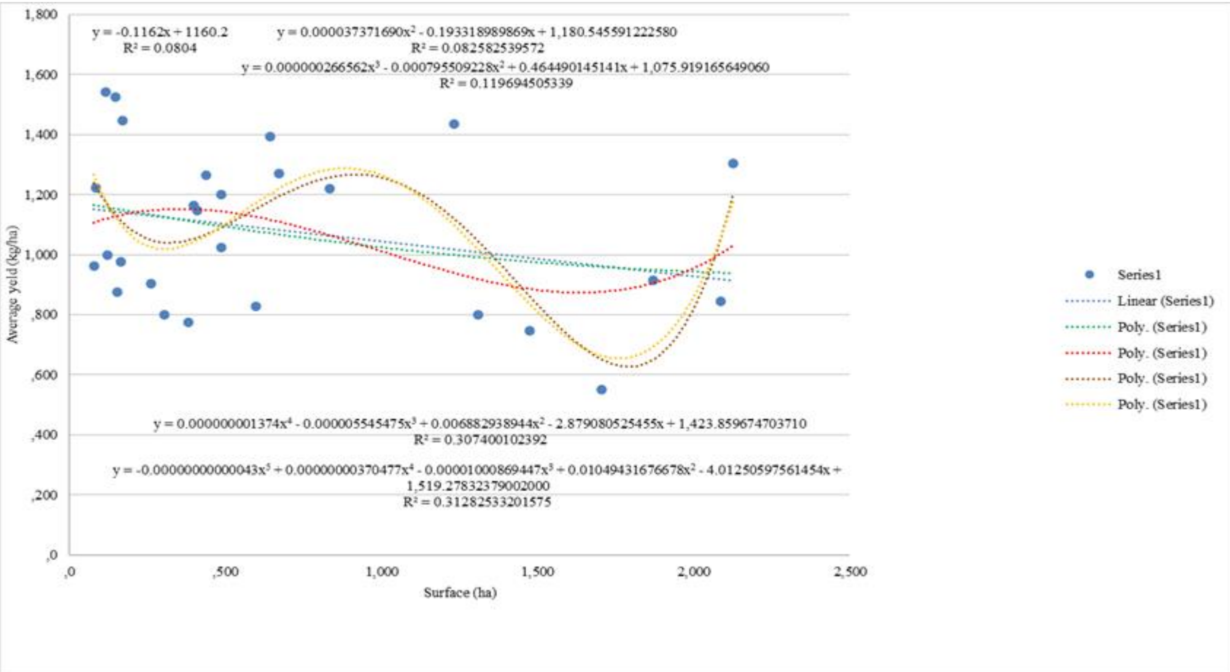

Fig. 4. Correlation between surface (ha) and average yield (kg/ha)
Source: Own design and calculation.

If we analyze the dependence between average output and total output, there is a very low positive correlation between the two (r = 0.02467). Starting from the values of the coefficients of determination (linear function and polynomial functions of degree 2, 3, 4 and 5), it is found that no mathematical prognostic model can be recommended for use (values less than 0.3 – Fig. 5).

The analysis of Romanian imports and exports of chickpeas was made in the context of the world market. In this respect, are worth noting the changes in trade policy related to agricultural products, which Romania has met during the period analyzed (transition from export quotas to liberalization of external markets).

Annually enter more than 1.3 million tons of chickpea in world markets to supplement the needs of countries unable to meet demand through domestic production [8]. The main exporters of chickpeas are Australia, India, Russia, Canada and the United States. The countries that import big quantity of chickpeas are Pakistan, India, Bangladesh, United Arab Emirates and Algeria [2].

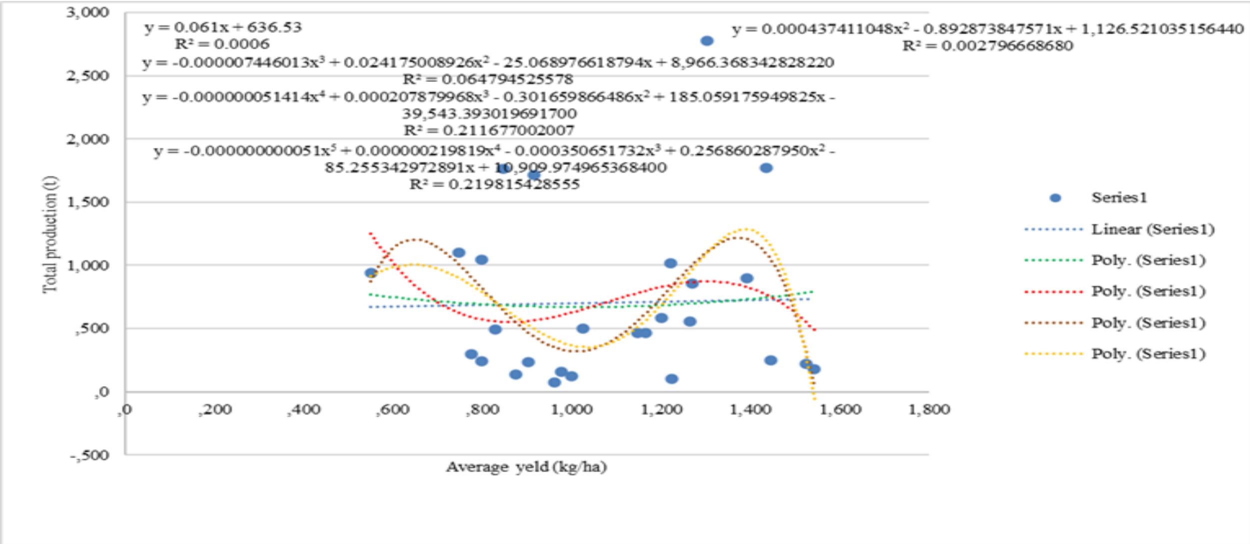

Fig. 5. Correlation between average yield (kg/ha) and total production (t)
Source: Own design and calculation.

We could say that the number of chickpea importing countries has been consistently increasing, which suggests an increase in the global demand [3].

In Romania, chickpeas must be take into account as an alternative to replacing meat products. In the market appears a varied, of products from chickpeas like beans and preparations (smoothies – humus, falafel, and couscous) [15].

Concrete issues relating to exports and imports of chickpeas are highlighted in the Figure 6.

The exports of chickpeas are at modest rates and are of uneven evolution. In the years 1992, 1994, 1996, 1997, 2000, 2002, 2007 and 2008 Romania did not realize the exports of chickpeas.

The variation limits of the indicator were 1 t in the years 2001, 2012 and 2014, respectively 320 t in the case of 2009. 13 years are met when Romania exported under 100 t and 6 years when this level was exceeded.

Romania has carried out imports of chickpeas during the entire period under consideration (from 48 t in the case of 1992 to 1,659 t at the level of 2018).

The indicator experienced an upward-uneven trend from 1992 to 2001, after which imports evolved upwards between 2002 and 2004 (384 to 1,191 t), descending between 2005 and 2009 (360 to 70 t), ascending between 2010 and 2018 (116 to 1,659 t).

Table 2 shows the correlation between total production, exports and imports.

Table 2. Values of correlation coefficient (r) and determination coefficient (R^2) - of total production, exports and imports

Correlation	R	R^2 linear function	R^2 polynomial function grade 2	R^2 polynomial function grade 3	R^2 polynomial function grade 4	R^2 polynomial function grade 5
Total production (t)-export (t)	-0.084548	0.0071	0.0407	0.3665	0.3859	0.4046
Total production (t) – Import (t)	0.777636	0.6047	0.6048	0.624	0.6277	0.6341
Export (t) - Import (t)	-0.014166	0.0002	0.0597	0.0597	0.1544	0.1582

Source: own calculations.

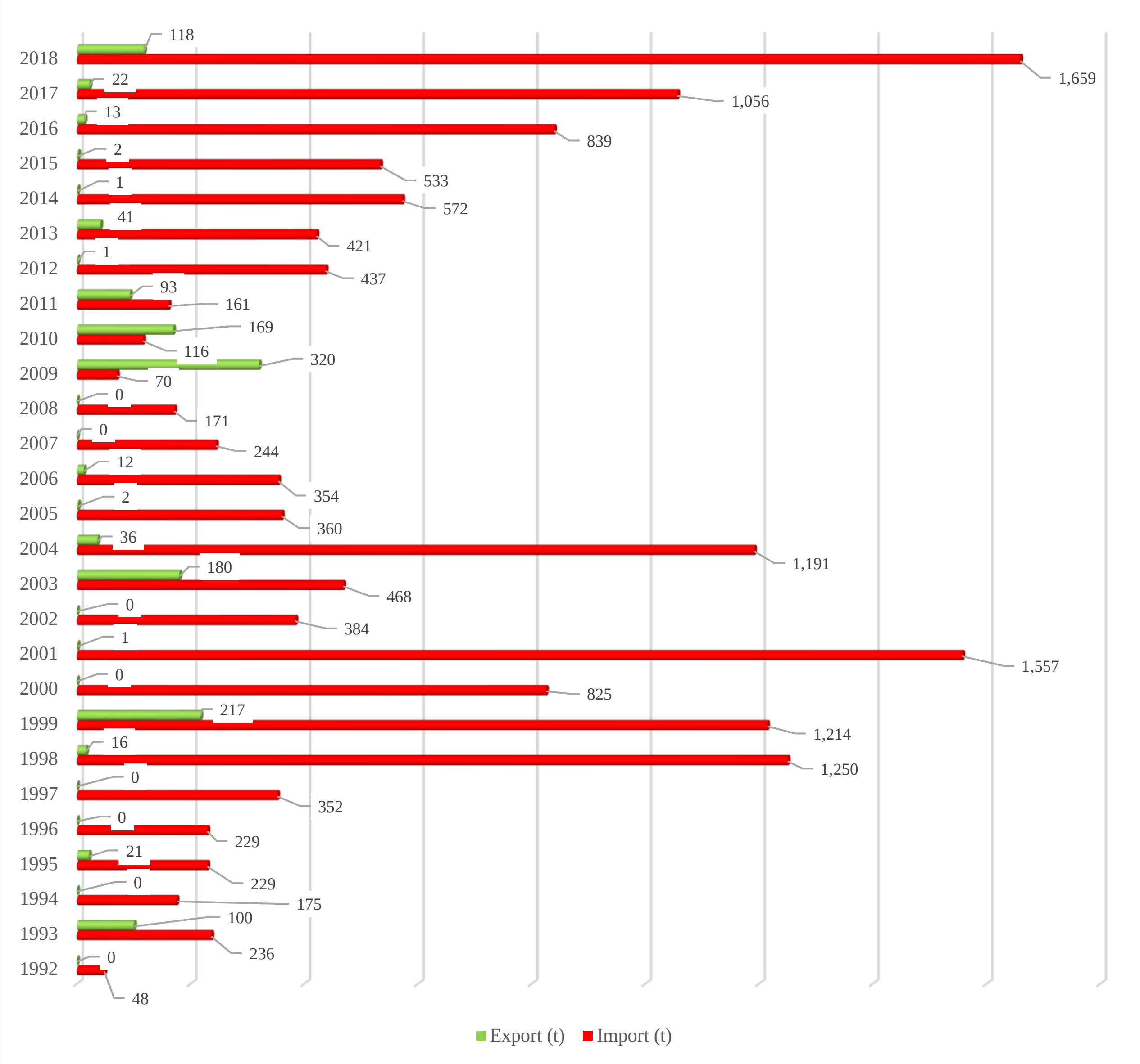

Fig. 6. Evolution of exports and imports of chickpeas (1992-2018)
Source: http://www.fao.org/faostat/fr/#data/TP, Accessed on 11.12.2020 [16].

Between total production and export, an indirect correlation is established which is not significant (r = -0.084548).

The mathematical models used (linear function, polynomial functions of grade 2, 3, 4, and 5) do not highlight a very significant link between phenomena (R^2 having values of 0.0071, 0.0407, 0.3665, 0.3859 and 0.4046 – Fig. 7). The correlation coefficient between total production and imports reveals a direct dependency between phenomena, a rather significant one (r = 0.777636).

The calculated determinants (R^2) by their values (0.6047 for the linear function 0.6048, 0.624, 0.6277 and 0.6341 respectively for the 2nd, 3rd, 4th and 5th polynomial function) highlight the links between total production and imports (Fig. 8).

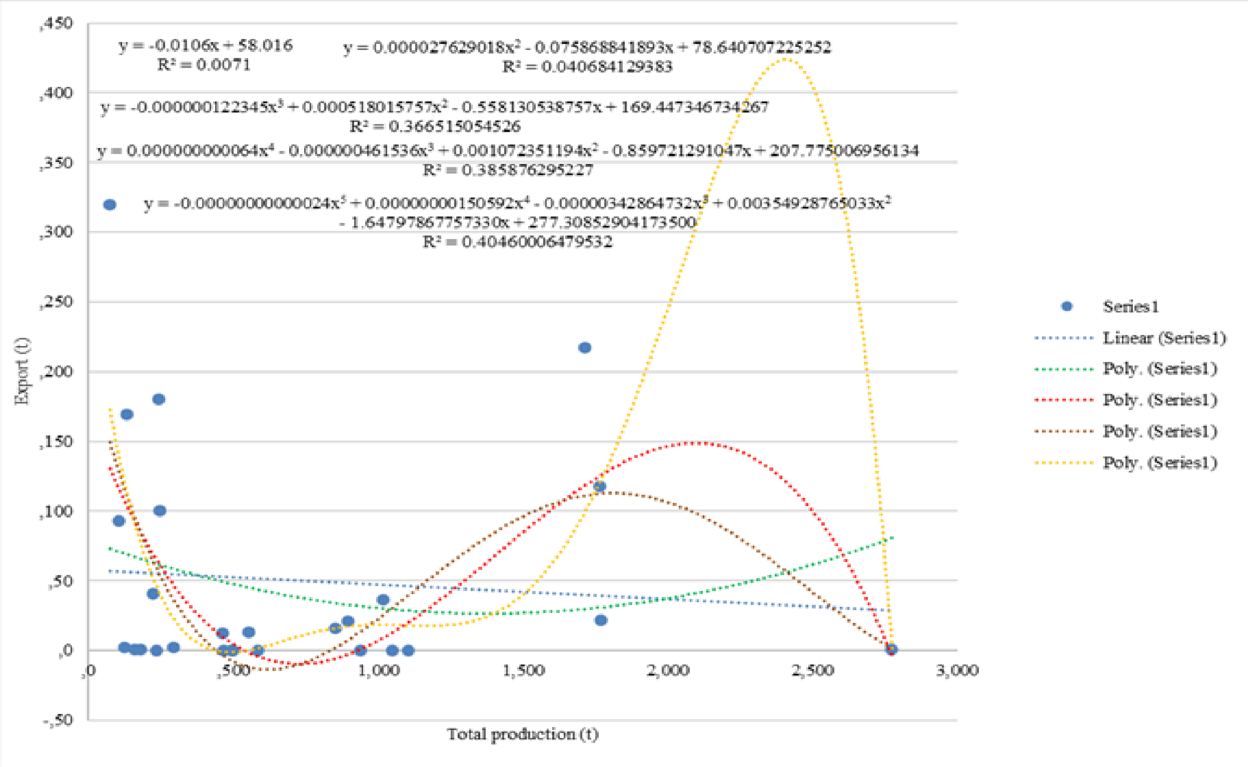

Fig. 7. Correlation between total production (t) and export (t)
Source: Own design and calculation.

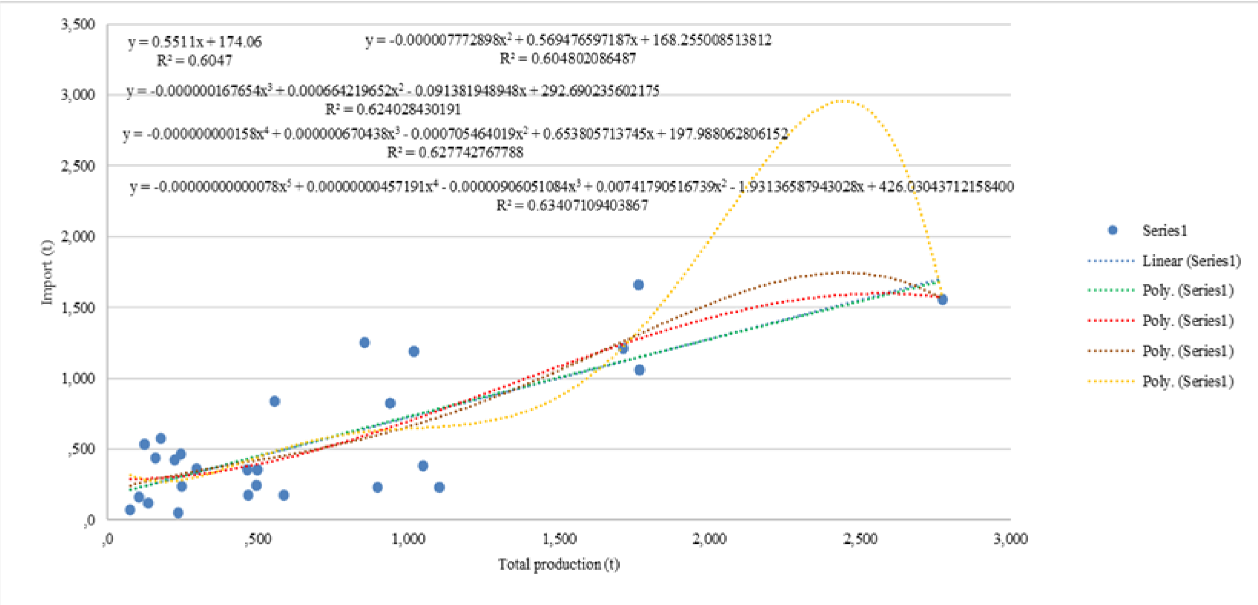

Fig. 8. Correlation between total production (t) and import (t)
Source: Own design and calculation.

There is a relatively low negative link between exports and imports (r = -0.014166). Linear function and grade 2, 3, 4 and 5 polynomial functions based on the determination coefficient (R^2 - 0.0002, 0.0597, 0.0597, 0.1544 and 0.1582) cannot be recommended as viable mathematical models (Fig. 9).

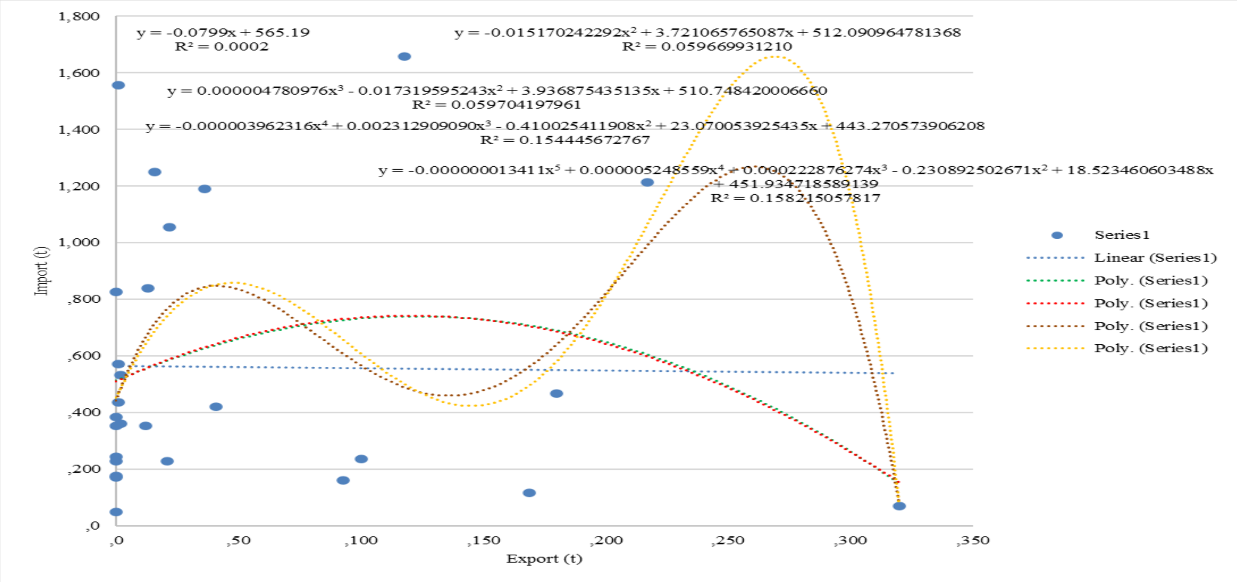

Fig. 9. Correlation between export (t) and import (t)
Source: Own design and calculation.

CONCLUSIONS

From the point of view of the cultivated area, there is a variation amplitude of 2,049 ha (2,127 ha in 2001 and 78 ha respectively in 2009), indicating that the indigenous producers had a very variable interest in this plant culture.
Total production also recorded a very large variation amplitude (2,698 t, with limits of 75 t in the case of 2009 and 2,773 t for 2001). The aspects are related to the transformations made by the manufacturing industry in Romania, but also to the possibilities of selling the product on foreign markets.
There is a direct correlation between the cultivated area and the total production, between the cultivated area and the average production there is an inverse (little significant) correlation, and between the average production and the total production there is an inverse correlation (less significant than the one mentioned above).
Between total production and export there is an indirect correlation that is not significant, a negative correlation is observed between exports and imports, while between total production and import the correlation is a fairly significant direct.
We consider that Romania can improve the situation of chickpea culture because the economic results are somewhat significant (producers in the southern area of Romania (Olt county), in the conditions of using the native genetic material - the basic biological category, obtained in 2018 average production of 2,800kg / ha at a production cost of 285.71 euro/t and sold the product at 500 euro/t, gross profit of 214.29 euro/t or 600.01 euro/ha). This situation may become even more favorable if the subsidy measures of producers are taken into consideration, given that chickpeas is a crop contributing to the improvement of soil properties. As a result, improvement of national trade balance for chickpeas can be achieved.

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ARE FOOD WASTE AND FOOD LOSS A REAL THREAT FOR FOOD SECURITY?

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Abstract

Food loss and waste is a global issue worldwide, posing a real challenge to both food security and sustainability. The productivity of our food system is reduced by food loss and waste, which can result in lower incomes for farmers and higher costs for food consumers. Food loss and waste occur at different levels along the food chain supply in production, postproduction procedures, processing, distribution and consumption. Concrete targets to reduce food loss and waste are necessary to be set at country levels focused on specific particularities. Thus, for developed countries the focus should be on waste, while for developing countries the focus should be on food loss, but also considering best solutions for reducing food waste in the future. The present review considers the most important data and relevant literature on this topic in order to offer significant insights and to identify knowledge gaps within literature. The present research should increase the interest for multifaced solutions to reduce food loss and waste in order to increase food security. Thus, short and long term solutions refer to proper identification of food loss and waste gaps along food chain supply, e-commerce platforms for products marketing, rethinking standards on aesthetic requirements for fruits and vegetables, shorter value chain in order to put the farmers in direct contact with markets and consumers, improved packaging during transport of fresh products, investing in agtech, biotechnology, smart packaging and consumers' education in using food and food-related resources more efficiently.

Key words**:** *food loss, food insecurity, food waste, resources, hunger,*

INTRODUCTION

In the last decades in the context of climate changes, food waste has become significant issue worldwide threatening food security by its multifaced aspects which have economic, social, technical, managerial, public health impact. Despite the worldwide request for nourishment security, millions of people still suffer from malnutrition around the world [1]. Food insecurity worldwide is not only about hunger, but also about unbalanced diets.

In fact, despite the cropping system progress, genetic and biotechnological advances, the relationship between food waste/food loss and food insecurity remains an increasingly societal problem and there is necessary new approach to identify those factors that contribute to a better management of food waste in order to reduce food insecurity [6][12][14][29][32][33]. For example, only the Covid-19 pandemic threatened food security up to an extra 132 million of people [27][40]. Previous research showed that if only 1/4 of the food wasted could be saved, it would be enough to feed all currently undernourished people [3]. More than 40% of food produced in the United States is not consumed and is ultimately wasted [17]. Another report suggested that around 25% of food waste is related to packaging along food chain supply because it does not meet

consumer demand for sustainable consumption [42]. Annually, 88 million tonnes of food are wasted in EU, which is equal to 174 kg food per person, 143 billion euros, 170 million tonnes of CO_2 [11].
A survey conducted with citizens in the EU-27 emphasised that factors like: attitudes, habits, motivation, education level, social norms, behaviour, income, facilities are strongly related with food waste [15][30].
By reducing food waste, it is possible to provide more food for consumption without increasing demand for higher yields [2]. Actually, in accordance with the Sustainable Development Goals (SDGs) is essential to reduce food insecurity by decreasing food waste at every stage of the supply chain (i.e., crop production and harvesting, processing, distribution and retail, restaurant and catering, household consumption) [36].

MATERIALS AND METHODS

The current study research included and synthetized relevant literature, indexed in international databases, to provide an integrated overview of the current state-of-knowledge on the article topic, adopting a qualitative informative approach based on books, scientific articles, news articles, reports and websites [39]. To reach the purpose of this paper there were used systematic, semi-systematic and integrative research approaches using an analytic comparation of current literature, papers, studies, reports and statistics in order to offer significant insights based on the article topic and to identify knowledge gaps within literature [24][38]. Also, it was used text mining method, which is a popular text analytical technique used to extract relationships and knowledge from a large number of textual documents. The literature, papers, studies and reports used in this review are organized into the following sections.

RESULTS AND DISCUSSIONS

Food waste and Food loss - facts and data

Different definitions were proposed for "food waste" and "food lost". Accordingly with U.N.Report: "Food loss occurs from farm up to and excluding retail, while food waste occurs at retail, food service and household level." Often, "food loss" and "food waste" refer to food products which are not consumed because of loss, waste or redirection for other uses [40].
A broader definition has been previously proposed by [37] who introduced the term "potential food loss and waste", including important preharvest losses due to pests and diseases attack, crops lost due to inefficient harvesting machineries end equipment, crops lost due to the unfavourable climatic events and food not produced due to lack of adequate agricultural inputs and technology.
Other authors define "food loss" as "an expected reduction in the quantity and quality of food during the production and post-harvest stages" [37]. This can be associated with pre- and post-harvest pest and diseases, lack of agricultural inputs, poor harvesting technics, unproper storage conditions, inefficient processing and packaging, volatile prices, gaps in distribution chain and inadequate consumption [13][22][25].
Nowadays food continues to be lost and wasted. Around the world about 1/3 of food destinated to human consumption is lost or wasted, the equivalent of 1 billion metric tonnes per year, which means $940 billion in economic losses annually.
An U.N. Report emphasized that today about 690 million people are hungry and three billion cannot afford a healthy diet. Actually, one in nine people remain unnourished [40].
Every year about 14% of the world's food is lost before even reaching the market [40].
Approximatively, 56% of food loss and waste occurs in developed countries, while 44% in developing ones, which means approximatively 1 billion metric tonnes, equivalent to 24 percent of all food calories produced for human consumption [40].
In terms of calories 61% per person per day are lost or wasted by consumers and 81% per person per day are lost or wasted in production, storage, transport, etc. [40].
Food loss and waste may occur at different stages along the food value chain: production, postproduction, processing, transport and

consumption. People buy more food than they need and usually end up by throwing away a large amount of food between 35-50% among all categories of food, fruits and vegetables, respectively roots and tubers are exposed to highest loss, both with 45%, followed by cereals (30%), fish and seafood (30%), oilseeds (20%), dairy (20%), meat (20%) [40].

It was estimated that in the UK, people waste significant amounts of basic groceries every day, including 20 million slices of bread, 5.2 million glasses of milk, 4.4 million potatoes, 2.2 million slices of ham, 1.2 million tomatoes and 0.9 million bananas [21]. Even when people think they do not waste food, actually they waste 2.9 kg per week (vegetables peelings, coffee grounds, eggs shells, bones, etc.) [21].

Definitely, consumers accounted for the largest share of food waste at 44%, followed by restaurants (33%), grocery stores (11%), institutions (10%), and industry (2%) [20].

This may be different by geography. Annually, consumers in wealthy countries waste as much food as sub-Saharan Africa's net food production. Most losses and losses in developing countries are in retail and home chains [23].

Food waste leads to waste of other natural resources. It was estimated that 1.4 billion hectares of land and 25% of the word’s fresh water are used to produce food that will be thrown away. For example, when an orange is thrown away, 80 litres of water are lost, while when 1 kg of lettuce is thrown away, 240 litres of water are wasted [26].

Annually, food loss is valuated at $400 billion, generating environmental impact, like greenhouse gas emissions [40].

Food waste/Food loss and greenhouse gas emissions

Food waste and loss not only wastes money, but it also has a detrimental impact on the environment by eliminating greenhouse gas emissions into the air, especially methane, which is 23 times more deadly than carbon monoxide and 25 times more potent than carbon dioxide for the environment. About 8-10% of global greenhouse gas emissions are associated with food that is not consumed [41].

It has been estimated that if food waste were a country, it would be the third largest polluting country in the world [41].

The more food loss occurs, the more carbon emission grows, because there are wasted the additional resources involved in the production and along the food chain supply.

Different foods affect the environment in different ways. For example, the greatest impact on the carbon footprint is given by wastage of cereals and vegetables, which are estimated to contribute to 25-30% of the carbon footprint of global food wastage.

Although meat accounts for only 5% of total food waste, it has a significant impact on climate change, generating more than 20% of our carbon footprint [16]. This is because meat contributes to the overall carbon footprint along with emissions of ruminants (methane), feed production and manure management.

The largest carbon footprint of losses in the food chain is the consumption phase (37% of the total), whereas consumption only accounts for 22% of total food waste. It was observed that at early stage of production, one kilogram of food that is wasted produces less carbon that it will have further along the supply chain [16]. Therefore, food loss and waste must be part of a global climate strategy to reduce the environmental impact of agricultural production and the entire food chain.

Solutions to reduce food waste and food loss

Food loss and waste have a major impact on global food production, which can lead to lower incomes for farmers and higher costs for consumers.

Therefore, reducing food waste and food waste is an urgent task and several actions can be taken to achieve the goal of “lossless, no-waste”. The operations in the waste hierarchy are: prevent, reuse, recycle, reprocess, recover energy, dispose. Prevention remains the top priority when it comes about food waste, followed by reuse of unsold food.

An important issue to avoid food waste is training courses for personnel at any stage of the supply chain and for consumers in order to get more clear information about food packaging, storage, preparing, portion size, nutritional values, proper combinations of food products and about food redirection to people in need, or to feed animals or to produce fertiliser or compost that can be used for soil enrichment or into renewable energy (biofuels) [19]. Composting is an environmentally-friendly way to reduce food waste [35].

Other solutions for food waste are applying innovation (e-commerce platforms for products marketing), rethinking standards on aesthetic requirements for fruits and vegetables, shorter value chain in order to put the farmers in direct contact with markets and consumers, improved packaging during transport of fresh products, investing in agtech. Also, biotechnology and gene editing have the potential to reduce food loss by increasing yield, breeding cultivars with favourable traits like drought and heat resistance, pest and diseases resistance and improved nutraceutical properties [4][5][7][8][9][28][34].

Other solution to reduce food waste is to use intelligent technology like disposable sensors with Internet-of-Things capabilities in order to monitor ideal temperature and humidity of perishable products in storage spaces. Only in Australia food waste in the cold food chain costs the economy $3.8 billion per year [31].

Smart packaging that monitors food conditions and detects when it can expire or printable food ink sensors for detecting gases produced by bacteria, might be other way to reduce food waste.

Marketing ugly fruits and vegetables, advertised as “ugly produce” associated with a moderate price discount might be also a solution for reducing food waste. About 30% of farmers crops are unfit for sale in supermarkets because they do not meet aesthetic standards and unattractive fruits and vegetables are perceived as lower in quality [18].

It was estimated $15.4 billion are lost annually that in The United States due to costumers’ rejection of “ugly”, “unpopular” fruits and vegetables [10]. However, reducing food waste and loss involves multiple strategies, but one of the most important tools remains costumers’ buying habits. But consumers will not eliminate food waste on their own. The websites, social media and mobile apps can help in educated costumers in using food and food-related resources more efficiently.

CONCLUSIONS

Crops pests and diseases, extreme weather conditions, harvest and postharvest operations, unstable food price and costumers’ habits and incomes can have a major impact on food lost and waste.

Food loss and wastage happens at all stages of the food supply chains for different reasons that are very much dependent on the specific conditions within each country. At a global level, it was noticed that in high income regions, volumes of wasted food are higher in the processing, distribution and consumption stages, whereas in low-income countries, food losses occur in the production and post-harvesting phases.

Reducing food waste and loss in order to decrease food insecurity includes agricultural solutions, better collaboration along the chain “farm to fork”, better cold chains, more intelligent demand and supply system, innovative packaging, reusing unsold and not consumed food for feeding animals or making compost.

Reducing food lost or food waste implies more food for all, less greenhouse gas emissions, healthier environment, and increased productivity and economic growth.

Reducing food waste and losses can lead to sustainable food security by improving food availability and food access, without increasing agricultural inputs and additional costs to the food chain.

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DEVELOPMENT OF EXPORT POTENTIAL OF UKRAINE'S AGRICULTURAL SECTOR

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Abstract

Given the trends of the economic development, economic crisis, situation of food security, impact of the pandemic Covid-19, it is sensible to research the situation in the agricultural sector in the world and in Ukraine, identify areas for development and assess export potential. These trends indicate the appropriateness and relevance of the study. The aim of the research is to study the state of the agricultural sector of Ukraine and identify areas of development, prospects for development, assessment of export opportunities and export potential. The initial data for the research are obtained on the portal of the State Statistics Service of Ukraine. In the process of research the methods of comparison, analysis, synthesis, generalization, SWOT-analysis are used. The results of the research indicate that Ukrainian enterprises of the agricultural sector are technically equipped, produce high quality products that fit international norms, but concerning the geography of trade of most rural companies, it should be noted a great number of unexplored markets. Moreover, it should be noted that the development of export potential will be facilitated by innovations in the agricultural sector, development of infrastructure in the country, attracting investment.

Key words**:** *export potential, agricultural sector of Ukraine, export, international activity*

INTRODUCTION

Ukrainian agricultural business occupies a particular position in international trade. For a long period of time, Ukrainian agribusiness remains an influential exporter on the world market of sunflower oil and grain. The leading positions in world trade are occupied by cereals, namely wheat, corn, barley, as well as sunflowers, sugar beets, beans, fruits and vegetables.

Ukraine's agriculture plays a significant role in the structure of exports. As of the end of 2020, the agricultural sector has brought the country almost 40% of foreign exchange earnings, showing stability over the past three years. Ukrainian agrarians produce 90-100 million tons of grain per year, which is one of the highest world indicators [7]. With annual sales of 50-60 million tons of grain, Ukraine ranked third in terms of exports [5]. Ukraine exported grain crops in 2021 for $12.35 billion, which is more than in 2020 for 31.1%, including corn was exported by $5.89 billion, wheat is by $5.07 billion, and barley is by $1.28 billion [8].

In this context, the purpose of the paper was to study the state of the agricultural sector of Ukraine and identify areas and prospects of development, assessment of export opportunities and export potential.

MATERIALS AND METHODS

The information base of the research was the data of the State Statistics Service of Ukraine. The article explores the tendencies of world trade in the agricultural sector of Ukraine, examines the prospects for export. The period considered for analysis the year 2020 compared to 2019.

The main studied indicators were: value indicators of total exports and imports of agrarian products, growth rates of trade in agrarian goods, volumes in international trade in agrarian goods, values of trade in agrarian goods by region, share of agricultural product in GDP.

The specific indicators reflecting the efficiency of foreign trade are trade balance, export/import ratio, terms of trade index (quantities and price), and indicators of export growth dynamics.

The methodology used in this research included general scientific and special methods of research of export potential as comparison, monitoring, abstraction and concretization, analysis, synthesis, induction, deduction, historical and logical methods. SWOT analysis used as a tool for assessing the external and internal environment of agribusiness.

RESULTS AND DISCUSSIONS

As of 2020, about 280,000 hectares of agricultural land under organic production are registered in Ukraine. Most of the land is concentrated under cereals is 133.4 thousand hectares, or 46% of all agricultural land under organic [8]. Over the past 10 years, the amount of agricultural land for organic production has increased by 39 thousand hectares [10].

Agribusiness in Ukraine is a priority segment in exports, given the signing of the Association Agreement between Ukraine and the EU and the Agreement on the Free Trade Zone. According to the State Statistics Service of Ukraine, for 9 months of 2021 Ukraine increased the total exports to the EU by 50% to $21.8 billion, for 9 months of 2020 this data was $14.7 billion [5]. Based on the monitoring data of the European Commission on trade in agricultural products, Ukraine occupies a top position in the structure of exporters of the agricultural sector to the EU countries.

After the signing of an agreement on a free trade zone between Ukraine and the EU, Ukrainian agrarians received additional quotas for honey, grape juice, processed tomatoes, barley, oats, wheat, barley and corn on preferential terms [2]. In addition to crop products, the European Commission has increased the quota for livestock products, namely, introduced duty-free import of chicken. Some tariff quotas are used up by Ukrainian exporters to the EU during the year, such agricultural products are honey, corn, barley groats and flour, processed starch [5].

Consider the commodity structure of Ukraine's foreign trade in agricultural sector in 2020 (Table 1).

For some goods, there is a negative trade balance and, accordingly, the export-import coverage ratio is below 1, such as live animals, fish and crustaceans, vegetables, edible fruits and nuts, natural shellac, meat and fish products, cocoa and cocoa products, vegetable processing products, different foods, alcohol and soft drinks and vinegar, tobacco and industrial tobacco substitutes etc.

Terms of trade are special index of export and import prices. If the index is greater than 100%, a country has positive terms of trade and the country is accumulating more capital from exports than it is spending on imports. Terms of trade quantitative and price is greater than 100% for meat and edible offal in Ukraine. Ukrainian agrarians took the leading positions in the world exports of 2020 for such goods as sunflower oil (1st place), sunflower meal (1st place), rapeseed (2nd place), millet (2nd place), corn (4th place), barley (4th place), wheat (5th place), soybeans (7th place) [3].

As for the import of agricultural products from Ukraine, it should be noted that there is a downward trend in 2020 for the following commodity groups as milk and dairy products, eggs, honey by 82.0%; fruits and nuts by 18.1%; tobacco by 12.3%; alcoholic and non-alcoholic drinks by 10.2%; vegetables by 23.6%; cocoa and cocoa products by 14.9%; other food products by 10.3%; grain products by 20.3%; fish and seafood by 5.5%; meat products by 26.1%; coffee, tea and spices by 13.0%; fat and oil products by 10.7%; processed products of vegetables and fruits by 10.0% [5].

Due to the aggravation of the food crisis, the market for agricultural products is growing on world markets. Analyzing the structure of the world market for agricultural products, we should pay attention to the uneven development of individual foreign markets.

Table 1.Commodity structure of Ukraine's foreign trade in agricultural sector in 2020 versus 2019

Code and name of goods*	Export			Import			Terms of trade index / quantitative	Terms of trade index / price	Trade balance	Export/ Import ratio
	thousand dollars USA	with 2020/ 2019 %	in% to the total	thousand dollars USA	with 2020/ 2019 %	in% to the total				
Total	49,212,901.3	98.3	100.0	54,091,267.8	89.0	100.0	92.9	99.3	-4,878,366.5	90.9
including:										
I. Live animals; animal products	1,188,368.1	93.1	2.4	1,257,768.0	117.4	2.3	77.0	101.3	-69,399.9	94.5
01 live animals	51,524.1	82.4	0.1	80,912.1	105.6	0.1	96.5	91,2	-29,388.0	63.7
02 meat and edible offal	652,235.8	91.6	1.3	165,010.4	104.0	0.3	113.1	105.2	487,225.4	395.3
03 fish and crustaceans	42,204.0	125.5	0.1	680,271.5	105.5	1.3	46.4	111.2	-638,067.5	6.2
04 milk and dairy products, poultry eggs; natural honey	426,598.9	94.0	0.9	308,396.9	182.0	0.6	119.5	83.8	118,202.0	138.3
05 other animal products	15,805.2	105.0	0.0	23,177.2	104.8	0.0	77.0	101.3	-7,372.0	68.2
II. Vegetable products	11,890,050.9	92.1	24.2	1,988,349.6	110.8	3.7	91.8	98.1	9,901,701.3	598.1
06 living trees and other plants	5,746.6	88.7	0.0	48,790.8	119.3	0.1	72.5	102.6	-43,044.2	11.8
07 vegetables	168,147.4	91.1	0.3	262,508.0	123.6	0.5	74.2	99.3	-94,360.6	64.1
08 edible fruits and nuts	238,399.6	91.7	0.5	794,893.7	118.1	1.5	71.7	108.3	-556,494.1	30.0
09 coffee, tea	15,011.2	128.2	0.0	251,294.7	113.0	0.5	96.3	117.8	-236,283.5	5.9
10 grain crops	9,417,313.8	97.8	19.1	178,912.0	98.9	0.3	102.4	96.6	9,238,401.8	5,263.6
11 products of the flour and cereals industry	154,639.6	76.5	0.3	35,161.0	100.2	0.1	88.7	86.1	119,478.6	439.8
12 seeds and fruits of oilseeds	1,842,436.6	71.9	3.7	388,047.9	96.8	0.7	70.1	105.9	1,454,388.7	474.8
13 natural shellac	944.1	115.3	0.0	28,036.0	99.1	0.1	125.1	93.0	-27,091.9	3.4
14 vegetable materials for production	47,412.0	90.8	0.1	705.4	99.6	0.0	124.9	73.0	46,706.6	6,721.3
III. 15 Animal or vegetable fats and oils	5,759,599.1	121.7	11.7	280,379.8	110.7	0.5	113.0	97.3	5,479,219.3	2,054.2
IV. Ready-made food products	3,361,124.0	104.4	6.8	2,968,950.4	113.5	5.5	90.0	100.4	392,173.6	113.2
16 meat and fish products	22,603.0	99.0	0.0	160,617.8	126.1	0.3	85.8	91.5	-138,014.8	14.1
17 sugar and confectionery	250,241.4	98.4	0.5	74,092.6	105.1	0.1	96.9	96.6	176,148.8	337.7
18 cocoa and cocoa products	201,400.2	98.4	0.4	375,925.4	114.9	0.7	84.2	101.7	-174,525.2	53.6
19 finished grain products	313,077.2	116.2	0.6	241,472.9	120.3	0.4	90.4	106.9	71,604.3	129.7
20 vegetable processing products	172,633.0	90.0	0.4	208,991.8	110.0	0.4	77.1	106.1	-36,358.8	82.6
21 different foods	159,621.3	111.9	0.3	484,871.9	110.3	0.9	101.1	100.4	-325,250.6	32.9
22 alcohol and soft drinks and vinegar	223,688.5	106.1	0.5	587,440.1	110.2	1.1	89.1	108.1	-363,751.6	38.1
23 residues and wastes of the food industry	1,576,500.6	106.1	3.2	278,047.9	120.1	0.5	88.9	99.3	1,298,452.7	567.0
24 tobacco and industrial tobacco substitutes	441,358.8	100.9	0.9	557,490.0	112.3	1.0	96.7	92.9	-116,131.2	79.2

Source: calculation by the author according to the data of the State Statistics Service of Ukraine [5].
Note: *according to Ukrainian classification of foreign economics goods.

The share of agricultural products in GDP can be divided into growing markets are 98 countries as 51%, underdeveloped markets are 37 countries as 19%, markets with insufficient supply and demand are 24 countries as12%, mature markets are 35 countries as 18%. Countries such as Australia, Belarus, Brazil, Bulgaria, Greece, Canada, China, Mexico, Germany, New Zealand, Russian Federation, USA, France, and Japan are steadily growing markets for agricultural products today. This group of markets is gradually growing from 1% to 10% in the share of agricultural products in the gross domestic product [5;

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11]. Vietnam, India, Moldova, Thailand, Ukraine belong to the group of countries with mature markets, they account for 10-25% of agricultural products in terms of GDP. 37 countries belong to the group of underdeveloped agricultural markets; in their GDP, the share of agricultural products ranges from 0% to 1%. Some countries are characterized by markets with insufficient demand and supply; these are the markets of countries with the largest share of agricultural products in GDP (25%-60%). The group of these countries is represented by the countries of Africa, Asia, the island states of the Indian and Pacific Oceans, which is about 12% of the world market, these countries produce agricultural products mainly for their own consumption and practically do not engage in foreign economic activity.

Thus, large producers of some agricultural products are almost always the world's leading exporters. However, China and India cannot be considered the leading exporters due to their large population, which creates demand for agricultural products and limits their supply on the world market. As for importers, these are countries where the production of agricultural products either does not fully meet domestic demand, or is limited by certain climatic conditions or other problems. Most countries of the world are quite productively using their domestic agricultural potential, but there are countries that, despite the existing opportunities, do not fully use their potential.

Today, when the market is saturated with both domestic and imported goods, and purchasing power is not very high, competition is intensifying. In order to make your product special or unique, you need not only knowledge of the customer's needs, but also new equipment, new technologies, and this requires significant investment. In market conditions, some companies benefit precisely because of the quality of service offered by the service, the use of advertising technologies, the correct positioning of goods in the market, trying to constantly expand market positions. Analysis of the world market for agricultural products showed that the market is unstable, volatile, which encourages the leadership of Ukrainian agricultural firms to expand foreign economic activity, seek new buyers in new countries, to minimize the risk of losing markets.

The features that characterize the agricultural market are seasonality, dependence on weather and natural conditions, the specificity of agricultural production, as well as inelastic demand for products, which determine the vital needs of the population. The world agricultural market is characterized, in addition, by the massive consumption of food, the social significance of goods, and the high level of state regulation with the help of tariff and non-tariff instruments, such as quotas, import duties, sanitary and phytosanitary measures, subsidies for producers (farmers) and exporters, and others [1]. The list of restrictive regulatory instruments is established by the governments of the countries taking into account national conditions and global significance. Exports of agricultural products are affected by price, location of production facilities, the amount of duties, the availability of quotas, as well as natural conditions that affect the quantity and the quality. The expansion of foreign markets of the enterprise is a complex and complex issue, to address which it is necessary to determine the factors influencing the choice of market for agricultural products (Figure 1).

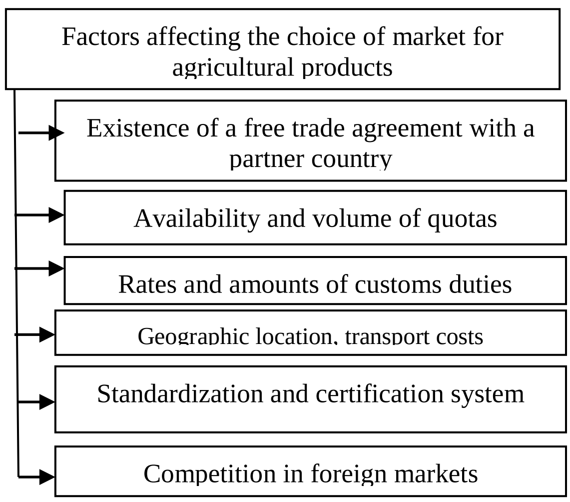

Fig. 1. Factors affecting the choice of market for agricultural products.
Source: designed by authors.

When studying the factors affecting the choice of markets for agricultural products, it should take into account industry characteristics, government regulation, terms of free trade agreements and others, presented in Figure 1. Agribusiness is a very diverse field of activity, each of the sub-sectors is characterized by its own characteristics. When choosing a country of export, suppliers need to study in detail trade regimes, take into account restrictions on the import of products that are introduced to protect domestic producers by setting customs duties, introducing quotas, requiring a special license, and more. Exported agricultural products must fit the quality requirements of the importing country, namely labelling, standardization, safety, etc. For guaranteed supplies of agricultural products, the governments of the countries sign interstate agreements. Export and import requirements are specific parameters required for analysis and accounting by national governments. Table 2 presents an analysis of the strengths and weaknesses, as well as threats and opportunities for Ukrainian agricultural producers in foreign markets.

Table 2. SWOT-analysis of Ukrainian agricultural producers in foreign markets

Strengths	Weaknesses
1. Product quality 2. Availability of quality certificates 3. Competitive price 4. Modern powerful equipment 5. Sufficient production capacity 6. Export deliveries to some countries have been established 7. Positive image	1. High competition in the market 2. Unbundled relationships with market counterparties 3. Location of production facilities of the enterprise far from the borders with EU countries
Opportunities	**Threats**
1. Gradual increase of quotas within free trade zones. 2. Strengthening integration processes 3. Stimulation and support of export of products of Ukrainian producers by the state.	1. Seasonality of agricultural products. 2. Unexpected price fluctuations in the world market. 3. High competition between agricultural producers on the world market 4. High standards and requirements for food products. 5. Complex process of finding contractors.

Source: designed by authors.

Based on the results of the SWOT analysis of Ukrainian agricultural producers regarding export opportunities, it is necessary to highlight the strengths that provide additional opportunities, enhancing the export potential. Ukrainian farmers manufacture high-quality products that fully comply with international quality standards, all products have the necessary certificates; agricultural firms are equipped with modern technologies.

In the process of studying the geography of exports of some Ukrainian agricultural producers, it is necessary to highlight such threats as ignoring the markets of developing countries, focusing on a narrow studied market segment, and lack of diversification. The market of African countries is interesting for research. Exports to the African continent should continue to grow as many African countries have problems with providing food to their populations.

In recent years, African countries have become a promising sales market for Ukrainian agricultural products. The reasons for the promising export of Ukrainian food products to African countries is that the population growth rates are one of the highest here, while the national food production does not provide the growing demand. According to UN estimates, the population of sub-Saharan Africa is approaching 1 billion, which is twice as many as in the EU or North America. That is, the increase in the population of African countries is able to meet the demand for Ukrainian food products. In addition, population growth is accompanied by rapid urbanization. Large agglomerations cover part of the demand for food through imports, as agricultural production in rural areas of African countries is unproductive. Also interesting is the fact that the rate of economic growth in African countries is ahead of the rate of population growth, i.e. countries are solvent.

At the moment, the main consumers of Ukrainian agricultural products on the Sub-Saharan Africa are Ethiopia, Nigeria, Djibouti, South Africa, Senegal, Kenya, Ghana and Mauritania. Considering that the incomes of the African population are quite low, and the prices for Ukrainian agricultural products are low, this makes them competitive in this market. Today, the supply of Ukrainian agricultural goods to Tanzania, Guinea, Mozambique, Cameroon, Congo, Namibia, Uganda, Mali, Angola, Liberia, Togo, Benin and Somalia remains insignificant. Wheat, corn, flour, poultry, pork, eggs, condensed milk and cream, and cheese are promising niches for export. Some of the competitive goods on the African market are grain, corn, dairy products.

African markets are not similar, have different capacities and diversified demand that meets Ukrainian supply. With a low standard of living, the population of Africa needs cheap goods of medium quality. The key criteria when choosing goods for sale in Africa are the ability to store the product for a long time without special equipment; low price segment; the presence of similar products on the market that are already familiar to consumers; use of B2C (own-brand) and B2B (distributor's) market technologies. The main competitors in the markets of Sub-Saharan Africa for Ukrainian agricultural producers are New Zealand and EU countries. Given the right export policy for Ukrainian agricultural firms to enter the markets of Sub-Saharan Africa, the range of its potential exports is in a wide range.

Expanding the market in Africa requires detailed preparation and planning of exports. One of the most difficult steps is choosing the target country. High levels of risk are inherent in exports to all African countries. In-depth research into local markets is needed to find partners and understand the external market. Essential goods and dry food are a priority for most markets. To determine the most attractive agricultural products for export, a comprehensive analysis of potential partner countries should be conducted.

Nigeria, Angola, South Africa and Ghana may be a priority for the export of Ukrainian agricultural firms. The economies of these countries are growing slowly due to the production of fuel and chemicals, but the agricultural sector is shrinking due to difficult weather conditions for agriculture.

To determine the feasibility of exports to Africa, it is also necessary to calculate the logistical component of exports. In the process of transportation to African countries, mainly sea transport is used, in terms of customs tariffs and fees, as most countries have not signed trade agreements; the full rate of payment is used. With regard to standardization and certification, all agricultural and food products exported to African countries must be accompanied by an appropriate phytosanitary, medical or veterinary certificate issued by the regulatory authorities of the exporter. Customs clearance involves the provision of the necessary package of documents, while obtaining an import permit simplifies this procedure and the process of inspecting goods. With regard to processed foods that can be supplied to African countries through an importer, separate registration of these products is not required. The main regulations governing food security in Africa are The Foodstuffs, Disinfectants and Cosmetics Act (FDCA) 54 of 1972: (Regulations on Food, Disinfectants and Cosmetics), Consumer Protection Act, 2008: (Consumer Protection Act), The Health Act, 1977: Animal Disease Act (1984), Meat Safety Act, 2000: Animal Disease Act, 2000) [4]. Thus, a brief study of the markets of African countries shows that entering these markets is a complex and time-consuming process, while the process of obtaining certificates of quality, compliance with standards is not quite demanding and unfeasible.

We will evaluate the prospects of exports of Ukrainian agricultural products to the EU countries. Some markets of European countries have been sufficiently studied by Ukrainian agribusiness and are actively used for export. Let's move on to assessing the difficulties of exporting agricultural products to the countries of the European Union. Firstly, Ukrainian farmers need to draw up and receive the required documents to confirm the conformity of products to EU requirements. Secondly, EU countries are exporters of a significant amount of agricultural products. In order to occupy leading positions in agricultural markets, EU countries are implementing modern technologies that help ensure the required production volumes, regardless of weather conditions. EU countries also buy agricultural products from other countries in order to create a strategic stock. In addition, the export of most agricultural goods to EU countries is subject to tariff quotas, which limit the volume of exports of Ukrainian agricultural producers. For example, milk has a tariff quota of 3,600 tons in 2019, 4,300 tons in 2020 and 5,000 tons in 2021 [6].

To enter the EU markets, Ukrainian agricultural firms use a B2B market strategy. Mandatory condition for export to the European Union is to obtain an operating permit number and issue a certificate EUR.1. Compliance with international food quality and safety standards is a prerequisite for the export of agricultural products to EU countries. As for the priority requirements for the import of Ukrainian agricultural products into the EU countries, they must be confirmed by a certificate of origin, have a quality certificate issued by the competent authority of the exporting country, and must also be checked at the EU checkpoint. At the same time, for each group of risks it is necessary to determine management methods and ways to prevent possible risk situations (Table 3).

Table 3. Risks of export of Ukrainian agricultural products to the EU and methods of their prevention

Group of risks	Risk factor	Management method	Methods of risk prevention
Competitive risks	Competitive impact on target markets	Risk localization and increased control	Improving quality; increase in volume, improving the effectiveness of communication policy
Risks of uncertainty of the external environment	Uncertainty of demand Uncertainty of the maximum price that can be expected	Risk dissipation	Signing forward contracts
Risks of potential losses	Focus on sales and marketing	Risk localization and increased control	Creating reserves of resources to cover contingencies
Risks of overestimation of opportunities for commercialization of development	Revaluation of relationships with prospective consumers	Risk localization and increased control	Diversification

Source: designed by authors.

Thus, risk assessment provides an opportunity to analyse the operating environment of the agricultural firm and develop tools to prevent risks. To prevent the main risks of agricultural exports to the EU, it is advisable to focus on improving quality, increasing supplies, effective communication policy with partners [9], concluding forward contracts, creating reserves of resources to cover contingencies, and diversifying export supplies.

Thus, the export of Ukrainian agricultural products to the EU countries has certain technical and organizational difficulties, which are quite expensive and labour-intensive. At the same time, Ukrainian agricultural firms' exporters to the EU have significant advantages that allow them to increase profitability, competitiveness, strengthen their position and reputation in the market. That is, Ukrainian agricultural firms should ensure a high level of quality of their own products, which would fully meet European standards in order to open new opportunities for foreign economic activity in the long run.

CONCLUSIONS

Ukraine has significant export potential in the agricultural sector. Expansion of exports is possible subject to mandatory food requirements. In addition, support by state institutions for the agricultural sector is important. To increase the export potential of Ukraine in the agricultural sector, it is necessary to develop and modernize the auxiliary infrastructure. An example of strengthening the agricultural infrastructure can be the development of seaports and their transfer to concessions to domestic and foreign investors. In addition, attracting investment is an important element in developing the export potential of the Ukrainian agricultural sector. The volume of investments in the agricultural sector of Ukraine in 2020 amounted to more than UAH 60 billion, of which UAH 45 billion went directly to agriculture [5; 6]. Investments were also directed to projects in the field of animal husbandry, such as the construction of farms, the development of organic animal husbandry, beekeeping, fish farming and aquaculture, which have a high profitability (on average 50-100%) and pay off within 3-5 years. In the crop production segment, the bulk of investments are directed to the construction of elevators and storage facilities for agricultural crops, start-ups in the field of growing berries, nuts, legumes, edible herbs and spicy crops. The important prerequisite for attracting investment in the agricultural sector of Ukraine was the opening of the land market. From 2024, the limit for land sales will be up to 10,000 hectares per person [6]. Currently, foreigners and foreign companies cannot officially own land.

Despite the fact that foreign investors are well aware of the competitive advantages of agricultural land, Ukraine is also known for quality and innovation in the agricultural sector. Ukrainian agro-technical companies are developing modern solutions aimed at improving traditional methods of agriculture and introducing organic production. In agriculture, there are new methods of work that involve digital and technological innovations that increase its efficiency. The use of drones in agriculture is one of the most promising innovative technologies. Unmanned aerial vehicles are used to plan and control the cultivation of plants, for chemical treatment of crops. GPS control allows you to control many parameters, including the location and routes of movement of all equipment; fuel consumption in motion, fuel consumption during parking, fuel consumption during field work, fuel consumption per 1 hectare of cultivated area, etc.; time of entry and exit from the field, time of downtime and field work; area of cultivated areas of fields. In addition, the system allows you to plot field maps or import them from other mapping programs; keep records of the history of field cultivation, crop rotation; automatically identify drivers to keep track of work time; set the prices of works for the preliminary calculation of the cost of work performed; compare the planned field work with those actually performed. Examples of the latest IT products introduced by Ukrainian agricultural companies are products for monitoring weather conditions, planning technological operations in agricultural production and modelling the risks of plant diseases; system of control and management of animal feeding on meat and dairy farms, etc.

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THE RELATIONSHIP BETWEEN YIELD AND PATHOGENS ATTACK ON THE ADVANCED BREEDING WINTER WHEAT LINES ASSESSED FOR ADULT PLANT RESISTANCE

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Abstract

During 2021-year, 155 wheat lines in various stages of breeding process were assessed in microcultures for adult plant resistance on the pathogens attack and the relationship with yielding capacity. The wheat lines Ursita and Voinic were considered as control cultivars. The assessment was performed under natural infection conditions, without the application of fungicides. The wheat lines were scored, depending on adequate scales: - Helminthosporium leaf blotch (Helminthosporium tritici repentis) - modified scale 0-9 was used for pathogens that produce leaf spots; - Septoria leaf blotch (Zymosptoria tritici sin. Septoria tritici) - the scale developed by Vrapi et al. (2012) – Septoria glume blotch (Parastagonospora nodorum - syn. Stagonospora nodorum; Septoria nodorum; Phaeosphaeria nodorum; Leptosphaeria nodorum) - the Bronnimann scale was used (1968); - Powdery mildew (Blumeria graminis f.sp.tritici sin. Erysiphe graminis) - the Saari-Prescot scale was used (1975); Leaf rust (Puccinia recondita f.sp.tritici) - the Cobb`s scale modified by Peterson was used (Peterson et al., 1948). For Helminthosporium tritici repentis, the most relevant pathogen, the attack distribution showed that most of the tested material - 32.9% was at note 3 and the lowest - 1.3% at note 6. The correlation between yield and attack of reticular spot of wheat leaves was noticed ($r = -0.14$), but not significant (the coefficients being below 0.16 - the value from which the correlation could be considered significant at $P = 5\%$). The fact that the other pathogens attacked less in the conditions in which they were present and the distribution of notes for Helminthosporium tritici repentis was mainly between 1-3 notes interval, suggests that the new breeding material showed a good adult plant resistance in natural infections in pedological and climatic conditions from Caracal Research Station.

Key words: *adult plant resistance, assessment, pathogen, natural infection, wheat lines*

INTRODUCTION

Worldwide natural systems and agricultural production have been affected by climate changes, epidemics and pandemics risks, biodiversity generated by invasive species, biotic and abiotic stresses, technological and genetical progress, land and crop management, cities development and world globalization [2][20][48][49][50][51].

In the last three decades technological innovations and research progress have greatly shaped Agriculture especially by new cropping systems, precision farming machineries, biotechnology, breeding for more resistant varieties, hi-tech solutions for controlling biotic and abiotic constrainers [11][12][13][14][15][16][54]. Among small grains, wheat (*Triticum aestivum* L.) is the third most produced crop in the world, behind maize and rice, and the wheat yields are projected to increase by 60% by 2050 to feed 9 billion population, while climate change is predicted to decrease production by 29% [32][35]. By 2080, global temperature is anticipated to increase by 4,5-degree Celsius declining by 6% in productivity per each degree Celsius [4][59].

Climate change constitutes also a severe threat to the health of spontaneous and crop plants, associated with changes in pathogens life cycles, increased incidence, pathogenicity, genetically recombination and aggressiveness traits, impacting both productivity and quality and resulting in food insecurity [9][24][34][52][53].

A better understanding of the factors that impact wheat yield may be the key for future increase of the production and breeding for disease resistance against already existing and emerging diseases among other measures [21][41][42][43]. Actually, the multi-disease resistance (MDR) or the "pyramiding" of resistance genes is an on-going process considering that only about 10% of the cultivars possessed superior resistance for the main diseases of wheat [37].

Among the most important foliar fungal diseases that affect wheat (*Triticum aestivum* L.) worldwide are Helminthosporium Leaf Blotch (HLB), Septoria Leaf Blotch (SLB), Septoria Glume Blotch (SGB), Powdery Mildew (PM), Tan Spot (TS), Leaf Rust (LR), Yellow Rust (YR), Stem Rust (SR), colonizing leaves, stems and internodes of wheat being associated with yield losses due to the reduction of photosynthetic aria of canopy. Also, it was observed that chlorophyll a and b concentrations were decreased in susceptible wheat cultivars [29].

Generally, the harvest losses caused by foliar diseases in the non-treated crops were 1,500 - 2,800 kg/ha [18]. Annually these diseases are responsible for 15-20% yield losses [27][45].

Worldwide, yield losses due to Helminthosporium Leaf Blotch (HLB) are variable but are considered to be very significant, ranging from 15% up to 90% reported in susceptible genotypes [56]. Disease severity may be aggravated by soil nutrient deficiencies, especially in potassium poor management [25].

Tan spot (TS) of wheat is caused by the necrotrophic fungal pathogen *Pyrenophora tritici-repentis* (Died.) Drechs. (anamorph: *Drechslera tritici-repentis* (Died.) Shoem.) and it occurs worldwide affecting kernels quality and leading to yield losses between 4% and 15% and even 50% in favourable conditions in susceptible cultivars [39].

Septoria Leaf Blotch (SLB) is caused by *Zymoseptoria tritici* (Desm.) (sin.*Septoria tritici* Rob. ex Desm., teleomorph Mycosphaerella graminicola) is the most damaging fungal wheat pathogen in Europe leading to yield losses up to 50% in epidemic years which were estimated to range from 800 to 2,400 million euros [28].

The fungus *Parastagonospora nodorum* is a necrotrophic fungal pathogen that causes Septoria glume blotch (SGB) of cereals, especially in wheat on adult plants. P. nodorum affects wheat quality and yield by up to 50% [26].

Powdery mildew disease caused by the obligate biotrophic fungus Blumeria graminis DC. E.O. Speer f. sp. tritici Em. Marchal (syn. Erysiphe graminis DC) is a widespread endemic disease with negative impact on grain yield which can reach 40% in susceptible cultivars, especially when infection occurs before or at flowering stage and the leaf flag is infected [3][5].

Cereal rusts are heteroecious and macrocyclic requiring two different unrelated hosts to complete a five-spore stage life cycle, being highly variable for virulence and molecular polymorphism.

Leaf rust caused by the fungus *Puccinia triticina* Eriks. (syn. *P. recondita* Rob. Ex Desm. f. sp. *tritici* Eriks. and Henn.) is the most common rust of wheat and widely distributed causing great losses in grain yield by decreasing the numbers of kernels per head and lower kernel weights. Leaf rust may reach 30% yield losses when the infection on flag leaf at spike emergence account 60-70% [36]. Other authors found that yield losses due to leaf rust ranged between 2% and 50% according to the level of resistance or susceptibility [8][44]. Also, [30] found that mean yield losses for susceptible genotypes were 51%, 5%, and 26% in the normal sowing date trial and 71%, 11% and 44% when sown late.

Stem rust (*Puccinia graminis* f. sp. *tritici*) are considered the most destructive of the three wheat rusts associated with a reduction in grain size and lodging of the plant leading to severe yield losses up to over 90% on severely infected fields on susceptible cultivars [22].

Worldwide wheat varieties are under the risk because new races of *Puccinia graminis* f. sp. *tritici* continuously evolves and these new races could be responsible for large epidemics causing big yield losses [33][58]. Ones of the most virulent races of stem rust are TTKSK and TKTTF causing up to 100% yield losses [1][40].

In the 2016 a new, highly virulent variant of race TTTTF was responsible for stem rust epidemics in Sicily, Italy [10]. Recently new virulent races, including TTRTF, were detected in North Africa and the Middle East [31][46].

Yellow rust caused by *Puccinia striiformis* f. sp. *tritici* (Pst) is other economically important disease of wheat that is frequently reported as producing epidemics in many areas of the world (2 or 3 years of every 5 years) leading to yield losses that ranged from 2% to total crop failure [19]. Some of the previous genes (Yr1, Yr2, Yr3, Yr4, Yr6, Yr7, Yr9, Yr10, Yr17, Yr22, Yr23, Yr26, Yr27) have lost partial or complete resistance in succession due to the emergence of new yellow rust races [7]. Currently, only genes Yr5, Yr15, Yr18 and Yr36 have maintained whole field resistance to yellow rust fungus [57].

Through years of research, it has found that yield losses due to the pathogens attack can be achieved by developing wheat varieties with complex adult-plant resistance (APR) [23]. The resistance effect conferred by all-stage resistance genes is the effect of adult plant resistance genes. However, all-stage resistance is often not durable, because new pathogens virulent races often evolve to overcome this type of resistance (race non-specific resistance).

The aim of the study was to evaluate the relationship between yield losses and pathogens attack on the advanced breeding winter wheat lines assessed adult plant resistance (APR), knowing that stability and durability of resistance is crucial to cope with wheat pathogens, unless pathogens quickly overcome the resistance.

MATERIALS AND METHODS

During, 2021-year, 155 wheat lines, with different origins, genetic background, yield potential and reaction to foliar pathogens, in various stages of breeding process, were assessed in microcultures for Adult Plant Resistance on the pathogens attack and the relationship with yielding capacity.

The wheat lines Ursita and Voinic were considered as control cultivars.

The trial was conducted during winter wheat growing season 2020-2021 in on the Breeding Field of the Agricultural Research Station Caracal of the University of Craiova, Romania (44°11’N and 24°37’E), where almost every year are favourable conditions for the attack of foliar pathogens.

The trial was conducted in a split–split-plot design with the main plots arranged in a randomized complete block with three replicates.

The plot size of each replicate was $7m^2$ (7 m × 1 m). All recommended cultural practices (i.e. fertilization, weeds control) and other management were applied.

The screening for Adult Plant Resistance (ADR) was performed under natural infection conditions, without the application of fungicides.

The assessments of leaf diseases severity were made at the growth stage 71–73 BBCH (kernel watery; early milk) and the wheat lines were scored, depending on adequate scales: Helminthosporium leaf blotch (*Helminthosporium tritici repentis*) - modified scale 0-9 pathogens that produce yellow leaf spots; Septoria leaf blotch (*Zymosptoria tritici* sin. *Septoria tritici*) - the scale developed by [60]; Septoria glume blotch (*Parastagonospora nodorum* - sin. *Stagonospora nodorum*; *Septoria nodorum; Phaeosphaeria nodorum; Leptosphaeria nodorum*) - the Bronnimann scale [17]; - Powdery mildew (*Blumeria graminis* f.sp.*tritici* sin. *Erysiphe graminis*) - the Saari-Prescot scale [55]; Leaf rust (*Puccinia recondita* f.sp.*tritici*) - the Cobb`s scale modified by Peterson [47].

Phenotyping screening was done through visual observations under natural field conditions.

At maturity, wheat plants were harvested and threshed, and grain weight was recorded. One thousand kernels were randomly counted from each plot's seed package and weighed to determine TKW.

RESULTS AND DISCUSSIONS

Plant breeding for disease resistance is one of the most important methods to incorporate new sources of resistance into wheat for diminishing the yield loss due to pathogens attack.

The inspections in the wheat trial have been performed periodically during May and June 2021 in order to identify typical symptoms of foliar pathogens attack. Screening for Adult Plant Resistance (APR) has started for each wheat genotype at the growth stage 71–73 BBCH on leaves, stems and internodes scoring every disease severity.

Varied responses of wheat (i.e., susceptible, partially resistant and resistant) were used to determine the role of different levels of adult plant resistance in reducing the yield loss caused by foliar pathogens infection.

For screening optimization and to predict the disease development, temperatures and rainfalls were taken into account.

In general, the trends of average temperature during the evaluation period tended to increase, which is more obvious during the later growth period (+0.8°C in May 2021 and +0.9°C in June 2021) and together with rainfall amount (55.6 mm in May 2021 and 103.2 mm in June 2021) favoured the infection and rapid development of foliar diseases, especially on susceptible cultivars.

Humidity was determined by the amount of rain of 516.8 mm, comparatively with multiannual average rainfall of 377.7 mm, while the average temperature was +13,6°C comparatively with multiannual average temperature of 11.8 °C (Fig. 1).

Fig. 1. Weather conditions during the study period (2020 year)
Source: Own calculation.

Data of the adult plant reaction showed a range of response levels of the tested wheat varieties to Helminthosporium leaf blotch, Septoria glume blotch, Septoria leaf blotch, Powdery mildew and Leaf rust.

Previous research showed that multi-gene pyramiding strategy has been successfully applied in many crops being an effective way to achieve durable resistance [6].

According with the symptoms exhibited and disease severity, the most relevant pathogen that affected wheat lines in 2021 was *Helminthosporium tritici repentis*, followed by *Zymosptoria tritici* and *Puccinia recondita* f.sp.*tritici*.

Screening for Adult Plant Resistance (APR) showed that 32.9% of wheat lines were resistant to the attack of *Helminthosporium tritici repentis* (note 3 - Resistant: Light infection of lower third of plant; lower most leaves infected at moderate to severe levels), while only 1.3% of wheat lines were moderately susceptible (note 6 - Moderately susceptible: Severe infection on lower third of plant, moderate on middle leaves and scattered lesions beyond the middle of the plant) and 2.6% of wheat lines were susceptible (note 7 - Susceptible: Lesions severe on lower and middle leaves with infection extending to the leaf below the flag leaf, or with trace infection on the flag leaf). Among all wheat lines assessed for resistance to *Helminthosporium tritici repentis* in 2021 year, 69% were resistant, 21.3% were moderately resistant, 7.1% were moderately susceptible and 2.6% were susceptible (Fig.2).

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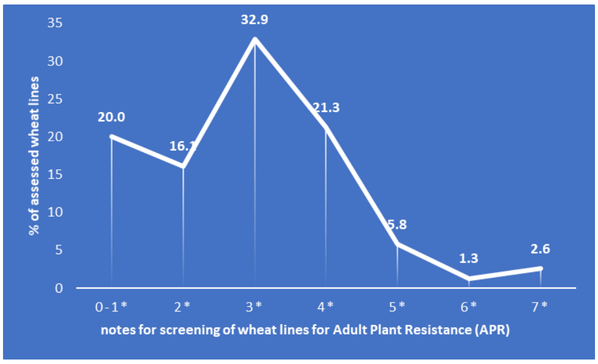

Fig. 2. Distribution of the notes for screening for wheat lines for Adult Plant Resistance to *Helminthosporium tritici repentis*
Source: Own calculation.

The results of screening for Adult Plant Resistance to *Helminthosporium tritici repentis* emphasized that the most resistant lines, with notes 1 or 2, were 18078G, 18090G, 18306G, 18319, 18022G, 18038G, 18001G, 13248G4-001, 13248G01022, with both descendants. On the other pole were the wheat lines 17054G1 and 17054G5, with common genealogy (VOINIC"S"/13248G4), which suggest that both lines have a genetic background for susceptibility to *Helminthosporium tritici repentis.*

All the wheat lines which showed resistance to Helminthosporium *tritici repentis* did not exhibited symptoms for powdery mildew (free of infection) and few of them showed small sized powdery speaks infecting less than 1% leaf area (note 1-resistant). Previous research showed that Adult Plant Resistance (APR) to powdery mildew is more durable than race-specific resistance [38].

The screening for the pathogens *Helminthosporium tritici repentis*, *Zymosptoria tritici*, *Parastagonospora nodorum*, *Blumeria graminis* f.sp.*tritici*, *Puccinia recondita* f.sp.*tritici*. showed that all wheat lines that exhibited specific attack symptoms, possess Adult Plant Resistance, being resistant, moderately resistant or moderately susceptible. Among assessed lines 13248G4-001 and 13248G01022 exhibited good Adult Plant Resistance to Septoria Leaf Blotch, having as genitors the wheat varieties Nogal and Otilia. Nogal has French origin and good resistance to foliar diseases and stay green for longer time, which has a great impact on the grain yield even under abiotic stress. The wheat variety Otilia, created at NARDI Fundulea, Romania, has as genitors F96052G16 -2/Faur, being remarkable by high yielding capacity and resistance to Fusarium Head Blight (FHB), Stripe Rust (SR) and Septoria Leaf Blotch (SLB).

The wheat lines show different levels of Adult Plant Resistance to Leaf rust (*Puccinia recondita* f.sp.*tritici*) and this aspect was noticed even for the lines (18306G, 17054G1, 17054G5) which have common genitors.

The screening for Multi Disease Resistance emphasized that in 2021-year conditions, the most resistant wheat lines were 18306G, 18039G, 18074G, 18041G and 8254G, while the most susceptible were 17321G2, 17282G3 and 17075G4.

The high prediction ability obtained for Multi Disease Resistance implies that genomic prediction could be used in future, thereby eliminating the necessity to separately screen large numbers of lines in breeding programs for several diseases. However, selection on phenotypic basis under natural infection does not give satisfactory results and often leads toward selection of false positive plants. Thus, selection efficiency can be improved by use of artificial inoculation. Therefore, to obtain a better selection of the resistant cultivars and to have a better approach on the impact of pathogens attack on grain yield are necessary investigations under both natural and artificial infections.

The effect of foliar diseases on the grain yield in 2021-year conditions was estimated to characterize and determine the capacity of wheat lines to tolerate these infections. Knowing that biotic and abiotic factors are correlated not just to the yield loss but also with each other (multicollinearity), regression models were used to estimate relationship between disease indices, abiotic factors and yield losses. However, multicollinearity is problematic because it can increase the variance of the regression coefficients, making it difficult to evaluate the individual impact that each of the correlated predictors has on the response of the wheat line.

The correlation (r = -0.14) between % disease severity of the most prevalent disease in 2021-year (Helminthosporium leaf blotch-

Helminthosporium tritici repentis) and % loss in grain yield component (1,000-kernel weight) due to the natural infection was not significant (the coefficients being below 0.16 - the value from which the correlation could be considered significant at P = 5%) (Fig.3)

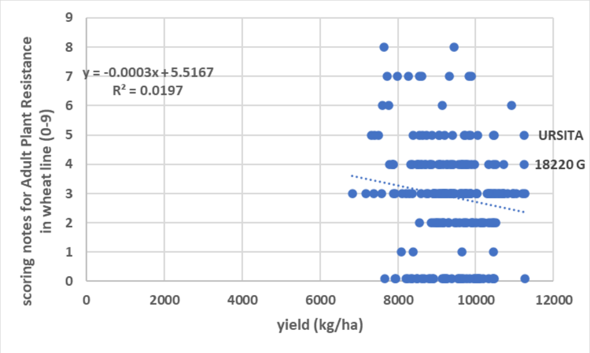

Fig. 3. Relationship between Helminthosporium leaf blotch disease severity and wheat lines yield under natural infection
Source: Own calculation.

Wheat lines Ursita and 18220 recorded high yields despite elevated Helminthosporium leaf blotch severity.
A significant negative correlation (r=-0.161) was observed between % disease severity and yield (kg/ha) among winter wheat lines investigated during 2020-2021 growing seasons for all pathogens assessed (P=5%> 0.16).
The value of determination coefficient (R^2 = 0.026), for all wheat lines assessed, indicated that only 2.6% of variation in grain yield could be explained by cumulated effect of pathogens attack (Fig.4).

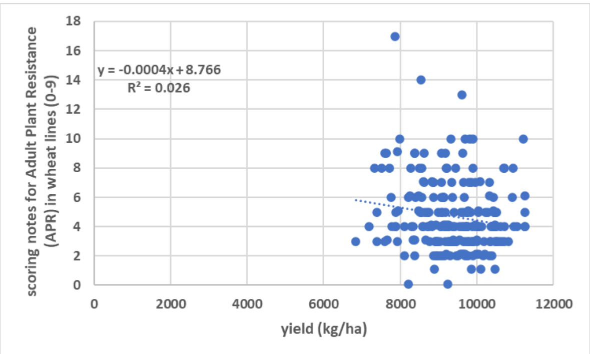

Fig. 4. Relationship between foliar diseases severity and wheat lines yield under natural infection
Source: Own calculation.

The results in this study also suggested that screening of wheat lines for Adult Plant Resistance (APR) in the field under natural infection and yield loss prediction should be constructed using data from few years trial period for a better quantification of visible diseases symptoms taking into account the variations in growing conditions that occur between seasons.

CONCLUSIONS

The research on the impact of foliar pathogens on Adult Plant Resistance (APR) in wheat genotypes form breeding program must be given special attention in the next years in the climatic conditions from Agricultural Research Station Caracal, Romania.
During 2021-year there was noticed a negative correlation between the attack of *Helminthosporium tritici repentis* and grain yield, but not significant one (r=-0.140). On the other side, a significant negative correlation (r=-0.161) was observed between % disease severity and yield (kg/ha) among winter wheat lines investigated during 2020-2021 growing seasons for all foliar pathogens assessed (P=5%>0.16). These findings suggested that in the present pathosystem most wheat lines assessed on phenotypic basis for Adult Plant Resistance (APR) emphasized resistance/tolerance to foliar pathogens attack under natural infection and may be selected for the next steps in the breeding program. The screening for Multi Disease Resistance emphasized that in 2021-year conditions, the most resistant wheat lines were 18306G, 18039G, 18074G, 18041G and 8254G, while the most susceptible were 17321G2, 17282G3 and 17075G4.
Climatic elements influencing yield loss and disease indices are correlated, thus, the screening for impact of each should be analyzed as part of a complex environmental system.

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POPULATION OCCUPIED IN AGRICULTURE AND AGRICULTURAL PRODUCTION VALUE IN ROMANIA, 2008-2020

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Abstract

The paper analyzed rural population, rural working age population, civil population occupied in agriculture and agricultural output value using the data from National Institute of Statistics for the period 2008-2020. Trend line, regression equations, coefficient of determination, Spearman's rank correlation coefficient represented the methodological means for processing the data. Romania had still a high labour resource accounting for 6.23 million persons in 2020, by 10% more than in 2008. In the period 2008-2020, the population able to work declined in almost all the regions, except North East and Bucharest Ilfov, but, the rural population having the age to work increased in various proportions in all the regions. However, civil population occupied in agriculture declined by -30% from 2,407 thousand persons in 2008 to 1,681 thousand persons in 2020. Population aging and migration are the main causes of this decrease. The decline in the territory ranged between -31.3% in North East and -25% in Bucharest-Ilfov. Agricultural production value increased by +21.6% from Ron 66,993 Million in 2008 to Ron 81,400 Million in 2020. In 2020, the highest agricultural output value was achieved in South Muntenia, North East, North West, South West Oltenia, South East. Analyzing the linear dependency between the ranks of civil population occupied in agriculture and agricultural output value, we noticed that in 2008, it was not found such a connection, as Spearman's correlation coefficient was $r_S = 0.1004$, $t_{crit\ 6;0.05}$ was 1,943 and $R^I = 0.4748 < 0.1943$. However, in 2020, between the ranks of the two studied indicators was found a linear dependency reflected by $r_S = 0.739$, $R^I = 2.26$, $t_{crit\ 6;0.05}$ was 1,943, therefore $R^I > t_{crit}$. As a final conclusion, while the population occupied in agriculture decreases, agricultural production value increases due to the decline in civil population occupied in this economic sector caused by aging and migration, increased performance in agricultural production, grace to technological progress and a better farm management, price volatility for agricultural products, financial support according to the CAP of the EU and Romania's Government.

Key words: *occupied population, production value, agriculture, Romania*

INTRODUCTION

Labor force is one of the major production factors in all the fields of the economy. In agriculture, due to the specificity of production processes, it is a mixture of production factors where, beside labor force, it is needed land (soil with its characteristics and quality, surface, property), fixed capital (machinery, equipment, farm buildings etc), working capital (current assets), technologies, innovations, investments and climate conditions [4, 10].

The main labor resource in agriculture is provided by rural population [16]. Romania has a high share of the rural population, accounting for 46% in the total number of inhabitants [1, 2].

The EU average is 4.4%, but there are countries with a higher share like Romania, Poland, Bulgaria, Italy and Spain, and also countries with a lower share like France and Hungary [9, 14, 17].

Despite its high number, rural population has specific demographic features among which the most important ones are: aging as young generation is more and more attracted by professions and jobs in the urban areas or to travel for work abroad; also, a high mortality rate and low birth rate, poverty, low training level and low living standard [1, 7, 15, 26, 29].

Income level is small in agriculture creating a gap against the income level of the employed people in the cities [16, 26, 27].

However, during the last decades, rural tourism and agrotourism have become an alternative for additional income for the rural population [5, 6].

In agriculture there is a low number of salaried persons, but the non salaried persons are more numerous (patrons, self-employed workers, unpaid family workers, members of cooperatives etc) [13, 14, 25].

Also, labor productivity is lower in Romania compared to the one in other EU countries [19, 20, 21].

Agriculture performance in terms of yield is low in Romania because of farm structure, dominated by small sized farms, the majority being subsistence and semi-subsistence farms. Large agricultural holdings represent about 1% of the total number of farms accounting for 3.2 million. But they work about a half of agricultural land [1, 2, 3, 14].

However, agricultural production value increased and Romania is an important contributor to the EU agricultural output value [12, 23, 24].

Despite that agricultural production value and also gross value added in agriculture increased, their value per ha utilized agricultural area is smaller than in other EU member states [14].

Agriculture contributes by 4.2% to Romania's GDP, this percentage being higher than in other EU countries [18, 22].

In the territory, there are discrepancies regarding rural population, employed and not employed population in agriculture, and agricultural production [5, 8, 28].

In this context, the purpose of the paper was to study the changes in rural population occupied in agriculture and agricultural production value, the link between these two indicators in Romania during the period 2008-2020, pointing out the discrepancies in the territory among micro-regions of development.

MATERIALS AND METHODS

Data collection

To set up this paper, the empirical data were collected from National Institute of Statistics for the period 2008-2020 regarding the following indicators:

- Civil occupied population at the national level, of which in the rural areas and also in the territory in the eight micro-regions of development: North West (NW), Center (C), North East (NE), South Muntenia (S Munt), Bucharest Ilfov (Buc If), South West Oltenia (SW Olt), West (W);
- Agricultural output value at the national level and also in each region of development.

Methodological aspects

The methodology used to process the data included:

-***Fixed basis index***, $I_{FB} = (X_n/X_1)x100$, used to quantify the increase/decrease in 2020 compared to 2008 level;

-***Regression equations*** *(linear and polynomial)* ***and coefficient of determination*** to emphasize the trend line and the determination degree of the variation for the dependent variable caused by the variation of the independent variable across the analyzed period;

- ***Spearman's rank correlation coefficient, r_S,*** which was used for determining the strength and direction of the relationship between the two analyzed indicators, using the formula:

$$r_S = 1 - \frac{6\sum d_i^2}{n^3 - n} \qquad (1)$$

where:

d_i^2 is the difference square and n is the number of micro-regions in Romania, that is 8. The values of r_S range between +1 and -1. A value closer to +1 reflects a positive association of the ranks and a value closer to -1 shows a negative relationship between the ranks of the studied indicators.

The significance of r_S was tested using " t-test", according to the formula:

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$$R^I = r_S \sqrt{\frac{n-2}{1-r_S^2}} \qquad (2)$$

The calculated R^I was compared with the "t_{crit}" value for df = n -2 = 6 and for α = 0.05 (95%) significance level.

The hypothesis of the study was:

H_O: There is no monotonic association between the two indicators, that is between agricultural production value and civil population occupied in agriculture.

H_1: There is a monotonic connection between the two indicators.

The interpretation of the results after making "t- test" was:

- if R^I < "t_{crit}" in one-tailed column for α = 0.05, then we accept the H_0, meaning that there is no monotonic relationship between the two indicators, there is no a linear dependency between them and r_S is deemed irrelevant;
- if R^I > "t_{crit}" in one-tailed column for α = 0.05, then H_O is rejected and H_1 is accepted, meaning that there is a monotonic link between the two indicators, a linear dependency and the value of Spearman's correlation coefficient is considered relevant.

-***The relative distance method from the highest performance*** was utilized to establish the hierarchy of the micro-region according to the level of agricultural production value.

The results were tabled and illustrated in graphics for a easier and better understanding of the dynamics and relationships between the two indicators taken into consideration.

Finally, the main conclusions were drawn and presented at the end of the article.

RESULTS AND DISCUSSIONS

Rural population and working age population in Romania's agriculture

Romania is a country with a high percent of population living in the rural areas. On 1st July 2020, of 22,089,211 inhabitants, a number of 9,646,940, represented the rural population accounting for 43.6% and this figure is the highest among the EU member states.

The dynamics of the rural population in the period 2008-2020 shows that in 2020 it was registered a slight decline from 9,743,696 persons in the year 2008 to 9,649,738 in 2020, meaning by - 0.01% less.

Regarding the dynamics of the working age population in the analyzed period, 2008-2020, we may affirm that in 2020, at the national level, the number of the people having an age suitable to work accounted for 14,605,601 persons, reflecting just a +0.3% increase in the year 2020 versus 2008, meaning a relatively stable situation.

However, in 2008, the rural working age population accounted for 5,661,263 persons, while in 2020 it increased to 6,231,928 persons, meaning by +10.08%.

Therefore, the share of rural working age population in rural population increased from 58.1% in 2008 to 64.58% in the year 2020.

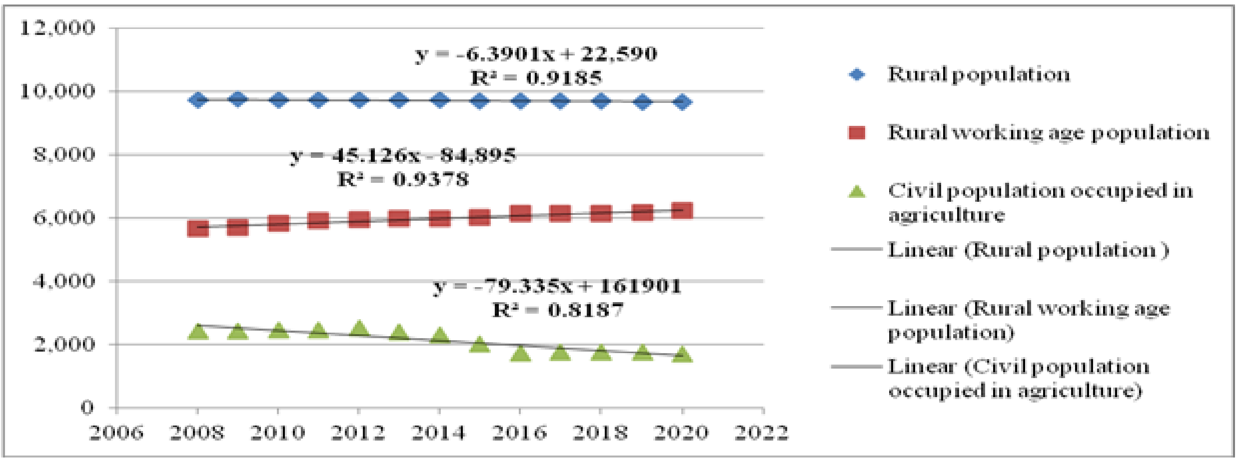

Fig. 1. Dynamics of rural population, rural working age population and civil population occupied in agriculture, Romania, 2008-2020 (Thousand persons)
Source: Own design based on NIS data, 2021 [11].

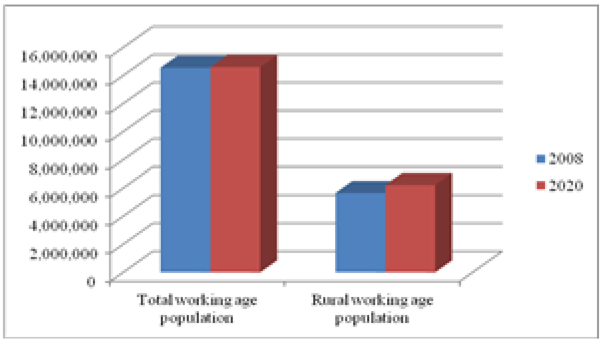

Fig. 2. Working age population in Romania, 2008-2020 (persons)
Source: Own design based on NIS data, 2021 [11].

In 2020, rural working age population represented 43% of working age population at the national level (Fig. 1 and Fig. 2). The dispersion of the working age population in the territory by micro-region is presented in Table 1. The data show that in the year 2008, the order of the micro-regions based of the number of persons having the age to work in the rural areas was: North East, South Muntenia, with the highest number of the population over 1.1 million, North West and South East with a population of 752 thousands persons in South East to 750 thousands in North West, 655 thousands in South East Oltenia, followed by the Central region with 616 thousands and West with 433 thousands and finally, Bucharest Ilfov with only 107 thousand persons. Therefore, it is a large variation of labour resource from a region to another. Of the total working age population in the rural areas, 52.2% is concentrated in South Muntenia region, followed by North East 49.5%, South West Oltenia 44.8%, North West 41%, South East 38.1%, Center 35.5%, West 32.1% and Bucharest Ilfov 6.3% (Table 1).

Table 1. Working age population by micro region in Romania in 2020 versus 2008 (Thousand persons)

	2008			2020		
	Total working age population	Rural working age population	% rural population in total	Total working age population	Rural working age population	% rural population in total
North West	1.849	760	41.08	1,868	834	44.91
Center	1,735	616	35.54	1,710	681	39.84
North East	2,442	1,209	49.50	2,661	1,413	53.12
South East	1,919	752	38.17	1,854	810	43.70
South Muntenia	2,126	1,111	52.26	2,054	1,153	56.15
Bucharest Ilfov	1,680	107	6.37	1,720	165	9.57
South West Oltenia	1,462	655	44.84	1,415	680	48.01
West	1,347	433	32.12	1,324	490	37.01

Source: Own calculation based on NIS data, 2021 [11].

In the year 2020 compared to 2008, at the country level it was noticed a decline in working age population in the Central, South East, South Muntenia, South West Oltenia and West, while in North West, North East, Bucharest Ilfov, the population able to work increased. At the same time, it was noticed an increase of the rural working age population in the same interval. In 2020, the decreasing order of the micro-regions based on the share of rural population able to work in the total working age population was as follows: South Muntenia 56.1%, North East 53.1%, South West Oltenia 48%, North West 44.9%, South East 43.7%, Center 39.85, West 37% and Bucharest Ilfov 9.6%.

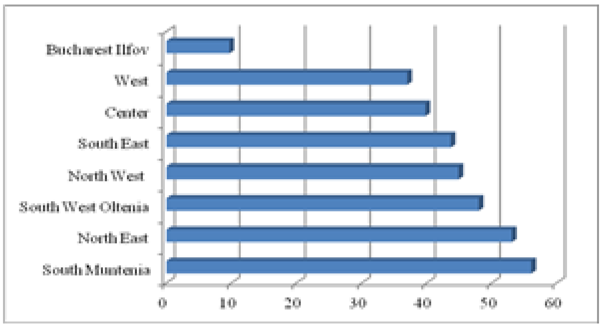

Fig. 3. The share of rural working age population in total working age population by region in the year 2020 (%)

Source: Own calculation and design based on NIS data, 2021 [11].

Regarding the distribution of working age population in the rural areas it was noticed the maintenance of the same hierarchy in 2020 compared to 2008 (Table 1 and Fig. 3).

In 2020, the distribution of working age population in the rural areas by micro region was, in the descending order: North East 22.6%, South Muntenia 18.5%, North West 13.5%, South East 13%, South West Oltenia 10.9%, Center 10.9%, West 8% and Bucharest Ilfov 2.6% (Fig. 4).

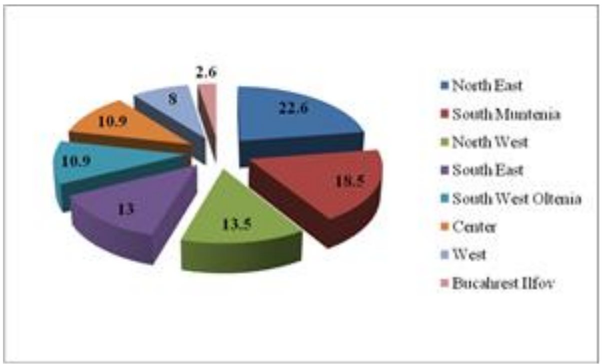

Fig. 4. The distribution of rural working age population by region in the year 2020 (%)
Source: Own calculation and design based on NIS data, 2021 [11].

Civil population occupied in agriculture

In Romania, the total civil occupied population declined from 8,747 thousand persons in 2008 to 8,441 thousand persons in the year 2020, meaning - 3.5% less.

Of the total civil occupied population in 2008, 2,407.4 thousand persons were occupied in the field of agriculture, forestry and fishing, meaning 27.5%.

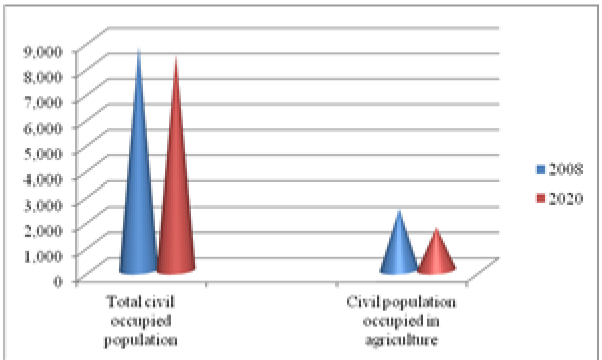

Fig. 5. Civil occupied population in Romania, 2020 versus 2008 (Thousand persons)
Source: Own design based on NIS data, 2021 [11].

In 2020, in this field, the civil occupied population accounted for only 1,681 thousand persons, meaning by 30% less than in 2008, and its share in the total occupied population at the country level decreased to 19.9%, meaning by -7.6 pp less (Fig. 1 and Fig. 5).

In the territory, the situation of civil occupied population by micro-region in the year 2020 versus 2008 is presented in Table 2.

In 2020 versus 2008, the total civil occupied population remained relatively stable in North West and Center regions at the level of 1,187 thousand persons and, respectively, 1,048 thousand persons. In almost all the other regions it registered a decline as follows: by -9% in North East, -10.4% in South East, -8.5% in South Muntenia, -10.1% in South West Oltenia, and -4.4% in West. The only exception was Bucharest Ilfov were it was registered an increase of +10.8%.

Regarding the civil population occupied in agriculture, forestry and fishing, the data from Table 2 showed an important decline in 2020 compared to 2008, as follows: -30.4% in North West, -29.8% in the Center, -31.3% in North East, -29.3% in South East, -30.7% in South Muntenia, -25% in Bucharest Ilfov, -30.3% in South West Oltenia and -28.9% in West.

In consequence, the share of the civil population occupied in agriculture in the total occupied population in the economy decreased in all the micro-regions in the period 2008-2020. In the year 2020 versus 2008, the weight accounted for: North East 30%, South West Oltenia 29.3%, South Muntenia 26.8%, South East 24.3%, North West 21.3%, West 17.4% and Bucharest Ilfov 1.9%.

This reflects a new orientation of the civil population to other fields of activity, the consequence of migration from rural areas to the cities or abroad looking for better paid jobs. However, this is a general trend in many countries not only in Romania.

The highest concentration of the population occupied in agriculture is in North East, South West Oltenia, South Muntenia, South East and North West, all these micro-regions summing over 1,511 thousand persons and the difference of 170 thousand persons is in the West and Bucharest micro-regions.

Table 2. Civil occupied population by micro region in Romania in 2020 versus 2008 (Thousand persons)

	2008			2020		
	Total civil occupied population	Civil occupied population in agriculture	% occupied population in agriculture in total	Total civil occupied population	Civil occupied population in agriculture	% occupied population in agriculture in total
North West	1,188	363	30.5	1,187	253	21.3
Center	1,047	242	23.1	1,048	170	16.2
North East	1,249	489	39.2	1,137	336	30.0
South East	1,058	325	30.1	948	230	24.3
South Muntenia	1,201	424	35.3	1,100	294	26.8
Bucharest Ilfov	1,282	36	2.8	1,421	27	1.9
South West Oltenia	867	327	32.7	780	228	29.3
West	856	201	23.5	819	143	17.4

Source: Own calculation based on NIS data, 2021 [11].

The decreasing order of the micro-regions based on their share in civil occupied population in agriculture in the year 2020 is the following one: North East 20%, South Muntenia 17.5%, North West 15%, South East 13.6%, South West Oltenia 13.5%, Center 10.1%, West 8.7% and Bucharest Ilfov 1.6% (Fig. 6).
This order of distribution is similar with the one reflecting the dispersion of the rural working age population by micro-region.

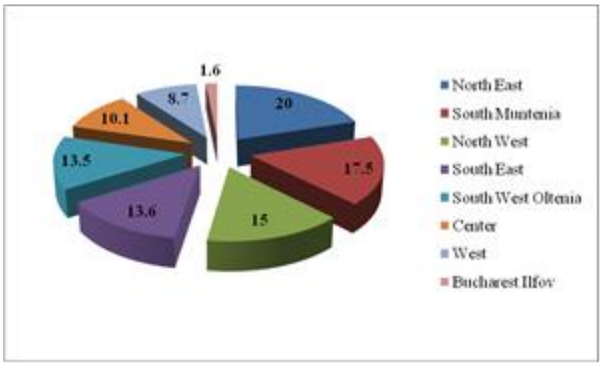

Fig. 6. The distribution of civil occupied population in Romania's agriculture in the year 2020 (%)
Source: Own calculation and design based on NIS data, 2021 [11].

In 2020, from the total rural population accounting for 6,231 thousand persons, only 1,681 thousand persons represented the civil population occupied in agriculture meaning 26.9%.

The rest of the population is below the age suitable to work, either too young or too old, or it is occupied in other sectors of activity.
The share of the population occupied in agriculture in the total rural population is different from a region to another, in 2020, ranging between 33.5% in South West Oltenia and 16.3% in Bucharest Ilfov (Fig. 7).

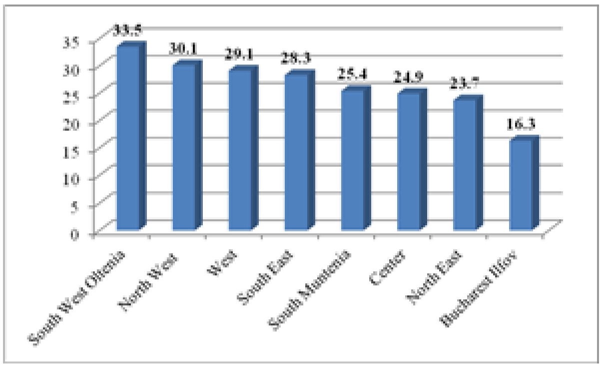

Fig. 7. Share of population occupied in agriculture in rural population in Romania in 2020 (%)
Source: Own calculation based on the data from NIS, 2021 [11].

Agricultural production value

In the analyzed interval, agricultural output value increased from RON 66.99 Billion in 2008 to RON 81.4 Billion in 2020 (Fig. 8).
The value of agricultural production in 2020 compared to 2008 by micro-region is presented in Table 3.

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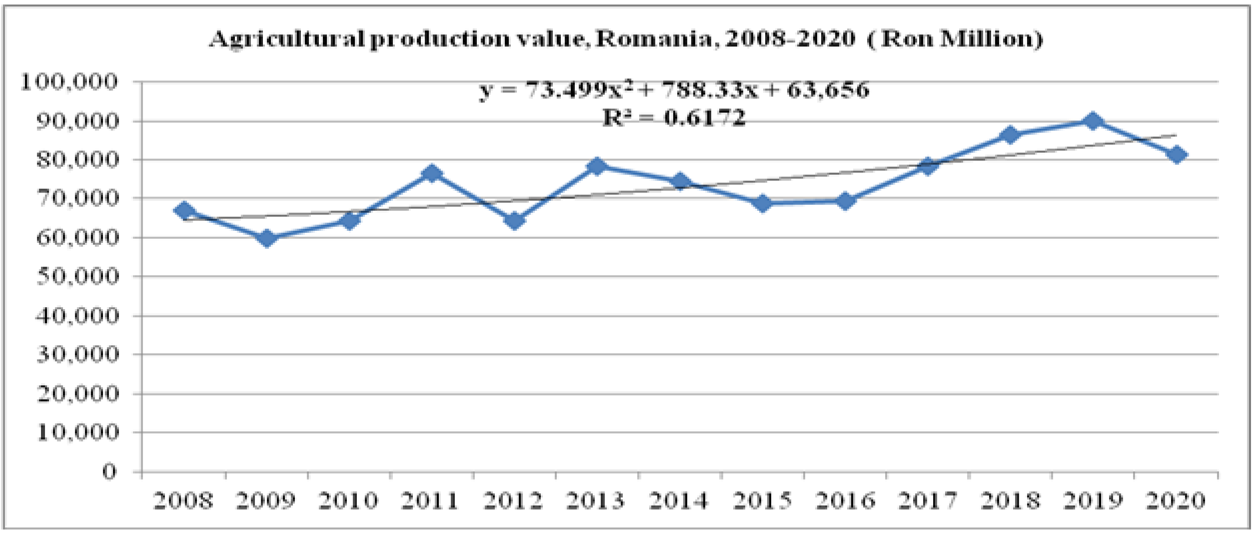

Fig. 8. Dynamics of agricultural production value in Romania, 2008-2020 (Ron Million)
Source: Own design based on the date from NIS, 2021 [11].

The data from Table 3 show that in the studied period, the value of agricultural production increased in all the micro-regions in various proportions.

The highest growth was registered in Bucharest Ilfov +98.8%, South West Oltenia +42.5%, West +37%. A moderate increase was noticed in North West +21.8%, Center +19.9%, South Muntenia +17.5%, North East +15% and the smallest increase of +3.6% in South East area.

Table 3. Agricultural production value by micro-region of Romania in 2020 versus 2008 (RON Million)

	2008	2020	2020/2008 %
North West	9,259	11,285	121.8
Center	8,082	9,690	119.9
North East	11,678	13,432	115.0
South East	10,558	10,940	103.6
South Muntenia	12,164	14,287	117.5
Bucharest Ilfov	727	1,445	198.8
South West Oltenia	7,684	10,947	142.5
West	6,842	9,373	137.0

Source: Own calculation based on NIS data, 2021 [11].

The regions which achieved the highest agricultural production value in the year 2020, in the decreasing order were: South Muntenia, North East, North West, South West Oltenia, South East, summing a value over RON 11,940 Million.

The contribution of the micro-regions to the value of agricultural output in 2020 was the following one: South Muntenia 17.5%, North East 16.5%, North West 13.8%, South West Oltenia 13.4%, South East 13.4%, Center 11.9%, West 8.8% and Bucharest Ilfov 1.7% (Fig. 9).

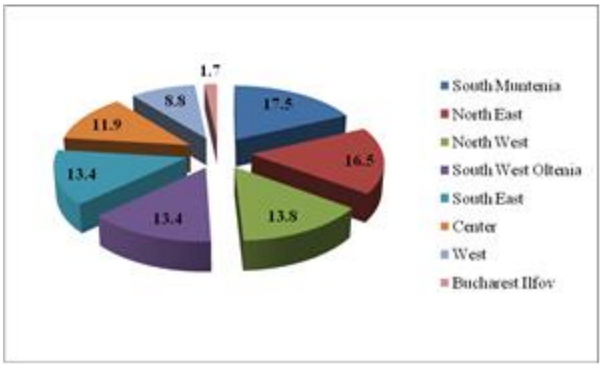

Fig. 9. The contribution of micro-regions to the agricultural output value in 2020 (%)
Source: Own calculation and design based on NIS data, 2021 [11].

Agricultural production value per civil person occupied in agriculture

Regarding this indicator, we may affirm that it registered a substantial increase in all the regions during the analyzed period as shown in Table 4.

In 2008, the decreasing order of the regions based on the level of agricultural production value per civil person occupied in agriculture was as follows: West, Center, South East,

South Muntenia, North West, North East, South West Oltenia and Bucharest Ilfov.
In 2020, West region remained in the top position, followed by the Central area on the 2nd position. South Muntenia remained on the 4th position, North West passed from the 5th position to the 7th position. South East moved from the 3rd position to the 6th one, North East passed from the 6th position to the 8th one. South West Oltenia climbed from the 7th position to the 5th position. Bucharest Ilfov climbed from the 8th position to the 3rd one.

Table 4. Agricultural production value per civil person occupied in agriculture in Romania in 2020 versus 2008 (RON/Person)

	2008	Rank	2020	Rank	2020/2008 %
North West	25.506	5	44,605	7	174.8
Center	33,396	2	57,000	2	170.7
North East	23,881	6	39,976	8	163.4
South East	32,486	3	47,565	6	146.4
South Muntenia	28,688	4	48,595	4	169.4
Bucharest Ilfov	20,194	8	53,518	3	265.0
South West Oltenia	23,498	7	48,013	5	204.3
West	34,039	1	65,545	1	192.5

Source: Own calculation.

Spearman's non-parametrical correlation coefficient between agricultural production value and civil occupied population in agriculture

First of all, it was built up the scatter plot reflecting the connection between population occupied in agriculture and agricultural production value to check if between the two variables it is a monotonic relationship.

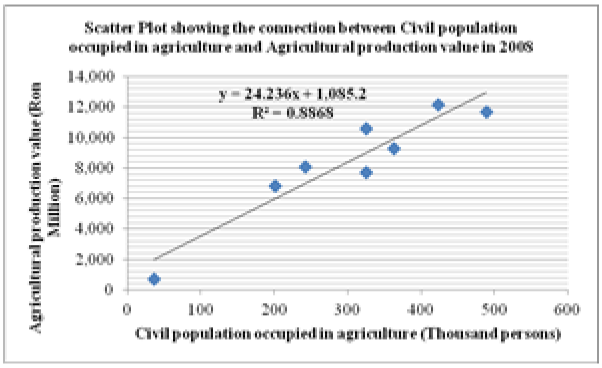

Fig. 10. The Scatter Plot showing the connection between Civil population occupied in agriculture and Agricultural production value in Romania in 2008
Source: Own calculation and design based on NIS data, 2021 [11].

Figure 10 shows that between the two indicators it is such a type of connection as long as the value of one variable increases, so does the value of the other variable.
In this case, running a Spearman's correlation is justified to measure the strength and direction of this monotonic link.
At this moment, it was set up Table 5 for ranking the data for each indicator a presented below. The results showed that in the year 2008, the value of Spearman's correlation coefficient, r_S was 0.1904. Using t-test, the value of R^I accounted for 0.4748 which is smaller than t_{crit} value = 1,943 for 6 degrees of freedom (df= N-2 = 6) and α = 0.05 significance level.
Therefore, Ho: hypothesis was accepted, meaning that there is no linear dependency between the ranks of the two indicators and the value of r_S quotient is considered irrelevant (Table 5).
Figure 11 reflects a monotonic connection between civil population occupied in agriculture and the value of agricultural production in the year 2020. Again, Spearman's correlation was determined to measure the strength and direction of this monotonic link.

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Table 5. Spearman's non parametrical correlation coefficient between civil population occupied in agriculture and agricultural output value in Romania the year 2008

	Civil occupied population in agriculture		Agricultural production value		d_i^2
	Thousand persons	Rank	RON Million	Rank	
North West	363	3	9,259	4	1
Center	242	5	8,082	5	0
North East	489	1	11,678	2	1
South East	325	6	10,558	3	9
South Muntenia	424	2	12,164	1	1
Bucharest Ilfov	36	8	727	8	0
South West Oltenia	326	4	7,683	6	4
West	201	7	6,842	7	0
					$\Sigma d_i^2 = 16$
$r_S = 0.1904$					
$R^I = 0.4748$					
$t_{crit\ 6;\ 0.05} = 1.943$					
Therefore, $R^I < t_{crit} = 0.4748 < 1.943$ ......H_0 is accepted.					

Source: Own results.

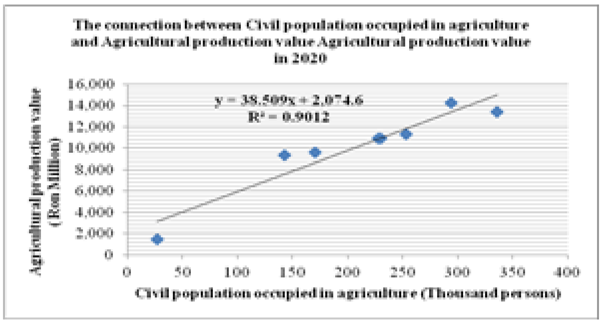

Fig. 11. The Scatter Plot showing the connection between Civil population occupied in agriculture and Agricultural production value in Romania in 2020
Source: Own calculation and design based on NIS data, 2021 [11].

In the year 2020, the value of r_S accounted for 0.739, the value of R^I was equal to 2.26 and comparing it with $t_{crit\ 6;\ 0.05} = 1.943$, we may easily notice that the calculated value is higher than the critical one in t-table for $\alpha = 0.05$.

In consequence, in this case, H_0: hypothesis is rejected and H_1: hypothesis is accepted, meaning that it is a liner dependency between the two variables and r_S quotient is considered relevant (Table 6).

Table 6. Spearman's non parametrical correlation coefficient between civil population occupied in agriculture and agricultural output value in Romania the year 2020

	Civil occupied population in agriculture		Agricultural production value		d_i^2
	Thousand persons	Rank	RON Million	Rank	
North West	253	2	11,285	3	1
Center	170	6	9,690	6	0
North East	336	1	13,432	2	1
South East	230	3	10,940	5	4
South Muntenia	294	5	14,287	1	16
Bucharest Ilfov	27	8	1,445	8	0
South West Oltenia	228	4	10,948	4	0
West	143	7	9,373	7	0
					$\Sigma d_i^2 = 22$
$r_S = 0.739$					
$R^I = 2.26$					
$t_{crit\ 6;\ 0.05} = 1.943$					
Therefore, $R^I > t_{crit} = 2.26 > 1.943$ ......H_0: is rejected, and H_1 is accepted.					

Source: Own results.

Hierarchy of the micro-regions based on the method of relative distance from the highest performance

Using this method of relative distance from the top performance, the hierarchy of the micro-regions in the year 2020 versus the one in 2008 is comparatively presented in Table 7. We may notice that the micro-regions, which remained on the same position regarding their performance in agricultural production value in 2020 versus 2008, were South Muntenia (1st position), North East (2nd position), West (7th position) and Bucharest Ilfov (8th position). In 2020, South East region passed from the 3rd position to the 5th position, North West moved from the 4th position in 2008 to the 3rd position in 2020. the Central area passed from the 5th position to the 6th one and South West Oltenia jumped from the 6th position to the 4th one.

Table 7. Hierarchy of the micro-regions based on the relative distance method from the highest performance in 2020 versus 2008

	2008	2020
1	South Muntenia	South Muntenia
2	North East	North East
3	South East	North West
4	North West	South West Oltenia
5	Center	South East
6	South West Oltenia	Center
7	West	West
8	Bucharest Ilfov	Bucharest Ilfov

Source: Own results.

CONCLUSIONS

This study pointed out that in the period 2008-2020, in Romania it is still a high labor resource accounting for 6.23 million persons in the last year, being by 10% higher than in the first year of the analysis.

In the territory, while the population able to work declined in the analyzed interval in almost all the regions, except North East and Bucharest Ilfov, the rural population having the age to work increased by +10% in North West, +10.5% in the Central area, +16.8% in North East, +7.7% in South East, +3.7% in South Muntenia, +53.9% in Bucharest Ilfov, +3.8% in South West Oltenia, +13% in the West region.

The civil population occupied in agriculture declined in 2020 compared to 2008. In 2020, it accounted for 1,681 thousand persons being by -30.2% smaller than 2,407 thousand persons in 2008.

This was caused by aging and migration to the urban areas and abroad. the decline in the territory was in various proportions ranging between -31.3% in North East and -25% in Bucharest-Ilfov.

As a result, the share of the civil population occupied in agriculture also decreased, in 2020 varying from 30% in North East to 1.9% in Bucharest Ilfov.

Agricultural production value increased by +21.5% at the country level due to the contribution of all the regions. It was registered a higher output value whose growth rate ranged between +98.8% in Bucharest Ilfov and 3.6% in South East.

In 2020, the highest level of agricultural production value was achieved in South Muntenia, North East, North West, South West Oltenia, South East, all together these five regions contributing by over Ron 11,940 Billion to the national agricultural output value.

In 2008, it was not found any linear dependency between the ranks of civil population occupied in agriculture and the value of agricultural production, as r_S = 0.1004, and $t_{crit\ 6;0.05}$ was 1,943 and R^I = 0.4748 < 0.1943. Therefore, H_1: hypothesis was accepted.

In 2020, it was accepted H_0: hypothesis meaning that between the ranks of the two studied indicators is a linear dependency as r_S = 0.739, R^I = 2.26, $t_{crit\ 6;0.05}$ was 1,943, therefore $R^I > t_{crit}$.

The relative distance from the highest performance in agricultural production value allowed to set up the hierarchy of the micro-regions which in 2020 was the following one: South Muntenia, North East, North West, South West, South West Oltenia, South East, Center, West and Bucharest Ilfov.

Taking into account the agricultural production value per civil person occupied in agriculture, in 2020, the highest level was carried out by West region, accounting for Ron 65,545 and the lowest level was Ron 39,976/person in North East region. Compared to 2008, in 2020, the level of this indicator increased in large proportions varying between +165% in Bucharest Ilfov and +46.4% in South East.

Therefore, while the population occupied in agriculture declines, agricultural production value increases due to the following factors of influence:
- the decline in civil population occupied in agriculture caused by aging and migration;
-the increased performance in agricultural production in the both sectors, vegetal and animal, sustained by technological progress and a better farm management;
-price volatility for agricultural products;
-intermediary consumption;
-subsidies and aids offered according to the EU CAP and Government.

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RURAL AREAS IN ROMANIA - DISCREPANCIES VERSUS URBAN AREAS AND EUROPEAN UNION

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Abstract

The paper analyzed rural areas in Romania from a territorial, demographic, economic, social and environment point of view in the year 2020 compared to 2011 in order to point out in what measure the gaps between rural and urban areas and EU rural areas have been reduced. The data from National Institute of Statistics and Eurostat were used in this comparison where fixed indices, structural indices, regression equations, determination coefficient helped to create an image on the changes. Rural areas keeps 89.6% of Romania's territory and 46.4% of its population, while at the EU level, the rural population accounts for only 29.1%. Rural population is aging, as 46% of people is aged of 50 and over. Depopulation caused by the negative natural movement and migration led to the decline in rural population. Rural poverty and social exclusion is higher, the EU average rate being 26%, while in Bulgaria, Malta and Romania is higher than 50%. Infrastructure regarding rural roads, water supply, sewerage and waste collection continue to be a big problem. Education level is lower, in 2020, only 17% graduates were from the rural areas, while in the EU 22% of the people aged 25-64 and 28.4% of the ones aged 30-34 have tertiary education. Rural digitalization is relatively weak as only 49% rural residents have digital skills compared to 62% in the cities. Of Romania's occupied population, 20% is in the rural areas and women accounts for 50%. About 83% of occupied population in agriculture are self employed. Salaried men in agriculture represent 3.5%, while women 1.1%, reflecting gender discrimination in total salaried population. Labor productivity in agriculture is small, just 20% of the national level. Per 1,000 AWU, labor productivity in Romania is the smallest in the EU. The rural average monthly income represents 64% of the income level in the urban areas and its growth rate is smaller. Agriculturists have the smallest income. Climate change diminished agricultural output and gross value added in Romania, and also the contribution to the EU. GDP/capita in rural Romania accounts for Euro 13,000, representing 65% of the EU average reflecting the gap in economic development and living standard. National Strategic Plan 2021-2027, whose implementation will involve the local authorities, is expected to transform rural areas in a resilient and diversified eco-system supplying agro-food products for ensuring food safety, in a consolidated economic and social sector using new knowledge, innovation and digitalization.

***Key words*:** *rural areas, territory, demography, economy, social aspects, environment aspects, Romania*

INTRODUCTION

Urbanization has determined a high concentration of the population of about 80% in the urban areas in the developed countries, while 50% of the population lives in the rural areas of the developing countries [22]. Therefore, rural areas are of a high importance at the world level for a any continent, country and region.

Rural areas represent 83% of the EU surface and according to "European Charter of Rural areas", rural space is defined as being "a continental and seashore land where there are small towns and villages and land is mainly utilized for: agriculture, forestry aquaculture and fishing; economic and cultural activities of the inhabitants (handicraft, small industry, services etc); leisure and recreation in extra urban areas or to protect nature; and other purposes" [2, 36].

The definition highlights the complex and multifunctional importance of the rural areas regarding territoriality, geography, demography, economy, social aspects, culture and history, environment and biodiversity.

The territorial importance of the rural areas resides in the fact that they are a constitutive part of the integrity of a country territory, besides the urban zones [17].

Geographically, rural areas are spread in various relief forms including plains, hilly and mountain zones, whose specificity has a deep impact on land structure and utilizations: agricultural area, forest land, natural reservations, seashore areas and also on the territorial administration and life of the small communities and localities [26, 49].

Demographic importance resides in the fact that rural areas are home for many people living in small villages and towns whose number differs from a region to another. In the rural communities, people is aging as the old persons are accustomed to live there and have no intention to change their domicile, while young generation would like to move to cities to enlarge the knowledge horizon, to find a better paid job and to benefit of urban life advantages in terms of comfort and living standard [32, 48, 55]. Natural movement has also a considerable impact on the rural population dynamics compared to urban zones. Depopulation and migration are phenomena which contribute to the decline of the rural population [4, 24, 25, 35, 47].

The social importance of the rural areas is emphasized by the fact that rural population is a valuable resource of labor force in the local economy and not only [5, 37]. Also, in the small communities, the relationships and communication between people are closer, and the households are larger as the family members are more numerous. The rural living style has its peculiarities and the involvement of the people in the local community is much higher than in the urban zones [8]. Gender inequality, domestic violence, poverty, social exclusion are more accentuated aspects than in the cities [23]. Dwellings quality and living standard is not comparable with the urban areas [30].

Economic importance consists in the fact that in the rural areas there is a large resource of raw materials for food and other processing industries. Urban areas rely on rural ecosystems services to cover their requirements and that is why rural areas play an important role on ensuring food safety and security [19].

Local economy is developed mainly due to the activities carried out in agriculture, forestry, fishing, aquaculture, rural and agri-tourism and partially in trade, fields where rural population could find jobs, get an income or develop its own small business [6, 9]. But in the rural areas labor market is weak, employment rate is low and unemployment is very high [21, 29, 46].

Labor productivity is lower in the rural areas compared to the urban ones. In the EU, there are also discrepancies regarding labor productivity among the member states [40, 41, 42].

Services have a pale presence or are missing regarding educational and training units, endowment and teachers' number, health and care units, facilities and medical staff, transportation means, postal and delivery, credit services, emergency services, business advisory services, recreational services etc. [54].

Also, infrastructure is much lower developed regarding roads, access to utilities (water supply, electricity, sewerage management etc. Digitalization is still pale, just a few households have access to internet. Investments are rarely made in the rural areas [51].

However, even thou there are still many aspects which need to be improved, rural areas are the key place where agricultural products are achieved, and also they contribute to gross value added and gross domestic product. At the EU level, agricultural production value and gross value added has continued to increase during the last decades enabling the rural areas to grow their contribution to GDP [15, 39, 43, 44].

From a cultural and historical point of view, rural areas contribute to the preservation of the national heritage of traditions and customs in terms of local architecture, folk music, dances, suits, handicrafts, religion, events with deep roots in the old history of each community, region and country [50].

More than this, rural space plays an important role in preserving the landscapes which are a treasure of the splendors of nature. Also, in the rural areas, the environmental factors: air, water, soil are much better conserved than in the cities.

The large range of plant species either belonging to the wild flora or to the cultivated crops, and also the great number of animal species from the wild fauna and farms which emphasize the key role of the rural areas in preserving biodiversity [32].

The Covid-19 pandemic has led to a new vision on the rural areas and induced changes in society behavior regarding home work and a higher appreciation of green spaces, and rural destinations become of more attraction for spending holidays. Therefore, the people and the authorities have become more conscious of the importance of rural areas in keeping our planet alive. Obviously, this affirmation reflects that rural and urban areas are closely linked from an economic, social and environment point of view [19].

Taking into account the vital importance of the rural areas, EU pays a special attention to this part of its territory and has established a new strategy of development for sustaining with specific measures and substantial funds the member states in the coming years [3, 10, 18, 20, 38].

For Romania, rural space is very important as about 46% of the population is living here and there are still many problems to solve for diminishing the discrepancies regarding demographic, economic, social and environment aspects compared to the urban areas [30, 33, 34, 52].

In this context, the purpose of the paper was to examine the changes in rural areas characterizing Romania in the year 2020 compared to the year 2011 in order to highlight in what measure the gaps between rural areas and urban areas were reduced. Also, the comparison with the EU rural areas was used to emphasize the directions in which Romania has to pay attention to benefit of the opportunities conferred by the recent EU strategy regarding the new development of the rural areas in the member states.

MATERIALS AND METHODS

The paper is based on the data provided by National Institute of Statistics and Eurostat and also a comprehensive literature on the topic.

The following aspects have been approached: surface of rural areas and its components, rural population (age structure, natural movement, poverty, social exclusion, households, education, digital skills), labor force (occupied population, occupied women, salaried and non-salaried persons, employment), labor productivity, income in the rural areas, economic development (agricultural production value, gross value added, GDP per inhabitant) and budget for rural development.

The methodology used to process the data referred to:

-Fixed basis index, $I_{FB} = (X_n/X_1)x100$, used to quantify the increase/decrease in 2020 compared to 2011 level;

-Regression equations and coefficient of determination to emphasize the trend line regarding the population of Romania and rural population in the period 2007-2021;

- Comparison between the level of the indicators mentioned above in the rural areas and urban areas and also in the EU quantifying the difference in percentages and percentage points in 2020 versus 2011.

The results were graphically displayed and also tabled. At the end, the main ideas reflecting the identified similarities and disparities were highlighted.

RESULTS AND DISCUSSIONS

Surface of the rural areas

Romania has 23,839,071 ha surface, of which rural areas account for 21,360,075 ha, meaning 89.6%. Romania's rural areas have a share of 6.37% in the EU's rural space.

The territory of the rural areas in Romania consists of 14.6 million ha agricultural land (68.5%) and 6.75 million ha forests and natural vegetation (31.5%). The largest proportion of agricultural land accounting for 64.3% is represented by arable land and the remaining includes 22.4% pastures, 10.6% meadows, 1.4% vineyards and 1.3% orchards [31].

At the EU level, in 2020, of 405.4 million ha total surface, rural areas represent 335.1 million ha, representing approximately 83%. The structure of the rural areas is divided into two parts of a relatively equal dimension: agricultural land 40% and forests and natural areas 43% [7, 10].

Rural space is under the pressure of the urbanization mainly in the proximity of the municipalities and cities which will affect in a way its surface, both at the EU level and in Romania.

Rural population

On January 1st, 2021, Romania had a population of 19,186,201 inhabitants. During the last decade, the population registered a decline of -9.3% compared to 21,130,503 inhabitants in 2007. Most of the people lives in the urban areas, but rural population has also an important share. In 2021, in the rural areas there were 8,900,241 inhabitants, but by -5.5% less than 9,413,931 in the year 2007. Therefore, rural population followed a similar decreasing trend influencing the tendency at the national level (Fig. 1).

Due to this dynamics, the share of rural population in the total population increased from 44.5% in 2007 to 46.4% in 2021.

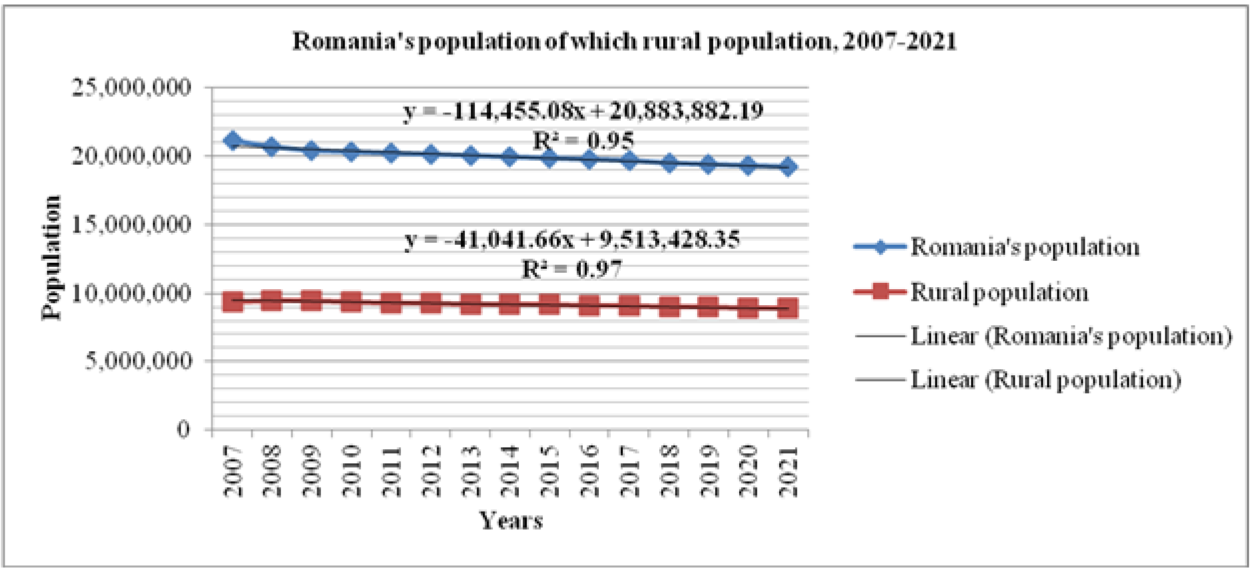

Fig. 1. Dynamics of Romania's population and rural population in the period 2007-2021
Source: Own design and calculation based on the data from [31].

Taking into consideration the average annual change during the period 2007-2021 accounting for 60,532.4 inhabitants at the national level and for 63,028.8 inhabitants in the rural areas, it is expecting that Romania's population to continue its decline and by 2030 to reach 18.64 million inhabitants of which 8.33 million in the rural areas (Table 1).

Table 1. Forecast of Romania's population and rural population by 2030

	Total population	Rural population	Share of the rural population in total (%)
2007	21,130,503	9,413,931	44.5
2021	19,186,201	8,900,241	46.4
Forecast			
2025	18,944,073	8,648,125.8	45.6
2030	18,641,413	8,32,981.8	44.7

Source: Own calculation based on the data from [31].

At the EU level, the share of the rural population is 29.1% and at the Europe level is about 20% [11]. But this proportion varies among the EU member states. The countries with the highest share of the rural population are: Romania (46%), Slovakia (46%), Slovenia (45%), Croatia (42%), Austria (41%), Poland (40%), Ireland (36%) [53].

One of the main features of Romania's population is aging. In 2021, the people of 50 and over 50 years old represented 38.8% compared to 36.1% in 2007. This age category is much higher in the rural areas, but it registered a slight decline from 47.4% in 2011 to 46% in 2021 in Romania's population [31].

However, in case of the EU, the population living in the rural areas and remote areas and being of 50 and over years old has the lowest share [10].

The actual age structure in Romania's rural population is caused by natural movement and migration.

Natural movement, characterized by the level of its main specific indicators: births and birth rate, deaths and death rate and natural growth (births-deaths) per 1,000 inhabitants, has favored the decline of the rural population as shown by the data presented in Table 2. While birth rate is a little higher, death rate has the highest level so that the natural growth has a negative sign and accounted for -6.9 per 1,000 inhabitants in the year 2020.

Table 2. Natural movement rates of Romania's population in the rural areas versus urban areas in 2020 compared to 2011

		2011	2020	2020-2011
Birth rate (births per 1,000 inhabitants)	Total	8.7	8.1	-0.6
	Urban	8.4	7.6	-0.8
	Rural	9.2	8.6	-0.6
Death rate (deaths per 1,000 inhabitants)	Total	11.2	13.4	+2.2
	Urban	9.0	11.8	+2.8
	Rural	14.1	15.5	+1.4
Natural growth (deaths-births per 1,000 inhabitants)	Total	-2.5	-5.3	-2.8
	Urban	-0.6	-4.2	-3.6
	Rural	-4.9	-6.9	-2.0

Source: Own calculation based on the data from [31].

Migration influenced population level in various ways: outflows from communes and villages to cities, inflows from cities to rural localities, emigration especially to the EU, and imigration of people from different countries.

During the last decades, an important number of people, especially from the regions with high risk of poverty went to cities looking for jobs and also in other EU member states mainly in Italy, Spain, United Kingdom and Germany.

Poverty and social exclusion

In the rural areas, poverty and social exclusion are higher than in the urban areas. These aspects are critical because in Romania there are isolated villages situated in the regions with a high risk of poverty. Here, there are no opportunities for jobs, labor market is weak and social exclusion is high. However, during the last decade, due to the measures and efforts made by authorities, a slight diminishing trend was noticed both in the cities and in rural localities.

This feature is not specific only to Romania, but also to other EU countries, especially the ones which became members after 2004.

In 2019, at the EU level, poverty rate accounted for 21% while in the rural areas it was 22%, smaller than 26% in the year 2015. In that year, Bulgaria, Malta and Romania registered a much higher percentage than the EU average (26%) of the rural people at risk of poverty and social exclusion, accounting for 55%, 50% and respectively 51%. In 2020, poverty and social exclusion accounted for 23.7% in the urban areas and 19.9% in the rural space. But the difference could be higher or lower from a country to another, from a region to another, and from cities to communes.

Rural/urban discrepancies are higher in certain Eastern and Southern European member states. Over 50% of rural poor people could be found in Lithuania, Romania, Hungary, Poland and Croatia, while the EU average is 33% [12].

However, rural areas situated in the proximity of the cities are deeply influenced by urbanization and adopt new forms of development.

Access to services and infrastructure

In the rural areas, infrastructure is not enough developed and services are rarely found in the communes and villages of Romania. The isolated areas are more exposed to the lack of infrastructure and services than the rural areas situated closer to cities. The local authorities are lacked of a corresponding budget to modernize the roads, ensure canalization, water supply, waste collection. However, many local authorities developed projects for modernizing infrastructure using funds coming from the EU. But at the national level, the rate of absorption of the EU funds was just about 44% of Euro 6.9 Billion allotted for the Regional Operational Program for the period 2014-2020.

In many rural localities there are no education units and health basic care units, the number of teachers per pupil as well as the number of patients per a family doctor is 1.3 times higher than the EU average. Also, there are many localities without any public transportation means to connect them to cities.

In 2014, "just 50% of the EU rural households were covered by fast broadband internet access compared to 80% in the EU territory". But there are larger differences among the member states. In 14 states, less than 50% of households benefit of this service. Romania has 40% coming on the 20th position in the EU, similar to Italy, Lithuania and Poland [12].

In 2020, in Romania, there were 7,518.1 thousand households by 1.235 more than in 2011 (7,426.5 thousand) and their share accounted for 3.84% in the EU number of households accounting for 195,455 thousand.

Many of these households have access to internet at home and in Romania, their share in the total number of households existing in the country, increased from 43.3% in 2011 to 78.2% in 2020 [31].

But, there are still discrepancies between the urban and rural areas, despite that during the last decade the weight of the households connected to internet at home increased both in the urban and rural areas (Table 3).

Table 3. Share of households connected to internet at home, Romania, 2020 versus 2011

	2011	2020	2020-2011
Number of households (1,000)	7,426.5	7,518.1	+91.6
Share of households with access to internet (%)	43.3	78.2	+34.9 pp
Urban area (%)	59.3	84.8	+25.5 pp
Rural area)%)	21.8	69.7	+47.9 pp

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

Education level in the rural areas

Education is an open door to knowledge, to find a job, to develop a future career and o have an income corresponding to your knowledge and skills. In the EU rural areas, in 2019 22% of the population whose age was 25-64 had a tertiary education, by +4 pp higher than in 2012. However, in the cities, education level is much higher than in the rural areas, with a positive impact on employment and income level.

For example, in the year 2020, in the EU-27, the people aged 30-34 with tertiary education (college, university, and vocational courses) represented 50% in the urban areas and only 28.4% in the rural areas [13]. In Romania, education level is much lower both in the urban areas and the rural ones, as the number of graduates of various education levels is lower compared to other EU countries and in the rural areas it is a critical situation. In 2020, in Romania, only a number of 514,930 persons graduated a type of education and being by 4.1% less than in 2011. Of the total number of graduates in 2020, 83% were from urban areas and only 17% from the rural ones, which reflects the gap of education level between rural and urban population. In the same year, 87,071 graduates were from rural areas, but their number was by 13% smaller than in 2011 reflecting a decreasing trend in education level (Table 4).

Table 4. Graduates of an education form in Romania, 2020 versus 2011

	2011	2020	2020/2011 (%)
Total number of graduates	536,747	514,930	95.9
-Urban areas	435,886	427,859	97.9
-Rural areas	99,861	87,071	87.1
Share of rural in total (%)	18.6	16.9	-1.7 pp

Source: Own calculation based on the data from [31].

The high school leavers have the highest share, but it declined from 9.03% in 2011 to 7.9% in 2020, meaning -1.13 pp. Vocational secondary education comes on the 2nd position and its share increased from 0.8% in 2011 to 4.23% in 2020, reflecting a growth of +3.43 pp. The graduates of a post high school and master vocational education come on the 3rd position with a share of 0.61% in 2011 and 1.12% in 2020. In 2020, only 0.04% of the total graduates of an university were from the rural areas (Table 5).

Table 5. Structure of the graduates in the rural areas by education level and type (%)

	2011	2020	2020-2011 (pp)
Total number of graduates from the rural areas	99,861	87,071	-12,790
(a) Total High school level	9.03	7.9	-1.13
- Theoretical high school and college	2.9	3.5	+0.6
-Technical high school	4.9	3.0	-1.9
-Agricultural high school	0.7	0.8	+0.1
-Forestry high school	0.02	0.03	+0.001
-Agro-mountain high school	0.01	0.01	-
-Veterinarian high school	0.31	0.32	+0.01
-High school for physical education and sport	0.07	0.13	+0.06
-Theological seminaries	0.12	0.11	-0.01
(b)Vocational secondary education	0.80	4.23	+3.43
(c) Post high school and master education	0.61	1.12	+0.51
(d) University graduates with diploma	No data	0.04	

Source: Own calculation based on the data from [31].

Digital skills

Digital skills are very important in the contemporary society as IT penetrated in all the fields of activity and it is progress factor.

During the Covid-19 pandemic, digital skills have become more important in finding a job, working from home and strengthening communication between the people. Digitalization has to be extended not only in the urban areas in "smart cities", but also in the rural areas where it is needed of new opportunities of development in the new so called "smart villages". It is a big gap between digital skills of the rural residents and the ones living in the cities.

At the EU level in 2019, 62% of the city residents had at least basic digital skills, while in the rural areas only 49% [12]. The situation regarding the number of people with basic and above basic digital skills is much better in Finland, Netherlands, Sweden, Denmark and Luxemburg compared to Italy, Romania and Bulgaria which are at the opposite pole. In Romania, the gap is much higher: 40% in the urban areas and 22% in the rural ones (Table 6). At the EU level, the people accessing internet daily represent 81% in the urban areas and 70% in the rural ones.

Employment in the rural areas

The opportunity of jobs is in general limited in the rural areas, the main occupation being agriculture, forestry and fishing which absorbs most of the labor force. In a lower measure, it is also important rural tourism and agro-tourism which has become an additional income source for the rural population during the last decades.

Table 6. Share of the people aged 16-74 with basic and above basic digital skills in certain representative EU countries in 2019 (%)

Countries with the highest share			Countries with the lowest share		
	Urban	Rural		Urban	Rural
EU Average	62	48	1. Italy	48	37
1. Finland	85	68	2.Romania	40	22
2. Netherlands	80	78	3.Bulgaria	40	18
3. Sweden	79	64			
4. Denmark	78	58			
5. Luxemburg	76	64			

Source: [13].

Occupied population in agriculture, forestry and fishing

In 2020, a number of 1,681.2 thousand persons were occupied with agriculture, representing 19.91% of the total civil occupied population in Romania. Since 2011, when there were 2,442 thousand persons occupied in agriculture, this means a reduction by -31.2%. The main causes are migration and aging (Table 7).

Table 7. Occupied population in agriculture, forestry and fishing, Romania, in 2020 versus 2011

	2011	2020	2020/2011 %
Total occupied population (1,000)	8,365.5	8,440.8	100.9
Occupied population in agriculture etc (1,000)	2,442	1,681.2	68.8
Share in agriculture in total occupied population (%)	29.19	19.91	-9.28 pp

Source: Own calculation based on the data from [31].

Women occupied in agriculture, forestry and fishing

In 2020, 852.9 thousand persons occupied in agriculture etc were women and their share in the total population dealing with agriculture accounted for 50.73% being by -4.64 pp smaller than 55.37% registered in the year 2011. Also, in 2020, women dealing with agriculture represented 22.2% in the total number of women occupied in the economy compared to 34% in the year 2011.

Table 8. Women occupied in agriculture, forestry and fishing, Romania, 2020 versus 2011

	2011	2020	2020/2011 %	2011	2020	2020-2011 pp
				Share of women in total occupied population (%)		
Women occupied in the economy (1,000)	3,977.3	3,833	96.3	47.5	45.4	-2.1 pp
				Share of women in total population occupied in agriculture etc (%)		
Women occupied in agriculture (1,000)	1,352.3	852.9	63.0	55.3	50.7	-4.6 pp
				Share of women occupied in agriculture in total occupied population in Romania (%)		
Share in agriculture etc (%)	34.0	22.2	-11.8 pp	16.1	10.1	-6.0 pp

Source: Own calculation based on the data from [31].

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But, if we analyze the share of women dealing with agriculture in the total active population in the country, the percentage is much lower accounting for 16.1% in 2011 and 10.1% in 2020.
All these figures show that women are discriminated in finding a job (Table 8).

Occupied population in agriculture by professional status

The highest share of the population occupied in agriculture belongs to self-employed workers and in 2021 it accounted for 89.5%, while in 2020 it declined to 83.3%. The difference of 10.5% in 2011 and 16.7% in 2020 belonged to salaried persons. However, in 2020, the weight of the salaried persons increased by +6.6 pp (Table 9).

Table 9. Structure of occupied population in agriculture by professional status, Romania, 2020 versus 2011

	2011	2020	2020/2011 (%)
Occupied population in agriculture etc (1,000)	2,572.6	1,821	70.78%
-Salaried (1,000)	269	303	112.63
Share of salaried (%)	10.5	16.7	+6.2 pp
-Self employed workers (1,000)	2,303.6	1,518	65.89
Share of self-employed (%)	89.5	83.3	-6.2 pp

Source: Own calculation based on the data from [31].

The average number of salaried population dealing with agriculture in Romania increased from 97,630 persons in 2011 to 123,570 persons in 2020, meaning by +26.5%. As a result, the weight of the salaried persons working in agriculture in the average number of salaried population working in the economy increased from 2.25% in 2011 to 2.45% in 2020. However, this share is very small as agriculture, forestry and fishing has a low input of salaried labor force.
Men are on the first position among the salaried persons, their share accounting for 71.3% in 2011 and 77% in 2020, reflecting a high gender discrimination (Table 10).

Table 10. Average number of salaried persons in agriculture by gender, Romania, 2020 versus 2011

	2011	2020	2020/2011 (%)	Share of average number of salaried persons in agriculture in average number of salaried persons in Romania (%)		
				2011	2020	2020-2011 (pp)
No. of salaried persons in agriculture	97,630	123,570	+126.5	2.24	2.45	+0.21
-Men (%)	71.3	77	+5.7	3.28	3.59	+0.31
-Women (%)	22.7	23	+0.3	1.08	1.19	+0.11

Source: Own calculation based on the data from [31].

Regarding the discrimination in employment between men and women in the EU, the statistics showed that men have the highest employment rate accounting for 80% in the rural areas and 78% in the urban areas [12].
In Romania, employment rate in agriculture is much smaller than in other sectors of the economy.
In 2020, in the EU, total active population employed in agriculture accounted for 4% (full time equivalent) and 20% for the whole agri-food industry.
In the EU rural areas, only 13% represents employment in the primary sector that is agriculture, forestry and fishing in total employment [12].
Therefore, unemployment is one of the big problems in the rural areas regarding especially the young people. In the period 2015-2017, at the EU level, the population of 15-64 years had only 8.7% unemployment

rate, while the people of 15-24 years had 18% and the people of 25-64 years had 5%.

In 2020, the unemployment rate in the EU accounted for 8.1% in the urban areas and 6.3% in the rural ones. However, there are people who leave agriculture and rural areas going to cities for better job opportunities [13].

The causes of this labor outflow is linked to the existence of numerous small family farms, of which about 40% are subsistence farms with less than Euro 8,000 standard output. And about over 90% of these small farms are especially in Romania, Latvia and Slovenia [12].

Volume of labor force in agriculture

Labor force input in Romania's agriculture in terms of annual work units (AWU) decreased from 1,532 thousand in 2011 to 1,331 thousand in 2020, meaning a loss of -13.2% [14].

Salaried labor input is very small in agriculture and it has continuously declined. From 206 thousand AWU in 2011, it reached 154 thousand AWU in 2020, while non-salaried labor input decreased from 1,326 thousand AWU to 1,177 thousand AWU in the same interval (Table 11).

Table 11. Labor input in Romania's agriculture (1,000 AWU), 2020 versus 2011

	2011	2020	2020/2011 (%)
Labor input in agriculture	1,532	1,331	86.8
- Non-salaried input	1,326	1,177	88.7
Share in total (%)	86.5	88.4	+1.9 pp
-Salaried input	206	154	74.7
Share in total (%)	13.5	11.6	-1.9 pp

Source: Own calculation based on the data from [14].

The figures showed that non-salaried labor input had the highest share accounting for 88.4% in 2020, being by +1.9 pp higher than in 2021.

Also, the data reflected the decline by -25.3% in salaried input in the same period of time.

In 2020, labor input in agriculture represented 15.6% of the EU total labor input, Romania coming on the 2nd position after Poland.

Labor productivity in agriculture

Labor productivity in agriculture is much lower than in other sectors of the economy.

Labor productivity per occupied person in agriculture

In Romania, in 2020, labor productivity per occupied person in agriculture accounted for Lei 23,078.8 being by 69.8% higher than in 2011, which is a positive aspect.

However, the share of labor productivity in agriculture declined from 23.5% in 2011 to 20.4% in 2020, as in other fields of activity it was recorded a higher growth rate (Table 12).

Table 12. Labor productivity per occupied person in agriculture, Romania, 2020 versus 2011 (Lei/person)

	2011	2020	2020/2011 (%)
Labor productivity at the national level	57,649.1	112,987.3	195.99
Labor productivity in agriculture	13,585.1	23,070.8	169.82
Share of agriculture in total productivity (%)	23.5	20.4	-3.1 pp

Source: Own calculation based on the data from [31].

Note: Average exchange rate according to National Bank of Romania: in 2011: 1 Euro= Lei 4.237; in 2020: 1 Euro = Lei 4.837.

Labor productivity per annual work unit (AWU)

This is the most important indicator which reflects labor productivity in agriculture allowing a more correct comparison with labor productivity in other sectors of the economy in full time equivalent, avoiding the variations caused by seasonal labor in agriculture.

In this case, labor productivity is expressed by the following indicators: agricultural output value per AWU, gross value added per AWU and Factor income per full-time labor equivalent AWU, being a measure of the net value added by the equivalent of each full-time worker in real terms (adjusted for inflation and expressed as an index) in the agricultural industry. Taking into account the decline of labor input in agriculture in terms of AWU and the increase of agricultural production value and of gross value added, the level of labor productivity increased in Romania. In 2020, labor productivity in terms of agricultural output value accounted for Euro 13.06 million per 1,000 AWU, being by 10.86% higher than in 2011 and in terms of gross value added it reached Euro 5.95 million per 1,000 AWU, being by 12.47% higher. Factor income declined by -0.43 pp in the analyzed interval (Table 13)

Table 13. Labor productivity in agriculture, Romania, 2020 versus 2011

	MU	2011	2020	2020/2011 (%)
Agricultural production value				
-Romania	Euro Mil./1,000 AWU	11.78	13.06	110.86
-EU-27	Euro Mil./ 1,000 AWU	40.0	50.2	+125.50
-Share of Romania in the EU average	%	29.45	26.01	-3.44
Gross value added				
-Romania	Euro Mil./1,000 AWU	5.29	5.95	112.47
-EU-27	Euro Mil./per 1,000 AWU	16.63	20.83	125.25
-Share of Romania in the EU average	%	31.80	28.56	-3.24
Factor income				
-Romania	2010 = 100	129.06	128.63	-0.43 pp
-EU-27	2010 = 100	108.3	131.88	+23.58 pp

Source: Own calculation based on [15, 16].

The data from Table 13 showed that in Romania, the share of agricultural production value per 1,000 AWU in the EU-27 level declined in 2020 versus 2011 by -3.44 pp, while the share of gross value added per 1,000 AWU in the EU level also decreased by -3.24. At the EU-27 level, agricultural output value increased by 25.50% and gross value added by 25.25%

Income in the rural areas

In the rural areas income level is smaller compared to income got by the people working in the urban areas. And this could create an image on the differences existing regarding the living standard. In Romania, average monthly income per person in the rural areas differs by social category: salaried, self-employed person, unemployed and pensioners. In 2020, the total average monthly income per person in the rural areas accounted for Lei 1,567.72, being by 121% higher than in 2011, which is a positive aspect, but it represented only 64.5% of the average monthly income per person in the urban areas. More than this, its share in 2020 was by -10.3 pp smaller than 74.8% recorded in the year 2011. This means that in the rural areas, the growth rate of the average monthly income was smaller than in the cities and towns. This aspect is available for all the social categories from the rural areas (Table 14).

Table 14. Share of average monthly income per person in the rural areas in the average monthly income per person in the urban areas by social category (%)

	2011	2020	2020-2011 pp
Salaried	74.9	71.9	-3.0
Self-employed	81.3	71.2	-10.1
Agriculturist	140.5	109.8	-30.7
Unemployed	88.3	65.0	-23.3
Pensioner	86.6	79.3	-7.3

Source: Own calculation based on the data from [31].

The data from Table 14 show that only the agriculturists registered a higher share of the average monthly income in the urban areas compared to the rural ones.

But, if in 2011, the agriculturists earned a higher average income by +40.5%, in 2020, their surplus was only 9.8%, meaning by -30.7 pp less.

Analyzing the level of average monthly income in the rural areas with the average monthly income per person in the economy, we may notice the gaps existing by each social category.

But, for all the categories of persons, we may also notice that average monthly income increased in various percentages ranging between +157.22% for salaried persons (the highest growth rate) and +61.8% for agriculturists (the lowest growth rate) in 2020 compared to 2011.

In the year 2011, in the rural areas, average monthly income per person is smaller than its average level in the economy for all the social categories. The gap existing between different social categories had the highest level for unemployed persons (-45.5%) and the lowest level for salaried persons (-2.8%).

In the year 2020, the share of average monthly income per person in the rural areas in the average income in the economy was much smaller for almost all the categories, except salaried persons, because the salaried persons registered an income by +3.3% higher than the average income in the economy. The other social categories recorded a reduced monthly income by -65.8% in case of unemployed persons, the highest discrepancy, and by -29.4% in case of rural pensioners (Table 15).

Table 15. Comparison between average monthly income per person in the rural areas and average monthly income per person in the economy, Romania, 2020 versus 2011

	MU	2011	2020	2020 vs. 2011 (%) and (pp)
Average monthly income per person in the economy (AMEE)	Lei/person	839.53	2,030.5	241.8 %
Average monthly income per person in the rural areas versus AMEE by social category				
-Rural areas	Lei/person	709.15	1,567.72	221.07%
	%	84.4	77.2	-7.2 pp
-Salaried	Lei/person	816.09	2,099.22	257.22%
	%	97.2	103.3	+6.1 pp
-Self-employed	Lei/person	545.4	1,046.45	181.1%
	%	59.2	45.3	-13.9 pp
-Agriculturists	Lei/person	618.2	1,000.88	161.8%
	%	73.6	49.2	-24.4 pp
-Unemployed	Lei/person	457.5	694.7	183.1%
	%	54.5	34.2	-20.3 pp
-Pensioners	Lei/person	766.38	1,434.12	187.1%
	%	91.2	70.6	-20.6 pp

Source: Own calculation based on the data from [31].

Note: Average exchange rate according to National Bank of Romania: in 2011: 1 Euro= Lei 4.237; in 2020: 1 Euro = Lei 4.837.

Agriculturists achieved Lei 1,000.88 per month in 2020 by 61.8% more than Lei 618.2 in 2011. But, their income represented 73.6% in the average income per person in the economy in 2011 and only 49.2% in 2020 (-24.4 pp).

Agriculturists come on the 3rd position after salaried persons and pensioners in the year 2011 and on the 4th position after salaried persons, pensioners and self-employed persons in 2020. And this shows that agriculturists became a disadvantages category and have a lower living standard.

In the EU, the situation is completely different, the discrepancies being much smaller despite that they exist between average wage in the economy and average income got by farmers.

Analyzing the entrepreneurial income achieved in the EU's agriculture per family work unit, we may notice that in 2020 its level increased by 23.30%, reaching Euro 14,998.10 compared to Euro 12,159.77 in the year 2011. Also, the share of its level in the EU average income in the economy increased from 42% in 2011 to 47% in 2020 meaning +5pp (Table 16).

Table 16. Farmers income compared to wages in the EU economy, 2020 versus 2011 (Euro/family work unit)

	2011	2020	2020/2011
Agricultural entrepreneurial income per family work unit	12,159.77	14,998.10	123.37
Share of average wage in the whole economy (%)	42	47	+5pp

Source: Own calculation based on the data from [12].

Economic development in the rural areas

Agricultural production value and gross value added

Agricultural production value declined in Romania from Euro 18.04 Billion in 2011 to Euro 16.84 Billion in 2020, meaning by -6.66% less. This happened due to the productions obtained in the vegetal and animal sector which were deeply influenced by climate conditions and also by price volatility. At the same time, gross value added in agriculture registered a decrease of -2.32% from Euro 8.11 Billion in 2021 to Euro 7.92 Billion in 2020.

At the EU -27 level, agricultural production value increased by 1.89% and gross value added by 5.3% in the analyzed interval.

As a result, in 2020, the contribution of Romania to the EU agricultural output value was 4.09% by -0.37 pp smaller than in 2011 and the contribution to GVA accounted for 4.48 % being by -0.34 lower than in the first year of the analysis [45] (Table 17).

Table 17. Agricultural production value and gross value added, Romania, 2020 versus 2011 (Euro Million)

	2011	2020	2020/2011 (%)
Agricultural production value, Romania	18,048.3	16,847.02	93.34
Agricultural production value, EU-27	404,134.06	411,772.2	101.89
-Romania's contribution to the EU (%)	4.46	4.09	-0.37
Gross value added in agriculture, Romania	8,109.08	7,921.71	97.68
Gross value added in agriculture, EU-27	167,973.36	176,966.93	105.35
-Romania's contribution to the EU (%)	4.82	4.48	-0.34

Source: Own calculation based on the data from [15].

Gross domestic product/inhabitant in the rural areas

GDP per inhabitant reflects in the best way the level of development in the rural areas compared to the urban ones. The statistics shows that in the rural areas GDP/capita is smaller than in the urban areas.

According to National Institute of Statistics, in Romania, GDP/inhabitant reached Lei 54,800.4 in 2020, being by 97.5% higher than Lei 27,739.7 in 2011, reflecting an important economic growth with a positive impact on living standard of the population [31]. According to Eurostat, in 2018, Romania registered Euro 13,000 GDP/capita in the rural areas. For this GDP level, the country came on the ante penultimate position among the EU member states compared to the EU-28 average which accounted for Euro 20,067 per capitaIn the descending order, the EU countries situated below the EU mean for GDP/inhabitant were: Portugal, Greece, Estonia, Poland, Slovakia, Lithuania, Hungary, Romania, Latvia and Bulgaria. All the other EU member states registered a higher GDP/capita than the EU mean in the rural areas (Table 18).

Table 18. GDP/inhabitant in the EU-28 rural areas in 2018 (Euro/capita)

GDP/capita < the EU average		GDP/capita > the EU average	
EU-28 average = Euro 20,067 per inhabitant in the rural areas			
1.Netherlands	36,000	1.Greece	16,300
2.Austria	32,500	2.Estonia	16,000
3.Denmark	31,500	3.Poland	15,500
4.Germany	30,300	4.Slovakia	15,500
5.Sweden	30,100	5. Portugal	14,200
6.Finland	28,600	6.Lithuania	14,200
7.Italy	26,700	7.Romania	13,900
8.Spain	24,100	8.Latvia	12,700
9.France	23,300	9.Bulagria	10,600
10.Czechia	23,000		
11.Slovenia	21.900		

Source: [12].
Note: No data for other EU countries.

In the EU rural areas, GDP/capita represents 66% of the EU average compared to 82% and 118% in the intermediate and, respectively, predominantly urban regions. The gap between rural and urban areas is much higher in the N-13 countries joining the EU after 2004, where GDP per capita is 48% of the EU average while in the N-15 is 87% [12].

Budget for rural development

Rural development is one the important priorities in the EU policy as mentioned in the program 2014-2020 and the new reformed policy regarding the future by 2030 and 2050.

For the period 2014-2020, according to the European agricultural fund for rural development (EAFRD) for rural development it was allotted a budget of Euro 95.5 Billion for the period 2021-2027 and in addition a surplus of Euro 8.1 Billion for recovers due to the challenges caused by Covid-19 pandemic. Each EU country has also developed its own budget for a similar purpose.

The main objectives of EAFRD are:

- to strengthen the transfer of knowledge and innovation in agriculture, forestry and rural areas;
-to support the growth of competitiveness and viability of the agricultural systems promoting new technologies and new types of farming (organic agriculture, conservation agriculture, circular economy, bio-economy, agro-ecology);
-to better organize the whole food chain enhancing short supply food chains, animal welfare and reducing risk management in agriculture;
-environment protection and biodiversity conservation;
-digitalization to be a tool for strengthening the new forms development both in the urban and rural areas.

The new vision in EU CAP reform aims to create a historical change "for rural regions by bridging the digital gap and transforming rural areas in partners to the green transition" [1, 18].

The future of the development of rural areas depends on how the funds provided by the EU are used by each member state and also on the national programs created for attaining this purpose.

In Romania, it was implemented the National Program for Rural Development in the period 2014-2020 and it was established the National Strategic Plan 2021-2027, which has "the following objectives:

(a) *Promoting an intelligent, resilient and diversified agro-food sector destined to ensure food safety*, whose expected results will be: stable incomes for farmers, high productivity and competitiveness of the agri-food sector, a higher adaptation of farming to climate changes, an increased food safety, a higher gross value added in agriculture, additional income for farmers, digitalization of agro-food system, and improving the links between research, innovation and practice.

(b) *Strengthening the actions for environment protection and adapting to climate change*, whose expected results will be: reduction of greenhouses gas emissions, a more efficient management of natural resources and reducing the pressure of agriculture on soil, water and air, ensuring health agro-food products, biodiversity conservation, and preservation of rural space features and natural landscapes.

(c) *Consolidation of the socio-economic structure of the rural areas*, whose expected results will be: increased income and life quality for the rural population, reduction of poverty and social exclusion, involving young people both in agricultural and non-agricultural activities, development of the mountain areas, new technologies for improving rural space.

(d) *Promoting knowledge, innovation and digitalization in agriculture and the rural areas*, whose expected results will be: improvement of farmers' knowledge, skills, by a sustained agricultural extension, innovation, and implementation of digitalization, improvement of public/private partnership" [27, 28].

CONCLUSIONS

Rural areas are very important in Romania due to their high share of 89.6% in the territory and of 46.4% of the rural people in total population, despite that the rural population is in a continuous decline due to aging and migration. At the EU level, the rural population accounts for 29.1% in total population of the EU.

In Romania, about 46% of the rural population consists of people whose age is 50 and over years, while at the national level is just 38.8%. In the EU, the people older than 50 has a lower weight.

Depopulation of the rural Romania is caused by the negative natural movement and migration.

Poverty and social exclusion is more accentuated in the rural space, and especially in the isolated villages. While the EU rural areas poverty and social exclusion rate is 26%, in Bulgaria, Malta and Romania the rate is much higher: 55%, 50% and 51%.

Rural infrastructure is still a non corresponding one regarding roads, water supply, sewerage and waste collection as the EU funds were used just in a small proportion accounting for 44% of the total budget allotted for the period 2014-2020.

Education level is lower in the rural Romania, as long as in 2020, only 17% of the graduates were from the rural areas. At the EU level, about 22% of the people aged 25-64 and 28.4% of the ones aged 30-34 have tertiary education.

In Romania, 69.7% rural households compared to 84.8% in the urban areas are connected to internet at home. Among the rural residents, 49% have digital skills compared to 62% in the cities.

Of Romania's occupied population, 20% works in the rural areas and its number continue to decline. Women represent 50% of the rural occupied population in agriculture and 10% in the national active population.

About 83% of occupied population in agriculture are self employed, and the salaried persons have the lowest share (17%). In total salaried persons at the country level, men salaried in agriculture represent 3.5%, while women just 1.1%, reflecting gender discrimination.

The volume of labor force in agriculture in terms of AWU is dominated by non salaried persons (88%), compared to 12% salaried.

In 2020, labor productivity in Romania's agriculture is small, just 20% of its national level. Per 1,000 AWU, labor productivity accounted for Euro13 million agricultural output value and Euro 5.95 million gross value added.

In the rural areas, average monthly income represents 64% of the income level in the urban areas and its growth rate is smaller. Agriculturists have the smallest income compared to other social categories in the rural areas.

In 2020, agricultural production value declined by -6.6% and GVA by -2.3% compared to the levels in the previous years due to the impact of the climate change, while in the EU it was registered an increase of +1.89%, and respectively +5.3%. In consequence, Romania's contribution to the EU agriculture output value is 4% and to GVA is 4.5%.

GDP/capita in the rural Romania accounts for Euro 13,000, representing 65% of the EU average of Euro 20,067/capita which reflects the gap regarding the economic development and living standard in the rural areas.

Rural areas could mitigate the effects of climate change passing to more green economy including organic, conservation and environment friendly agricultural practices, preserving biodiversity and the beauty of landscapes, therefore, they could be a crucial part of the transition to a green and sustainable Europe.

National Strategic Plan 2021-2027 is destined to transform rural areas in a resilient and diversified eco-system supplying agro-food products for ensuring food safety, in a more adapted zone to climate change and protector of environment. This requires the consolidation of economic and social structure in the rural areas using new knowledge, innovation and digitalization.

To attain the objectives of the EU policy regarding the new rural areas development, the national programs have to be adapted to local conditions, based on the identification of strengths and weaknesses of the community. Therefore, local authorities plays the key role in the process of sustainable development of the rural areas.

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THE IMPORTANCE OF PRODUCTION AND IMPORT FOR ENSURING FOOD AVAILABILITY IN ROMANIA

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Abstract

The paper analyzed the importance of production and import in food availabilities in Romania in the period 2015-2020,using the data provided by National Institute of Statistics. the following indicators were studied: total consumption, consumption per inhabitant, production, production/consumption rate, import, import/consumption rate, export, trade balance, import/export ratio, food availabilities, production share and import share in food availabilities, self-sufficiency rate. Dynamic analysis, mean, growth rate in 2020 versus 2015, comparisons were the main tools used for data processing. The results showed that consumption increased for fruits, vegetables, meat, fish, and declined for potatoes, cereals, sugar and eggs, as consumers are more oriented to a healthier diet. Production increased for fruits (26.7%), meat(3.3%), potatoes (2.8%), but it declined for sugar (-65%), eggs (-17%), milk (-5%), fish (-5%), and vegetables (-2.7%). In 2020 vs.2015, production covered consumption of cereals, potatoes, fruits, eggs and milk, but not for meat and fish. Imports increased for all the products, the growth rates varying between 136.7% for sugar and 17% for fish and cereals. The coverage rate of consumption by import was 101% for cereals, 97% for sugar, 91% for fish, 64% for fruits, 39% for meat, 38% for fats, 29% for potatoes, 23% for milk, 17% for vegetables and 10% for eggs. Agro-food export increased for all the products, but with a lower rate than import, resulting a negative trade balance, cereals and honey being excepted. Import/export ratio was the smallest for cereals (0.34), but high for the other products (21.5 for potatoes, 13.7 for fish, 12 for fruits, 10.1 for vegetables, 4 for milk, 3.8 for sugar, and 3.6 for meat). Self-sufficiency rate was over 100% for cereals and honey, and below 100% for all the other products, the lowest level being for fish and sugar. The share of import in food availabilities was 91% for fish, 89% for sugar, 39% for meat, 35.9% for fruits, 32.4% for cereals, 30% for fats, 20.7% for vegetables, 18.4% for milk, 17.6% for potatoes, and 8.1 % for eggs. As a conclusion, the high share of imports is a result of the incapacity of agricultural production to cover market needs for all the product categories. Farmers have to increase productivity, product quality, to join in associative forms, and create short supply food chains to sell their products. Imports are justified mainly in cases where production is not sufficient to cover the internal market.

Key words: *production, import, export, food availabilities, self-sufficiency, Romania*

INTRODUCTION

Food is a fundamental item of human existence. Food availability, everyone's access to it and consumption of healthy food are the key components of food security destined to ensure life on the Earth. In 1996, FAO defined food security as follows: "each person has physical, social and economic access at all times to sufficient, safe and nutritious food to cover food requirements and preferences imposed by a healthy and active life" [9].

Food security has a positive economic and social impact as it could ensure economic development, growth and stability, a lower unemployment rate by creating new jobs, a higher productivity, new opportunities for commercial transactions and trade development, reduction of poverty and health improvement [54].

To cover the demand, food supply has to correspond as volume, diversity, quality and sufficiency, and agriculture is called to achieve a higher production and of a higher quality.

To enhance agricultural production, farmers have to improve yields, using new technologies based on the use high value varieties and hybrids for different crops, an improved crop structure and a corresponding crop rotation, a higher plant density, integrated pest and weeding control, a rationale fertilizer, soil and water management, modern machinery and equipments, to optimize livestock and increase animal production by efficient breeding programs and using high quality forages and quantitatively sufficient, paying attention to animal health and welfare etc [57].

Also, for developing agricultural production, the trade exchanges between various countries could offer and improve the access to resources, equipments, technologies, other goods and services for agriculture and other connected fields of activity. Therefore, the participation to international trade has an economic, social and political importance for any country [13, 53].

Exports and imports in terms of net exports could contribute to the increase of GDP, besides personal consumption expenditures, gross private investment and government purchases [32, 56].

The importance of production to assure domestic market with agro-food products cannot be denied and has to be closely related to the access to resources as volume and structure, labor input, and processing technologies in order to obtain high value and quality products [52].

However, it is not possible as a country to produce all sorts of agro-food products taking into consideration the geographical position, soil quality and climate conditions, crop and livestock structure, labor qualification, productivity level, efficiency along the product chain.

For this reason, imports play their role in completing domestic production for covering the market needs. Import volume and structure is determined by the development level of agricultural production and its potential to cover the internal needs of the population and processing industries in a country. In general, agro-food products subject to import cannot be produced in the country or are achieved in small amounts. Imports also depend on production costs, delivery price, commercial relationships among various countries, trade agreements, comparative advantage etc. [24].

Imports of equipments and technologies could be welcome to strengthen agriculture to develop to produce more and of higher quality, to improve the competitiveness of the products which could be exported [12].

Also, import of agro-food products could be destined for re-export when prices on the international market are favorable, and the exporting country could benefit of the difference between a low import price and a higher export price.

Beside import, export is also very important for any country, as it is a source of foreign currency which could improve trade and payment balances, and create a resource for economic development. Export could diminish labor migration, offer jobs, increase labor qualification, technological level and value added, enhance internal production efficiency, and stimulate export itself.

If exports exceed imports, the country registers a trade surplus and stimulate economic growth and increase GDP [2, 50].

When the difference between export and import is negative, the country is a net importing country, dependent on resources, technologies, agri-food products from outside the frontiers, and this is very costing and reflects that the potential of the country is not enough exploited [1].

Trade exchanges have to be efficient favoring export/import ratio for assuring food safety and also export earnings to cover import expenses and improve the trade balance [11].

An unbalanced demand/offer ratio in the domestic market reflects a food crisis and oblige the country to stimulate production and to complete it by imports of agri-food products, which could produce a negative trade balance [8].

The export/import ratio has a deep impact of the efficiency of foreign trade, also influencing GDP, exchange rate, inflation rate etc.

Adding agro-food production to import and substracting export, we may obtain food availabilities for consumption [49] and dividing production by food availability we can determine self-sufficiency ratio (SSR), which reflects the share of production in food supply availability [4, 10].

As production to cover consumption needs, the ratio must be over 100%. If it is less 100%, agro-food production is not able to cope with the population's demand. Therefore, the higher the ratio between production and food availabilities, the higher the self-sufficiency rate [16].

Romania is a country with a high agricultural potential, both in crop and animal sector. It could produce cereals, especially maize and wheat [45], oil seeds cultivating sunflower, rape, soybean [26, 46], potatoes [20, 21, 51, 55], vegetables [7, 37], fruits [6, 18, 36, 41], sugar [3], milk and dairy products [27, 30, 39, 42], eggs [5, 47], meat [28], of various sorts like: pork [33, 34, 48], poultry meat [19], beef [38], sheep and goat meat [42], fish [15, 22], honey [17, 25, 35, 40].

Also, Romania has an intense foreign trade mainly with the EU member states, being both as an importing and as an exporting country [29, 31, 43, 44].

In this context, the purpose of the paper was to study the dynamics of production, import, export, food availabilities, self-sufficiency rate, production/consumption ratio, import/consumption ratio, export/import ratio in Romania in the period 2015-2020 using the data from National Institute of Statistics. The comparison between the 2020 level versus 2015 was used to quantify the changes by 10 groups of agro-food products: Cereals and cereal products, Potatoes, Vegetables and vegetable products, Fruits and fruit products, Sugar and sugar products, Milk and dairy products, Eggs, Meat and meat products, Fish and fish products, and Fats of vegetal and animal origin. Finally, it was aimed to evaluate in what measure production and import assure the domestic market with agro-food products and if imports are really justified.

MATERIALS AND METHODS

In order to set up this paper, the data were collected from National Institute of Statistics for the period 2015-2020.

The following indicators were studied in the period of reference mentioned above:

-*Total consumption of agro-food products* as a reflection of demand;

-*Average annual consumption of agro-food products per inhabitant;*

-*Usable Production (P_u)* including the amounts of obtained primary products, producers' self-consumption and processed products;

-*Coverage rate of consumption by production* (C/P%) calculated as a ratio between production and consumption reflecting in how much of total consumption is assured by internal production;

- *Import (I)* including the amounts of agro-food products bought from other countries;

-*Coverage rate of consumption by import* (I/P%) determined as a ratio between import and total consumption, reflecting how much of total consumption is assured by import.

-*Export (E)* including the amounts of agro-food products sold by the country to other countries;

-*Agro-food trade balance* was determined as a difference between the exported amounts of agro-food products and the imported amounts.

-*Agro-food export/import ratio* was calculated in order to establish Romania's status of exporting or importing country in the international trade and to reflect the efficiency of its agro-food trade.

-*Stock variation (±Vs)* representing the difference between the stock at the end and at the beginning of the year.

-*Supply of agro-food availabilities (S_a)* including all the amounts of available agro-food products destined to cover the domestic needs of the country. It was calculated based on the formula [14]:

$$S_a = Pu + I - E - (\pm Vs) \qquad (1)$$

-*Share of import in the availabilities of agro-food products for consumption ($I_{\%}$)* according to the formula:

$I_{\%} = I / S_a \times 100$ (2)

-*Self-sufficiency rate* (SSR) reflects in what measure domestic production meet the internal consumption requirements and it was determined using the formula:

$SSR = P_u / S_a \times 100$ (3)

-*Almost all indicators mentioned above* were analyzed by 10 groups of products: Cereals and cereal products (in equivalent grains), Potatoes, Vegetables and vegetable products (in equivalent fresh vegetables), Fruits and fruit products (in equivalent fresh fruits), Sugar and sugar products (in equivalent of refined sugar), Milk and dairy products (in equivalent fresh milk with 3.5% fat), Eggs, Meat and meat products (in equivalent fresh meat), Fish and fish products (in equivalent fresh fish) and Fats of vegetal and animal origin.
For the quantitative indicators it was calculated the sum for the period 2015-2020 and the average level according to the formula:

$\bar{X}_i = \sum X_i / n$ (4)

where: X_i = the analyzed indicator in the period 2015-2020 and n the number of years
Also, it was determined the Fixed basis index ($I_{FB\%}$) in 2020 versus 2015, using the formula:

$(I_{FB\%}) = (X_n/X_1) x100$ (5)

Comparison method was also used to identify the positive or negative differences between the levels of indicators in 2020 versus 2015.
The results were tabled and interpreted, and finally the main conclusions were drawn.

RESULTS AND DISCUSSIONS

Dynamics of total consumption of agro-food products as a reflection of demand
Consumption of agro-food products registered various trends in the analyzed period, depending on the group of products, changes in consumers' behavior looking for healthier diets and the evolution demographic aspects.
In 2020 versus 2015, consumption increased by: +19.1% for fruits and fruit products (in equivalent of fresh vegetables), +13.2% for meat, +12% for fish and fish products (in equivalent fresh fish) and +3.5% for vegetables and vegetable products (in equivalent fresh vegetables), +0.8% for milk and dairy products (in equivalent fresh milk with 3.5%), and +0.7% for fats of vegetal and animal origin. But, total consumption declined in case of cereals (-6%), potatoes (-7.7%), sugar (-3%) and eggs (-13%) (Table 1).

Table 1. Dynamics of total consumption of agro-food products by group of products, Romania (Thousand tons)

	2020	Total consumption 2015-2020	Mean	2020/2015 %
Cereals and cereal products	3,936	24,264	4,044	94.0
Potatoes	1,788	11,169	1,861.5	92.3
Vegetables and vegetable products	3,745	22,301	3,716.8	103.5
Fruits and fruit products	2,073	11,903	1,983.6	119.1
Sugar and sugar products	492	2,996	499.3	97.0
Milk and dairy products	5,011	29,918	4,986.3	100.8
Eggs	228	1,472	245.3	97.0
Meat and meat products	1,490	8,559	1,426.5	113.2
Fish and fish products	121	751	125.1	112.0
Fats of vegetal and animal origin	428	2,552	425.3	100.7

Source: Own calculation based on the data from NIS, 2022 [14].

The detailed situation by group of products is as follows:

-in case of cereals, it was noticed a decline in consumption for wheat and rice, but an increased consumption for maize;

-while the total consumption of tomatoes and other vegetables increased, consumption of cabbage, onion, and roots declined;
- apples, cherries, other indigenous fruits and exotic fruits registered a higher consumption, while total consumption of grapes, plums, peaches and nectarines decreased;
-in case of meat, pork, poultry meat, sheep and goat meat registered a higher consumption while the total consumption of beef and veal declined;
-while total consumption of vegetal oil and margarine decreased, butter and pork fat recorded a higher consumption.

Average annual agro-food consumption per inhabitant

This indicator is a reflection of the variation in total consumption and the number of the population and characterizes, besides other indicators, the living standard.

The average annual consumption of cereals accounted for 20.4 kg grains/capita in the year 2020, being by -3.3% lower than in 2015. The decrease by type of cereals was different as follows: -1.85 for wheat, -8.3% for maize and -11.5% for rice, but the order of cereals importance in consumption remained the same: wheat, maize and rice.

The average consumption for potatoes reached 93.4 kg/capita in 2020, reflecting a decline by 5% compared to 2015.

Consumption of vegetables was by +6.45 higher in 2020 versus 2015, but the situation by type of vegetables was as follows: +9.1% for tomatoes, +3.5% for cabbage, +11.3% for other vegetables, but -1.45 for onion and -1.4% for roots.

Also, fruits have become more important in the Romanians' diet. In 2020, the average annual consumption accounted for 107.6 kg/capita being by +22.5% higher than in 2015. Important increases were noticed for almost all the categories of fruits: +12.3% for apples, +14.5% for grapes, +71.7% for plums, +7.9% for cherries, +33% for other indigenous fruits and + 32.5% for exotic fruits. The only exception is represented by peaches and nectarines whose consumption declined by -22.1%.

Table 2. Average annual consumption of agro-food products per inhabitant in 2020 versus 2015 (kg/capita)

	2015	2020	2020/2015 %
Cereals	211.2	204.4	96.7
-Wheat and rye	163.4	160.5	98.2
-Maize	42.3	38.8	91.7
-Rice	5.2	4.6	88.5
Potatoes	98.3	93.4	95.0
Vegetables	182.6	194.4	106.4
-Tomatoes	38.6	42.1	109.1
-Cabbage	42.1	43,6	103.5
-Onion	21	20.7	98.6
-Roots	14.2	14.0	98.6
Other vegetables	42.6	47.4	111.3
Fruits	87.8	107.6	122.5
-Apples	25.9	29.1	112.3
-Grapes	6.9	7.9	114.5
-Plums	4.6	7.9	171.7
-Cherries	3.8	4.1	107.9
-Peaches and nectarines	5.9	4.6	77.9
-Other local fruits	10.9	14.5	133.0
-Exotic fruits	29.8	39.5	132.5
Sugar and sugar products	25.6	25.5	99.6
Milk and dairy products	250.7	260.2	103.8
Eggs	13.1	11.8	90.0
Meat	63.4	77.4	122.1
-Pork	31.3	37.3	119.2
-Poultry	23	28	121.7
-Beef and veal	6.3	5.4	85.7
-Sheep and goat	2.2	2.6	118.2
Fish	5.5	6.3	114.5
Fats and oils	21.5	22.2	103.2
-Vegetal oil	14.6	15.6	106.8
-Margarine	3.6	2.7	75.0
-Butter	1.0	1.5	150.0
-Pork fat	2.3	2.4	104.3

Source: Own calculation based on the data from NIS, 2022 [14].

The average annual consumption of sugar and products made of sugar recorded a slight decline (-0.6%).

The average annual consumption of milk and dairy products increased by +3.8% in 2020, accounting for 260.2 kg.

In case of egg consumption, it was noticed a decrease by 10% in 2020 when its level accounted for 11.8 kg/capita.

The average annual meat consumption increased by +22.1% in 2020, when it reached the record of 77.4 kg per capita. However, by sort of meat, in the year 2020, a Romanian consumed in average: 37.3 kg pork, 28 kg poultry meat, 5.4 kg beef and veal, and 2.6 sheep and goat meat.

In the interval 2015-2020, consumption increased by +21.7% for poultry meat, +19.2% for pork, +18.25 for sheep and goat meat, but it declined by -14.3% for beef.

The average annual consumption of fish and fish products had an ascending trend reaching 6.3 kg/capita in 2020, being by 14.5% higher than in 2015.

The consumption of fats reached 22.2 kg/capita in 2020, by +3.2% more than in 2015. Vegetal oil is the most consumed, 15.6 kg/capita in the year 2020, followed by margarine and pork fat and butter. While the consumption of vegetal oil, butter and pork fat increased by +6.8%, +50% and, respectively, +4.3%, the consumption of margarine decreased by 25% (Table 2).

Dynamics of agro-food production

The increased demand for agro-food products in the domestic and also in the EU market has been a key factor to stimulate production growth mainly after Romania's adhesion to the common market in 2007. Despite that farm structures and size characterize a subsistence and semi-subsistence agriculture, production recorded an ascending trend grace to the efforts to improve technologies and the efficiency of land and labor input, to diversify and raise the offer volume and quality.

In the period 2015-2020, agro-food production had a different evolution from a group of products to another, from a year to another and from a region to another in Romania.

The statistics proves that in 2020 it was recorded either a higher or a lower production compared to 2015 depending on the group of agro-food products.

From a quantitative point of view, the achieved production was higher for the following groups of products: fruits (+26.7%), fats of vegetal and animal origin (+12.1%), meat (+3.3%), potatoes (+2.8%), and cereals (+0.6%). In case of the other groups of products, the production declined as follows: by -65.4% for sugar and sugar products (in equivalent of refined sugar), by -17.1% for eggs, by -5.2% for milk and dairy products (in equivalent milk of 3.5% fat, butter excluded), by -5% for fish and fish products (in equivalent fresh fish), and by - 2.7% for vegetables (in equivalent fresh vegetables), leguminous grains and melons (Table 3).

Table 3. Dynamics of agro-food production by group of products, Romania (Thousand tons)

	2020	Total production 2015-2020	Mean	2020/2015 %
Cereals and cereal products	19,089	147,331	24,555.16	100.6
Potatoes	2,699	16,831	2,895.16	102.8
Vegetables and vegetable products	3,605	22,464	3,744	97.3
Fruits and fruit products	2,527	14,049	2,341.5	126.7
Sugar and sugar products	187	2,058	343	34.6
Milk and dairy products	5,439	33,040	5,506.6	94.8
Eggs	272	1,773	295.5	82.9
Meat and meat products	1,075	6,418	1,069.6	103.3
Fish and fish products	19	134	22.3	95
Fats of vegetal and animal origin	453	2,557	426.16	112.7

Source: Own calculation based on the data from NIS, 2022 [14].

However, it worth to mention that the highest level of production accounted for: 31,112 thousand tons cereals etc in 2018, 3,117 thousand tons potatoes in 2017, 3,990 thousand tons vegetables etc in 2018, 2,958 thousand tons fruits in 2018, 539 thousand tons sugar and sugar products in 2015, 5,732 thousand tons milk and dairy products in

2015, 328 million eggs in 2015, 1,084 thousand tons meat and meat products in 2017, 25 thousand tons fish and fish products in 2017 and 453 thousand tons fats in 2020.

The lowest production was achieved in 2015 for cereals, potatoes, meat and fats, in 2016 for vegetables and fruits, in 2017 for milk and dairy products, in 2018 for sugar, and in 2020 for eggs and fish.

The variations were caused by the diversity of technologies applied, farm size, crop structure, livestock level and structure and climate factors.

The EU unique market favored commercial exchanges between the member states, and Romania's market was invaded by imports which affected local producers especially in case of potatoes, fruits, vegetables, milk and pork meat.

In the year 2020, among cereals, the top products were maize and wheat and rye grains whose share in total output accounted for 57.3% and, respectively, 35.5%.

Vegetable production was dominated by cabbage (27%), tomatoes (19.3%), onion (9%), roots (5.7%), and other vegetables (21%).

Within fruits, the highest contribution to production was given by grapes (37%), plums (30.4%), and apples (21.6).

Cows and buffaloes contributed by 97% to milk production, the difference coming from sheep and goats.

The structure of meat production included: 45.3% poultry meat, 36.9% pork, 8.1% beef and veal, 5.1% mutton, lamb and goat meat.

Vegetal oils dominates the production of fats with a share of 79%.

The coverage rate of consumption by production

Analyzing the rate in 2020 versus 2015, it was noticed the best coverage in case of cereals, production exceeding consumption 4.84 times in the year 2020, when the coverage rate was by +31.9% higher than in the first year of the studied period. This reflects that there are important amounts of cereals which could be destined to export.

In case of potatoes, the coverage rate accounted for 150% in 2020, being by +15.4% higher than in 2015. Therefore, also, it was recorded a surplus which could be valorized to export, and the imported amounts are justified only for diversifying the offer.

In case of fruits, the production was able to cover the demand, in 2020, the coverage rate being 121.95, by +7.45 higher than in 2015.

Analyzing the situation by fruit category, production was not able to cover the requirements for apples, cherries, peaches and nectarines and of course, for exotic fruits, which cannot be produced in Romania. Therefore, the imports are compulsory for these categories of fruits for satisfying consumers' needs.

For vegetables, the coverage rate declined by -6.25 from 102.4% in 2015 to 96.25 in 2020, showing that production could not meet the domestic market requirements. The critical situation was for tomatoes, onion, roots and other vegetables, which need to be supplied from other countries.

In case of sugar and sugar products, the coverage rate of consumption declined by 62%, accounting for only 38% in 2020 due to the failure in sugar beet growing and processing industry. Therefore, sugar production requires to be completed by imports to meet market needs.

In case of milk and dairy products, consumption is covered by production, the coverage rate in the year 2020 being 108.5%, but by -6.8% smaller than in 2015, which justify imports to satisfy better the market with a more diversified offer.

Egg consumption is covered by internal production, but the coverage rate declined from 125.1% in 2015 to 119.3% in 2020, meaning by -5.8% less.

Meat is in a critical situation during the analyzed period, as demand is higher and higher, while the offer in terms of domestic production is not enough. If in 2015, the coverage rate of consumption by production was 79%, in 2020, it declined by -6.9%, accounting for 72.1%. This explains why imports are needed to complete the local offer and cover consumers' requirements. Therefore, at present, imports of pork, poultry and beef are justified.

Fish consumption could not be covered by domestic production in the analyzed interval.

In 2015, the coverage rate was 18.5% and in 2020, the rate was just 15.7%, by -2.8% smaller. The need of fish in the domestic market is compulsory to provide the required quantities and a large range of fish sorts to consumers.

The consumption of fats is covered by internal production, the coverage rate being 105.8% in 2020, by +10.8% higher than in 2015. But, it is still necessary to provide more margarine and butter in the market (Table 4).

Table 4. The coverage rate of consumption by production (%)

	2015	2020	2020-2015 (pp)
Cereals and cereal products	453.0	484.9	+31.9
Potatoes	134.6	150.0	+15.4
Vegetables and vegetable products	102.4	96.2	-6.2
Fruits and fruit products	114.5	121.9	+7.4
Sugar and sugar products	106.3	38.0	-68.3
Milk and dairy products	115.3	108.5	-6.8
Eggs	125.1	119.3	-5.8
Meat and meat products	79.0	72.1	-6.9
Fish and fish products	18.5	15.7	-2.8
Fats of vegetal and animal origin	95.0	105.8	+10.8

Source: Own calculation based on the data from NIS, 2022 [14].

Dynamics of the import of agro-food products

Import is required to cover the deficit between demand and offer in the internal market as production cannot supply 100% agro-food products for covering the population' needs. In the analyzed period 2015-2020, the imported quantities of food products increased as follows: +137.8% for sugar, +89% for potatoes, +84.5% for milk and dairy products, +68.3% for fats, +42.6% for vegetables, +30.6% for meat, +26.4% for fruits, +21% for eggs, +17.2% for cereals and +17% for fish (Table 5).

Table 5. Dynamics of agro-food imported amounts by group of products, Romania (Thousand tons)

	2020	Total import 2015-2020	Mean	2020/2015 %
Cereals and cereal products	3,981	18,523	3,087.16	117.2
Potatoes	518	2,449	408.16	189.0
Vegetables and vegetable products	910	4,757	792.8	142.6
Fruits and fruit products	1,328	7,444	1,240.6	126.4
Sugar and sugar products	478	2,195	365.8	237.8
Milk and dairy products	1,159	5,719	953.16	184.5
Eggs	23	120	20	121.0
Meat and meat products	584	3,179	529.8	130.6
Fish and fish products	110	654	109	117.0
Fats of vegetal and animal origin	165	866	144.3	168.3

Source: Own calculation based on the data from NIS, 2022 [14].

In 2020, in the cereals import, various types of grains had the following shares: maize (36.8%), wheat (37.7%), other cereals (22.5%) and rice (2.9%).

The share of various vegetables in the imported amounts was: 35.6% tomatoes, 3.2% cabbage, 8.9% onion, 9.6% roots (carrots, celery, parsley, parsnips etc) and 31.9% other vegetables.

Also, the amount of imported melons increased reaching 55 thousand tons in 2020.

Leguminous grains (peas, beans, lentils etc) also registered an increased import accounting for 42 thousand tons in the same year.

As fruit production was deeply affected by the extreme meteorological phenomena during the analyzed period and could not meet the requirements of the domestic market, important amounts of fruits were imported. In 2020, the highest share in fruit imports belonged to: apples (13.1%), grapes (5.9%), peaches and nectarines (5.5%), plums (2%), and cherries (0.8%), and also to the Mediterranean and exotic fruits which cannot be produced in Romania (62.6%, especially including: bananas, oranges, tangerines, lemons, pineapple, kiwi, kaki, avocado etc).

In 2020, regarding the structure of meat import, the shares of various meat sorts were: pork 59.4%, poultry meat 27%, beef 4.3% and other types 5.1%.

The import of fish and fish products reached 110 thousand tons in 2020, the import being 5.8 times higher than production and compulsory to cover consumer's demand which has continuously raised looking for a healthier diet. The imported fats had the following structure: vegetable oil 67.2%, margarine 14.5%, butter 9.7% and other fats 8.5%.

The coverage rate of consumption by agro-food import

Taking into account the dynamics of import and total consumption, the calculated coverage rate of consumption by import in the year 2020 was higher than in 2015 for almost all the groups of products in various proportions, except vegetables where the rate declined by -0.6 pp.

The results proved a high share of import in consumption as follows: 101% for cereals, 97.1% for sugar and sugar products, 90.9% for fish and fish products, 64.1% for fruits, 39.2% for meat, 38.5% for fats, 28.7% for potatoes, 23.1% for milk and dairy products, 17% for vegetables and 10.5% for eggs (Table 6).

Table 6. The coverage rate of consumption by import (%)

	2015	2020	2020-2015 (pp)
Cereals and cereal products	81.1	101.1	+20.0
Potatoes	14.0	28.7	+14.7
Vegetables and vegetable products	17.6	17.0	-0.6
Fruits and fruit products	60.3	64.1	+3.8
Sugar and sugar products	39.6	87.1	+57.5
Milk and dairy products	12.6	23.1	+10.5
Eggs	7.2	10.1	+2.9
Meat and meat products	33.9	39.2	+5.3
Fish and fish products	87.0	90.9	+3.9
Fats of vegetal and animal origin	23.0	38.5	+15.5

Source: Own calculation based on the data from NIS, 2022 [14].

Dynamics of the export of agro-food products

Most of agro-food production is consumed on the domestic market, but exports are also intensified bringing foreign currency in trade and payment balance stimulating the economic growth.

Romania has a high potential for food export, but there are still problems related to production level and diversity, gross value added, product quality and competitiveness, and the unbalanced demand/offer ratio in the domestic market.

The exported amount of agro-food products, its structure and dynamics differ from a group of products to another.

In the year 2020 versus 2015, the volume of export increased by +162% for fats, by +100% for fish, by +42.8% for vegetables, by +27.3% for milk and dairy products, by +19.6% for cereals, by +5.25 for meat and by +2.4% for sugar. In case of potatoes, eggs and fruits, the exported quantities declined by -20%, -11.2% and, respectively, -6.1% (Table 7).

Table 7. Dynamics of agro-food exported amounts by group of products, Romania (Thousand tons)

	2020	Total export 2015-2020	Mean	2020/2015 %
Cereals and cereal products	11,525	70,470	11,745	119.6
Potatoes	24	208	34.6	80.0
Vegetables and vegetable products	90	783	130.5	142.8
Fruits and fruit products	108	622	103.6	93.9
Sugar and sugar products	126	743	123.8	102.4
Milk and dairy products	256	1,481	246.8	127.3
Eggs	16	103	17.1	88.8
Meat and meat products	160	977	162.8	105.2
Fish and fish products	8	38	6.3	200
Fats of vegetal and animal origin	76	429	71.5	262.0

Source: Own calculation based on the data from NIS, 2022 [14].

Among cereals, maize and wheat grains are the top exported products with a share of 50.2%, and 38%.

The volume of exported vegetables included a mix of sorts (roots, cucumbers, pumpkins, onion, cabbage, eggplants etc) summing 72% and tomatoes 10%.

Apples accounted for 28.7% in fruit exported amount, being followed by grapes (4.6%), cherries (4.6%), and other sorts.

Meat exports are dominated by poultry meat, representing 65% and pork 13.1%, beef 4.3%, mutton and goat meat 3.1%, and other sorts 10%.

Vegetal oil accounts for 93.4% of the total exported amounts of fats.

Dynamics of quantitative agro-food trade balance

Even though both agro-food export and import increased, the growth rate of import exceeded the export almost every year and this resulted in a higher and higher negative trade balance for almost all the food products, except cereals and honey.

Table 8. Difference between the quantitative agro-food export and import by group of products, Romania (Thousand tons)

	2015	2016	2017	2018	2018	2020	Total 2015-2020	Mean	2020/ 2015 %
Cereals and cereal products	+6,240	+8,122	+8,188	+10,002	+11,851	+7,544	+51,947	+8,657.8	120.8
Potatoes	-244	-347	-298	-361	-497	-494	-2,241	-373.5	202.4
Vegetables and vegetable products	-575	-626	-511	-712	-710	-820	-3,974	-662.3	142.6
Fruits and fruit products	-935	-1,136	-1,163	-1.167	-1,201	-1,220	-6,822	-1,137	130.5
Sugar and sugar products	-78	-118	-151	-383	-370	-352	-1,452	-242	451.2
Milk and dairy products	-427	-606	-680	-787	-835	-903	-4,238	-706.3	211.4
Eggs	-1	-7	-3	+4	-3	-7	-17	-2.83	700.0
Meat and meat products	-295	-310	-336	-425	-412	-424	-2.202	-367	143.7
Fish and fish products	-90	-93	-98	-106	-127	-102	-616	-102.6	113.3
Fats of vegetal and animal origin	-69	-75	-78	-72	-54	-89	-437	-72.8	128.9

Source: Own calculation based on the data from NIS, 2022 [14].

Therefore, we could affirm that Romania is a net exporting country for cereals and honey and a net importing country for the rest of food products.
In 2020 in comparison with 2015, the quantitative difference between import and export was higher as follows: 7 times for eggs, 4.5 times for sugar, 2 times for potatoes, 2.1 times for milk and dairy products, 1.43 times for fats, 1.31 times for fish and fish products.
In case of cereals, the export exceeded import by +7,549 thousand tons, meaning by +20.8% compared to 2015 (Table 8).

Dynamics of agro-food import/export ratio

As a consequence of the evolution of the absolute values of import and export amounts, the import/export ratio had the smallest level in case of cereals, accounting for 0.34 and reflecting that imports only 34% of exports, which is a positive aspect in Romania's trade.
In case of all the other products, where the imported quantities were higher than the exported ones, the import/export ratio registered higher levels than 1.
In 2020, compared to 2015, this ratio reflected an increasing trend in case of potatoes, fruits, sugar, milk and dairy products, eggs, meat, while in case of fish and fats it was noticed a declining tendency.
Based on the level of import/export ratio, the decreasing order of the groups of agri-food products was the following one in the year 2020: potatoes (21.58), fish (13.75), fruits (12.29), vegetables (10.11), milk and dairy products (4.52), sugar (3.79), meat (3.65), fats (2.17) and eggs (1.43).
In 2020, compared to 2015, the import/export ratio increased and decreased in various percentages from a group of products to another.
In case of potatoes, sugar and sugar products, milk and dairy products, fruits and fruit products, meat and meat products, it increased by +136.3%, 132.5%, +44.8%, +34.6%, and, respectively, +24.1%.
But, also, it decreased by -41.5% for fish, by -36.5% for fats, by -4.7% for eggs, by -2.9% for cereals and by - 0.1% for vegetables, which is a positive aspect (Table 9).

Table 9. Import/export ratio for agro-food products, Romania, 2015-2020

	2015	2016	2017	2018	2018	2020	2020/2015 %
Cereals and cereal products	0.35	0.32	0.26	0.17	0.16	0.34	97.1
Potatoes	9.13	14.88	7.34	9.20	14.07	21.58	236.3
Vegetables and vegetable products	10.12	6.85	3.00	6.35	6.40	10.11	99.9
Fruits and fruit products	9.13	12.36	14.21	12.90	11.62	12.29	134.6
Sugar and sugar products	1.63	1.86	2.20	4.45	4.03	3.79	232.5
Milk and dairy products	3.12	3.87	3.50	3.74	4.28	4.52	144.8
Eggs	1.05	1.53	1.18	0.8	1.16	1.43	95.3
Meat and meat products	2.94	2.94	2.99	3.51	3.45	3.65	124.1
Fish and fish products	23.5	32.0	20.6	18.66	11.58	13.75	58.5
Fats of vegetal and animal origin	3.37	2.09	2.11	1.91	1.51	2.17	64.3

Source: Own calculation based on the data from NIS, 2022 [14].

Dynamics of the share of production in the availabilities of agro-food products for consumption

Taking into account the level of production, import, export and stock variation, the degree of self-sufficiency, reflecting the weight of production in total availability of food products for consumption, exceeded 100% only in case of cereals. For all the other groups of products, the share of production was below 100%, in various proportions along the studied period.
In 2020, in the descending order of the self-sufficiency rate, the hierarchy of the analyzed groups of agro-food products was the following one: cereals, eggs, potatoes, milk and dairy products, vegetables, meat, fruits, sugar and fish.

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The critical situation is in case of fish and fish products, where the self-sufficiency rate is the smallest in comparison with all the other products. But, it had a declining trend from 18.5% in 2015 to 15.7% in 2020, showing that internal production is not enough to cover the market needs and but it is increasing [15].

The causes could be find in the fact that local production covers just about 10% of consumption, the low production is determined by the high production costs, the lack of offer from the retailers' side, the small amounts delivered to "horeca" sector which does determines a continuous production cycle, an existing modest fleet of modern fishing boats etc. [22].

Also, in case of sugar, internal production decreased due to the reduced surfaces cultivated with sugar beet, the lack of labor force, high cost per ha, the failure of processing industry, sugar low price and reduced consumption of sugar as consumers are more conscious that a healthy diet means low sugar. In consequence, the self-sufficiency rate decreased from 100.6% in 2015 to only 34.9% in 2020, which justified to call imports to complete the market offer [3].

Fruit production is not enough to cover consumption for many reasons among which the most important ones are: the existence of old plantation of low productivity, the high investment cost for setting up new plantations, the low consumption of fruits per inhabitant in the country compared to other EU countries, the lack of modern air-conditioned warehouses and firm contracts with supermarkets [6, 18, 36, 41].

Meat production declined due to the decrease in pig, cattle, and poultry livestock, high production cost, a low live weight at slaughter, a low acquisition price per kg live weight, and a low concentration of meat processing companies in the country. For covering the market requirements, imports are justified but affect local producers [33, 34, 38, 41, 47].

Vegetable production has also problems regarding climate change for field vegetables and high cost for vegetables grown in green-houses and plastic tunnels, the lack of labor input, high cost of farm input, lack of producers associations, lack of air-conditioned warehouses, low acquisition price from retailers [7, 37].

Production of milk and dairy products decreased due to the decline in dairy cows livestock, high price for farm input, high production cost per kg, low milk yield and quality, low gross margin, low milk acquisition price offered by processors and low income for dairy farners. For these reasons, more milk and dairy products are imported to cover consumption [23, 30, 39].

Potatoes production is not able to cover the needs of consumption due to increased prices for farm inputs, high production cost per ha, climate change, low acquisition price, invasion of imported potatoes in the market which affects Romanian farmers [20, 21, 51, 55].

Honey production has followed an ascending trend due to the high demand on the EU market especially in the Western countries as Romanian honey has the highest quality. For this reason the number of bee hives and apiaries increased and honey production as well assuring a good income to beekeepers [17, 25, 35]. In Romania, consumption is still low compared to other countries.

Table 10. Self-sufficiency rate in agro-food products, Romania, 2020 versus 2015

	2020 (%)	2020-2015 (pp)
Cereals and cereal products	155.6	+5.2
Potatoes	92.1	+5.4
Vegetables and vegetable products	82.3	-5.9
Fruits and fruit products	68.5	+1.3
Sugar and sugar products	34.9	-65.7
Milk and dairy products	86.4	-6.7
Eggs	96.8	-5.7
Meat and meat products	72.1	-6.9
Fish and fish products	15.7	-2.8
Fats of vegetal and animal origin	83.9	+1.5

Source: Own calculation based on the data from NIS, 2022 [14].

Despite that imports have appeared during the last years, they represent unimportant amounts compared to domestic production and high potential of Romania for export, for this product the country being a net exporting country. Therefore, self-sufficiency for honey is also over 100%, like in case of cereals [40].Compared to the level of the year 2015, in 2020, the self-sufficiency rate declined in percentage points as follows: - 65.7 pp for sugar, -6.9 pp for meat, -6.7 pp for milk, -5.9 pp for vegetables, -5.7 pp for eggs, -2.8 pp for fish. Also, the rate increased by +5.4 pp for potatoes, +5.2 pp for cereals, +1.5 pp for fats and +1.3 pp for fruits (Table 10).

Share of import in the availabilities of agro-food products for consumption

Taking into consideration that production has in general a declining trend in the availabilities of food products for consumption, the share of import registered an ascending trend in case of all the groups of products.

In 2020, the highest share of import was recorded as follows: fish 90.9%, sugar 89.17%, meat 39.19%, fruits 35.9%, cereals 32.45% and fats 30.55%, followed by vegetables 20.77%, milk and dairy products 18.4%, potatoes 17.67% and eggs 8.18%.

Also, in 2020 versus 2015, the share of import in the availability for consumption increased for all the groups of food products. The difference in percentage points was therefore positive and ranged between +0.55 pp for fats and +51.67 pp for sugar (Table 11).

Table 11. The share of import in the availabilities of agro-food products for consumption, Romania, 2015-2020 (%)

	2015	2016	2017	2018	2018	2020	2020-2015 (pp)
Cereals and cereal products	26.47	28.55	22.17	15.80	17.55	32.45	+5.98
Potatoes	9.10	12.5	11.09	13.26	18.49	17.67	+8.57
Vegetables and vegetable products	14.9	18.07	17.67	18.36	19.36	20.77	+5.87
Fruits and fruit products	35.3	39.83	37.53	31.42	35.06	35.99	+0.69
Sugar and sugar products	37.5	47.29	50.00	94.27	92.30	89.17	+51.67
Milk and dairy products	10.19	13.18	15.60	17.31	17.13	18.40	+8.21
Eggs	5.9	6.25	6.25	6.02	7.71	8.18	+2.28
Meat and meat products	34.0	34.70	36.01	39.73	38.56	39.19	+5.19
Fish and fish products	87.0	81.33	83.73	86.15	91.44	90.90	+3.90
Fats of vegetal and animal origin	30.0	29.38	29.48	30.50	32.92	30.55	+0.55

Source: Own calculation based on the data from NIS, 2022 [14].

CONCLUSIONS

The analysis showed that in the period 2015-2020, consumption of agro-food products in Romania increased for fruits, vegetables, meat, fish, and declined for potatoes, cereals, sugar and eggs, reflecting that consumers are more oriented to a healthier diet.

Agro-food production succeeded to increase by 26.7% for fruits, 3.3% for meat and 2.8% for potatoes, but it decreased for sugar (-65%), eggs (-17%), milk (-5%), fish (-5%), vegetables (-2.7%).

As a result, in 2020 versus 2015, the coverage of consumption by production increased 4.8 times for cereals, 1.5 times for potatoes, 1.3 times for fruits, 1.19 times for eggs and 1.08 times for milk. But, for meat and fish, production was able to cover just 72%, and respectively, 15.7%, which reflected the need of imports.

Imports increased for all the groups of products, the highest rate belonging to sugar (136.7%), potatoes (+89%), fats (68%), vegetables (43%), meat (31%), fruits (26%), eggs (21%), fish (17%) and cereals (17%).

As a result, the coverage of consumption by import in 2020 versus 2015 was: 101% for cereals, 97% for sugar, 91% for fish, 64% for fruits, 39% for meat, 38% for fats, 29% for potatoes, 23% for milk, 17% for vegetables and 10% for eggs.

The dynamics of agro-food export reflected an increase for all the groups of products, which is a good point for Romania's trade. But, the growth rate of exports was exceeded by the import growth rate, which led to a negative balance for almost all the products, except cereals and honey.

Import/export ratio was the smallest for cereals (0.34) as the exports are higher than imports. In case of all the other groups of products, import/export ratio was high: 21.5 for potatoes, 13.7 for fish, 12 for fruits, 10.1 for vegetables, 4 for milk, 3.8 for sugar, and 3.6 for meat.

Self-sufficiency rate was over 100% for cereals and honey, and below 100% for all the other products, the lowest level being for fish and sugar.

In food availabilities, import accounts for 91% for fish, 89% for sugar, 39% for meat, 35.9% for fruits, 32.4% for cereals, 30% for fats, 20.7% for vegetables, 18.4% for milk, 17.6% for potatoes, and 8.1 % for eggs.

Romania has a high share of imports caused by the fact that agricultural production is not able to entirely cover consumption needs for all the product categories.

Low productivity level in many farms, product quality which does not meet quality standards and the lack of associative forms to assure low cost farm inputs and an efficient product marketing disadvantage Romanian producers which cannot meet the requirements of the domestic market.

Also, the high share of retailers favor imports and does not stimulate local producers, who are not able to compete. For this reason, for many agro-food products carried out by small producers, it is needed to develop short supply food chains which could ensure a close contact producer-consumer and encourage production and its valorisation.

Imports are justified mainly in cases where production is not sufficient to cover the internal market.

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TOURIST ARRIVALS AND OVERNIGHT STAYS IN HOTELS IN ROMANIA DURING THE COVID-19 PANDEMIC VERSUS 2019 AND FUTURE TRENDS IN 2022

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Abstract

The paper analyzed the dynamics of tourist arrivals and overnight stays in Romania during the COVID-19 pandemic versus 2019 and expectations in 2022. The methodology includes dynamics and structural indices and regression equations. Of the highest performance achieved in 2019, tourist demand declined to 48% in 2020 and 65% arrivals in 2021, and to 64% and 67% overnight stays. Hotels accounted for 64-67% in total arrivals and 45-64% in stays. The Romanians' share during the pandemic was 92.9% in 2020 and 85.2% in 2021. In hotels, their weight 69%. The polynomial equations showed a parabolic trend of arrivals and stays by month. Thus, 2021 was a better year than 2020 and in 2022 it is expected that arrivals to represent 85% of the 2019 level. In 2022, 941 new 5 stars hotels will be built to assure more comfort and accommodation capacity. Hotel managers have to use creative and efficient methods to attract more tourists. Offer diversification, customized packages, bonuses, price flexibility, high quality services, an intensified virtual promotion (web-site, social media) could attract more visitors and improve hotels performance.

Key words: *arrivals, overnight stays, hotels, tourism, COVID-19 pandemic, future expectations, Romania*

INTRODUCTION

During the last decades, despite that global tourism had an ascending evolution, being the most dynamic branch of the world economy, it has become more and more affected by disasters and crises [2].

Besides natural disasters (floods, fires, droughts, tsunamis, hurricanes, earthquakes, etc.), recessions, terrorist attacks, epidemics registered during the last decades, the COVID-19 outbreak was an unexpected event affecting the whole globe by the fast spread of the virus [5, 11]. It has deeply disturbed tourism industry and many other economic sectors, employment, work style, cultural and sport activities and human life [18].

The restrictive measures imposed by each state to protect population's health and diminish the spread of the virus (thresholds of movement, travels, frontiers' closing, green certificate, COVID tests), had and still have a negative impact on tourism and travel industry [10], leading to losses in tourist flows, occupancy rate, personnel, income and turnover [4].

Domestic tourism has a great importance in many countries being a tool to strengthen economic growth, create jobs, improve infrastructure, preserve cultural heritage, reduce poverty and improve life quality [3].

In the two years of the pandemic, it was the drive of the sector in its forms adopted by many people: close to home, open-air, nature based products and rural tourism [13, 29].

A balanced demand/offer ratio assures tourism growth [6], but during the COVID-19 pandemic, the supply remained the same or extended by investments while the demand of tourism services suffered due to the fluctuation in the infection degree, restrictive or relaxed measures taken by the authorities, loss of jobs, income reduction, illness contracting.

Across 2020 and 2021, tourism has been supported by UNWTO and other organizations [22]. But the most difficult task belonged to governments which had to provide immediate measures. The periods of relaxed measures have been a mouth of fresh air helping tourism to restore. To face the challenges and diminish the negative effects, a new strategy was adopted to build resilience, pointimg out the responsibilities and intervention actions for recovery [14, 9].

Tax exemption and provision of loans at reduced interest rates, increased government expenses, cost efficiency, travel subsidies, low airfares have been measures taken for sustaining tourism but temporary as long as people's willingness to travel is still low [13]. Government subsidies, technology innovation, local involvement, consumer and employee fidelity are the key four factors which could build resilience in tourism industry [26].

Keeping the highest accommodation capacity, hotels play the key role in supporting domestic tourism and economic growth. During the pandemic, room rates fluctuated in connection to the period of holidays and organized events [21]. To encourage customers, at the beginning, hotels offered discounted rooms, and then created unique and customized packages according to the desires of their clients who were willing to pay higher prices [8]. The online platforms have become the main communication tool with the customers [15].

The percentage of people admitted to be accommodated and served in the restaurants has been respected to assure a safe stay to tourists and staff protection. Terraces were installed or extended, and a corresponding distance was assured between tables. Hygiene materials were assured in rooms, restaurants, bars and the protection rules were displayed (wearing a mask and respecting social distance, etc.). The hotel staff was vaccinated in 2021 [12].

A special attention was paid to service quality, the main criterion influencing the customers' confidence and satisfaction degree [22]. As an emblem of a tourism brand, service quality is given by hotel staff who provides intangible services such as: information, room reservation, assistance, personalized services, etc. [30].

The gradual vaccination has contributed to an increased consumer confidence, relaxed travel restrictions and it is expected to sustain tourism to return to the pre-pandemic level in the coming years [28, 29].

In Romania, HoReCa sector has been deeply affected mainly in the year 2020, and in a lower proportion in the year 2021. The fluctuation of the activity was connected to the pandemic trend, the people's fear to travel and resulted in a low tourist flow, overnight stays, income, and turnover, and, in consequence, it required support from the Government. The turnover of the hotels accounted for only Euro 570 million, much less than in 2019. The whole tourism industry registered 705% less turnover.

The hotel managers applied a flexible policy (discounted rooms, cancellation without penalty) to encourage customers. Then, during the relaxation periods mainly starting from May-June till September late, when usually holidays are planned, the demand increased and prices went up [1]. Also, an important role played the "holidays vouchers" and the discount for "last minute" and "early booking" for sustaining tourism.

In addition, during the pandemic, using their own digital platforms, restaurants have successfully developed deliveries of packages and special menus for certain occasions at the request [16].

In this context, the purpose of the paper was to analyze the dynamics of the domestic tourism in terms tourist arrivals and overnight stays in Romania during the years 2020 and 2021 in order to evaluate in what measure tourism was affected by the COVID-19 pandemic compared to 2019, the year with the highest performance in tourism industry. The results are expected to offer an image of the future trends and on how hotel managers have to proceed to attract more tourists.

MATERIALS AND METHODS

In order to set up this paper, the statistical data were provided by National Institute of Statistics for the period 2019-2021. For the

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year 2021, there were taken into account just 11months for which the data were available.

The studied indicators were: number of tourist arrivals and tourist overnight stays at the national level and also in hotels in the years of the COVID-19 pandemic 2020 and 2021 versus the year 2019.

The data have been processed utilizing the following methods:

-The dynamics index with fixed basis, $I_{FB} = (X_n/X_1) \times 100$ for establishing the increase/decrease in the years 2020 and 2021 compared to 2019.

- Structural Index, S%, for reflecting the distribution of arrivals and overnight stays by type of tourists (Romanians and foreigners) and also, for showing the share of these indicators in hotels compared tourist arrivals and overnights stays in Romania.

- Graphical illustration of the dynamics of each variable using the polynomial equation of the 2nd degree, $Yi = a + bt + ct^2$, considered the model suitable to present the trend by months of the two analyzed indicators.

Also, the coefficient of determination, R^2, was calculated to assess in what measure the variation of the indicator level was caused by time change. The results have been commented, tabled and illustrated in graphics and finally the main conclusions were drawn.

RESULTS AND DISCUSSIONS

Tourism demand in terms of arrivals in Romania

The year 2019 represented the peak in Romania's tourism both regarding the demand in terms of tourist arrivals and overnight stays, and also the offer expressed in various tourism services with the most favourable impact on income and turnover. In this year, 2019, Romania had 13,374 thousand tourists, of which 79.9% Romanians and 20.1% foreigners. In the year 2020, when the COVID-19 pandemic started, tourism was deeply affected economically and socially like in many other countries. Tourist flows declined and overnight stays as well for many reasons like: the fear to travel, loss of jobs and a reduced income per family, etc. When the infection rate was lower and the restrictions were more relaxed, most of people has been oriented to spend vacations close to home, choosing safer destinations with accommodation in smaller hotels and tourist guesthouses in isolated areas, using more time in open air [19].

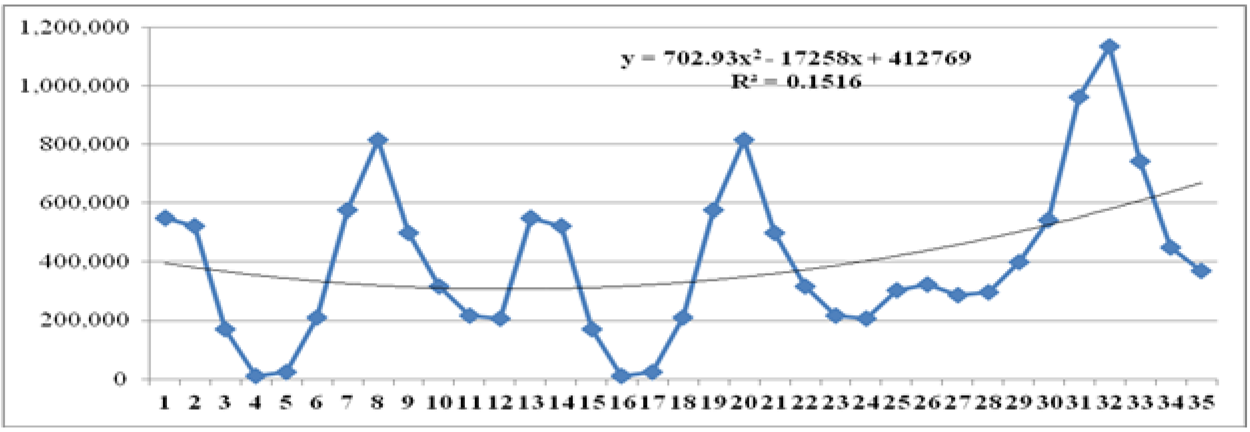

Fig. 1. Monthly dynamics of tourist arrivals in Romania in 2019, 2020 and 2021 (35 months)
Source: Own calculation and design based on NIS, 2022 [17].

Once vaccination has begun on December 27, 2020 and continued in the year 2021, the authorities started to apply more relaxed measures earlier and for a longer period than in 2020, and as a consequence tourist arrivals have recovered.

In 2020, tourist arrivals accounted for 6,398 thousand being by 52.13% less than in 2019, while in 2021, their number was 8,697 thousands, being by 35.9% higher than in 2020 and by only 35% smaller than in 2019 (Figure 1).

In total arrivals, Romanians have the highest share: 79.93% in 2019, but 92.9% in 2020, as most of tourists preferred to spend their holidays in the country and not to travel abroad to uncertain destinations. From about 20% in 2019, foreign tourists registered only 7.1% in 2020.

In 2021, Romanian tourists represented 85.29% in total arrivals while foreign tourists increased their weight especially during the periods when they had the feeling of health safety due to vaccination and green certificate and also when restrictions looked to be more relaxed (Table 1).

Table 1. Dynamics of tourist arrivals in Romania in 2020 and 2021 versus 2019 (Thousands)

	2019	2020	2021	2020/2019 %	2021/2019 %	2021/2020 %
Total arrivals	13,374	6,398	8,697	47.87	65.02	135.92
Romanian	10,691	5,944	7,418	55.60	69.39	124.92
Foreign	2,693	453	717	16.91	26.72	157.99
Share of RO (%)	79.93	92.90	85.29	+12.97 pp	+5.36 pp	-7.61 pp
Share of FO	20.07	7.10	14.71	-2.97 pp	-5.36 pp	+7.61 pp

Source: Own calculation based on NIS, 2022 [17].
Note: pp represents percentage points.

The most attractive destinations for tourists in Romania during the pandemic remained in general the same like in 2019. Their importance in the decreasing order, is: Bucharest, the capital of Romania and the cities of residence in the 41 counties, the resorts in the mountain areas [20, 24], the seashore resorts at the Black Sea [21, 23], the balneary resorts [25], the Danube Delta and the city of Tulcea, other destinations.

Tourism demand in terms of overnight stays in Romania

The year 2019 also recorded the highest performance in terms of overnight stays, whose number accounted for 30,086 thousand, of which 82.41% belonged to the Romanian tourists.

In the year 2020, the overnight stays declined by 45.23% accounting for 14,579 thousand, of which 93.16% reflected the Romanians' demand.

In 2021, due to the growth in the arrivals, the stays in accommodation units also increased and reached 19,552 thousands, of which 91.29% belonged to the Romanian visitors.

In this year, the number of foreigners who visited Romania went up, having a positive influence on the number of stays (Figure 2 and Table 2).

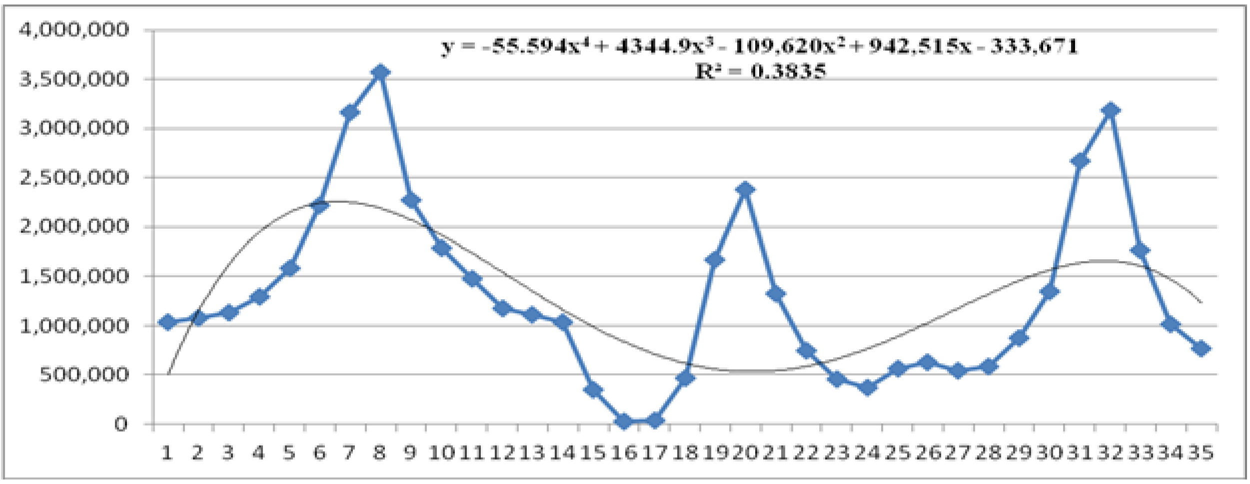

Fig. 2. Monthly dynamics of overnight stays in Romania's tourism in 2019, 2020 and 2021 (35 months)
Source: Own calculation and design based on NIS, 2022 [17].

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Table 2. Dynamics of overnight stays in Romania's tourism in 2020 and 2021 versus 2019 (Thousands)

	2019	2020	2021	2020/2019 %	2021/2019 %	2021/2020 %
Total overnight stays	30,086	14,579	19,552	48.45	64.98	134.11
Romanian	24,795	13,582	17,850	54.77	71.99	131.42
Foreign	5,291	997	1,702	18.84	32.16	170.71
Share of RO (%)	82.41	93.16	91.29	+10.75 pp	+8.88 pp	-1.87 pp
Share of FO	17.59	6.84	8.71	-10.75 pp	-8.88 pp	+1.87 pp

Source: Own calculation based on NIS, 2022 [17].

Tourism demand for accommodation in hotels

Besides transport, public food and entertainment services, accommodation is an important factor which influences tourism demand [27].

Hotel is the main accommodation unit preferred by tourists [7] for it offers: comfort conditions, high quality services (reception, accommodation, restaurant, bar, information and assistance services, cultural and artistic events, entertainment, commercial services, etc.), online access for booking and payment.

The number of hotels is dominant in Bucharest, in the cities of residence of all the counties, and also in the seashore resorts at the Black Sea, in the mountain and balneary resorts.

In addition, taken into consideration the large variety of hotels depending on their stars, it is obviously that hotel offer suits to any tourist, of course the decision is made by client in function of the budget allotted for accommodation during the length of stay.

Tourist arrivals in hotels

In Romania, the dynamics of arrivals in hotels follows the same trend as at the national level.

After the peak of 9,275 thousand arrivals in hotels in the year 2019, in 2020, their number was by 55.62% smaller due to the pandemic.

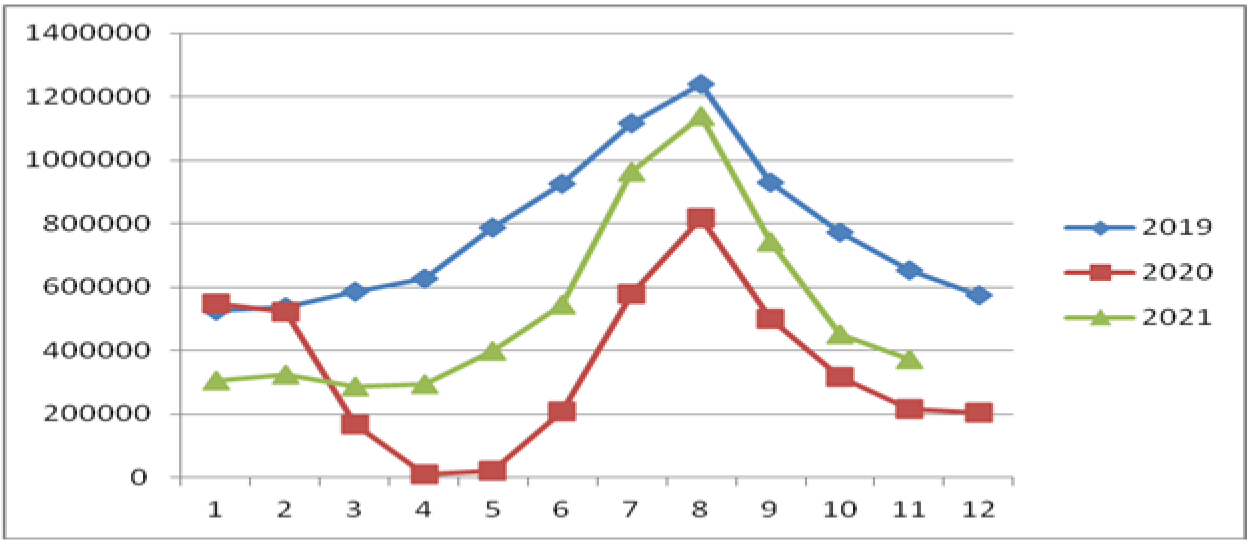

Fig. 3. Monthly dynamics of tourist arrivals in hotels in the years 2019, 2020 and 2021 (number)
Source: Own calculation and design based on NIS, 2022 [17].

As a result, the activity, staff and turnover in hotels, and in "HoReCa" in general was negatively affected. Hotels were facing with closure for a period of time or reduced activity, low tourist flows and overnight stays, a low occupancy rate, reduction of personnel, low income and turnover.

The situation was more difficult in 2020 than in 2021. In 2021, it was noticed a recover of tourist arrivals determined by the vaccination campaign, and more relaxed measures applied for a longer period of time lasting from May to September in 2021 compared to July September in 2020. In 2021, the number of arrivals in hotels increased by 38.2%

compared to 2020, and by only 26.35% versus 2019 (Figure 3). The share of the Romanians who preferred accommodation in hotels represented 75.41% in the total arrivals in the country in 2019, but during the pandemic their share reached 90.33% in 2020 and 88.47% in the year 2021. The percentage difference belonged to foreign tourists. If in 2020, their weight was the smallest, accounting for 9.67%, in 2021 it reached 11.53% (Table 3).

Table 3. Dynamics of tourist arrivals in hotels in Romania in 2020 and 2021 versus 2019 (Thousands)

	2019	2020	2021	2020/2019 %	2021/2019 %	2021/2020 %
Total arrivals	9,275	4,117	5,822	44.38	62.78	141.41
Romanian	6,995	3,719	5,151	53.17	73.64	138.50
Foreign	2,280	398	671	17.45	29.40	168.59
Share of RO (%)	75.41	90.33	88.47	+14.92 pp	+13.06 pp	-1.86 pp
Share of FO	24.59	9.67	11.53	-1492 pp	-13.06	+1.86 pp

Source: Own calculation based on NIS, 2022 [17].

The share of tourist arrivals in hotels in total arrivals accounted for 69.35% in 2019, while in 2020 it declined by -2.41 pp, but in 2021 it increased by +2.59 pp compared to 2019.
Romanians had the highest share in arrivals in hotels and this accounted for 65.43% in 2019. In 2020, it was noticed a slight decline by -2.87 pp, but in 2021, it was observed an increase by +4 pp compared to the year 2019. This reflects a tendency to recover in the number of arrivals in hotels and also the preference of tourists for this type of unit where to be accommodated (Table 4).

Table 4. The share of tourist arrivals in hotels in total arrivals in Romania in 2020 and 2021 versus 2019

	2019	2020	2021	2020-2019	2021-2019	2021-2020
	%	%	%	pp	pp	pp
In Total	69.35	64.35	66.94	-5	-2.41	+2.59
Romanian	65.43	62.56	69.43	-2.81	+4	+6.87
Foreign	84.97	87.85	93.58	+2.87	+8.61	+5.73

Source: Own calculation based on NIS, 2022 [17].

Foreign tourists' arrivals in hotels had a high share, 84.97%, in total arrivals of foreigners in 2019, but during the pandemic, this weight raised by +2.87 pp in 2020 and +8.61 pp in 2021. Also, in 2021, the share recorded +5.73 pp versus 2020 (Table 4). Studying the evolution of tourist arrivals, we may easily notice the parabolic shape of the distribution of arrivals by month, the peaks being reached in summer season when most of people have vacation and also when the incidence of infection had the lower rate, as confirmed by the calculated regression equations and the values of R square (Table 5).
The regression equations could be used for setting up the adjusted values and trend.

Table 5. Regression equations and R square reflecting the time evolution of tourist arrivals in hotels by month in Romania in the studied years: 2019, 2020 and 2021

	$Yi = a + bt + ct^2$	R^2
2019	$y = -16{,}261x^2 + 232{,}052x + 145{,}392$	$R^2 = 0.6773$
2020	$y = -26.219x^2 - 732.59x + 349{,}239$	$R^2 = 0.0002$
2021	$y = -14636x^2 + 216174x - 94512$	$R^2 = 0.4252$

Source: Own calculation based on NIS, 2022 [17].

Tourist overnight stays in hotels

The number of overnight stays in hotels is closely linked to tourist arrivals.

In 2019, Romania registered the highest level of stays in hotels, accounting for 21,785 thousands. During the pandemic, their number decreased by 54.27% in 2020, but with only 36.07% in 2021, reflecting that in this year the situation was better being recorded a surplus of stays of +39.8% compared to the year 2020. Most of the Romanian tourists preferred accommodation in hotels and their overnights stays reached the highest level of 17,322 thousand in 2019, but a lower level by 47.51% in 2020 and by 27.98% in 2021, the years of the pandemic. In 2021, it was noticed an increase by +37.1% versus 2020.

The stays of the foreign tourists in hotels represented 20.49% in the total overnight stays in 2019. In 2020, their weight decreased and reached only 8.74%, but in 2021, it was found a slight growth by +10.44% (Figure 4 and Table 6).

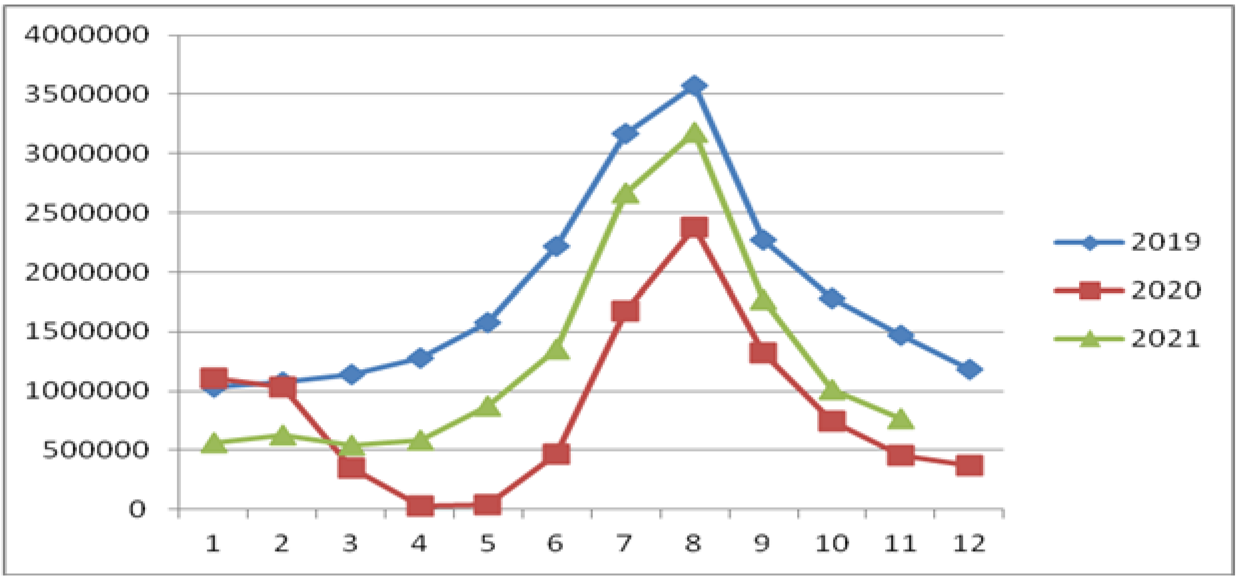

Fig. 4. Monthly dynamics of tourists' overnight stays in hotels in Romania in the years 2019, 2020 and 2021 (number)

Source: Own calculation and design based on NIS, 2022 [17].

Table 6. Dynamics of tourists' overnight stays in hotels in Romania in 2020 and 2021 versus 2019 (Thousand)

	2019	2020	2021	2020/2019 %	2021/2019 %	2021/2020 %
Total overnight stays	21,785	9,963	13,929	45.73	63.93	139.80
Romanian	17,322	9,093	12,476	52.49	72.02	137.20
Foreign	4,463	870	1,453	19.49	32.55	167.01
Share of RO (%)	79.51	91.26	89.56	+11.75 pp	+10.05 pp	-1.70 pp
Share of FO	20.49	8.74	10.44	-11.75 pp	-10.05 pp	+1.70 pp

Source: Own calculation based on NIS, 2022 [17].

The overnight stays in hotels have the highest share in total stays in Romania's tourism. In 2019, their weight registered 72.40%, but during the pandemic, it recorded a slight decline by -4.07 pp in 202 and -1.16 pp in 2021. In 2021, also it was noticed a recover by +2.91 pp more than the level of 2020.

The stays in hotels of the Romanian tourists has the highest share in total overnight stays in the tourism of the country. It accounted for 69.86% in 2019.

During the pandemic, only in 2020, this share declined by -2.92 pp, but in 2021, it was by +0.03 pp higher than in 2019 and by +2.95 pp over the level of 2020.

The majority of foreign tourists prefer accommodation in hotels. For this reason, in the total overnight stays in the country, they accounted for 84.35% in 2019, and with higher levels in 2020 and 2021: 87.26% and, respectively, 85.37% (Table 7).

Table 7. The share of tourists' overnight stays in hotels in total overnight stays in Romania's tourism in 2020 and 2021 versus 2019

	2019	2020	2021	2020-2019	2021-2019	2021-2020
	%	%	%	pp	pp	pp
In Total	72.40	68.33	71.24	-4.07	-1.16	+2.91
Romanian	69.86	66.94	69.89	-2.92	+0.03	+2.95
Foreign	84.35	87.26	85.37	+2.91	+1.02	-1.89

Source: Own calculation based on NIS, 2022 [17].

The overnight stays in hotels registered a similar trend line like the arrivals, as reflected by the parabolic shape, taking into account the values recorded in each month in the three analyzed years. The regression equations and the values of R square determined for this indicator are shown in Table 8. Also, in this case, the regression equations could be used for setting up the adjusted values and trend. The lowest rates accounted for 6.9% in the month of April and 6.9% in May.

Then, starting from June, the rate increased and reached the highest level of 44.6% in August, but smaller than 62.5% in 2019 and than 57.5% in 2021.

Table 8. Regression equations and R square reflecting the time evolution of tourists' overnight stays in hotels by month in Romania in the studied years: 2019, 2020 and 2021

	$Yi = a + bt + ct^2$	R^2
2019	$y = -52{,}434x^2 + 75{,}6834x - 262{,}973$	$R^2 = 0.5785$
2020	$y = -12{,}090x^2 + 171{,}931x + 367{,}579$	$R^2 = 0.0414$
2021	$y = -47{,}230x^2 + 68{,}7134x - 683{,}903$	$R^2 = 0.4247$

Source: Own calculation based on NIS, 2022[17].

Net use of accommodation capacity in hotels

This indicator followed a similar tendency during the analyzed years. The lowest rates were carried out in the year 2020, much below than the ones achieved in 2019.

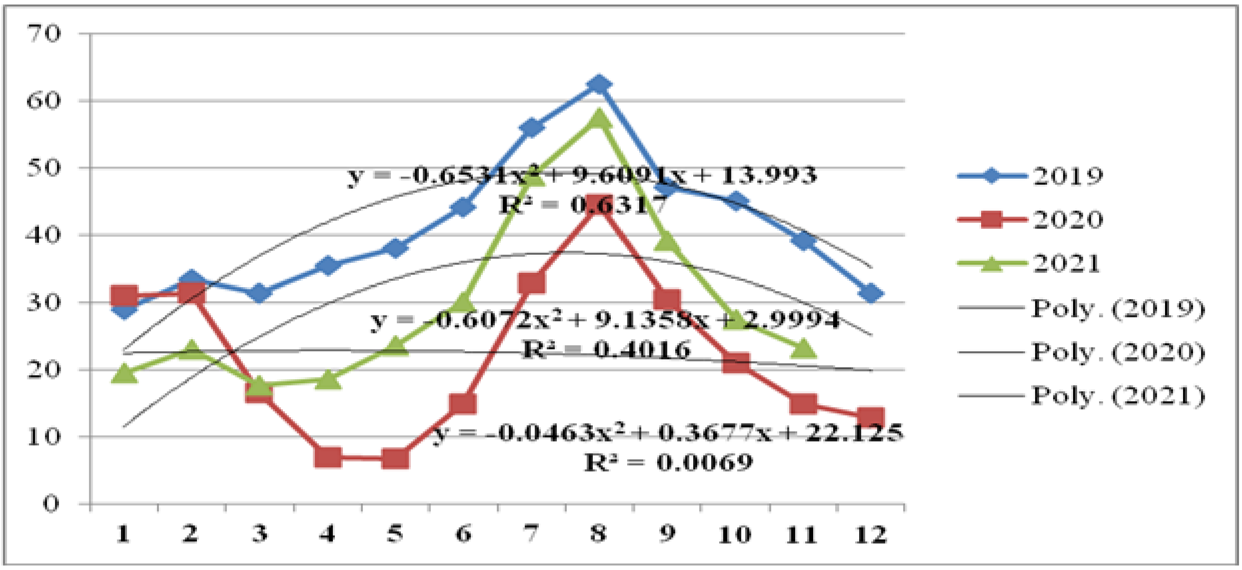

Fig. 5. Monthly dynamics of net use of accommodation capacity in hotels in Romania in the years 2019, 2020 and 2021 (%)

Source: Own calculation and design based on NIS, 2022 [17].

The year 2021 was the best from this point of view for hotel industry. In this year, the lowest rate was 17.7% registered in March and the highest 57.5% in August (Figure 5).

Future expectations on tourist arrivals and overnight stays in hotels and what hotels managers have to do to attract more tourists

The results in 2021 are promising. In 2022, it is expected as tourist arrivals and overnight stays to represent about 85% of the 2019 level, taking into account that the relaxation measures will start from the middle of March, assuring a longer safe period for travels.

To sustain HoReCa sector, Romanian Government, by means of Ministry of Entrepreneurship and Tourism has implemented the Program of Business Recovery and Relaunch especially developed by SMEs. Government credits for Start-Up, SMEs' Pro, Garant Construct and Innovation were offered to tourism units affected by pandemic. Also, grants for working capital were destined to compensate the losses.

In addition, important EU funds are available for the development of production activities.

To diminish the difficulties in assuring labor force, public aids are offered for seasonal employees and also technical unemployment has been reintroduced.

During the COVID-19 pandemic, the need for accommodation has increased, as tourists requested extra comfort and services in the same place. For this reason, in 2022, 940 new 5 stars hotels will be built as, at present, Romania has only 41 of this standard.

Hotel managers have to keep pace with tourist market and to adapt to the increased competition and to grow tourists flow, they have to use creative and efficient methods like the following ones: Integration of accommodation offers in the packages of travel agencies; Virtual promotion on the hotel web-site of the services offered (relevant images, virtual tour etc); Use of an easily accessible reservation system (room availability, fast online and telephone reservation); Diversification and increase of quality services (safety, hygiene, cleanliness, comfort, meals, spa, jacuzzi, fitness, massage etc); Personalized offers, special packages, promotions, free for children, alternative payment methods (Tourist Pass Card), loyalty programs and other bonuses for customers; Promoting the hotel on Google, Facebook, Instagram, the use of influencers on social media and advertise on map applications; Use of hotel software for managing activities; Taking into account the customers' reviews on Booking and Trip Advisor and fixing the reported problems, and also checking the accommodation conditions (furniture, installations etc) to maintain comfort; Organizing events even in small groups in pandemic (courses, conferences, anniversaries etc).

CONCLUSIONS

The study showed the negative impact of the COVID-19 pandemic in the Romanian tourism demand. After the peak of 13.3 million arrivals and 30 million overnight stays in the year 2019, in the years 2020 and 2021, total arrivals represented only 47.8% and, respectively, 65%, while the overnight stays accounted for only 48.4%, and, respectively, 64.9%.

Romanians are the main category of visitors and the pandemic offered them a chance to rediscover their own country, as their share in total arrivals increased in 2020 to 93.1% and in 2021 to 91.2%.

In 2019, there were recorded 9.3 million arrivals and 21.7 million overnight stays, representing 69.9% and respectively 72.3% of tourism industry. In 2020 and 2021, compared to 2019, the arrivals in hotels represented only 64.4%, and, respectively, 66.9%. Also, the overnight stays, accounted for 45% and, respectively, for 64%.

Romanians dominate arrivals in hotels, having a share ranging between 62% and 69%, and also 89-91% in overnight stays. Less foreigners visited Romania in pandemic, but in 2021 it was noticed a slight growth. Most of foreigners prefer hotels, their share accounting for 87-93% in arrivals and 85-87% in overnight stays during the pandemic.

In consequence, the net occupancy rate in hotels was much lower in 2020 versus 2019 and much better in 2021 compared to 2020.

The rate was 6.9% in April, and its peak was 44.6% in August 2020. In 2021, the rate reached the peak of 57% in August and the lowest level, 17.7%, in March. The rate is higher in hotels than the average rate in the national tourism.

Thus, the worst year in Romania's tourism demand was 2020, but 2021 has brought a recovery and hopes that in the coming years, tourism could return to the pre-pandemic level.

The measures taken by Romania's Government and Ministry of Entrepreneurship and Tourism have sustained tourism industry to recover.

The relaxing measures which are going to be taken from the middle of March 2022 give a hope that in this year tourist arrivals and overnight stays will be higher, being estimated at 85% of the 2019 level.

To improve its performance, hotel industry needs a more flexible strategy. A diversified offer, customized packages, bonuses, price flexibility, high quality services, an intensified communication with customers, booking and cancelling facilities, more measures for assuring a safe stay, an intensified advertising in media and other initiatives could attract more visitors and meet in a higher measure their needs with a positive impact on occupancy rate and business return.

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THE ECONOMIC IMPORTANCE OF THE SPONTANEOUS FLORA WITHIN OLTENIA PLAIN, ROMANIA

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Abstract

The present paper deals with the results of the research conducted over a long period of time (i.e. about 25 years), on the economic importance of the spontaneous flora in the Oltenia Plain. The study was mainly motivated by the gradual decrease in the number of people who resort to traditional practices and by the widespread use of synthetic products, which have rapid but unhealthy effects. The analysis of the employment of useful species in this part of Oltenia highlights a worrying aspect: the use of spontaneous plants is age-dependant and it declines at younger ages. The medicinal species are still of great importance and they are used in almost all settlements within Oltenia Plain, although their use is more significant in rural areas and less important in urban ones. Unlike the pre-2000 period, when tinctorial species were employed to a greater extent, they are now used only occasionally, by the elderly.

Key words**:** *Oltenia Plain, flora, economic importance, Romania*

INTRODUCTION

The use of plants in order to cure or prevent diseases emerged with the appearance of the human beings, that is, millennia ago.

The popular names given to the plant species by common people were diverse and suggestive, indicating their interest in the knowledge of the flora.

In addition to the scientific interest connected to the study of the flora and vegetation of a territory, it is of significance the practical, applicatory study related to the direct or indirect employment of plants that are useful for human needs and not only.

The vegetation specific to the plain area is xerophilous, being characteristic of the steppe, forest-steppe and nemoral areas. If we take into account the growing surfaces occupied by agricultural land, the spontaneous flora is characteristic on relatively limited surfaces within the plain area.

Worldwide cultivated and spontaneous plants are affected by different biotic and abiotic constrainers, limiting their yielding capacity and adaptability in the areas affected by climate change effects [23].

In this part of Oltenia, the landscape is often scattered with species that possess important therapeutic properties, some of them being the only source of botanical raw materials highly required by the pharmaceutical industry; other species are appreciated from an aromatic, culinary, fodder or melliferous point of view; all of these species are used in various industrial activities. The floristic studies carried out by Professor Ph.D. Al. Buia [8] demonstrate that there is no natural steppe in Oltenia Plain, but an artificial one resulted from anthropogenic activities. Nevertheless, this region possesses certain steppe elements (*Festuca valesiaca*, *Chrysopogon gryllus*, *Stipa capillata*, *Poa bulbosa*) that attest to the presence of some conditions similar to those of the steppe proper [29].

The alteration of the floristic composition characteristic of this part of Oltenia resulted from the influences of the zoo-anthropogenic factor (manifested through the expansion of areas occupied by agricultural land, the irrational grazing, the repeated mowing in certain areas, which leads to the elimination of late flowering plants, the pollution of surface and groundwater), combined with the climate changes occurred during recent years.

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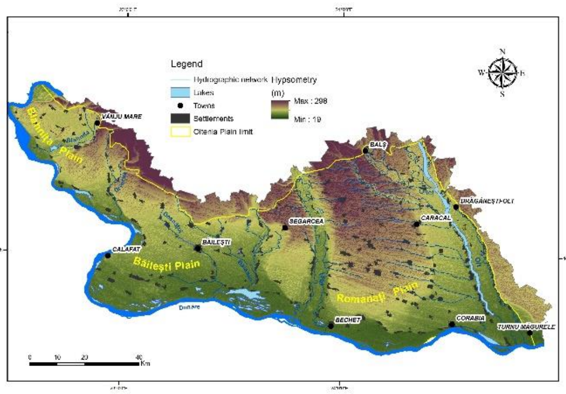
Information on the study of spontaneous flora within Oltenia Plain can be found in several specialized works that include floristic inventories from certain areas [2, 7, 10, 11, 12, 14, 16, 17, 31] or contributions to the knowledge of flora and vegetation [5, 6, 7, 9, 13, 15, 25, 24, 26]. The first data are characteristic for the end of the 19th century [3, 24, 30, 32] and the mentions continue until the present [20, 21, 22, 33, 34, 35, 36, 37, 38, 39, 40, 42]. Data regarding the general characterization and the geomorphology of Oltenia Plain have been published by different researchers [1, 19].

The studies conducted until the present show that the spontaneous plants from Oltenia Plain also include many taxa of economic importance. They are classified as useful plants. This category includes: medicinal, aromatic, honey, food, tinctorial, seasoning and fodder plants.

MATERIALS AND METHODS

Oltenia Plain is the oldest sector of the Romanian Plain, which appears as a dry land area above water level; it is closely linked to the Getic Plateau through the transitional relief forms on the northern side. Resembling a water belt, two rivers mark most of its boundaries, namely the Danube to the west and south and the Olt to the east [28] (Map 1).



Map 1. Oltenia Plain
Source: internet processing.

From a geological point of view, it can be stated that this relatively rigid platform region appears as a strongly sedimented depression.

The relief of this region is made up of plains, terraces and floodplains, while the soils are represented by chernozems, psamosols, alluvia and alluvial soils, marshy soils etc. The presence of sands within Oltenia Plain leads to the appearance of a dune relief in certain areas [14, 17, 42].

The climate is temperate-continental, with sub-Mediterranean influences characterized by autumn rains and mild winters.

The lacustrine origin of this unit places it into the category of tabular plains and it is connected to the appearance of terraces due to the horizontal migration and the deepening of the large rivers (the Jiu, the Olt, the Danube).

All these conditions related to physical geography of the area have led to the diversification of the vegetation cover.

Based on a long field experience, as well as on the published results concerning this part of the country [2, 5, 8, 14, 15, 17, 25, 27, 28, 29, 33, 34, 35, 36, 38, 42], in the present paper it is discussed about the plants with local economic importance, which are used by the inhabitants of the areas that neighbour the surfaces with natural or seminatural vegetation. The scientific name of the species is in accordance with that used in the specialized field guides in Romania [18, 41], while the abbreviations of the authors of the species presented in the paper originate in the work *Authors of plant names* [4].

The analysis of the economic importance of the spontaneous flora within Oltenia Plain was carried out after consulting a sample of 369 people of different ages, which were divided into the following age groups: up to 20 years; between 20 and 40 years old; between 40 and 50 years old and over 50 years. Both rural and urban environments were represented during the survey. A number of 123 persons reside in the urban areas of Calafat, Băilești, Bechet, Dăbuleni, and Corabia, while the remaining 246 persons are inhabitants of different rural settlements located within Oltenia Plain (e.g. Poiana Mare, Rastu Vechi, Negoi, Danube, Gighera, Ostroveni, Ianca, Grojdibodu etc.).

The research was carried out in order to capture useful qualitative information on the use of spontaneous flora in the plain area of Oltenia.

The questions addressed to the people in the researched area were: Do you use plants from the spontaneous flora?; What are the most used plants in nature; Collect plants as ....; What category of plants do you collect? From what year do you collect plants from the spontaneous flora? Do you collect useful plants for your own use or do you sell them? Where do you manage to capitalize on the production obtained? What is the way to capitalize on production? How much do you estimate the revenue from spontaneous plant collection (RON)? Have you so far accessed European funds for the establishment/ development of crops with useful plants? In the next period, do you intend to access European funds for the development of your business?

The answers received confirmed what we also noticed in the area: the collection is done only for their own use, no income is obtained and very few have accessed European funds. If before 1990 there were useful plant collection centers in the area, now they are completely missing.

RESULTS AND DISCUSSIONS

Although the areas covered by spontaneous vegetation in the Oltenia Plain are very modest, their presence is highly important due to the phytodiversity and to the high sozological value of some taxa [29].

The research conducted during recent years in these areas has led to the selection of plant species of importance in the local economy.

A first group of spontaneous plants that are **highly significant for the economy** of the area comprises **the medicinal plants**.

Some of them are widely used: *Matricaria recutita* L. presented in Photo 1.

Photo 1. *Matricaria recutita* from Rastu Vechi locality(Dolj county)
Source: Original image.

Also, *Chelidonium majus* L., *Prunus spinosa* L., *Hypericum perforatum* L. (Photo 2), *Taraxacum officinale* Weber ex Wiggers, *Urtica dioica* L., *Sambucus nigra* L. (Photo 3), *Crataegus monogyna* Jacq., *Rosa canina* L., *Arctium lappa* L., *Artemisia absinthium* L., *Plantago major* L., *P. lanceolata* L., *Origanum vulgare* L. (Photo 4), *Agrimonia eupatoria* L.

Photo 2. *Hypericum perforatum* from Plenița locality (Dolj county)
Source: Original image.

Photo 3. *Sambucus nigra* from Bistreț locality (Dolj county)
Source: Original image.

Photo 4. *Origanum vulgare* from Perișor locality (Dolj county)
Source: Original image.

Others are only occasionally employed: *Padus avium* Mill., *Centaurea cyanus* L., *Consolida regalis* S.F. Gray, *Cichorium intybus* L., *Symphytum officinale* L., *Capsella bursa-pastoris* (L.) Medik., *Tussilago farfara*, *Eqiusetum arvense* L., *Anchusa officinalis* L., *Humulus lupulus* L., *Convolvulus arvensis* L., *Alliaria officinalis* L., *Salvia sclarea* L., *Leonurus cardiaca* L., *Marrubrium vulgare* L., *Lythrum salicaria* L., *Malva sylvestris* L., *Fraxinus excelsior* L., *F. ornus* L., *Polygonum aviculare* L., *Adonis vernalis* L., *Geum urbanum* L., *Salix alba* L., *Verbascum phlomoides* L., *Hyoscyamus niger* L., *Fumaria officinalis* L., *Gypsophila paniculata* L., *Helichrysum arenarium* (L.) Moench, *Abutilon theophrasti* Medik., *Aristolochia clematitis* L., *Carduus acanthoides* L., *Heracleum sphondyllium* L., *Linaria vulgaris* L., *Salvia nemorosa* L., *Teucrium chamaedrys* L., *Tribulus terrestris* L., *Malus sylvestris* (L.) Mill., *Pyrus pyraster* (L.) Burgds., *Armoracia rusticana* P. Gaertn.

The spontaneous honey plants within Oltenia Plain are of low importance in the framework of the entire surface, because of the large areas covered by agricultural land and by black locust plantations. The grassland vegetation comprises more honey species as compared to the forest vegetation (*Tilia tomentosa* Moench, *T. platyphyllos* Scop.).

Commonly used food plants include *Rumex crispus* L. (during spring) (Photo 5), *Fragaria viridis* (Duchesne) Weston, *Rubus candicans* Weihe ex Rchb and *Rumex acetosella* L.(during May and June).

Photo 5. *Rumex crispus* from Cârna locality (Dolj county)
Source: Original image.

The aromatic plants have a low representation in terms of number of species, but compensate through the significant populations in the field. Of this category, few species are used by the population living in the plain area of Oltenia: *Artemisia absinthium* L., *A. vulgaris* L., *Portulacca oleracea* L., *Origanum vulgare* L., *Mentha pulegium* L.

The plant species used for seasoning are found only in xeric meadows. The particular taste characteristics related to the spontaneous plants that grow in the plain area of Oltenia are due to the chemical composition of their vegetative organs, especially to the essential oils and terpene hydrocarbons, which have a high concentration. Among the species that are frequently used in the area, there are to be mentioned: *Thymus glabrescens* Willd., *Th. pannonicus* All. (Photo 6).

Photo 6. *Thymus pannonicus* from Radovan locality (Dolj county)
Source: Original image.

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Tinctorial plants In 1866, the agronomist Ion Ionescu de la Brad was the first to speak about the Romanian folk chromatics as a branch of the household industry, connecting it with the agricultural life of the Romanian people and, thus, giving an economic significance to it. In the work titled *Agricultura României* (Eng. *Agriculture in Romania*), he stated:" They (the women) go to pick the tinctorial plants from the field and then they paint the wool with these plants, giving it all kinds of colours". The agronomist drew attention to the importance of plant dyes and to the value of vegetable-dyed fabrics, while pointing out the danger associated to the regression of this folk art, as a consequence of the penetration of urban civilization into the traditional rural environment.

The traditional Romanian chromatic is confirmed by the works of art kept in museums: carpets and other heavy fabrics, clothing. There was a small number of old colours: white, black, brown, yellow, and red. Later on, blue and green colours appeared. These were cold, serious colours. The dyes were said to be so durable that the fabric could tear and still the colour would not fade. The process of plant colouring relies on 3 groups of dyes: flavones (which give yellow colours), carotenoids (which give red colours) and anthocyanins (which give blue colour).

Because of the competition with the synthetic dyes discovered during the past century, the artistic craft of vegetable painting underwent a strong regression in the plain region of Oltenia.

Among the spontaneous tinctorial species used by the inhabitants of the study area, there are to be mentioned: *Quercus robur* L., *Galium verum* L., *Alkanna tinctoria* Tausch (Photo 7), *Hypericum perforatum* L., *Origanum vulgare* L., *Anchusa officinalis* L., *Cynoglossum officinale* L., *Anthemis tinctoria* L., *Crataegus monogyna* Jacq., *Malus sylvestris* (L.) Mill., *Rosa canina* L., *Euphorbia cyparissias* L., *Cornus sanguinea* L., *Viola hirta* L., *Viola tricolor* L., *Salix fragilis* L., *Cruciata glabra* (L.) Ehrend, *Symphytum tuberosum* L., *Achillea millefolium* L., *Matricaria recutita* L.

A brief presentation regarding the usefulness of some tinctorial plants, as resulted from the discussions with the local people, includes the following aspects: *Quercus robur* (tinctorial value – the bark is harvested from old trees from October to February and used fresh to obtain black and ochre colours); *Hypericum perforatum* (tinctorial value - the aerial part, in fresh and dry state, is used to obtain beige, green and brown colours); *Origanum vulgare* (the whole plant has tinctorial value; fresh or dried flowers harvested in July serve to paint in cherry red, while the whole plant harvested during the maximum flowering period (June-July) gives a reddish-brown colour); *Euphorbia cyparissias* (tinctorial value - the aerial part harvested during May-June is used to obtain the yellow colour, while harvested during July-August, it gives a dark brownish red).

Photo 7. *Alkanna tinctoria* from the protected area ”Ciuperceni-Desa” (Dolj county)
Source: Original image.

The fodder plants from the Oltenia Plain are strongly affected by the drought in the soil, which determines the reduction of the bioproductive function. Among the fodder species found in the field, there are to be mentioned: *Lathyrus sphaericus* Retz., *Hordeum bulbosum* L., *Lolium perenne* L., species of certain genera, such as Medicago (*M. minima*, *M. orbicularis* (L.) Bartal., *M. falcata* L., *M. arabica* (L.) Huds., *M. polymorpha* L., etc.), Trifolium (*T. repens* L., *T. pratense* L., *T. campestre* Schreber; *T. arvense* L., *T. subterraneum* L., *T. ornithopodioides* Sm., *T. incarnatum* L. subsp. *molinerii* (Balbis ex Hornem) Cesati, *T. strictum* L.), Vicia (*V. grandiflora* Scop., *V. angustifolia* L., *V. lathyroides* L.), Festuca (*F. pratensis* Huds., *F. rupicola* Heuff., *F. valesiaca* Schleicher ex Gaudin, Poa (*P.*

angustifolia L., *P. pratensis* L., *P. sylvicola* Guss.) and more.

Based on the information collected from the inhabitants of the area (by different age categories), the author conducted an analysis of the economic importance of the spontaneous flora within the plain area of Oltenia, which underlines the high importance assigned to these plants by the population older than 50 years (Fig. 1).

In relation to the economic importance assigned to the spontaneous flora, the low proportion of persons in the 20-40 age group (i.e. 12% of the total) is partly explained by the small number of people living in rural areas, as well as by the growing number of pharmacies that facilitate the rapid purchase of products, without sustained effort.

The 2nd place is held by people falling in the 40-50 age group (i.e. 32%) and the last place belongs to young people, up to 20 years (by about 7%), who are increasingly attracted to the modern aspects, leaving the traditional ones in second place.

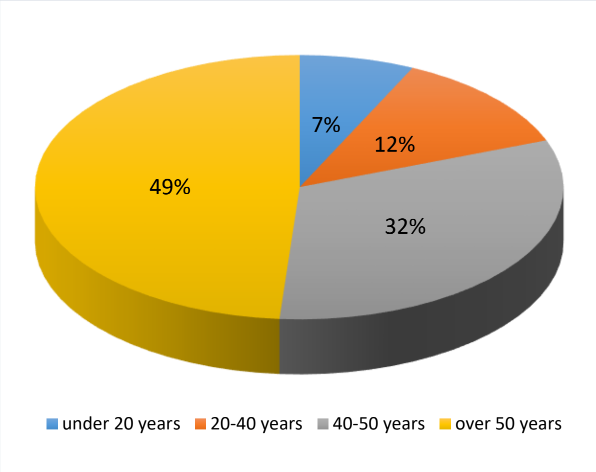

Fig. 1. Distribution of the economic importance assigned to spontaneous flora by age group (%)
Source: Own calculation.

Practically, the economic importance of the spontaneous flora from the Oltenia Plain is age-dependent and it declines in relation with the decrease of age of questioned persons.

The analysis of the different plant categories, according to their usage, highlights the predominance of medicinal species (33%). They are closely followed by melliferous and **fodder species** (Fig. 2).

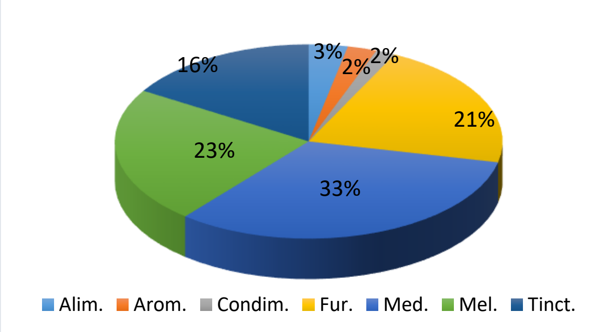

Fig. 2. Structure of different plant categories based on their use
Source: Own calculation.

Tinctorial species, which were widely used in the past, also have a good representation. Unfortunately, nowadays they are used less frequently and only by the village elders.

The analysis of the importance held by the spontaneous flora in the local economy, as assigned by the respondents residing in the rural and urban settlements located in Oltenia Plain, highlights a higher percentage in the case of the inhabitants of villages (with over 80%), while the values characteristic to the urban environment do not exceed 40% (Fig. 3).

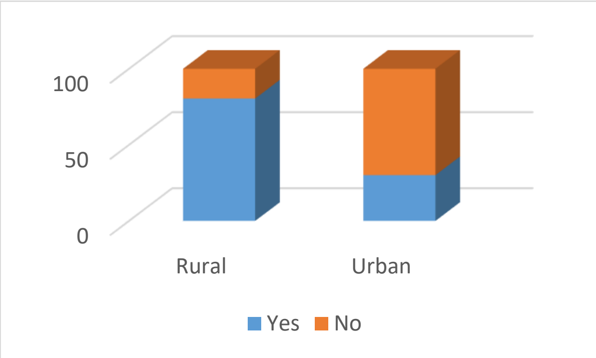

Fig. 3. The importance assigned to spontaneous flora in selected rural and urban areas of Oltenia Plain (%)
Source: Own calculation.

The surface occupied by the spontaneous flora from the Oltenia Plain is very small due to the extension of the agricultural lands (about 20%). The largest share is held by the meadows.

Following the discussions with the inhabitants of the area, it was found that the use of spontaneous plants is done only for domestic use. At the level of the Oltenia Plain there are no spontaneous plant collection centers and no processing companies.

CONCLUSIONS

The analysis of the economic importance of the spontaneous flora within Oltenia Plain underlines its continuous decline during the recent period. In order to increase its future importance for the residents of the area, we recommend the implementation of awareness actions that would help informing about the advantages of the prudent use of spontaneous flora (such as a healthier life, very low costs as compared to synthetic products, long-term efficiency is much greater by rationally using the products provided by nature) and more.

Finally, we can conclude that if no measures are taken in order to make local people aware of the need to preserve biodiversity and the local traditions, then the relatively near future will witness the replacement of the traditional culture by modern habits, while customs and traditions will be found only in museums.

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SIMULATION OF CHANGE IN PERFORMANCE INDICATORS (NET PROFIT, LAND AREA, NUMBER OF EMPLOYEES) OF AGRICULTURAL COOPERATIVES OF UKRAINE

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Abstract

The purpose of the paper was to assess the potential opportunities for the development of agricultural cooperatives until 2030. The importance of modeling the forecast parameters of development in time to ensure the effective functioning of cooperatives was substantiated. It was found that the size of their net income is most affected by: the area of agricultural land, the number of enterprises, the number of employees and the total cost of production. A research using the STELLA program showed that the number of agricultural cooperatives will be reduced 13.1 times by 2030, according to the area of agricultural land they will decrease 1.5 times, and the amount of profits will increase significantly in contrast to losses. This is due to the processes of concentration of cooperative structures, automation of production and implementation of innovative technologies.

Key words: *prediction, agricultural cooperatives, dynamic model, STELLA program*

INTRODUCTION

Market transformations are accompanied by changes in all sectors of Ukraine's economy, including agriculture. The organizational structure of production, management system and land relations, which affect the development of agricultural cooperatives, have undergone significant transformations.

Today, the issues of ensuring the conditions for the revival, stabilization and further development of cooperation, which should provide realization of collective [31] personal and public interests, are relevant for Ukraine.

Agricultural cooperatives are specific form of property relations with a special mechanism of functioning and dynamics between members of the cooperative, business entities and the state. The purpose of their creation is to reduce the costs of members of the cooperative for consumer and production needs; increase in return, labor income and economic growth of cooperative members [30]. This is confirmed by proposals for the introduction of new production facilities to agricultural enterprises on a corporate basis [16].

Zinovchuk V. [40] considers an agricultural cooperative as a voluntary combination of efforts and resources of organizational and legal forms of management interested in achieving certain results, in particular to obtain a net profit.

The founder of the cooperative movement, the French economist Charles Gide [14], expressed the view that "neither capitalism nor socialism, only cooperation" can ensure the development of the village. N. Nelson considered the mission of cooperation to make people moral and promote economic relations [5]. M. Tugan-Baranovsky [36], in turn, argues that agricultural cooperatives help increase agricultural productivity and have a greater ability to survive in competition with monopolists. M. Popov believes that the peasants see in the cooperative social and economic protection from monopolists [6].

The role of cooperation in the formation of vertical integration structures and business environment is important, due to the performance of cooperatives social function [22].

The development of agricultural cooperatives in rural areas was facilitated by a number of factors, in particular: the difficulty of access to markets, given their monopolization; price disparity for industrial and agricultural products; the need for cheap loans that could be provided by credit unions [24].

However, the development of agricultural cooperation in Ukraine is accompanied by problematic issues. These are high prices for machinery, fertilizers, fuel and planting material, weak resources, difficulties in selling agricultural products and lack of proper state support.

"Bottlenecks", which are inherent in agricultural cooperatives, highlights Yu.V. Ushkarenko [37] - weak material and technical base, unsatisfactory financial support and insufficient investment attractiveness [23].

Social, economic, organizational and other difficulties faced by agricultural cooperatives in Ukraine in their production activities negatively affect the results of their management. Under these conditions, the role of forecasting as an important component of planning activities of business entities has been increasing [33].

Forecasting is a responsible step in planning and determining the most important factors that affect the economic activity of agricultural cooperatives, as it deals with probabilistic judgments about the state of their development in the future.

It is important for the country's economy to what extent the development of cooperation will meet domestic needs in the nearest future. In particular, the level of profitability and stability of production will depend on the dynamics of consistency of forecast indicators of cooperation development. Therefore, the issues of forecasting the main indicators of their development are relevant.

The methodical approach to ensuring the effective functioning of cooperatives is based on the application of a program of system dynamics aimed at direct modeling of forecast parameters of their development in time and allows tracking the relationship between variables, in particular those that have a significant impact on agricultural production. Agrarian business needs significant support for the processes of reproduction of resource potential, and the main place is occupied by the provision of fixed assets in particular: land, and employees, which we have included in the forecasting program STELLA.

The purpose of the article is to highlight the results of forecasting the net profit of agricultural cooperatives of Ukraine until 2030 using the software STELLA.

The hypothesis of the study is the assumption that in a competitive environment on the efficiency of agricultural cooperatives, which is expressed in net profit, the most important influence is: the area of agricultural land, number of enterprises, number of employees and total cost of production.

MATERIALS AND METHODS

Our research is practical. It was conducted quantitatively and qualitatively on the principles of complexity in the organization of development of agricultural cooperatives. In this investigation, the category of "complexity" can be observed as one that leads to the inclusion in the production of the whole set of social and production elements (composition), which, acting as a single goal, must achieve a specific intermediate or final goal.

A detailed description of STELLA programs is also given in publications [8, 9, 10, 11, 18, 27, 38, 19, 25, 28].

Five indicators of activity of agricultural cooperatives in the STELLA program were selected for modeling, with the value $p \leq 0.05$ (ie only those that are estimated as statistically reliable). These are such indicators as: area of agricultural land (AREA), number of enterprises (ENTERPRISES), number of employees (EMPLOYEES), cost (VALUE) and net profit (NET PROFIT). Due to the fact that the general indicator of the effective operation of agricultural cooperatives is the net profit, its forecasting for the future is important.

STELLA (Structural Thinking, Experiential Learning Laboratory with Animation) has created a model of system dynamics [13] with feedback, in which processes take place over time [34]. The latter is achieved through a specific discrete variable - "time". This program set both the simulation period - the total simulation time of 40 years, and the simulation step - 1 year - an hour of simulation step (elementary unit of time).

We chose STELLA because of its accuracy and reliability of calculations, intuitive and user-friendly interface, and widely recognized iconography modeling.

RESULTS AND DISCUSSIONS

The model allowed to create the formula needed to study the impact on net income (Converter) such indicators as: area of agricultural land (AREA), number of enterprises (ENTERPISES), number of employees (EMPLOYEES), as well as cost (COST PRICE). The Graphical Function, the graphical element of the STELLA program, such as (Graph Pad) and the tabular element (Tabel Pad) which show results of the forecast has been used.

Data for 1990-2017 were used for modeling. To verify the created model, statistical information for 2017 was introduced, ie the results of the forecast for 2017 were compared with the real performance indicators for 2017. After testing the model, a forecast of possible changes in the studied indicators for the period up to 2030 was made.

Statistical processing of the collected data, gave us the opportunity to obtain a mathematical equation, which characterizes the relationships that exist between the selected indicators. It should be noted that the collected data were analyzed for dependent indicators to exclude cases that could violate the established regression equation. In the end, after the elimination of insignificant samples, the regression equation is constructed. All indicators were tested on a probability test $p \leq 0.05$ to eliminate those that showed a lack of statistical accuracy.

To create a model in the STELLA program, we used the Stock (Stock) element, for which the initial value of NET PROFIT agricultural cooperatives has been set since 1990. The formula, which was previously calculated in the Statistica 13.1 program, all elements were connected using Arrovs (Action Connector).

Statistically significant results with $p \leq 0.05$ were obtained for all 4 analyzed parameters. We are watching almost zero values of p in the results of regression analysis for the dependent variable NET PROFIT (Table 1).

Table 1. Results of regression analysis for NET PROFIT

Dependent Variable	Test of Whole Model vs.SS Residual										
	Multiple R	Multiple R2	Adjusted R2	SS Modle	df Modle	MS Modle	SS Residual	df Residual	MS Residual	F	p
NET PROFIT	0.838575	0.703207	0.611887	193,693.6	4	48,423.39	81,749.41	13	6,288.416	7.700411	0.002074

Source: authors' own calculations.

Based on beta testing, we conclude that the most important in the further development ofagricultural cooperatives is the calculation of net income using variables such as number of employees (EMPLOYEES) and cost price (COST PRICE) (Table 2).

Table 2. Essential results for AREA, ENTERPRISES, EMPLOYEES and COST PRICE

Effect	Parameter Estimates (Agricultural cooperatives) Sigma restricted parameterization									
	NET PROFIT Param.	NET PROFIT Std.Err	NET PROFIT t	NET PROFIT p	-95,00% Cnf.Lmt	+95,00% Cnf.Lmt	NET PROFIT Beta (β)	NET PROFIT St.Err.β	-95,00% Cnf.Lmt	+95,00% Cnf.Lmt
Intercept	-103.841	264.7002	-0.39230	0.701196	-675.691	468.0092				
AREA	0.643	0.6066	1.05921	0.308788	-0.668	1.9530	0.793450	0.749095	-0.82487	2.411771
ENTERPRISES	-1.890	0.7254	-2.60599	0.021757	-3.458	-0.3233	-0.860517	0.330208	-1.57389	-0.147146
EMPLOYEES	0.002	0.0037	0.42887	0.675037	-0.006	0.0095	0.257954	0.601470	-1.04144	1.557352
COST PRICE	0.137	0.0351	3.90026	0.001825	0.061	0.2127	0.939492	0.240879	0.41910	1.459880

Source: authors' own calculations.

Created in Statistica 13.1., the formula has the following form:

$$NET\ PROFIT = -956.110261781+0.222583100314*AREA+0.0317929447539*"ENTERPRIZES"-0.00365882303718*"EMPLOYEES"+0.531263339584*"COST\ PRICE" \qquad (1)$$

Analysis of standardized endpoints for the dependent variable showed the absence of values exceeding ± 3 sigma (Fig. 1), which indicates the absence of significant data deviations.

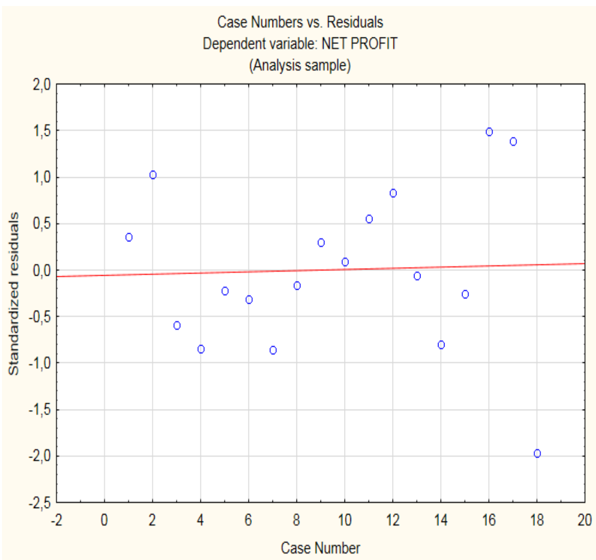

Fig. 1. Results of regression analysis, variable dependent NET PROFIT
Source: authors' own calculations.

This formula was entered in the Inflows NP (Fig. 2) in the model.

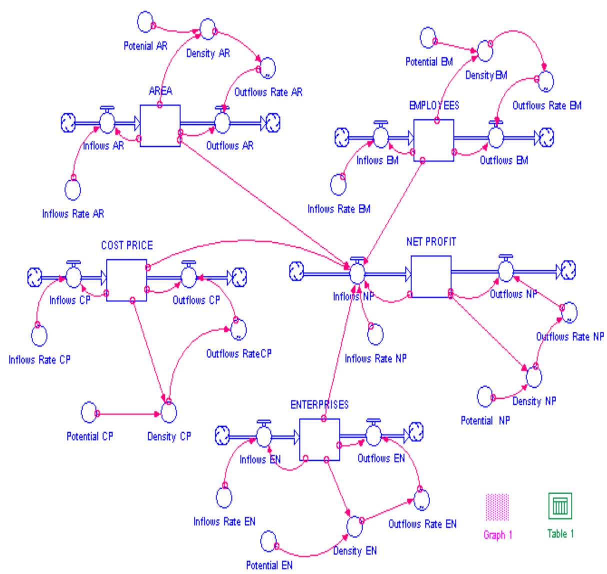

Fig. 2. Created a model in the STELLA program
Source: authors' own calculations.

In Fig. 2 shows a block diagram of the model. Relationships between variables are displayed as graphical functions in STELLA. The convenience of this method is that the appearance of the function can be changed directly on the computer screen with the mouse cursor. We see the production rectangle created in the model as a stock for agricultural products (UAH million). This stock is replenished by the inflow Net profit with the feedback arrow. The flow is influenced by 3 elements of the model (AREA, ENTERPRISES, EMPLOYEES, COST PRICE). On the right - a graph element (Graph Pad) and a table element (Tabel Pad).
The model's verification consisted of a comparison of real data from 2017 (as data from 2018 were absent) with data forecasted

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in the model for 2017. We see that the model for 95-100 % hit the real data in 2017.
The results of the forecast showed the possible decrease in the AREA (Fig. 3) from 3,787 in 2000 to 365.30 thousand hectares in 2030 (Table 3).

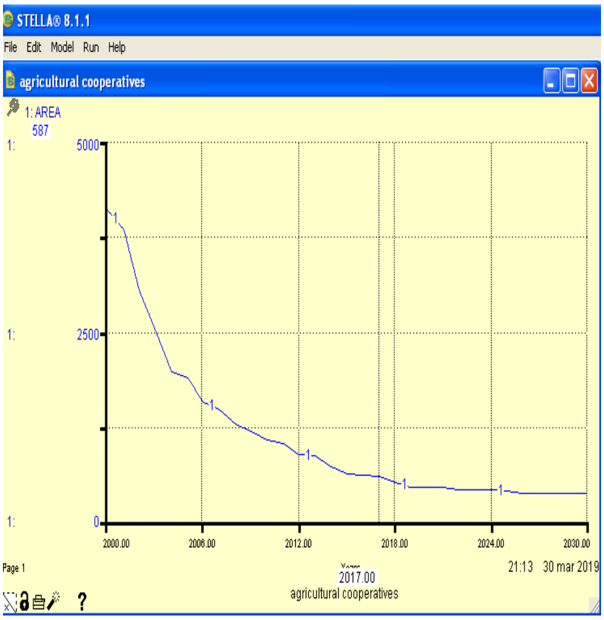

Fig. 3. Graphical representation of forecasting of AREA in STELLA program
Source: authors' own calculations.

In 2017, real statistics amounted to 549.1 thousand hectares and were included in the model for verification of this year's figure, respectively, 587.3 thousand hectares.
The analyzed variables by 2030 can also be seen in the table (the special character separates the thousands of values).
Reducing the area of agricultural land is possible due to the termination of contracts of landowners with tenants or reorganization of agricultural cooperatives into other forms of management.
According to N. Bondina [3], the most efficient use of land resources plays an important role in ensuring the normalization of cooperatives, as well as helping to protect soils and increase their fertility.
One of the main indicators for assessing the state of development of agricultural cooperatives is the change in the number of cooperatives.

Table 3. Table view of forecasting results for AREA in STELLA program

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Years	AREA
2000	4†100.00
2001	3†845.11
2002	3†034.22
2003	2†513.86
2004	1†972.72
2005	1†889.66
2006	1†557.17
2007	1†462.12
2008	1†269.78
2009	1†174.19
2010	1†074.41
2011	1†025.07
2012	871.34
2013	854.54
2014	708.80
2015	620.66
2016	606.66
2017	587.30
2018	508.51
2019	439.20
2020	438.20
2021	442.58
2022	412.57
2023	412.75
2024	413.62
2025	400.80
2026	354.78
2027	358.33
2028	361.92
2029	365.53
Final	365.30

Source: authors' own calculations.

At the same time, the number of enterprises (Fig. 4) tends to decrease from 3,136 in 2000 to 240 enterprises in 2030. In 2017, the statistics obtained were 448 and were modeled in the model for the verification of this year, respectively, 471 enterprises.
For comparison, in 2006-2017 the number of cooperatives in Spain decreased by 8%, their turnover increased by 56%. At the same time, large cooperatives have increased exports and

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their dynamism [4].

Fig. 4. Graphical representation of forecasting of agricultural cooperatives in STELLA program
Source: authors' own calculations.

The results of the forecast (Fig. 5) showed a possible reduction of the number of employees from 338,446 in 2001 to 9,000 in 2030, a reduction of 37.6 times, indicating the mechanization and optimization of agricultural processes and mass layoffs of workers.

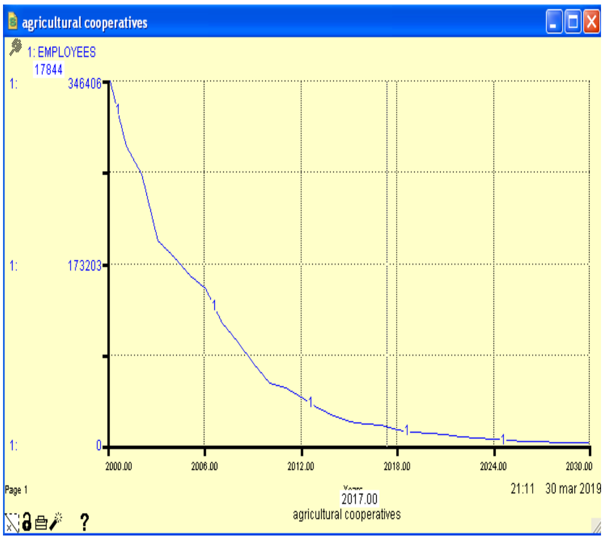

Fig. 5. Graphical representation of forecasting of EMPLOYEES in STELLA program
Source: authors' own calculations.

In 2017, real statistics were 17,213 people, and in the model for verification of this year, people were calculated accordingly 17,844.
Fig. 5 testifies that in agricultural cooperatives the number of employees of a highly skilled managerial staff is mainly reduced due to the low wages, they are forced to look for other ways of earning money. Automation and mechanization of production processes, including agriculture, leads to layoffs. In order to preserve jobs, taking into account not only economic but also social aspects of enterprises, as an option, we can consider the expansion and diversification of their activities.
At the same time, the forecast of the growth of the cost price of agricultural products and services (Fig. 6) from 2,319.7 million UAH in 2000 will increase to 13,529 million UAH in 2030. In 2017, the collected statistical data amounted to UAH 5,814.3 million. After that, the model provided for a further increase in cost. UAH 6,106 million was taken into account in the model for verification.

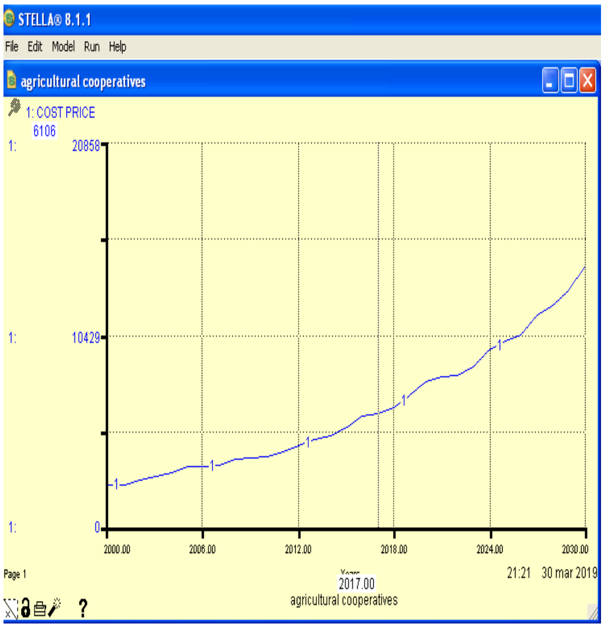

Fig. 6. Graphical representation of forecasting of COST PRICE in STELLA program
Source: authors' own calculations.

Net profit (Fig. 7) will increase in the predicted model and will make 7,625 million UAH in 2030. In 2017, the statistic data obtained amounted to 1,893.7 million UAH, and simulated in the model for verification of this year were accordingly 1,758 mln UAH. After that, the model predicted the next increase in net profit.

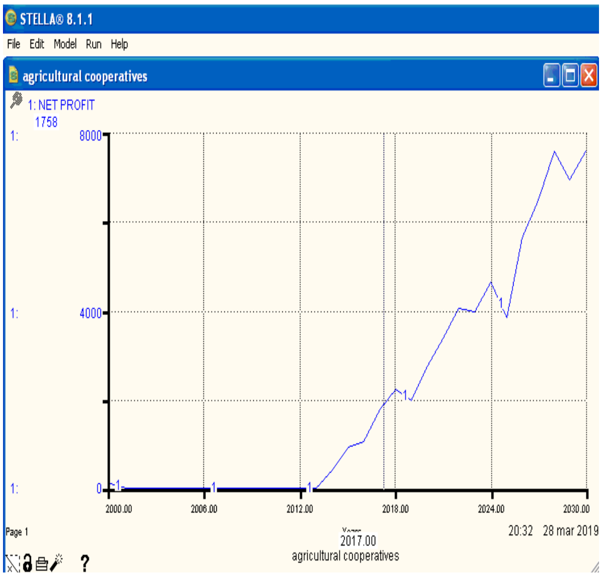

Fig. 7. Graphical representation of forecasting of NET PROFIT in STELLA program
Source: authors' own calculations.

As we see (Figure 3-7), the model predicts that at decrease of the number of agricultural cooperatives (ENTERPRISES) and the number of their employees (EMPLOYEES), and even with rising costs of agricultural products and services in Ukraine, there may be positive changes - increase the net profit. The growth of the cost of agricultural products and services is influenced by inflationary processes, which are observed every year.

As we can see, the Model assumes (Fig. 3-7) that with a decrease in the number of agricultural cooperatives (ENTERPRISES) and, accordingly, the number of employees (EMPLOYEES), despite the growth in the cost of agricultural products and services, there may be positive changes to increase net profit. The cost growth is justified, because it is caused by the increase of the state-regulated minimum wage and the cost of material and technical resources used in the production process. The cost growth of agricultural products and services may be influenced by an increase in production, which, given the automation of production processes and increase the scale of production, can be ensured even by reducing the number of cooperatives. The cost growth is also due to the significant impact of inflation.

The results of the study showed that in agricultural cooperatives after 2019 is projected to grow net income compared to its size in 2017. In particular, by 2030, compared to 2017, it will increase 596 times.

The results of forecasting the main indicators of development of agricultural cooperatives for the period up to 2030, allowed the following conclusions:

1. According to the forecast, the number of agricultural cooperatives by 2030, compared to 2017, will decrease to 240, ie 1.9 times. Due to a significant reduction in the number of agricultural cooperatives in 2017 to stimulate an increase in their number, the Cabinet of Ministers of Ukraine adopted the “Concept of the Development of Farmers and Agricultural Cooperatives for 2018-2020” [26], which should contribute to their future growth.

2. The area of agricultural land will decrease to 365.3 thousand hectares, or 1.5 times.

This decrease in the area of agricultural land is due to both natural phenomena (waterlogging, soil erosion, which manifests itself in the destruction of soil cover and demolition of its particles by water flows (water erosion) or wind (wind erosion)), exacerbated by human economic and industrial activities transport and housing construction, soil contamination with chemical and biological components, mineral development, etc.

3. The number of employees will decrease by 1.9 times by 2030, compared to 2017. In addition to automation and mechanization of production processes, the development of agritourism [12], which promotes self-employment in rural areas, can have a significant impact on the projected reduction of STELLA workers in agricultural cooperatives [19].

4. The projected total cost of agricultural products and services of agricultural cooperatives will increase from UAH 2,319.7 million. in 2000 to UAH 14,099 million in 2030. In 2017, according to real statistics, the cost of agricultural products and services amounted to 5,814.3 million UAH.

The growth of the total cost of agricultural products and services of agricultural cooperatives in 2017, compared to 2000, occurred 2.5 times, and the growth in 2030, compared to 2000, according to the forecast, may be 6.1 times.

The cost growth analyzed in the program may be influenced by inflation. In general, for the period 2014 - 2017, the overall level of consumer prices according to official data increased by 129% [35]. In 2019, consumer inflation slowed to 4.1% (from 9.8% in 2018) - the lowest level in six years [17]. In September 2021, annual consumer inflation accelerated to 11% (from 10.2% in August). On a monthly basis, prices rose by 1.2% [7].

5. The net profit of cooperatives is projected to increase 4 times by 2030, compared to 2017. Net income will tend to increase due to increased agricultural production and rising purchase prices, as well as - the introduction of advanced technologies of labor organization, the use of new cost-effective machines and mechanisms, comprehensive quick-pay equipment, which will increase productivity.

It is proved that agricultural cooperatives play an important role on the way to the market, in particular for: forming consignments of goods for the best selling price; coordination on the production of the product range; ensuring systematic deliveries throughout the year; development of primary and deep processing; creation of a proper procurement and marketing material and technical base; reduction of production costs; independent access to the end user; opportunities to attract funding and improve cash flow [1]. However, this is not confirmed by the data of our forecast model.

Existing agricultural cooperatives do not yet have a significant impact on rural development. The main obstacles to their development are: monopolization and oligarchization of markets, poverty and aging of peasants, weak ability of the population to reconcile the interests of joint activities, a large number of intermediaries, lack of economic and legal instruments at the stage of transition to the bioeconomy [21, 39] absence of economic benefits for further development [20, 2]. Ignoring the problems of development of agricultural cooperatives as a system can lead to a decrease in the efficiency of agricultural production and the weakening of the traditionally formed rural system.

The problems analyzed in the article are relevant for Ukraine at the stage of its accession to the EU. The most important thing should be further systematic study of organizational, social and other measures designed to ensure the effective functioning of agricultural cooperatives [29, 32], which will contribute to the growth of net income. Among such measures, we consider it appropriate to use elements of marketing that include various marketing tools and allow you to compete and properly distribute net profits [15]. In addition, the components of the marketing strategy significantly affect the economic development of all activities of agricultural cooperatives.

CONCLUSIONS

The main performance indicator of agricultural cooperatives is net profit. In order to forecast net income in agricultural cooperatives of Ukraine, an original model was created in the STELLA program. Using this model, the influence of the number of agricultural cooperatives, land area, cost of agricultural products and services on their net profit was determined.

Our study showed possible trends to increase net income while reducing the number of agricultural cooperatives, the area of agricultural land, the number of employees and increasing the total cost of agricultural products and services in agricultural cooperatives by 2030.

The activities of agricultural cooperatives should be focused on priority areas and ensure the growth of quality of life and well-being of rural areas where they operate. As a result of the process of strategic management, the activities of agricultural cooperatives should reach a new level of development, with the definition of priority areas. Public authorities of Ukraine should concentrate their efforts for ensuring the development of agricultural cooperatives, as well as promote their quantitative and qualitative growth.

We believe that a negative factor is the reduction in the number of agricultural cooperatives, as they should help to improve relations in local communities, aimed at maintaining adequate living conditions and improving the social infrastructure of rural areas.

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REPRODUCTIVE QUALITIES OF SOWS AT DIFFERENT DURATIONS OF PREVIOUS LACTATION

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Abstract

To achieve the goals of our study, we investigated the dependence of reproductive qualities of sows on different duration of previous lactation. For the study, three hundred pigs were selected into two separate groups with an equal number of 150 animals in each, taking into account the age, genotype and fatness. The first group included sows that had previous lactation for 28 days and the second group included sows that had previous lactation for 21 days. After seventh week of gestation, including results of ultrasound scanning, all pregnant sows were transferred into two identical sections for keeping females with established gestation, where they were kept in stable groups of 60-65 heads. On 110 day of gestation, all sows were transferred to the farrowing branch where they were kept during pregnancy and lactation under identical feeding conditions and microclimate. As a result of the study it was found that duration of previous lactation had no impact on gilts productivity besides the indicator weight of piglets nest at birth, which was 3.15% higher in sows with traditional duration of lactation. There was no difference in the growth intensity of suckling piglets in sows with traditional and reduced lactation.

***Key words*:** *oestrus, durations of previous lactation, pregnancy, farrow, growth intensity*.

INTRODUCTION

Pig farming has been a traditional branch of animal husbandry in Ukraine since ancient times, which today provides a third of the population's demand for meat products [7]. In Ukraine, as in most developed countries, it is characterized by intensification and concentration of production. This in turn requires a constant increase in pig productivity to ensure the competitiveness of the industry in the meat market [15, 4]. One of the methods of intensification of pig breeding is to reduce the duration of the sows suckling period [14, 6, 19, 24]. This is due to the use of the latest advances in genetics, biochemistry, physiology, feed production technology and improved housing conditions for sows and their offspring [9, 16].

The advantage of early piglets weaning, according to scientists from different countries [29, 2, 27], is more intensive use of sows by reducing its reproductive cycle, which provides more piglets from them and more efficient use of production areas of farrowing buildings.

Different countries use different terms of weaning piglets, so in the USA and Canada piglets are weaned at 14-16 days, while in the EU they are weaned at the age of 28 days [10, 5, 18]. At the same time, in most countries with developed pig breeding, the duration of lactation of sows is 21 days [12].

There is no consensus among scientists and pork producers today about the age of weaning piglets and its effectiveness. Thus, researchers in pig breeding [11, 20, 21, 22, 25, 28] point to the positive results of early piglets weaning from sows.

However, there is a dissenting opinion of other scientists [3, 26], which indicates the negative effects of reducing the lactation period on the further growth and development of piglets and sow health. At the same time, according to studies by scientists [1, 8], no probable divergence was obtained in the effectiveness of traditional and shortened weaning of piglets from sows.

Thus, we observe the lack of an unambiguous approach to assessing the dependence of sow productivity on lactation.

In order to study the impact of the duration of lactation of sows on its further productivity and economic efficiency of different weaning periods of piglets, we conducted a comprehensive study in an industrial pig farm.

MATERIALS AND METHODS

The experiment compared the reproductive qualities, technological and economic parameters of local sows of Irish origin, which had a previous lactation for 28 and 21 days.

For this purpose, according to the scheme of the experiment, three hundred pigs were selected into two separate groups with an equal number of 150 animals in each, taking into account the age, genotype and fatness (Table 1). The control group (group 1) included sows who had previous lactation for 28 days. The experimental group (group 2) included their analogues, whose previous lactation was 21 days.

All experimental sows were placed in pairs into the conditions of the industrial pigsty of Globinsky Pig Complex LLC, Poltava region, Ukraine, where they were artificially inseminated with mixed boars semen of the synthetic terminal line MaxGro genetic company HermitageGenetics. During the idle and conditionally pregnant period, sows in both groups were reared in identical individual pens measuring 0.7 by 2.4 m on a partially slotted concrete floor with standardized feeding, which was regulated by means of volumetric feed dispensers. Watering of sows was carried out from drinking bowls of a constant level. On the seventh week of gestation, after ultrasound scanning, all pregnant sows were transferred into two sections for keeping females with established gestation. They were kept there in stable groups of 60-65 heads, on a fully slotted concrete floor at the rate of 2.2 m^2 per head. Feeding of experimental animals was dosed using BigDutchman's Calmatic feed stations with compound feeds, which were produced at their own compound feed plant for conditionally pregnant sows. The indoor ventilation system for both groups was similar.

Our current research respond to the basic principles of behavior with experimental animals defined in the "European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes" (1986) and requirements of the Law of Ukraine "On the Protection of Animals against Cruelty" (2006).

Factor analysis of the study results was performed by Statistica v.10.

Table 1. Scheme of the experiment for research gilts reproductive characteristics at different durations of the previous suckling period

Indicators	Group I, n = 150	Group II, n = 150
Duration of previous lactation, days	28	21
Number of sows at insemination, heads	150	150
Number of sows on farrowing, heads	120	120
Duration of the studied lactation, days	28	28

Source: Own calculations.

On 110 day of gestation, all sows were transferred to the farrowing branch of farm, where they were kept during pregnancy and lactation under identical feeding conditions and microclimate. Farrowing and suckling piglets were carried out in a farrowing branch with 60 heads in each section in pens measuring 1.8 by 2.4 m. The floor was completely slotted and made of cast iron for sows and of polymer for piglets. Each pans was equipped with a water heating mat and an

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infrared lamp to create a local microclimate for the piglets.
From the second day of lactation, sows were fed eat at will, using individual feed dispensers of Sowmax company HogSlat Ukraine. Their watering was carried out from an individual nipple autodrinker located near the feeder. The piglets of both groups were fed from 7 days of age with Cargil pre-starter feed, using a removable round feeder, which was attached to the lattice floor. And the piglets were watered from a bowl autopouler located in the rear part of the pans.
The experiment studied the following indicators of sow productivity: duration of idle period, duration of gestation, duration of the reproductive cycle, the proportion of sows that came in time after weaning piglets, fertility of sows after weaning piglets, the percentage of their farrowing, the duration of the study feed for the reproductive cycle and the frequency of pans using for farrowing sows, total quantity of piglets born, sow fertility and the quantity of piglets weaned from the sow, high fertility and nest weight of piglets at weaning. In the process of weaning piglets of both experimental groups were outweighed and on the basis of these data was calculated the intensity of their growth.

RESULTS AND DISCUSSIONS

No statistically probable divergence in sows of both group was obtained for the total quantity of born offspring, sow fertility, piglets weight at birth, the quantity of piglets weaned from the sow, piglet preservation, nest weight of piglets at weaning. However, all these indicators tended to increase in animals with longer lactation. A significant excess of 0.55 kg ($p \leq 0.05$) was observed in animals of the group I over analogues from the experimental group II only for indicator of the weight of piglet nest at birth (Table 2).
Thus, the duration of previous lactation had no impact on gilts productivity besides the indicator weight of piglets nest at birth, which was 3.15% higher in sows with traditional lactation duration (group 1).
There were also no significant differences in the intensity of growth of suckling piglets. Both absolute and average daily and relative gains did not depend on the duration of previous lactation (Table 3).

Table 2. Dissemblance in reproducible characteristics of gilts at different durations of the previous period of sucking

Indicators	Group I, n = 150	Group II, n = 150
Total quantity of born offspring, heads	14.62±0.249	14.45±0.170
Sow fertility, heads	13.43±0.203	13.31±0.145
Piglets weight at birth, kg	1.39±0.05	1.36±0.005
The weight of piglet nest at birth, kg	18.67±0.176[1]	18.10±0.189
The quantity of piglets weaned from the sow, heads	11.56±0.232	11.47±0.216
The middle-weight of piglets weaned from the sow, kg	7.83±0.175	7.76±0.091
Piglet preservation,%	86.11±0.331	86.17±0.41
The nest weight of piglets at weaning, kg	90.49±1.112	89.01±1.235

Source: Own calculations.
[1] - $P < 0.05$.

Table 3. Growth intensity of suckling piglets at different suckling durations

Indicators	Group I, n = 150	Group II, n = 150
Absolute gain, kg	6.44±0.232	6.40±0.217
Average daily gain, g	238.5±0.328	237.0±0.352
Relative gain, %	139.70±0.128	140.35±0.135

Source: Own calculations.

The duration of the studied lactation was almost the same in sows of both groups. Pre-lactation was 7.07 ($p \leq 0.001$) days longer in group I gilts comparatively to group II gilts. As a result, the gilts of group I had a longer idle period by 0.42 ($p \leq 0.01$) days (Table 4).
Also in animals of group II the gestation period was longer by 0.39 days ($p \leq 0.05$). However, despite the longer idle and gestation periods, due to the reduction of the term of sucking by 7.07 days, the length of time of the reproductive cycle in sows of the experimental group was probably 6.26 days shorter ($p \leq 0.001$). This made it possible to receive 0.11 more farrowings from each sow during the year, and due to the shorter lactation period to use 2.6 times more often each of the farrowing pens available on the breeder. The increase in the quantity of feed consumed by 36.3 kg was due to an increase in the time spent by animals in the department of conditionally pregnant and pregnant sows. The reason for the increase in this stay was the reduction of the suckling period in sows of group I. The cost of additional feed consumed was 8.6 EUR.

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Table 4. Technological and economic indicators of sows for different durations of the previous weaning period

Indicators	Group I, n = 150	Group II, n = 150
Duration of the previous sucking period, days	27.83±0.107[3]	20.76±0.102
Duration of idling period, days	4.71±0.091	5.13±0.107[2]
Duration of pregnancy, days	115.32±0.103	115.71±0.112[1]
Duration of the reproductive cycle, days	147.86±0.109[3]	141.60±0.114
Number of farrowings per year, times	2.47	2.58
Achieving oestrus after weaning,%	89.33	86.0
Number of piglets received per year, heads	33.17	34.35
Number of weaned piglets per year, heads	28.55	29.59
The cost of additional products, EUR	-	25.1
Fertility of sows after weaning piglets, %	96.27	93.80
The percentage of farrowing, %	95.35	93.39
Duration of the studied sucking period, days	27.79±0.101	27.67±0.144
The frequency of use of the pans for farrowing, times	10.4	13.0
The duration of idle and offspring periods per year, days	286.0	300.5
Average daily feed intake during the growing season, kg	2.5	2.5
Feed consumed by pregnant sows during the year, kg	715.0	751.3
The cost of feed consumed by pregnant sows during the year, EUR	168.9	177.5
Quantity of days of sucking period during the year, days	79.0	64.5
Feed consumed by suckling sows during a day, kg	6.1	6.0
Feed consumed by suckling sows during the year, kg	482.0	371.5
The cost of feed consumed by suckling sows during the year, EUR	167.9	129.4
The cost of feed consumed per year, EUR	336.8	306.9
Difference, EUR		-29.9

Source: Own calculations.
[1] – $P < 0.05$; [2] – $P < 0.01$; [3] – $P < 0.001$.

Animals of the experimental group consumed 8.6 EUR more cheaper feed due to the increase in the duration of keeping in the department of conditionally pregnant and pregnant gilts. At the same time, they spent 14.5 days less in the farrowing branch and consumed 110.9 kg less expensive feed for suckling sows, the cost of which was 38.5 EUR. In general, 336.8 EUR were spent per year on feeding one sow during the traditional duration of lactation, while for the shortened suckling period the cost of feed was 29.9 EUR less. With a reduced weaning period of piglets (group II) from one sow per year received 34.35 piglets, of which 29.59 heads were weaned, while the traditional duration of the lactation period (group I) per year was obtained by 1,18 heads or 3.56% and weaned by 1.04 heads or 3.64% of piglets less compared to sows who had reduced lactation. The cost of additional products at today's prices is 25.0 EUR.

But with the positive results of reducing the duration of the sucking period in our experiment we revealed its negative consequences. Thus, sows with reduced lactation were 3.33% worse at achieving oestrus after weaning piglets. Of sows that achieved oestrus after weaning the piglets were fertilized after insemination by 2.47% less and part of them on 1.96% less reached farrowing. In general, after weaning the piglets and before the next farrowing sows with a reduced duration of lactation had 7.76% more technological dropout and death.

Thus, sows with a reduced suckling period had an 8,9% longer service period, a 0.34% longer gestation period and a 4.42% shorter reproductive cycle, which allowed to obtain 0.11 farrowings per year and 1.26 more piglets per year. Due to the reduction of the duration of lactation by 7.07 days, the intensity of use of the farrowing pens increased by 25.0% and decreased by 29.9 EUR feed cost of keeping a sow. At the same time, 7.76% less sows in the experimental group started the next farrowing. The reason for this, we believe their poorer achieving oestrus after weaning piglets, their poorer fertility and higher rates of their disposal after farrowing. Thus, like [1, 8], we can say that a significant direct effect of weaning on reproductive quality and growth intensity of piglets has not been established. Simultaneously, it contradicts with our previous study [23], which found a significant effect of increasing lactation on improving indicators of the weight of one head at birth by 1.45-5.76%, the average daily gain of piglets by 0.61-15.03% and indicators preservation of piglets 0.60-3.59%. Also, our conclusion does not coincide with study [13], which states that with a shorter weaning period, the total number of weaned piglets is higher ($p < 0.05$). However, the study found a positive effect of early weaning on the efficiency of the farm's production facilities and the growth of economic benefits from the use of this method, as claimed by other scientists [11, 20, 21, 22, 25, 28]. However, our findings coincide with reports [10, 5, 3] about some negative impact of reducing the lactation period on the indicators of the achieving oestrus after weaning piglets, their subsequent fertilization and the duration of the service period.

In our study, we obtained worse characteristics of fertilization and farrowing due to the reduction of the duration of the lactation period, which corresponds to the data obtained by other authors [17].

CONCLUSIONS

The duration of previous lactation had no impact on gilts productivity besides the indicator weight of piglets nest, which was 3.15% higher in sows with traditional duration of lactation, but for all indicators of reproductive characteristics there was a tendency to increase in animals with traditional suckling duration. There was no difference in the growth intensity of suckling piglets in sows with traditional and reduced lactation. Gilts, whose suckling term was shorter, had a 4.42% shorter reproductive cycle, which allowed to receive 3.64% more farrowings and 3.56% of piglets per sow per year and wean 3.64% more, which gave additional products in the amount of 25.0 EUR. Due to the reduction of lactation duration by 7.07 days, the intensity of use of the farrowing pens increased by 25.0% and decreased by 29.9 EUR feed cost of keeping a sow. At the same time, due to achieving oestrus after weaning piglets of sows with a reduced suckling period after weaning, worse fertilization and more care during the gestation period, less than 7.76% of them came from weaning to the next farrowing.
Sows with reduced lactation duration had an 8.90% longer service period and a 0.34% longer gestation period.

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EVOLUTION OF DEMAND FOR TOURISM SERVICES ON THE TERRITORY OF SUCEAVA COUNTY, ROMANIA, IN THE PERIOD 2010-2019

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Abstract

The analysis of arrivals, during the period 2010-2019, for Suceava County, indicates the fact that the number of tourists strongly increased by 139.7% in 2019, with respect to 2010. Overall, the average level of arrivals, registered 310 thousand persons, with an absolute average increase by 30.2 thousand persons and a relative increase by 10.2%. The study on the absolute and relative dynamics of overnight stays during the same period, in Suceava County, reveals that their number strongly increased by 120.2% in 2019, compared to 2010. In total, the average level of overnight stays registered 693.3 thousand persons, with an absolute average increase by 61.5 thousand persons and a relative increase by 9.1%. The medium level of the average length of stay (Romanians + foreigners) registered 2.27 days, with an absolute average decrease by 0.02 days and a relative decrease by 1%. The study on the absolute and relative tourist density during the period 2012-2019, in Suceava County, pointed out that this had almost doubled in 2019, compared to 2012 (increasing by 98.1%). Overall, the average level of the tourist density registered 53.22 tourists/100 inhabitants, with an average increase by 5.28 tourists/100 inhabitants and a relative increase by 24%.

Key words: *overnight stays, arrivals, average length of stay, density of tourist movement*

INTRODUCTION

Suceava County, known mostly under the name of Bukovina (and thus appears sometimes an unjustified separation of a sub-region Bukovina in some programs that promote Suceava County, where Bukovina brand is associated with Moldovia brand – according to [2]), illustrates one of the most complex tourism-oriented region in the country. The exceptional tourism capacity, with a great variety and diversity in objectives of national and international interest, landscape areas with an outstanding beauty, diverse therapeutic factors etc. displays the capacity to develop a high quality hospitality industry [16]. Due to the available favorable conditions, beautiful places, air and water cleanliness, mountainous zone, as well as the invaluable cultural and religious existing heritage, Suceava County has a high tourism potential. Beside the picturesque scenery of the region, well known hospitality, folk traditions, customs, specific gastronomy, the holiday traditions and the folklore clothing give local color, to the delight of tourists [6].

Suceava County introduces itself as an important tourism zone of the country. Beside the great attractiveness of the mountainous landscape, the tourism potential of the county is defined also by the variety, density and value of the religious and architectural monuments, natural reserves and outstanding ethnographic zones - many of them unique in the world - where in particular the monasteries come into attention [11].

The most significant characteristic of relief in Suceava County is the diversity, as here can be found mountains, inter-mountains depressions, hills, plateaux, plains, valleys with terraces and river plains [3].

The dynamic development of tourism, under its two correlated aspects - production and consumption, asserts the receptiveness of this field to society dynamics [8] and, in the same time, the tourism - as a form of activity within the services sector - is characterized as being a necessary activity, meant to satisfy a certain social need [4, 15]. In Suceava County, the tourism potential and the material and technical facilities support the carrying out of different tourism forms: mountain-related tourism and hiking, equestrian tourism, spa-based tourism, cultural tourism, religious tourism, eco-turism, rural tourism and agri-tourism, but also the business and congress related tourism [12].

MATERIALS AND METHODS

The number of tourists accommodated in tourist boarding units (arrivals) includes all the persons (Romanians and foreigners) who travel outside their own residence locality, for a period less than 12 months and who stay at least one night into a tourist boarding unit in areas visited by them within the country, the main reason of the journey being other than to carry on a paid activity in the visited destination [9].

The tourist overnight stay is a 24-hours period, starting with the hotel hour, for which a person is registered in the bookkeeping of tourism unit and is hosted for the paid price, even if the effective length of stay is shorter than the mentioned period. The overnight stays related to the supplementary installed beds (paid by customers) are also included [9].

The average length of stay is determined by the ratio between the number of days/tourist (NTZ) and the number of tourists (T) and reflects the possibility of the tourism offer to retain a tourist into a certain area, region or country [4, 5, 10]:

$$D_s = \frac{\sum NZT}{\sum NT}$$

where:

D_s - average length of stay;

NZT - number of days/tourist;

T – number of tourists.

The density of tourist movement is the indicator that directly interconnects the tourist movement with the resident population in the concerned zone or country. It is calculated as the ratio between the number of tourists (T) and the number of inhabitants (P) [14, 17]:

$$D = \frac{\sum T}{P}$$

The absolute indicators represent a basic form of dynamic series, and they are used to obtain the general indicators [7, 14].

The level indicators are the terms of a series formed by absolute indicators ($y_1 \ldots y_t \ldots y_{t-1}$).

The total level of term $\sum_{t=1}^{n} yt$, is calculated only for time interval series with absolute measures.

The absolute change is calculated:

-with fixed basis ($\Delta_{t/1}$)

$$\Delta_{t/1} = y_t - y_1 \quad \text{where, } t=2,n$$

-with in chain basis (mobile or variable basis) ($\Delta_{t/t/1} = y_t - y_{t-1}$)

$$\Delta_{t/t/1} = y_t - y_{t-1} \quad \text{where, } t=2,n$$

Relative indicators

They provide a presentation tool, mainly by percentage. In this situation is mandatory to mention, within the title or outside the table, the reference basis, so that the data interpretation can be correctly done.

Index of dynamics is calculated:

-with fixed basis ($I_{t/1}$):

$$I_{t/1(\%)} = \frac{yt}{y1} x100$$

-with in chain basis ($I_{t/t-1}$):

$$I_{t/t-1(\%)} = \frac{yt}{yt-1} x100$$

Rhythm [rate] of dynamics:

-with fixed basis ($R_{t/1}$):

$$R_{t/1} = I_{t/1(\%)} - 100\ \%$$

with in chain basis ($R_{t/t-1}$):

$$R_{t/t-1(\%)} = I_{t/t-1(\%)} - 100\%, \quad t = 2,n$$

Average indicators:

$\bar{y}$ – the average level of the interval time series: $\bar{y} = \frac{\sum_{t=1}^{n} yt}{n}$

$\bar{\Delta}$ – the average level of the absolute change (increase or decrease):

$$\bar{\Delta} = \frac{yn-y1}{n-1}$$

$\bar{I}$– the average index of dynamics:

$$\bar{I} = \sqrt[n-1]{\frac{yn}{y1}}$$

$\bar{R}$ – the average growth rate:

$$\bar{R} = \bar{I} - 100$$

In order to adjust the number of tourists, it has been used the method of trends adjusted according to the linear trend for the time interval 2010-2019.

The linear model has the shape: ***y* = a + bt**.

R is the correlation between the values forecasted by the equation and the actual values. **R²** is used to indicate the change in values compared to the trend line [13].

RESULTS AND DISCUSSIONS

Analysis of the tourism demand.

Based on the statistical data provided by the National Institute of Statistics, with regard to the tourism demand, we could study the level and dynamics of the following indicators: level of total arrivals; level of total overnight stays; average length of total stays and by tourist type; tourist density. These indicators will be hereby characterised both in dynamics and as structure.

Level and dynamics of arrivals and overnight stays.

By studying the absolute and relative dynamics of entrances during the period 2010-2019, in Suceava County (Table 1), it could be noticed that their number increased significantly in the year 2019, compared to the reference year (2010), by 139.71%. With respect to the previous year, increases with variations between 1.26% (in 2013) and 19.12% (in 2015) were recorded. In total, the average level of entrances registered 310,033.6 tourists, with an absolute average increase by 30,172.88 tourists and a relative increase by 10.2%. This increase might have as cause the zonal economic growth, determining implicitly a rather high interest of tourists for the concerned zone.

Table 1. Absolute and relative changes in arrivals, in Suceava County (2010-2019)

Years	Arrivals (tourist number)	Absolute changes		Index of dynamics (%)		Rhythm of dynamics (%)	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2010	194,365	-	-	-	-	-	-
2011	229,519	35,154	35,154	118.08	118.08	18.08	18.08
2012	238,611	44,246	9,092	122.76	103.96	22.76	3.96
2013	241,629	47,264	3,018	124.31	101.26	24.31	1.26
2014	260,684	66,319	19,055	134.12	107.88	34.12	7.88
2015	310,548	116,183	49,864	159.77	119.12	59.77	19.12
2016	342,710	148,345	32,162	176.32	110.35	76.32	10.35
2017	385,676	191,311	42,966	198.42	112.53	98.42	12.53
2018	430,673	236,308	44,997	221.57	111.66	121.57	11.66
2019	465,921	271,556	35,248	239.71	108.18	139.71	8.18
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	310,033.6	30,172.9		1.102 (110.2 %)		10.2	

Source: Own calculation, on the basis of data from NIS.

The adjustment based on graphic representation represents an evaluation tool for the development trend, according to which the method (procedure) that has to be used to estimate the long and short term trend can be chosen [1].

In order to estimate the number of tourist entrances during the next five years (2020-2024), in Suceava County, we used the adjustment function y = 31,539x – 60,000,000 obtained through the graphic method according to the linear trend. **R²** has been used to indicate the changes in value compared to the trend line (R^2 = 0.9845) (Fig. 1).

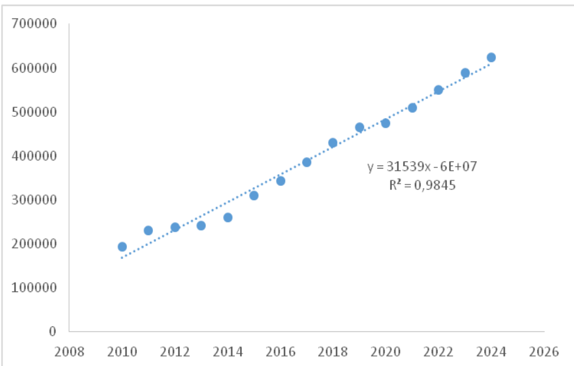

Fig. 1. Dynamics and estimation of entrances in the period 2010-2024, in Suceava County
Source: Own calculation.

By studying the absolute and relative dynamics of overnight stays during the period 2010-2019, in Suceava County (Table 2), it could be seen that their number has significantly increased in 2019, with respect to the reference year (2010), by 120.22%.

Compared to the previous year, it could be noticed a low decrease during the year 2013 (by 1.54%), while over the remaining period, increases by up to 20.75% (in 2011) have been recorded. Overall, the average level of overnight stays registered 696,295.6 overnight stays, with an absolute average increase by 61,534.4 overnight stays and a relative increase by 9.1%.

Table 2. Absolute and relative changes in overnight stays, in Suceava County (2010-2019)

Years	Overnight stays (number)	Absolute changes		Index of dynamics %		Rhythm of dynamics %	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2010	460,637	-	-	-	-	-	-
2011	556,249	95,612	95,612	120.75	120.75	20.75	20.75
2012	586,237	125,600	29,988	127.26	105.39	27.26	5.39
2013	577,232	116,595	-9,005	125.31	98.46	25.31	-1.54
2014	583,642	123,005	6,410	126.70	101.11	26.70	1.11
2015	699,491	238,854	115,849	151.85	119.84	51.85	19.84
2016	759,754	299,117	60,263	164.93	108.61	64.93	8.61
2017	815,732	355,095	55,978	177.08	107.36	77.08	7.36
2018	909,535	448,898	93,803	197.45	111.49	97.45	11.49
2019	1,014,447	553,810	104,912	220.22	111.53	120.22	11.53
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	696,295.6	61,534.4		1.091 (109.1%)		9.1	

Source: Own calculation, on the basis of data from NIS.

The adjustment according to the linear trend of the overnight stays for the following five years (2020-2024), in Suceava County, has been achieved with the adjustment function y = 590,39x-100,000,000. **R²** has been used to indicate the changes in value compared to the trend line (R^2 = 0.9787) (Fig. 2).

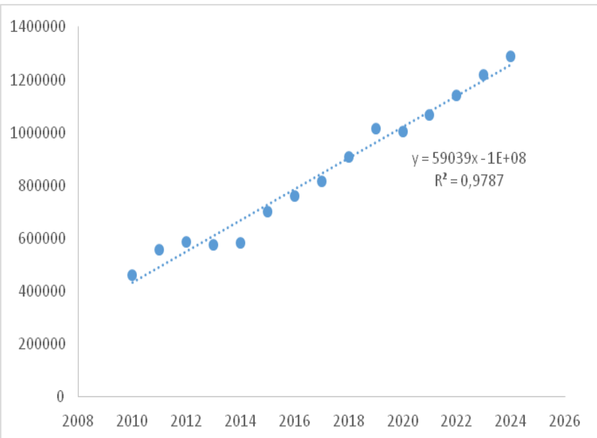

Fig.2. Dynamics and estimation of overnight stays in the period 2010-2024, in Suceava County
Source: Own calculation.

Under the conditions when the factors with impact on tourism activity will keep the same rhythm also during the next five years of the analysed period (Table 3), in the year 2024 in Suceava County, the number of tourist entrances will be about 624 thousand, while the number of overnight stays will be about 1,288 thousand.

Table 3. Estimation of arrivals and overnight stays in the period 2020 – 2024, in Suceava County

Years	t(x)	Arrivals y = 31,539x – 60,000,000	Overnight stays y = 590,39x-100,000,000
2020	11	474,717	1,005,235
2021	12	509,746	1,065,968
2022	13	549,470	1,140,185
2023	14	588,827	1,218,104
2024	15	624,007	1,287,860

Source: Own calculation.

Analysis of tourist movement

From the structure of tourist movement by tourist types, in Suceava County, during the period 2010-2019 (Table 4), it could be seen that the number of foreign tourists has a low share (14.28%) within the total entrances in county, and the number of overnight stays related to foreign tourists has also a low share (10.91%) within the total overnights in county.

The average length of stay - as an indicator that shows the average time (days) of staying in the accommodation units and thus reflects the offer possibility to keep the tourists within a certain zone or region [17] - displayed fluctuations during the analysed period (2010-2019), both for Romanian and foreign tourists.

Table 4. Structure of tourist movement by tourist types, in Suceava County (2010-2019)

Years	Arrivals (number of persons)			Overnight stays (number of persons)		
	T	TR	TS	T	TR	TS
2010	194,365	169,755	24,610	460,637	415,073	45,564
2011	229,519	196,896	32,623	556,249	493,933	62,316
2012	238,611	200,423	38,188	586,237	517,394	68,843
2013	241,629	200,233	41,396	577,232	501,180	76,052
2014	260,684	220,514	40,170	583,642	511,179	72,463
2015	310,548	264,553	45,995	699,491	620,170	79,321
2016	342,710	290,960	51,750	759,754	674,581	85,173
2017	385,676	332,352	53,324	815,732	729,758	85,974
2018	430,673	372,156	58,517	909,535	815,713	93,822
2019	465,921	409,793	56,128	1,014,447	924,586	89,861
	$\bar{y}$			$\bar{y}$		
	310,033.6	265,763.5	44,270.1	696,295.6	620,356.7	75,938.9

Note: T - total; TR – Romanian tourists, TS – foreign tourists.
Source: Own calculation.

For the foreign tourists, the average length of stay increased only in the year 2011 (by 3.24%) compared to the reference year, while the remaining period registered decreases with respect to the reference year, by up to 13.52% (in 2018 and 2019) (Table 5).

Table 5.Absolute and relative changes in average length of stay by domestic tourist, in Suceava County (2010-2019)

Years	Ds (Romanian tourists)	Absolute changes		Index of dynamics (%)		Rhythm of dynamics (%)	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2010	2.44	-	-	-	-	-	-
2011	2.50	0.06	0.06	102.45	102.45	2.45	2.45
2012	2.58	0.14	0.08	105.73	103.2	5.73	3.2
2013	2.50	0.06	-0.08	102.45	96.89	2.45	-3.11
2014	2.31	-0.13	-0.19	94.67	92.4	-5.33	-7.6
2015	2.34	-0.10	0.03	95.90	101.29	-4.1	1.29
2016	2.31	-0.13	-0.03	94.67	98.71	-5.33	-1.29
2017	2.19	-0.25	-0.12	89.75	94.80	-10.25	-5.2
2018	2.19	-0.25	0	89.75	100	-10.25	0
2019	2.25	-0.19	0.06	92.21	102.73	-7.79	2.73
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	2.36	-0.02		0.99 (99%)		-1	

Source: Own calculation.

In the case of Romanian tourists, it has been noticed an increase in the average length of stay compared to the reference year, only in the years 2011, 2012 and 2013, the increase in the year 2012 reaching 5.73%. The remaining period registered decreases by up to 10.25% (in the years 2017 and 2018) (Table 6).

In total, the medium level of the average length of stay (Romanian tourists +foreign tourists) recorded, in the analysed period (2010-2019), 2.27 days, with an absolute average decrease by 0.02 days, respectively a relative decrease by 1% (Table 7).

Table 6. Absolute and relative changes in average length of stay by foreign tourist, in Suceava County (2010-2019)

Years	Ds (foreign tourists)	Absolute changes		Index of dynamics (%)		Rate of dynamics (%)	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2010	1.85	-	-	-	-	-	-
2011	1.91	0.06	0.06	103.24	103.24	3.24	3.24
2012	1.80	-0.05	-0.11	97.29	94.24	-2.71	-5.76
2013	1.83	-0.02	0.03	98.91	101.66	-1.09	1.66
2014	1.80	-0.05	-0.03	97.29	98.36	-2.71	-1.64
2015	1.72	-0.13	-0.08	92.97	95.55	-7.03	-4.45
2016	1.64	-0.21	-0.08	88.64	95.34	-11.36	-4,66
2017	1.61	-0.24	-0.03	87.02	98.17	-12.98	-1.83
2018	1.60	-0.25	-0.01	86.48	99.37	-13.52	-0.63
2019	1.60	-0.25	0	86.48	100	-13.52	0
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	1.73	-0.02		0.98 (98%)		-2	

Source: Own calculation.

Table 7. Absolute and relative changes in the average length of stay, in Suceava County (2010-2019)

Years	Total Ds	Absolute changes		Index of dynamics (%)		Rhythm of dynamics (%)	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2010	2.36	-	-	-	-	-	-
2011	2.42	0.06	0.06	102.54	102.54	2.54	2.54
2012	2.45	0.09	0.03	103.81	101.23	3.81	1.23
2013	2.38	0.02	-0.07	100.84	97.14	0.84	-2.86
2014	2.23	-0.13	-0.15	94.49	93.69	-5.51	-6.31
2015	2.25	-0.11	0.02	95.33	100.89	-4.67	0.89
2016	2.21	-0.15	-0.04	93.64	98.22	-6.36	-1.78
2017	2.11	-0.25	-0.10	89.40	95.47	-10.6	-4.53
2018	2.11	-0.25	0	89.40	100	-10.6	0
2019	2.17	-0.19	0.06	91.94	102.84	-8.06	2.84
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	2.27	-0.02		0.99 (99%)		-1	

Source: Own calculation.

The variation in value for the average length of stay in Suceava County, during the analysed period (2010-2019), points out a decrease of the purchasing power of clients for the provided tourism services, under the conditions when the share of Romanian tourists in the total entrances is over 85% (85.72%) and also the probable use of some too high tariffs, that are not appropriate for the provided services.

In order to estimate the average length of stay (Romanian tourists + foreign tourists) in the next five years (2020-2024), in Suceava County, it was used the adjustment function y = -0.0379x + 78,708 obtained by the graphic method according to the linear trend. The indicator R^2 = 0.9287 points out a good trend approximation by the linear function (Fig. 3).

The estimation of the average length of stay in the case of Romanian tourists was carried out also with the adjustment function obtained by the graphic method, according to the linear trend: y = -0.0406x + 84,156.

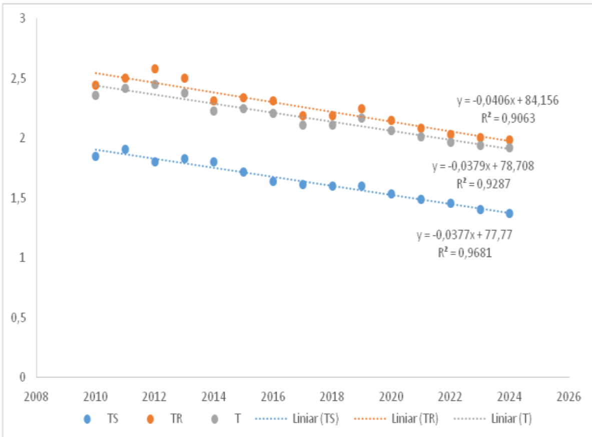

Fig. 3. Dynamics and estimation of average length of stay in the period 2010-2024, in Suceava County
Note *T - total; TR – Romanian tourist; TS – foreign tourists.*
Source: Own calculation.

The value of the coefficient R^2=0.9063 indicates also a good trend approximation by the linear function. In order to estimate the average length of stay in the case of foreign students, the adjustment function obtained by the graphic method according to the linear trend was: y = -0.0377x+77,770. The value of the coefficient R^2 = 0.9681 indicates a very trend good approximation by the linear function (Fig. 3).

Under the conditions when the factors with impact on tourism activity will keep the same rhythm also during the next five years (Table 8), in the year 2024, in Suceava County, the

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average length of stay (Romanian tourists + foreign tourists) will be about 1.9 days.

Table 8. Estimation of average length of stay, by tourist types, in the period 2020 – 2024, in Suceava County

Years	t(x)	Average length of stay		
		T y = -0.0379x + 78,708	TR y = -0.0406x + 84,156	TS y = -0.0377x +77,770
2020	11	2.07	2.15	1.54
2021	12	2.01	2.08	1.49
2022	13	1.97	2.03	1.45
2023	14	1.94	2.00	1.41
2024	15	1.92	1.98	1.37

Note: T - total; TR – Romanian tourist; TS – foreign tourists.
Source: Own calculation.

The average length of stay in the case of Romanian tourists will be about 2 days, while the average length of stay, in the case of foreign tourists, will be about 1.4 days.

The density of tourist movement ($Dt_{pop.}$) is the indicator that directly interconnects the tourist circulation with the resident population of a certain zone or country. The density of tourist movement ($Dt_{pop.}$) in Suceava County, in the period 2012 – 2019, is given in Table 9.

As a rule, this indicator has a below 1 value in the zones with medium and low tourist movement [17], as it is also the case of Suceava County, where in the year 2019 was recorded the highest value of 0.74 tourists/inhabitants. If the dynamics of the average length of stay registered fluctuations during the analysed period, the density recorded significant increases as follows: if in 2012, by each 100 inhabitants were 38 tourists, in 2019 the ratio was about 75:100. This fact derived from the growth in tourist number, as well as from the numerical decrease of population in Suceava County, in the analysed period.

Table 9. Tourist density, in the period 2010-2019, in Suceava County

	2012	2013	2014	2015	2016	2017	2018	2019
Resident population*	632,985	632,041	631,587	630,621	629,115	627,975	625,778	623,896
Arrivals	238,611	241,629	260,684	310,548	342,710	385,676	430,673	465,921
Dt_{pop} (tourists/inhab., tourists/100 inhab.)	0.37 37.69	0.38 38.23	0.41 41.27	0.49 49.24	0.54 54.47	0.61 61.41	0.68 68.82	0.74 74.68

Note: *resident population on 1st July
Source: Own calculation, on the basis of data from NIS.

Studying the absolute and relative dynamics of tourist density during the period 2012-2019, in Suceava County (Table 10), it could be noticed that this had almost doubled in 2019, compared to 2012 (increasing by 98.14%).

Table 10. Absolute and relative changes in tourist density, in the period 2012-2019, in Suceava County

Years	Dt_{pop} Tourists /100 inhab.	Absolute changes		Index of dynamics %		Rhythm of dynamics %	
		$\Delta_{t/1}$	$\Delta_{t/t-1}$	$I_{t/1}$	$I_{t/t-1}$	$R_{t/1}$	$R_{t/t-1}$
2012	37.69	-	-	-	-	-	-
2013	38.23	0.54	0.54	101.43	101.43	1.43	1.43
2014	41.27	3.58	3.04	109.49	107.95	9.49	7.95
2015	49.24	11.55	7.97	130.64	119.31	30.64	2.78
2016	54.47	16.78	5.23	144.52	110.62	44.52	10.62
2017	61.41	23.72	6.94	162.93	112.74	62.93	12.74
2018	68.82	31.13	7.41	182.59	112.06	82.59	12.06
2019	74.68	39.99	5.86	198.14	108.51	98.14	8.51
	$\bar{y}$	$\bar{\Delta}$		$\bar{I}$		$\bar{R}$	
	53.22	5.28		1.24 (124%)		24	

Source: Own calculation.

In total, the average level of tourist density registered 53.22 tourists/100 inhabitants, with an absolute average increase by 5.28 tourists/100 inhabitants and a relative increase by 24%.

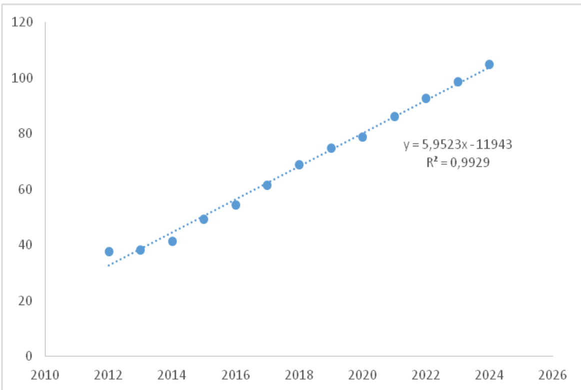

Fig. 4. Dynamics and estimation of tourist density in the period 2012-2024, in Suceava County
Source: Own calculation.

In order to evaluate the tourist density in the next five years (2020-2024), in Suceava County, the adjustment function y= 5.9523x – 11,943 obtained by the graphic method, according to the linear trend, was used. **R²** has been used to indicate the changes in value compared to the trend line (R^2 = 0.9929) (Fig. 4).

Under the conditions when the factors with impact on tourism activity will keep the same rhythm also during the next five years (Table 11), in the year 2024, in Suceava County, the tourist density will be about 105 tourists to 100 inhabitants.

Table 11. Estimation of tourist density in the period 2020 – 2024, in Suceava County

Years	t(x)	Tourist density y = 5. 9523x – 11,943
2020	9	78.81
2021	10	86.05
2022	11	92.70
2023	12	98.64
2024	13	104.88

Source: Own calculation.

CONCLUSIONS

During the period 2010-2019, the average level of entrances in Suceava County recorded 310 thousand persons, with an absolute average increase by 30.2 thousand persons and a relative increase by 10.2%. The average level of overnight stays, during the same period (2010-2019), in Suceava County, registered 696.3 thousand, with an absolute average increase by 61.5 thousand and a relative increase by 9.1%. These increases could be caused by the zonal economic growth, determining implicitly also a higher interest of tourists for the concerned zone.

The structure of tourist movement by tourist types during the period 2010-2019 indicates the fact that the number of foreign tourists has a small share (14.3%) within the total entrances in Suceava county, while the number of overnight stays related to foreign tourists has also a small share (10.9%) within the total overnights in county.

Under the conditions when the factors with impact on tourism activity will keep the same rhythm also during the next five years, in the year 2024, in Suceava County, the number of tourist entrances will be about 624 thousand, while the number of overnight stays will be about 1,288 thousand.

The average length of stay in Suceava County presented fluctuations during the analysed period (2010-2019), both for the Romanian and foreign tourists. For the foreign students, it has increased by only 3.24% in the year 2014, compared to the reference year. In the case of Romanian tourists, the most important increase of the average length of stay, with respect to the reference year, was about 12.44% in the year 2012. Overall, the medium level of the average duration of (total) stays recorded 2.27 days, with an absolute average decrease by 0.02 days and a relative decrease by 1%. The decrease of the average length of stay in Suceava County, during the analysed period (2010-2019), indicates a reduction in the purchasing power of clients for the provided tourism services and also the probable use of some too high tariffs, that are not appropriate for the provided services. If the factors with impact on tourism activity will keep the same rhythm also during the next five years, in the year 2024, in Suceava County, the average length of (total) stays will be about 1.9 days; the average length of stay in the case of Romanian tourists will be about 2 days, while the average length of stay for foreign tourists will be about 1.4 days.

The average level of tourist density, in Suceava County, during the period 2012-2019, registered 53.22 tourists/100 inhabitants, with an absolute average increase by 5.28 tourists/100 inhabitants and a relative increase by 24%. Under the conditions when the factors with impact on tourism activity will keep the same rhythm also during the next five years, in the year 2024, in Suceava County, the tourist density will be about 105 tourists /100 inhabitants.

If the dynamics of the average length of stay recorded fluctuations during the analysed period, the tourist density registered significant increases, this fact deriving from the growth in tourist number, but also from the numerical decrease of population in Suceava County, in the analysed period.

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STUDY ON THE MANAGEMENT OF THE AGRITOURISM PENSIONS PROMOTION IN THE APUSENI MOUNTAINS AREA

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Abstract

The present paper aimed to identify the methods of promoting agritourism pensions, especially in the field of agritourism pensions in the area of the Apuseni Mountains. Aspects regarding the structure of the promoting way of the agritourism pension are systematically presented according to the development region, the gender and the age of the pension owner. At the same time, the paper evaluates the connection between the promotion on the Internet according to the development region and the classification category of the agritourism pension. It was also necessary to evaluate the link between promotion by participating in tourism fairs organized at regional, national level and the development region. The main research tool, that was the basis for this study, was the questionnaire applied to 110 managers of agritourism pensions in the Apuseni Mountains area. The data presented in the paper fully represent the answers given by the managers of the agritourism pensions mentioned above. Following the analysis, it was found that the most used and useful method of promotion, agreed by most managers is promotion with the help of the Internet.

Key words: *questionnaire, management, Apuseni Mountains, agritourism pension, promotion, Romania*

INTRODUCTION

Promotion, an important factor of the marketing mix, with a decisive role in achieving objectives, [15] is the set of actions related to attracting potential customers, by informing them and satisfying their desires by increasing the economic efficiency of the marketing act [3]. As stated by Prof. A Morrison, as well as Prof. O. Snak, the marketing mix for the hospitality industry is composed of 11 elements, the "11 Ps", where the promotion is also found (Fig. 1).
In the tourism field, promotion means how to attract new, potential clients, as well as retaining old clients, both directly and through reservation networks or travel agencies, addressing the general public, or just a well-defined niche. The promotion of the agritourism pension is a process of communicating a real and quality image to the potential client [5] and aims to inform him about the offer of products and services from the tourist reception unit[12] influencing the customer in accepting the tourist services, so the buying behavior [3]. The objectives of tourism promotion are to consolidate, create and change attitudes and behaviour of tourists [14].
Professor Philip Kotler in his paper Marketing Management, 1997, presents the communication and promotion tools that can be used successfully by any entrepreneur in the tourism field [3, 7] (Table 1).

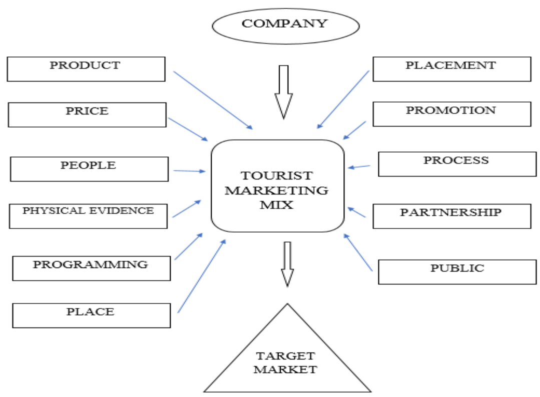

Fig. 1. Structure of the tourist marketing mix
Source: [3].

Table 1. Communication and promotion tools

ADVERTISING	SALES PROMOTION	PUBLIC RELATIONS	PERSONAL SALES	DIRECT ADVERTISING
RECOMMENDED				
Advertisements printed or broadcast on radio or TV The outside of the packaging Movies Brochures and leaflets Posters and flyers Phone books Print ads Panels Display of logos Posters displayed in sale points Symbols and logos	Games, contests, raffles, lotteries Gifts Free samples Fairs and trade events Exhibitions Demonstrations Coupons Discounts Entertainment Commercial stamps Group sales	Press conferences Speeches Seminars Yearbooks Charitable activities SPONSORSHIP Publications Community relations Influencing political decisions Own means of information Company magazine Special events	Commercial presentations Business meetings Simulation programs Samples Trade fairs and exhibitions	Catalogs Materials sent by post Online shopping Shopping on TV
EXISTENT				
Brochures and leaflets Street signs	Fairs and trade events Exhibitions	Community relations Own means of information Special local cultural and artistic events	Trade fairs and exhibitions	Catalogs Online package shopping on booking sites

Source: Processed after Cojocariu *et al* (2004) [3].

The specific information influencing the decision to buy the tourist service by tourists refers to the use of the AIDA principle [2] based on attracting attention, creating interest, stimulating desire and leading to triggering the purchase action [10]. The promotion strategy is part of the company's management strategy and is a complex process, which must take into account the economic and social environment, competition, market, promotional tools [3]. Regardless of the instrument for promoting the agritourism pension, the objectives of the promotion must be established, which are found in the managerial objectives. The promotion mix in the tourism field involves, among other things, the establishment of a promotion policy, a strategy for presenting tourist services but at the same time attracting as many tourists as possible to increase the efficiency of tourism.

The setting of a strategy for promoting the agritourism pension must take into account the questions: „Whom are the tourist products or services offered to?"; „Who are the customers targeted to receive the products and services offered?"; „Where are these customers?"; „What do customers want?"; „What expectations of the clients must the tourist products / services satisfy?"; „What promotional activities are carried out to attract customers?"; „How do you want tourist products or services to be perceived by those for whom they are intended?"; „Where do customers expect to find them?"; „When is the right time to be offered to them?"; „How much will this cost?" [12].

MATERIALS AND METHODS

The purpose of this study was to identify methods of promoting agritourism pensions in the Apuseni Mountains area and the relationships that are established taking into consideration the characteristics of theagritourism pension owner, the classification category of agritourism pension, the development region which the tourist accommodation structure is part of.

In order to carry out this work we used as a means of collecting information the questionnaire that was applied to a number of 110 managers of agritourism pensions in the Apuseni Mountains area, counties that are part of the following development regions: Central Region - Alba county, North-West Region - Bihor, Cluj, Sălaj counties, West Region - Arad, Hunedoara counties.

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Taking into account the bibliographic sources regarding the promotion tools, the promotion policy within the marketing mix, the existing promotion methods at the agritourism pensions in the Apuseni Mountains area were highlighted. In the paper, the information provided following the application of the questionnaire was processed, using the statistical indicators Chi square and the Pearson coefficient.

RESULTS AND DISCUSSIONS

For a good presentation of the tourist services, the owners of agritourism pensions from the Apuseni Mountains area [13] tried by several means to make their presence known in the tourist field (Table 1). Thus, a number of 51 respondents made web pages on the Internet, 46 respondents made brochures, leaflets, business cards, they installed billboards with the pension in visible places, on the road (Photos below).

Photo 1. Advertising panel with the accommodation units from Albac commune, Alba county
Source: Own archive.

Photo 2. Advertising panel Casa Florelaagritourism pension, Căpușu Mic village, Cluj county
Source: Own archive.

Photo 3. Advertising panel Saranis Agritourism Pension, Beliș commune, Cluj county
Source: Own archive.

84 respondents stated that they used booking and promotion sites for both domestic and international tourism market, especially Hungarian, among which we can mention: www.portalturism.com, www.LaPensiuni.ro, www.Travelminit.ro, www.Carta.ro, www.TurismInfo.ro, www.HotelGuru.hu,, www.CautPensiuni.ro, www.Booking.com, www.DirectBooking.com, www.TripAdvisor, www.Travlocals.com, or they advertised on facebook.

A number of 21 respondents participated in local, regional or national activities or fairs: ex Albac National Rural Tourism Fair (i.e. Daiana Pension, Albac commune, Alba county), (Photo 4) at the Fair Bucharest International Tourism Board (eg Pension from Vaţa to Brad in Vaţa de Jos commune, Hunedoara county or Casa Pera Pension in Basarabasa village, Vaţa de Jos commune, Hunedoara county).

Photo 4. Promotion of Daiana Pension at the National Rural Tourism Fair 2018 in Albac, Alba County
Source: Own archive.

A small number of agritourism pensions are ANTREC members with the help of which they are promoted in the pages of specialized magazines (i.e. Dorel Codoban, Agritourism

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Pension - Roşia, Bihor County), or through local, national, international promotion organizations with which they are in partnership (eg Traditional House Experience - Roşia, Bihor county, is in partnership with numerous national and international bodies with which it attracts its target group. egApuseni Experience, AlpinExpe, Romanian Ecotourism Association, Bihor Center for Protected Areas and Sustainable Development, Eco-Jur, Romanian Speleology Federation, Technical Solutions Camp.)

A successful promotion is also through the pensions' clients, which is a gratifying thing, something affirmed by 75 respondents. A number of 52 respondents stated that they used the promotion services of travel agencies, with which they have concluded collaboration contracts. As examples of travel agencies we can mention Porolisum Tour from Zalău, Travelminit from Cluj, Hello Romania. The Davincze Tours travel agency from Sâncraiu commune has been successfully promoting, for more than 10 years, the agritourism pensions in the area, attracting tourists from both Romania and Hungary [4]. The quality of tourist services within the agritourism pension, the way of treating each tourist are just a few elements that meet the requirements of any person staying at the pension, which is the best messenger of promoting tourism, taking into account that the most important means of marketing is the word-of-mouth system [6].

This was also found in the case of tourism from agritourism pensions in the Apuseni Mountains area, where 68% of respondents said that former customers recommended the accommodation where they were accommodated to other people (relatives, friends). Regardless of the development region in which the agritourism pensions are located, the promotion is done through several means in order to inform the tourists about the tourist services offered. It is found that there is no significant relationship between the development region and the mode of promotion. Thus, it is found that 65% of respondents in the Central development region mentioned that promotion through customers is the most useful means, and 60% of respondents make known their agritourism business through the website. 68% of the owners of agritourism pensions in the North-West development region focus on promotion through clients, and 56% mentioned that travel agencies are reliable business partners in the tourism field. And 80% of the owners of agritourism pensions in the West development region put the promotion through customers in the first place, followed by 70% of the respondents with the business in the West region studied, on the promotion through brochures, leaflets, business cards. (Fig. 2, Table 2).

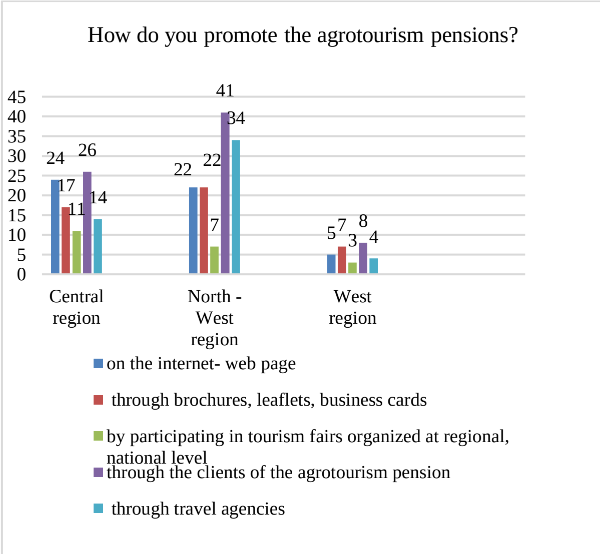

Fig. 2. Structure of the way of achieving the agritourism pension promotion according to development region
Source: Own design and calculation.

Given the link between the pension owner's gender and how to promote the structure of the tourist reception, it is found that there is a significant normal relationship between these criteria, both men and women try to make pensions known through several ways of promotion. We can mention the fact that 67.65% of the gentlemen' answers and 68.42% of the ladies' answers of the agritourism pensions owners refer to the promotion through the clients of the agritourism pension. The least emphasis is put on promotion by participating in local, national, international trade fairs. Only 7 men, representing 20.59% and 14 women, representing 18.42% specified the fact that they participated in tourism fairs organized in order to promote the pension they ran (Table 2). The statistical analysis on the evaluation of web promotion via the website by development region shows that there is a significant link, which means that there are major differences between respondents' answers by development region. The majority of respondents who specified that they promote the agritourism pension through the Internet using the website of the tourist reception unit, that is 24, are located in the Central development region, followed by 22 respondents in the North-West region, and the least in number, that is 5, are located in the West development region (Table 3).

Table 2. Structure of the promotion methodof the agritourism pension by development region and pension owner's gender

Development region. owner's gender		UM	How do you promote the agritourism pension?				
			On the internet - web page	Through brochures. leaflets. business cards	By participating in tourism fairs organized at regional. national level	Through the clients of the agritourism pension	Through travel agencies
Region	Central region	no	24	17	11	26	14
		%	60.00	42.50	27.50	65.00	35.00
	North-West region	no	22	22	7	41	34
		%	36.67	36.67	11.67	68.33	56.67
	West region	no	5	7	3	8	4
		%	50.00	70.00	30.00	80.00	40.00
Gender	masculine	no	18	13	7	23	14
		%	52.94	38.24	20.59	67.65	41.18
	feminine	no	33	33	14	52	38
		%	43.42	43.42	18.42	68.42	50.00
Grand total		no	51	46	21	75	52
		%	46.36	41.82	19.09	68.18	47.27

Source: Simina F. A.-E., 2020, Questionnaire agritourism pensions from the Apuseni Mountains

Table 3. Assessment of the connection between internet promotion - web page by development region

Development region	UM	On the internet - web page		Total		
		yes	no	**no**	**%**	
CENTRAL REGION	no	24	16	40	36.36	
NORTH-WEST REGION	no	22	38	60	54.55	
WEST REGION	no	5	5	10	9.09	
Total	no	51	59	110	100	
	%	46.36	53.64	100	*	
Indicators	χ2 Test	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0702					
Degrees of freedom	2					
CHIINV (theoretical Chi)	≥	3.22	4.61	5.99	9.21	13.82
CHIINV (calculated Chi)	5.31		*			
Pearson coefficient	0.215					

Source: Simina, F. A.-E., 2020, Questionnaire agritourism pensions from the Apuseni Mountains.

Table 4. Assessment of the connection between internet promotion - web page and the classification category of agritourism pension

Classification category	**UM**	On the internet - web page		**Total**		
		Yes	no	**no**	**%**	
2 daisies	no	11	33	44	40.00	
3 daisies	no	36	25	61	55.45	
4 daisies	no	4	1	5	4.55	
Total	**no**	51	59	110	100	
	%	46.36	53.64	100	*	
Indicators	**χ2 Test**	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0008					
Degrees of freedom	2					
CHIINV (theoretical Chi)	≥	3.22	4.61	5.99	9.21	13.82
CHIINV (calculated Chi)	14.28					***
Pearson coefficient	0.339					

Source: Simina, F. A.-E., 2020, Questionnaire agritourism pensions from the Apuseni Mountain.

The evaluation of the link between the promotion on the internet - the website and the classification category of the pension shows that there is a very significant link, which means that there are major differences between respondents' answers by classification category, so that 4 pensions out of 5 classified with 4 daisies are promoted through the web page, 36 units of 3 daisies and 11 pensions of 2 daisies have web page (Table 4). The statistical analysis on highlighting the significance between the development region and the participation in tourism fairs of representatives of agritourism in the Apuseni Mountains area shows the fact that there is a strong link, which means that there are significant differences between the answers given by the development region. The majority of those who participated in tourism fairs are from the Central development region, 11 in number, and the fewest are from the West region, only a number of 3 owners of agritourism pensions (Table 5).

Table 5. Assessment of the connection between promotion by participating in regional and national tourism fairs and development region

Development region	UM	By participating in tourism fairs organized at regional. national level		**Total**		
		yes	no	nr	%	
CENTRAL REGION	no	11	29	40	36.36	
NORTH-WEST REGION	no	7	53	60	54.55	
WEST REGION	no	3	7	10	9.09	
Total	no	21	89	110	100	
	%	19.09	80.91	100	*	
Indicators	χ2 Test	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0934					
Degrees of freedom	2					
CHIINV (theoretical Chi)	≥	3.22	4.61	5.99	9.21	13.82
CHIINV (calculated Chi)	4.74		*			
Pearson coefficient	0.203					

Source: Simina, F. A.-E., 2020, Questionnaire agritourism pensions from the Apuseni Mountains.

Table 6. Assessment of the connection between promotion through travel agencies and development region

Development region	**UM**	Through travel agencies		**Total**		
		Yes	no	**no**	**%**	
CENTRAL REGION	no	14	26	40	36.36	
NORTH-WEST REGION	no	34	26	60	54.55	
WEST REGION	no	4	6	10	9.09	
Total	**no**	52	58	110	100	
	%	47.27	52.73	100	*	
Indicators	**χ2 Test**	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0929					
Degrees of freedom	2					
CHIINV (theoretical Chi)	≥	3.22	4.61	5.99	9.21	13.82
CHIINV (calculated Chi)	4.75		*			
Pearson coefficient	0.204					

Source: Simina F. Andora – Evelina, 2020, Questionnaire agritourism pensions from the Apuseni Mountains

The statistical analysis on the assessment of the link between promotion through travel agencies depending on the development region where the agritourism pensions in the Apuseni Mountains are located shows that we have a major correlation, which means that there are significant differences between responses by development region, most of the owners who promote their agritourism pension are from the North-West region, 34 in number, followed by 14 respondents from the Central region and 4 respondents from the West region (Table 6). The evaluation between the correlation between the respondents'age and the way of promoting agritourism pensions through travel agencies shows that we have a distinctly significant link, which means that there are major differences between respondents by age of respondents.Most respondents who concluded contracts with agencies of tourism in order to promote agritourism services are aged up to

40 years, numbering 16. Only 9 respondents aged between 41 and 50 answered that they promoted their agritourism pension through travel agencies. Over 47.27% of the respondents out of the 110 respondents specified that travel agencies in the country or abroad promote agritourism in the Apuseni Mountains area (Table 7).

Table 7. Assessment of the connection between promotion through travel agencies and the age of the agritourism pension owner

Age	UM	Through travel agencies		Total		
		yes	No	**no**	**%**	
<40	**no**	16	14	30	27.27	
41-50	**no**	9	27	36	32.73	
51-60	**no**	12	9	21	19.09	
>60	**no**	15	8	23	20.91	
Total	**no**	52	58	110	100	
	%	47.27	52.73	100	*	
Indicators	**χ2 Test**	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0098					
Degrees of freedom	3					
CHIINV (theoretical Chi)	≥	4.64	6.25	7.81	11.34	16.27
CHIINV (calculated Chi)	11.40				**	
Pearson coefficient	0.306					

Source: Simina, F. A.-E., 2020, Questionnaire agritourism pensions from the Apuseni Mountains

Table 8. Assessment of the connection between promotion through brochures, leaflets, business cards and the classification category of the agritourism pension

Classification category	UM	Through brochures, leaflets, business cards		Total		
		yes	No	**no**	**%**	
2 daisies	no	12	32	44	40.00	
3 daisies	no	33	28	61	55.45	
4 daisies	no	1	4	5	4.55	
Total	**no**	46	64	110	100	
	%	41.82	58.18	100	*	
Indicators	**χ2 Test**	Significance threshold				
	≤	0.2	0.1	0.05	0.01	0.001
CHITEST (Sig value)	0.0137					
Degrees of freedom	2					
CHIINV (theoretical Chi)	≥	3.22	4.61	5.99	9.21	13.82
CHIINV (calculated Chi)	8.59				*	
Pearson coefficient	0.269					

Source: Simina, F. A.– E., 2020, Questionnaire agritourism pensions from the Apuseni Mountains.

The statistical analysis on the link between promotion through brochures, leaflets, business cards according to the classification category of the agritourism pension shows that we have a significant link between these criteria, which means that there are significant differences between the answers given by respondents taking into account the classification category of agritourism pensions. Most of the answers regarding the promotion of agritourism services through brochures, leaflets, business cards were given by 33 owners of agritourism pensions classified with 3 daisies and the least only by one respondent, owner of an agritourism pension classified with 4 daisies (Table 8).

The effort made by the managers of agritourism pensions together with the local community. authorities. entrepreneurs. national tourism associations for promotion lead to the development of tourism activities in rural areas [11] a place where several types of tourism can be successfully developed. including adventure tourism [9] cultural tourism. leisure and recreation tourism and more recently “slow tourism” [8]. The full use of natural. economic and human resources to an area with a rich tourism potential can be achieved by involving local communities in the tourism sector by supporting the initiative groups for the development and promotion of local tourist offer. in order to protect the environment and cultural assets [1].

CONCLUSIONS

The promotion policy is an important element in the tourist marketing mix. It is rightly said among people that "advertising is the soul of trade." a statement that must be considered by managers of agritourism pensions. From the answers given by the 110 agritourism pension managers from the Apuseni Mountains area from the 6 counties studied (Alba, Arad, Bihor, Cluj, Hunedoara, Sălaj) we identified the most used promotion techniques. informing potential tourists about the services offered by the accommodation units such as agritourism pensions. It can be seen that the use of the Internet in promoting agritourism has gained ground in front of the classic means that is advertising on paper through brochures. leaflets. business cards. catalogues. We can conclude that 51 respondents promote their agritourism activity using a website. over 80 of agritourism pensions owners use the specialized sites for national and international promotion and reservation on the Internet or have Facebook. The clients are among the best promoters of the services of the agritourism pension. this fact being confirmed by 75 owners of agritourism pensions from the Apuseni Mountains area. The travel agencies also brilliantly promote the agritourism activity. which was also stated by 52 respondents. The promotion strategy used by agritourism pension managers must take into account the clear information of potential tourists about the available tourist offer. In order to attract new tourists in perspective. it is recommended that the managers of agritourism pensions in the Apuseni Mountains area should be more and more actively involved in the projects of the communities they belong to and together with them they should make an interactive map on the internet with the tourist units from this area.

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ANALYSIS OF AGRITOURISM AND TOURISM POTENTIAL OF RURAL AREAS IN THE SYSTEM OF THEIR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF UKRAINE

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Abstract

In the article we proved that rural tourism in a market economy is becoming increasingly important, because it helps to solve the problems of rural development, namely: the outflow of young people to cities, declining employment, low incomes of the rural population, and more. The purpose of the article is to study rural agritourism and substantiate the tourist potential of rural areas of Ukraine on the basis of sustainable development. In the process of studying the dynamics of rural green tourism in Ukraine, it was found that the number of farmsteads in Ukraine is increasing and the development of agritourism is intensifying. In the article we found that the saturation of rural tourist farmsteads is unevenly distributed throughout Ukraine, due to natural and climatic conditions, the presence of historical and cultural sites, and the preservation of ethnic traditions. In the article we proved that the development of rural green tourism not only helps to preserve and develop recreational areas in rural areas but also helps to solve socio-economic problems of the village, which reduces rural unemployment by attracting youth and the local population, reproduction of labour potential, slowing down migration processes in villages, increasing the level of infrastructure in the region, replenishing local rural budgets.

Key words**:** *agritourism, rural areas, rural green tourism potential, sustainable development*

INTRODUCTION

Sustainable development of rural areas is extremely important in the process of ensuring the growth of socio-economic indicators of regional development. At the same time, the UN Sustainable Development Program directly provides for the definition of such goals, the achievement of which will overcome the problems of ecology, poverty, and education, which is extremely relevant for rural areas. At the same time, one of the important areas of management and support of measures to achieve these goals may be the accelerated development of the tourism industry in rural areas. In particular, in Ukraine, rural areas have a very rich natural resource potential for recreation, which is the basis for the development of agritourism. However, its effective development is impossible without the proper development of infrastructure and the functioning of an effective organizational and management mechanism for green tourism.

In addition, recently in the world new trends were noticed regarding the assurance of high environmental friendliness in all areas of economic activity, which has received appropriate support from the tourism industry. Currently, thanks to the development of agritourism, many countries have reduced unemployment among the rural population by involving them in activities in a new area. Also in most European countries, the priority of rural development is the reorientation of the rural population to activities in the field of services, one of which is green tourism. In addition, global trends of intensification of agritourism development are also explained by the fact that this is an area of rapid capital turnover with relatively small investments. On the other hand, agritourism is an effective means of ensuring the development of the existing infrastructure of rural areas, as well as a contributing factor to the diversification of the region`s economy and industries that serve the tourism sector. Therefore, in the context of the financial and economic crisis and international restrictions on population movement caused by the COVID-19 pandemic, the importance of domestic tourism for Ukraine, as well as any country, is growing significantly.

Studies of the problems of ensuring the socio-economic development of rural areas are quite widely disclosed in the works of modern scientists and practitioners. It is possible to identify two typical approaches of different researchers to the importance of green tourism. In particular, scientists such as O. Agres [1], I. Balaniuk [3], Y. Chaliuk [7], V. Byrkovych [6], M. Dziamulych [9-14], M. Latynin [17], I. Marcuta [19], L. Melnychenko [20], T. Shmatkovska [34-36], O. Stashchuk [40-42], N. Vavdiiuk [45-46]. Ya. Yanyshyn [49], I. Zhurakovska [51] and others define green tourism as a traditional element of the service sector and emphasize the need to ensure the infrastructural aspects of the development of this area. Such views are based on the principles of agritourism development as a separate element of the general sphere of tourism business and provide for the use of appropriate tools to regulate demand, involving significant investment in services.

Another approach, which is revealed in the works of such researchers as O. Apostolyuk [2], O. Binert [4], A. Boiar [5], N. Dyshliuk [8], A. Hrebennikova [15], V. Lypchuk [18], L. Neschadyi [21], A. Popescu [22-33], R. Sodoma [37-39], I. Yakoviyk [48], O. Yatsukh [50] and others, involves the consideration of agritourism in a broader sense – taking into account the need to achieve sustainable development of rural areas. In our opinion, the relevance of these approaches is higher, as it involves ensuring the effective functioning of not only a single area of economic activity, but also implies the comprehensive development of services, which includes green tourism, and also requires the growth of socio-economic development of rural areas.

MATERIALS AND METHODS

The purpose of the article is to study rural agritourism and substantiate the tourist potential of rural areas of Ukraine on the basis of sustainable development.

In order to determine which patterns are embedded in the distribution of data and at what value are grouped most indicators with deviations, the study used the grouping method, which is the division of the statistical population into groups that are homogeneous on a certain basis. The method of statistical groupings allows us to trace the relationship between the characteristics that underlie the grouping, and the selected indicators. The method of statistical groupings makes it possible to develop primary statistical material so that all the essential features and peculiarities of the studied social phenomena are clearly expressed.

When grouping, the number of groups depends on the degree of variation of the grouping feature and the size of the population. For a discrete feature, the range of variation of which is limited, the groups are usually as many as the feature. In the case of general variation of the discrete feature, as well as continuous, the range of variation is divided into n intervals.

That is if the grouping feature has a planned nature of variation and equal intervals are used, then the number of intervals (groups) can be tentatively determined by the Sturgis formula:

$$n = 1 + 3.322\, lgN$$

where:

n – number of intervals (groups);

N – aggregate scope.

Next, you need to determine the width of the interval. The grouping interval is the difference between the maximum and minimum value of the feature in each group. The magnitude of the intervals is divided into equal and unequal. If the variation of the grouping feature is insignificant, and the distribution of population units is relatively uniform, then equal intervals are used.

The value of the interval when grouping using equal intervals is determined by the formula:

$$h = \frac{X_{max} - X_{min}}{n},$$

where:
h – the magnitude (width) of the interval,
X_{max} – the maximum value of the grouping feature,
X_{min} – the minimum value of the grouping feature,
n – number of groups.

If the grouping feature changes in size use unequal intervals in which the difference between the upper and lower limits is not the same. Determining the boundaries of the intervals, the width h should be rounded, and the boundaries themselves are denoted with such precision that the division of the elements of the population into groups was unambiguous.

RESULTS AND DISCUSSIONS

Rural tourism in a market economy is becoming increasingly important, because it helps to solve the problems of rural development, namely: the outflow of young people to cities, declining employment, low incomes of the rural population, and more.
Rural tourism in general and agritourism, in particular, solve the problems of business diversification in the regions engaged in agricultural production and increase the level of employment of labour potential through the creation of additional jobs. At the same time, rural tourism performs a huge cognitive function and contributes to the education of citizens to care for nature, understanding the nature and problems of labour in agriculture. In addition, rural tourism is a kind of relatively cheap, but quite pleasant and at the same time active recreation, recreation, and health [44].
In order to assess the economic potential of agritourism entities, it is necessary to study the dynamics of rural green tourism development by the main characteristics, namely: the number of farmsteads, the number of vacationers, the average capacity (Fig. 1, 2, 3).

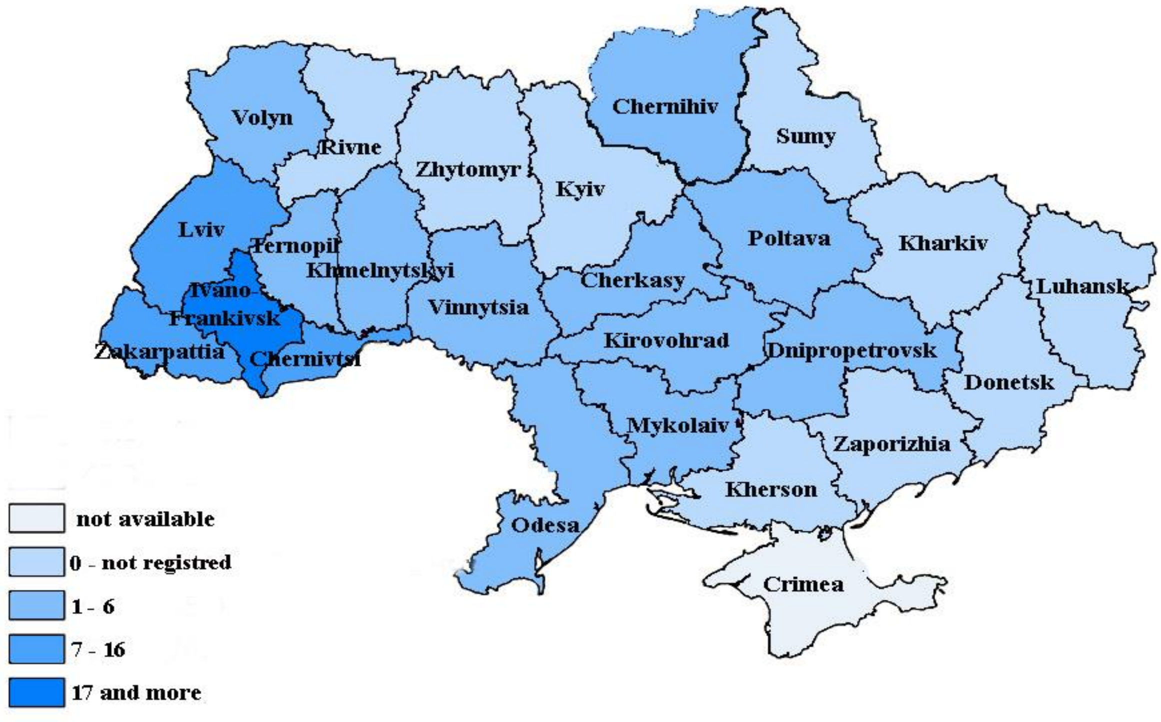

Fig. 1. Cartogram based on the results of grouping the regions of Ukraine by the number of tourist farmsteads in rural settlements in 2017, units (taking into account natural persons-entrepreneurs operating in the field of agritourism)*
*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories".
Source: own development.

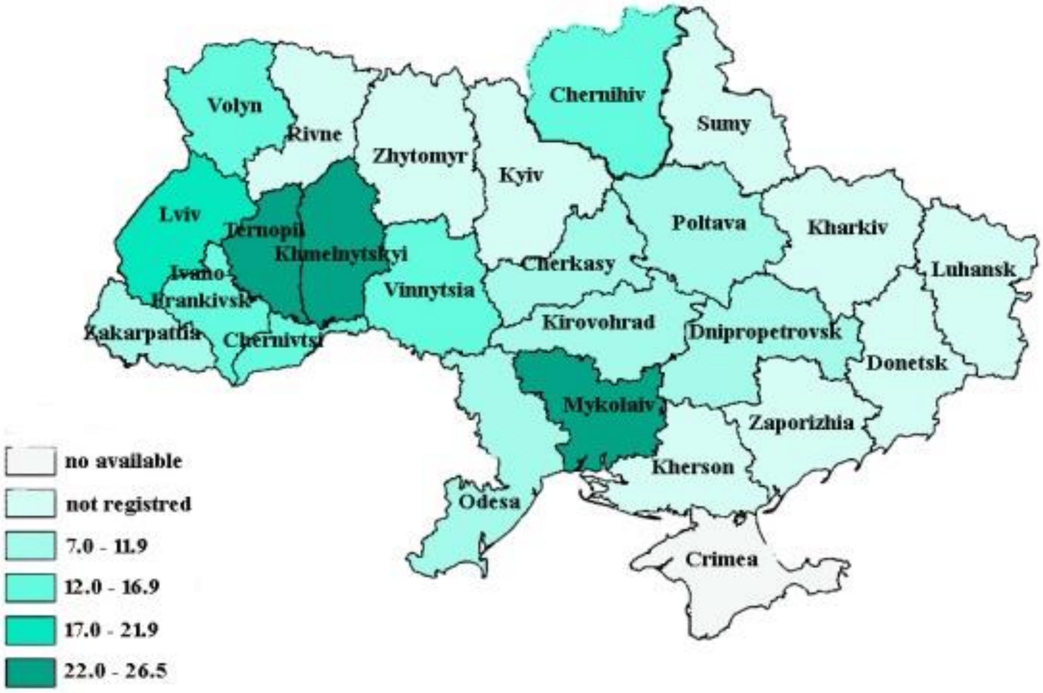

Fig.2. Cartogram based on the results of grouping the regions of Ukraine by the average capacity of tourist farmsteads in rural settlements in 2017, units, (taking into account natural persons-entrepreneurs operating in the field of agritourism)*

*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories”.

Source: own development.

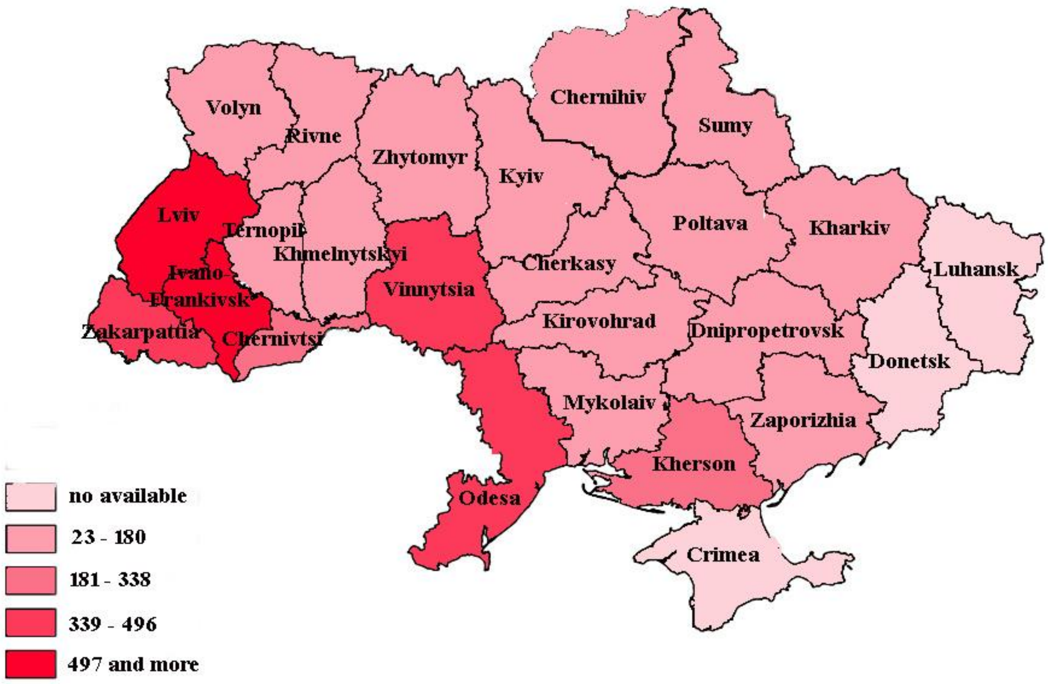

Fig. 3. Cartogram based on the results of grouping the regions of Ukraine by the number of tourist farmsteads in rural settlements in 2020, units (taking into account natural persons-entrepreneurs operating in the field of agritourism)*

*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories”.

Source: own development.

In the process of studying the dynamics of rural green tourism in Ukraine, it was found that the number of farmsteads in Ukraine is increasing and the development of agritourism is intensifying, as evidenced by statistics on the number of tourists (Figs. 1 and 2). But there is a fact that the official and actual data of business in the field of agritourism differ: first, this is due to the fact that a significant number of domestic tourists do not always use the services of tour operators or travel agents, in contrast to outbound tourists; secondly, a significant part of rural farmsteads are not officially registered, i.e. they are cut down «in the shadows», which in turn is associated with minimal support from both local authorities and the state as a whole.

According to the results of the study, the largest number of rural farmsteads is concentrated in the Western region of Ukraine, in particular, 81.2% of farmsteads are located in the Ivano-Frankivsk region, 4.2% of farmsteads are located in the Chernivtsi region, and 3.7% of farmsteads are registered in the Lviv region of Ukraine (Figs. 1 and 3). Thus, it can be stated that the saturation of rural tourist farmsteads is unevenly distributed throughout Ukraine, due to natural and climatic conditions, the presence of historical and cultural sites, and the preservation of ethnic traditions [16].

To study the specifics of additional services offered by owners of tourist farmsteads in rural areas of Ukraine, a questionnaire was conducted to determine a detailed list of additional service offers for tourists offered in modern realities in rural settlements of the Lviv region (Table 1).

Based on the analysis of Table 1 it is determined that the most popular for tourists additional offers of goods and services were: barbecue and firewood (96.8%); gazebo and gazebo (95.5%); hiking in the woods (92.9%); harvesting berries, mushrooms, medicinal herbs (90.3%); toboggan and ski rental (78.7%); cooking home meals to order (71.0%). Slightly fewer farmsteads offered: transport services (68.4%); bicycle rental (61.3%); the possibility of swimming in the river and lake (63.2%); care and feeding of domestic animals (58.1%); fishing (29.7%); taking a bath (27.2%); horseback riding (20.6%). Thus, it can be argued that active recreation is not a priority of green tourism.

Table 1. List of additional offers, goods, and services in rural tourism farmsteads of the Lviv region in 2020, UAH

Offers, goods and services	Availability		Average cost, UAH
	Number of farmsteads	%	
Cooking homemade dishes to order	110	71.0	150-300
Horseback riding for 1 hour	32	20.6	100-200
Sledding and carriage rides, for 1 hour	29	18.7	350-550
Bicycle rental, for 1 hour	95	61.3	25-40
Swimming in the river and lake	98	63.2	-
Boating, for 1 hour	21	13.5	100-150
Toboggan and ski rental, per day	122	78.7	50-160
Fishing, for a day	46	29.7	80-170
Hiking in the woods	144	92.9	-
Availability near medical sources	37	23.9	-
Harvesting berries, mushrooms, herbs	140	90.3	-
Transport services, by arrangement	106	68.4	100
Barbecue and firewood (one bundle)	150	96.8	40-80
Gazebo and gazebo	148	95.5	-
Care and feeding of pets	90	58.1	-
Bath (3-5 people), for 1 hour	43	27.7	150-320
Apitherapy, sleep on hives, for 1 session	5	3.2	100-300
Folk crafts (master class)	12	7.7	100-200
Dairy products	75	48.4	-
Meat products	86	55.5	-
Baked goods	48	31.0	-
Vegetables and fruits	134	86.5	-
Wines, liqueurs and tinctures	27	17.4	-
Eggs	96	61.9	-
Fish	10	6.5	-
Beekeeping products	13	8.4	-
Mushrooms, berries, herbs	140	90.3	-

Source: Own development based on [43].

In addition, according to the results of the questionnaire, it was found that of household products in rural farmsteads, tourists asked the most: vegetables and fruits (86.5%); eggs (61.9%); meat products (55.5%); dairy products (48.4%); bakery products (31.0%). The smallest of the list of domestic products offered were domestic low-alcohol beverages (17.4%), beekeeping products (8.4%), and live fish (6.5%). In general, this characteristic indicates a slight change in preferences compared to the traditional consumer food basket of the average tourist.

It is important to note that the cost of services and products in rural farmsteads in Ukraine is characterized by a certain price differentiation. In particular, home cooking of

Ukrainian cuisine cost from 150 to 300 UAH, fishing – from 80 to 180 UAH, sleigh rides, and carriages costs from 350 to 550 UAH per hour. This is due to both the difference in the quality of relevant services and the infrastructural features of a particular rural farmstead.

Significant adjustments in the functioning of the tourism industry in general, including rural agritourism, were made by the COVID-19 pandemic, which virtually stopped activities in this area for more than half of 2020. In particular, according to the UNWTO, international tourism has missed more than 1 billion international tourists. At the same time, the loss of total export earnings from international tourism on a global scale is estimated at $ 1.3 trillion. In total, there are between 100 and 120 million direct tourist jobs in the world.

It should be noted that in early 2021, the UN World Tourism Organization has developed a model of intensification of tourism around the world, considering the positive and negative scenarios (Fig. 4).

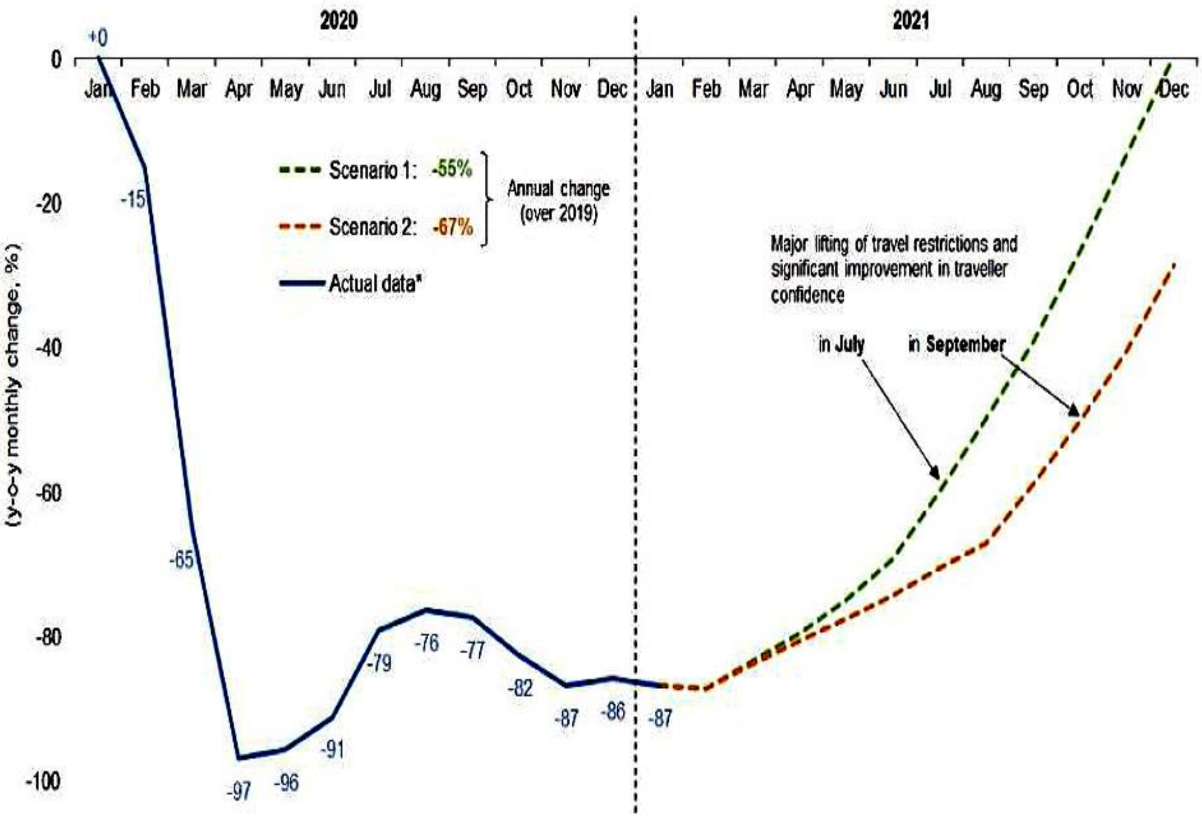

Fig. 4. International Tourist arrivals in 2020 and Scenarios for 2021 (y-o-y, monthly change)
*Actual data is preliminary and based on estimates for destinations which have not yet reported monthly results (Data as of March 2021).
Source: [47].

Given that the annual results will be summarized only in 2022, it can already be argued that the positive scenario did not work, and to achieve the indicators of January 2019, the tourism sector will not succeed in the near future. The next waves of the pandemic lead to further restrictions on the movement of tourists and pose a systemic threat to the tourism business in general and rural agritourism in particular.

However, rural agritourism, as limited to local areas, in most cases does not require its participants to travel cross-border or may even take place within one region at relatively short distances for tourists relative to their homes. In this aspect, rural agritourism has good prospects for development in a pandemic, because even weekend tours often take place in the form of recreation in rural areas.

The main properties of tourist resources and the level of their impact on the functioning of rural agritourism in Ukraine were studied by us on the basis of a survey of representatives of the tourist market and owners of rural farmsteads, which was conducted by questionnaire (Fig. 5).

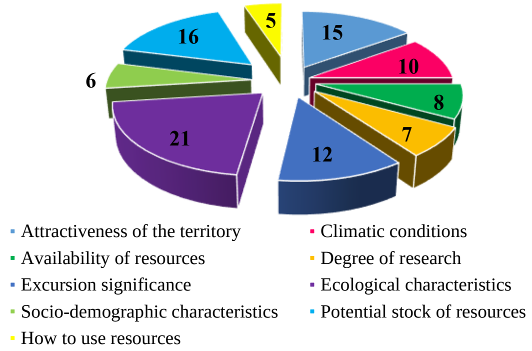

Fig. 5. The degree of influence of tourism resources on the organization of rural green tourism in Ukraine in 2019, %
Source: [43].

As we can see from the survey, the most significant impact on the organization of rural green tourism in Ukraine has the ecological characteristics of the territory – 21%. At the same time, 16% of respondents give priority to the potential stock of resources that can be used in the tourism sector. For 15% of experts, the most important factor is the attractiveness of the territory, 12% – the availability of excursion potential, 10% – climatic conditions in the region. Other characteristics received less than 10% of the votes of experts and can be considered insignificant in their overall importance for the development of rural agritourism in today`s realities in Ukraine.

Thus, we can conclude that the environmental component remains the basis for the organization of rural green tourism. Improving the efficiency of agricultural farms working in this area should be largely based on the provision of environmentally friendly services to their customers.

The level of arrangement of rural farmsteads is also important for green tourists, which depends on the general state of infrastructure development in rural areas. Therefore, to assess it, consider the infrastructure of households in Ukraine (Fig. 6).

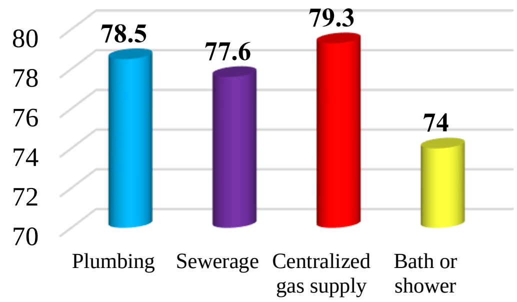

Fig. 6. Arrangement of rural tourism farmsteads and housing of rural households in Ukraine in 2019,%
Source: [43].

As you can see, according to the results of the analysis, 78.5% of households have water supply and sewerage, 79.3% – equipped with gas supply services, and 74% – have a bath or shower. At the same time, the absence of these conditions in households applies to rural areas, where instead of the general water supply is used individual water supply from artesian wells for individual farms, and sewerage is based on a system of local septic tanks that require specialized maintenance. Such factors complicate the functioning of farmsteads. At the same time, the lack of gas supply can be a competitive advantage, as heating with firewood is an important component of agritourism, which is characterized by its traditionalist perception of tourists and in this aspect plays the role of a popular service.

We will also consider the specifics of assessing directly by rural households the level of their access to socio-economic benefits (Fig. 7).

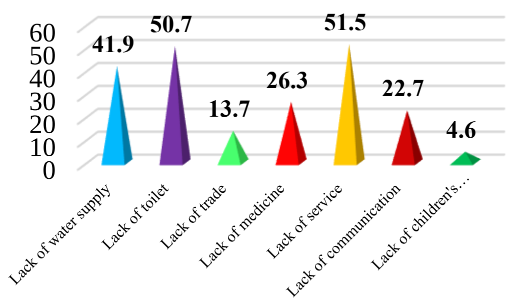

Fig. 7. Assessment of the availability of socio-economic benefits by rural households in Ukraine in 2019, %
Source: [43].

Based on Fig. 7 it can be concluded that the majority of the rural population of Ukraine notes problems with the proper provision of certain socio-economic benefits. In this aspect, it should be noted that 41.9% of rural households are not provided with a water supply and 50.7% – with centralized sewerage. The lack of social and public service facilities has also been identified as a problem. Undoubtedly, this creates many inconveniences for rural residents. In turn, these problems create obstacles for the development of agritourism, as they require from the owners of farmsteads additional investments to ensure the appropriate level of comfort for their visitors. At the same time, certain problems are unsolvable by the owners of green tourism facilities (for example, easily accessible medical care or logistical problems of communication) and require the involvement of state institutions to address these issues.

If we talk about the dynamics of income from agritourism in the leading countries of the world, the indicators indicate a trend of increasing incomes in this area. In particular, according to the analysis of the European Bank, in countries with developed agritourism, the average value of income received by farmsteads is correlated with the annual income of the farm from one cow [20].

Consider the dynamics of income from green tourism in some European countries (Fig. 8).

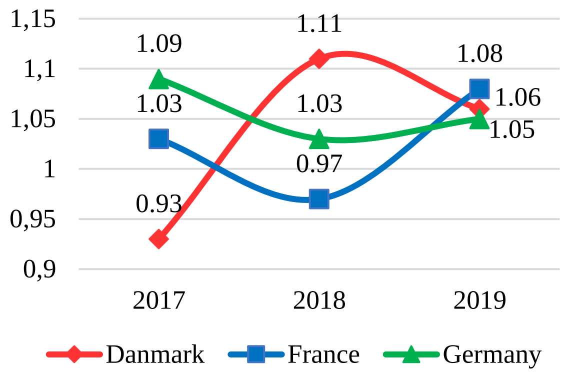

Fig. 8. Income growth rates in the field of rural agritourism in European countries for 2017-2019
Source: [43].

The study found that by 2020, the average growth rate of income from rural agritourism in some European countries was quite stable and had a general upward trend. At the same time, the data of 2020 are objectively distorted due to the total decline of the entire tourism sector. However, as already mentioned, the potential for the resumption of rural agritourism is greater than the rapid resumption of global interstate tourism flows.

At the same time, for comparison, we analyzed the economic indicators of the functioning of rural agritourism in Ukraine for 2015-2019 (Table 2).

Table 2. Economic indicators of rural green tourism entities in Ukraine for 2015-2019

Investigated indicators	2015	2016	2017	2018	2019	Relative deviation, 2019 to 2015, (%)
Income from agritourism services provided, UAH thousand	10,189.7	16,966.7	11,219.9	18,369.0	41,879.5	411.0
Expenses, thousand UAH	5,046.6	10,283.0	6,756.8	10,186.9	25,052.8	496.4
Financial result, thousand UAH	5,143.1	6,683.7	4,463.1	8,182.1	16,826.7	327.2
Number of nights, units	112,520	130,695	93,341	106,233	200,709	178.4
The average length of stay, man-days	2.2	2.6	2.4	2.2	2.5	113.6
Coefficient of the utilization of the capacity of estates	0.26	0.19	0.15	0.19	0.16	61.5

Source: Own development based on [43].

According to the analysis of the Table 2 established that for the five years preceding the crisis of 2020, the dynamics of income from rural agritourism services in Ukraine recorded their overall growth by 411%. At the same time, the costs of farms operating in the field of rural agritourism increased, which increased by a total of 496.4%. This is due to both a significant increase in the cost of utilities, which occurred during this period and an increase in costs to improve the material base of rural farmsteads. Regarding the specific characteristics of the industry itself, it is worth noting the positive trends in the increase in the number of overnight stays by visitors to rural farmsteads by 78.4%, as well as an increase in the average length of stay of guests – by 13.6%. Thus, we can say about the positive trends in the development of rural agritourism, as the growth of these indicators indicates an improvement in the quality of services provided by farms operating in the study area.

CONCLUSIONS

Thus, we come to the conclusion that in Ukraine agritourism, as a separate and specific area of the tourism industry has significant prospects for the development and increase in the number of tourists involved in this type of recreation. The positive dynamics of the industry`s performance, which was observed before the global economic downturn due to COVID-19, indicates an increase in demand for this type of service. In addition, financial indicators show an increase in the number of funds raised by the owners of farmsteads for the development of their own businesses. Given the current conditions, it can be argued that further intensification of tourist flows aimed at the development of green tourism will also contribute to the inflow of investment resources from financial institutions interested in investing in both current and long-term. Currently, an additional factor that stimulates the development of agritourism is the cross-border anti-epidemiological sanitary restrictions that restrain external tourist flows, some of which are aimed at rural green tourism. This allows farmsteads and farms involved in this field to obtain and accumulate the resources needed to maintain and develop their own business in rural areas and expand it in the future.

In the current conditions of the global pandemic and the permanent economic crisis, rural agritourism in Ukraine is becoming an effective alternative to foreign resorts, as many Ukrainians will choose ecological rural estates for active recreation. Thus, the development of rural green tourism not only helps to preserve and develop recreational areas in rural areas but also helps to solve socio-economic problems of the village, which reduces rural unemployment by attracting youth and the local population, reproduction of labour potential, slowing down migration processes in villages, increasing the level of infrastructure in the region, replenishing local rural budgets, etc.

The results of the study indicate that the prerequisite for sustainable development of rural areas in Ukraine is the stimulation and support of entrepreneurship in the field of rural green tourism at both the state and regional levels. That is why in order to intensify the development of rural agritourism and bring farmsteads “out of the shadows” there is a need to improve the existing regulatory framework, find new sources of financial and investment direction, as well as to develop an appropriate set of organizational and economic measures.

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ANALYSIS OF THE INFLUENCE OF FINANCING ON THE SUSTAINABLE LOCAL DEVELOPMENT OF THE RURAL TERRITORIES, PART OF THE LAGS, THROUGH THE LEADER METHOD

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Abstract

This article aims to highlight the importance of funding through the M19 LEADER measure on eligible territories from a qualitative perspective through the use of quantitative and qualitative research methods: questionnaire and interview, designed to confirm or deny the importance of LEADER funding on rural development of the LAG territory at the level of the Romanian regions. The analysis was realised in period between 31.10.2020 – 31.05.2021. The data collected come in support of a deeper understanding of the LEADER approach and the way in which it acts in the territory, implicitly of the identification and remedy of deficiencies. Following the analysis, based on a series of questions sent to the representatives of the local action groups, questions related to territorial, financial and social issues were found that: over 70% of LAGs face an aging population and lack of jobs work, over 70% of the eligible territories being inhabited by the population aged between 40 and 50, territories where agriculture is the main income-generating resource (100% of respondents). All respondents consider that LEADER financing is very important but also insufficient for the needs of the territory (over 85% of respondents).

Key words: *LEADER, LAG, sustainable development, local development, financing*

INTRODUCTION

Scientific knowledge is realized through the scientific analysis of the surrounding world, the analysis that is realized from different points of view [13]. The process of scientific research uses all the methods and theories on them, procedures and rules, elements that constitute the research methodology.

The LEADER approach is an innovative approach whose principles operate and are implemented in the eligible territories through the Local Action Groups. These, through their specificity and uniqueness, attract the financing provided by measure 19 LEADER, whose purpose is meant to lead to the rural development of the perimeter of the structure with direct effects on the quality of life of the inhabitants. The impact that financing through LEADER has on the territory is periodically analyzed through various methods of data collection, quantitative and qualitative to highlight the degree of absorption, relevance of financing, the degree of rural development of the eligible territory and possible deficiencies to be remedied or improved in the future. This article follows the relevance of the financing through the M19 LEADER measure, in the light of the answers collected from the representatives of the local action groups and not starting from official financial data published by the Managing Authority in charge of controlling and monitoring their activity. The answers received in the completed questionnaire in conjunction with those received in the interview will validate or invalidate the contribution of the LEADER approach in the territory.

Quantitative and qualitative methods are not necessarily mutually exclusive. Both methods can be used in a unique, staged process to highlight a certain truth, while maintaining scientific rigor [4], [6]. The difference between a quantitative and a qualitative research begins with the formulation of the research problem [5].

Qualitative research is based on the assumption that people attribute certain meanings to the world in which they live, and these meanings are to some extent different from one person to another [8].

The main objectives of this type of approach are attitudes, models of daily behaviors, individual experiences in relation to the social and interpersonal environment, aspects related to cultural values and norms, interpersonal, verbal and nonverbal communication [1], [2], [12].

MATERIALS AND METHODS

This article aims to highlight the pros and cons of financing through M19 LEADER from a qualitative but also quantitative perspective. The following were used as research methods: survey, using as a technique the survey and the interview (as a qualitative research method). A set of 22 questions was developed, which contained both closed questions (with predefined answer options) and open-ended questions (without predefined answer options, the answer being to the respondent's assessment and his perception of the questionable event), with reference to territorial, financial and social aspects, which were transmitted to the representatives of all the Local Action Groups, respectively 239. Of the 8 regions, the Bucharest-Ilfov region did not answer any questions, if we refer to the number of existing LAGs, about 2% of the total. Responses were collected and centralized through online data collection tools. Both quantitative and qualitative data were collected, related to the perception of the responding human factors on the impact of funding through measure 19 LEADER on the territory of the LAG. The data collected from various sources were centralized by regions and the three components, analyzed and the possibility of a correlation between the financing obtained through measure 19 LEADER, certain specific indicators and the perception of the impact of financing in the LEADER eligible territory was studied.

Investigation, using as a survey technique - is a method of quantitative research by asking people who have certain knowledge about a particular or phenomenon under analysis, people who have certain characteristics (education, age, gender, etc.) or simply people to find out the opinions, attitudes related to a certain topic, etc. The opinion poll collects information through a questionnaire that contains closed information with answer options. In order to obtain relevant information, certain rules must be observed in selecting the group of respondents, the data collected being very quantitative.

The opinion poll has 5 essential characteristics [7].

1. involves a large number of cases;
2. their selection must be made according to rigorous sampling criteria;
3. data must be collected in normal situations, as close as possible to daily life;
4. the collection is made in accordance with standardized procedures;
5. data are in a quantitatively measurable form, the simplest being the presence or absence of an attribute.

Investigation - interview - is a technique used to collect qualitative data, respectively the opinions of people who are or may be interested in the intervention, in the given context, their perception of the events studied and their effects in the territory, time, etc. The interview is useful to highlight cause-effect links, phenomena and processes associated with the financing process, qualitative aspects of the financing effect, factors influencing the absorption of funding in the territory, issues regarding the motivations of the interviewees or lack of motivation opinions, ideas on possible measures. correction or regarding the lessons learned, etc. The qualitative interview allows free exploration of the universe under investigation, without constraints on the form, number or order of questions. Usually, the interview is a way for the researcher to explore the psychic universe of other people, but in qualitative phenomenological research

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the researcher himself is interviewed by an expert, not involved in that research. This is what is called, with an expression taken from the philosopher Edmund Husserl, "bracketing interview"[9].

RESULTS AND DISCUSSIONS

The responses received from the representatives of the Local Action Groups were centralized in each region in order of importance and grouped into three components: territorial, financial and social in order to make it easier to understand the relevant issues. In the answers to the questionnaire questions the first two most important answers were highlighted, and in the interview questions the answers are presented in the order of importance expressed by the respondent, taking into account how many times this answer is found in the opinions of the interviewees. It is followed in each component if there is a correlation between the quantitative answers collected and the qualitative ones.

It should be mentioned that the Bucharest-Ilfov region, on the territory of which 4 Local Action Groups operate, did not answer any questions.

Territorial component

Table 1. Centralization of the answers to the questionnaire within the territorial component

In which region is the LAG you represent located?		North East	South East	South	South West	West	North West	Centre	Bucharest Ilfov
What are the main issues of the LAG community you represent?	Aging population	57.1	70	80	85.7	100	20	76.9	0
	Inefficiently capitalized natural resources	4.28	50	30	28.6	100	40	84.6	0
	High degree of poverty	71.4	70	40	42.9	0	20	7.7	0
	Insufficient or non-existent utilities	71.4	40	70	42.9	66.7	40	38.5	0
	Fragmented agricultural land	21.4	30	50	28.6	66.7	40	30.8	0
	The lack of jobs	64.3	80	90	85.7	66.7	80	53.8	0
What are the main resources located in the territory of the LAG you represent?	Agriculture	100	100	80	100	100	100	84.6	0
	Forestry	21.4	10	40	14.3	33.3	20	23.1	0
	Aquaculture	7.1	40	1	0	33.3	20	15.4	0
	Services, excluding tourism	28.6	10	60	28.6	66.7	40	30.8	0
	Tourism	28.6	40	20	14.3	66.7	80	46.2	0
	Traditional crafts	21.4	20	30	14.3	33.3	20	23.1	0
	Non-agricultural business, production	7.1	30	40	28.6	0	40	46.2	0
	Non-agricultural business, services	71.4	60	100	42.9	100	100	84.6	0
	Social	42.9	60	20	42.9	66.7	40	38.5	0
	Cooperation	7.1	20	10	14.3	33.3	20	23.1	0
What changes have you noticed in the LAG community as a result of the absorption of financial resources allocated through M19 Leader?	Collaboration between community members	42.9	20	50	42.9	66.7	60	53.8	0
	Increasing the number of young people eager to return to rural areas	50	60	60	28.6	0	60	38.5	0
	Increasing the quality of life	78.6	30	60	42.9	66.7	40	76.9	0
	The evolution towards modernity by changing the mentality of the inhabitants	57.1	70	60	57.1	66.7	60	69.2	0
	I didn't notice any change	0	0	0	14.3	0	0	0	0
What is the average age of people who have received funding through the LAG?	25-35 years	28.6	20	0	14.3	33.3	20	15.4	0
	36-45 years	50.1	80	90	71.4	66.67	80	69.2	0
	46-55 years	21.3	0	10	14.3	0	0	15.4	0

Source: Own calculation.

Table 2. Centralization of the answers in the interview for the question “What resources are insufficiently exploited in the territory of the LAG you represent?”, territorial component

Region							
North East	South East	South	South West	West	North West	Centre	Bucharest Ilfov
Agriculture: production and processing	Agriculture: primary products, animal husbandry	Agriculture: products, land; Fruit resources	Tourism	Tourism	Tourism	Tourism (eco-tourism)	-
Jobs	Tourism	Human resource	Agriculture	Traditions and culture	Traditional crafts	Natural resources (including mineral water)	-
Traditions, crafts, local products	Human resource	Tourism	Human resource	Tangible and intangible heritage: natural resources (geothermal water)	Agriculture (vegetable growing, animal husbandry), including processing	Agriculture, including processing	-
Fishery resources	Environment	Aquaculture	Crafts	Aquaculture	Forestry (forest products), including processing	Forestry	-
Tourism: tourist objectives, artistic formations	Local primary products (reeds, rushes)	Services	-	Human resource	Gastronomic resources	Local products (meat, milk, berries)	-
Tangible and intangible cultural heritage; Therapeutic groundwater	-	Social	-	-	-	Human resource	-
-	-	-		--	-	Entrepreneurship	-

Source: Own construction.

Table 3. Centralization of the answers in the interview for the question "What benefits have been brought to the community as a result of the implementation of the LEADER approach in the territory of the LAG?"

Region							
North East	South East	South	South West	West	North West	Centre	Bucharest Ilfov
Increasing living standards	Rural development	Increasing the quality of life	Increasing the quality of life	Cooperation between public and private actors, cooperation between communities between counties	Jobs created	Jobs created, tourism development	-
Collaboration between community members	Job creation	Job creation	New created jobs.	Creating business in the field of tourism	Increasing the degree of information, association, involvement in community life, rural economic development	Increasing the quality of life	-
Rural development	Increasing the quality of life	Rural development	Direct involvement of local actors in the decision-making process	Jobs created	Changing the mentality of the inhabitants and their involvement in community issues	Community cooperation	-
Access to funding, increased confidence in funding with European funds, distribution of funding to almost the entire territory of the LAG	Renewal of the agricultural machinery park	Establishment of medical centers	Modernized agricultural holdings, creation of new non-agricultural activities	The public's confidence in non-reimbursable programs has increased.	-	Supported / modernized agricultural holdings, farm efficiency	-
-	Increasing the level of information, counseling and cooperation	Modernization of agricultural holdings	Changing mentality, improved local public services;	-	-	The emergence of new categories of services (eg dental)	-
-	Better perception on accessing funds and funds distributed strictly for this territory	Raising awareness of accessing European funds	-	-	-	Purchase of equipment necessary for the collection and preparation of biomass from forests, pastures, hayfields	-

Source: Own construction.

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Financial component

Table 4. Centralization of questionnaire answers within the financial component

Questions	Answers	Regions							
In which region is the LAG you represent?		**North East**	**South East**	**South**	**South West**	**West**	**North West**	**Centre**	**Bucharest Ilfov**
How important do you consider funding, through M19 Leader, for the rural development of the LAG territory you represent?	Very important	92.9	90	100	85.7	100	80	76.9	0
	Important	7.1	10	0	14.3	0	20	15.4	0
	Moderately Important	0	0	0	0	0	0	7.7	0
	Slightly Important	0	0	0	0	0	0	0	0
To what extent is the funding obtained through M19 Leader sufficient for the needs of the territory of the LAG you represent?	More than enough	7.1	0	0	0	0	80	0	0
	Enough	21.4	0	0	0	0	20	7.7	0
	Insufficient	71.4	100	100	100	100	0	92.3	0
In the LAG that you represent, the allocated amounts went mainly to?	Agriculture	92.9	70	70	71.4	0	60	38.5	0
	Non-agricultural business, production	7.1	30	40	28.6	0	40	46.2	0
	Non-agricultural business, services	71.4	60	100	42.9	100	100	84.6	0
	Social	42.9	60	20	42.9	66.7	40	38.5	0
	Cooperation	7.1	20	10	14.3	33.3	20	23.1	0
What are the main result and monitoring indicators, assumed by SDL, as a result of the implementation of the actions financed by M19 Leader?	Supported farms	78.6	70	90	71.4	66.7	40	46.2	0
	Supported non - agricultural activities	57.1	5	50	57.1	66.7	60	46.2	0
	Jobs created	92.9	100	90	100	100	100	92.3	0
	Cooperative partnerships	28.6	30	20	28.6	100	40	38.5	0
	Social measures	71.4	60	80	42.9	66.7	60	30.8	0
To what extent can the assumed performance indicators indicate the progress made towards the rural development of the community?	To a very large extent	7.1	0	40	14.3	0	0	7.7	0
	To a large extent	71.4	30	40	42.9	66.7	100	38.5	0
	To a small extent	21.4	70	20	42.9	33.3	0	53.8	0
	To a very small extent	0	0	0	0	0	0	0	0
To what extent have the amounts allocated to the LAG you represent through M19 Leader been contracted? *	95-100%	64.3	40	50	57.1	66.7	20	75	0
	85-94.9%	28.6	50	40	42.9	0	80	25	0
	75-84.9%	0	10	0	0	33.3	0	0	0
	65-74.9%	0	0	10	0	0	0	0	0
	50-64.9%	7.1	0	0	0	0	0	0	0
	Under 50%	0	0	0	0	0	0	0	0
To what extent were the contracted amounts paid?	100%	0	10	10	0	0	0	7.7	0
	70-99%	71.4	30	20	57.1	33.3	20	30.8	0
	50-69%	21.5	60	70	42.9	33.3	80	61.5	0
	Under 50%	7.1	0	0	0	33.3	0	0	0
Would you like to see a change in the way the financial resources are distributed through Leader to the LAG in the next programming period?	No	42.9	30	20	28.6	0	0	23.1	0
	Yes	57.1	70	60	71.4	100	100	61.5	0
	I never thought	0	0	20	0	0	0	15.4	0

Source: Own calculation. *31.01.2021.

Within the territorial component, the centralized data reveal the following aspects: over 63% of the regions underline the fact that one of the main problems in the territory is the aging population from which automatically derives a high degree of poverty corroborated with lack of jobs. regions, as shown in Table 1.

At the same time, the acute problems facing the "Romanian village" tend to worsen, and among the main causes are the migration of rural people to large urban centers or other more developed countries, due to unsatisfactory living conditions [3]. The decline in the rural population is explained by the decline in the birth rate, the high mortality rate and the migration mainly from rural to urban and to other countries [11].

On the other hand, the answers given to the interview question confirm the problems in the territory, as shown in Table 2. All regions agree that agriculture is the main natural resource of the perimeter of the Local Action Group (87.5%), but also services and then tourism, but insufficiently exploited, which is in line with the high degree of poverty and lack of jobs.

Tourism is a dynamic branch of the Romanian economy with a high potential to create jobs, to employ young people and also women [10].

Over 87.5% of respondents notice an evolution in the mentality of the inhabitants of the private-public partnership, the increase of the quality of life following the attraction of the financing through the 19LEADER measure (50%) but also a better collaboration between the community members. To the interview question on the benefits of implementing the LEADER approach in the LAG territory (Table 3), the first answers, in order of importance, are rural development implicitly by increasing the quality of life and creating jobs, which may suggest the intention to attract young people in the territory of the LAG in order to counteract the negative effects of the aging population, in accordance with the age range of those who benefited from funding through the LAG (87.5% of respondents say that the average age of funding beneficiaries is between 35 and 45 years, more preferably 40), implicitly LEADER, as it appears from the existing question in Table 1 with reference to this aspect.

Question 1 - interview: If this organizational structure did not exist, the LAG, with specific funding, what other development opportunities would your community have? Specify the sources.

Answer 1: "On a scale from 1 to 10, somewhere at 2. We have 2 communes, which have through the LAG the first projects with European funding (and not because they had no projects submitted but because they were always below the national score and were always waiting)

A2: "The funds are insufficient. At the national level, the communities had little chance of funding due to the extremely restrictive selection criteria, the funds were unevenly distributed in the country and in the N - E region they were the fewest in the country. Through the LAG, the funds are distributed in a balanced way and reach every commune in the territory. "

A3: "LAGs are perfect tools for attracting money for small / medium projects that cannot be funded from other sources. Competition is much higher at the national level, and the "bottom-up" approach is non-existent at the level of Operational Programs outside the LEADER axis. ”

A4: "RNDP, however, the financing measures through LEADER are designed according to the bottom-up principle, starting from the specific needs in a given territory, which cannot be achieved through RNDP.

A5: "The chances would be disproportionate because most would not benefit from the actions of informing and animating the territory, the selection calls would go unnoticed. There is also the impression that EU funds are preferentially or fraudulently distributed. ”

A6: "Yes, with little chance: National Rural Development Program, Human Capital Operational Program, National Local Development Program, Administrative Capacity Operational Program, Agency for the Financing of Rural Investments, Government funds. ”

A7: ” In other partnerships, none. "

A8: ” Other answers: local budget, investors, Danube Strategy, Large Infrastructure Operational Program, FLAG”.

Question 2 - Interview: What proposals do you have regarding the organization and distribution of financial resources to the LAG through LEADER?

Answer 1: "Increase the percentage according to the LEADER measure and maintain the criterion of distribution per inhabitant and area (ex. 12%)."

A2: "LAG resources should be set according to national and local priorities. LEADER is not a small RNDP program but it should fill the gaps at the local level compared to the national program. Local needs and priorities vary from area to area. In the mountain area, for example, there are other needs than in the plain area. Also, the national contribution to the LEADER program may increase depending on the priorities identified in the SDLs: the development of community services and infrastructure (water-sewer, roads of local interest, telecommunications,

nurseries, etc.); stimulating the development of the association and covering local needs (product processing, storage, marketing structures, cooperatives). ”
A3: "Depending on the territory, the population, the degree of poverty and the complex of atypical measures specific to LEADER.
A4: "Decentralization, as a national concept, must be achieved. Implicitly increasing the importance of the LAG structure, as a share of financial allocation and as a multi-fund approach.”
A5: "Let's not take into account the number of inhabitants and the surface of the territory, we are a Gal with a cumulative population not scattered, so to distribute larger amounts, we promote and we have nothing to offer people because the money runs out quickly.”
A6: “To take into account the contracting and payment percentages obtained in the previous year.”
A7: “National flat-rate measures to be implemented only through Leader. ”
A8: ”Territory, population, performance, assumed criteria.”
A9: "Using the same fundraising algorithm."
A10: “Other answers: depending on the number of inhabitants, not on the area; 50% - inhabitants, 50% - surface”.

Social component

Table 5. Centralization of the answers to the questionnaire within the social component

Questions	Answer options	Regions							
In which region is the LAG you represent?		**North East**	**South East**	**South**	**South West**	**West**	**North West**	**Centre**	**Bucharest Ilfov**
What is the age category of the active people in the territory of the LAG you represent?	Over 50 years	14.3	10	0	14.3	66.7	0	7.7	0
	Between 40 and 50 years	57.1	70	50	85.7	33.3	40	76.9	0
	Between 30 and 40 years	28.6	20	40	0	0	60	15.4	0
	Between 20 and 30 years	0	0	10	0	0	0	0	0
What are the chances of achieving the young people from the LAG community, in the territorial area served by it?	Very High	7.1	0	30	0	0	0	7.7	0
	High	14.3	10	10	14.3	33.3	60	30.8	0
	Moderate	64.3	40	60	42.9	66.7	40	53.8	0
	Low	14.3	40	0	42.9	0	0	7.7	0
	Very Low	0	10	0	0	0	0	0	0
To what extent have the number of jobs assumed by SDL, as a result of the implementation of projects financed by M19 Leader, been achieved?	Over 100%	71.4	50	70	71.4	66.7	40	53.8	0
	100%	7.2	40	0	0	0	40	15.4	0
	70-90%	14.3	10	20	14.3	33.3	20	7.7	0
	50-69%	7.1	0	10	14.3	0	0	7.7	0
	Under 50%		0	0	0	0	0	15.4	0
What is the average age of people who have received funding through the LAG?	25-35 years	28.6	20	0	14.3	33.3	20	15.4	0
	36-45 years	50.1	80	90	71.4	66.67	80	69.2	0
	46-55 years	21.3	0	10	14.3	0	0	15.4	0

Source: Own calculation.

The financial part of this analysis highlights the fact that 87.5% of the respondents consider that the financial allocation is very important but insufficient for the development needs of the partnership, consider 75% of the respondents (Table 4). The allocations went mainly to services (75% of respondents) and to agriculture (62.5% of respondents). The allocation structure is in line with the main result and monitoring indicators assumed in the SDL, respectively jobs created - 75% of respondents (this being a direct consequence of the specific territorial assessment in order to develop an SDL that would lead to increased development rural areas of the LAG) and supported farms - 50% of respondents. The importance of funding through M19 LEADER is also supported by the answers received in Question-Interview 1, which emphasizes that there are small communities that in the absence of this funding would have no other chance of accessing funds because they would not meet the selection criteria. , through this organizational structure, public-private partnership -GAL- manage to attract financial resources. In a percentage of 62.5%, the distributed amounts were contracted, and most of the respondents (62.5%) claim that they were also paid in proportion of 50-69%

(* the reference date being 31.01.2021). At the same time, in their opinion, the assumed result and monitoring indicators reveal the degree of rural development of the eligible territory LEADER, which can be supported by the high percentage of non-agricultural business (services) sustained in conjunction with the increase of jobs, but also with the increase of quality. as a derivative of material benefits. However, the majority of respondents (87.5%) want to change the way funds are distributed at LAG level through LEADER, increase the percentage of funding allocated to this measure, including decentralization (Question 2 - interview).

Question 1 - interview: What benefits have been brought to the community as a result of the implementation of the LEADER approach in the territory of the LAG?

Answer 1: "Top-down community development through job creation. Development of the tourist area. ”

A2: "Increasing competitiveness, support for business development, support for the development of social services."

A3: "Revarsarea Social Center and Grindu Cultural Center."

A4: "New units at standards adapted to the present for the activity of preschoolers."

A5: "Quality services for the population, infrastructure for public and social services, support for the introduction of hot water and heating systems."

A6: "Improving the quality of life in rural areas is by far the greatest benefit to rural areas."

A7: “Increasing the possibilities for spending free time.”

A8: "Newly created jobs, setting up new businesses, attracting young people to rural areas."

A9: "The CLLD approach distributed money evenly across the territory and brought added value, describing a larger community with less money."

A10: “Job creation, modernization of social services.

From a social point of view, we notice that in all regions, the active population is in the age range of 40-50 years, which strengthens the respondents' opinion according to which the aging population is one of the problems of the LAG territory (Table 5). Even if the 40-50 age range is not considered an age range of the "old" population, there is this tendency to age, especially by depopulating the territories with the young population, which in the absence of opportunities migrates to urban areas. The chances of achieving a young LAG perimeter is "average", according to the respondents of the questionnaire (75%). Thus, the financing through M19 LEADER has the role of creating jobs for them and retaining them in the territory of the LAG, a fact confirmed by the percentage of 87.5% of beneficiaries aged between 35-45 years who obtained financing through this measure, implicitly job creation and accomplishment. Also, the attracted funding has led not only to material but also immaterial benefits, which can be likened to the establishment of social centers or unions for preschoolers, as evidenced by the answers to Question-Interview 1.

CONCLUSIONS

The data collected show that funding through the 19 LEADER measure is very important for eligible territories but at the same time insufficient, as evidenced by the centralization of responses. A deeper analysis shows that the 3 components: territorial, financial and social are interdependent, so that to solve the problems found in over 63% of the regions (aging population, lack of jobs, insufficiently exploited resources) we try to solve them by directing financing to the respective segments, which results from the centralized answers within the financial component, respectively over 75% of the allocation went to services and agriculture, with direct effect on the increase of the number of jobs. Funding received through M19 LEADER gives small communities the opportunity to access funding, as representatives of local action groups tell us, respectively: "We have 2 communes, which have through the LAG the first projects with European funding (and not because they had no projects submitted , but because they were always below the national score and were always waiting), but at the same time they claim that in order to be more obvious the positive effects, the general percentage allocated to LEADER must increase. Through the sustained financing programs, there is a timid beginning of attracting young people to rural areas, the age range that obtained funding through the LAG being between 35-45 years, but also increasing the quality of life of residents by establishing or modernizing units. for preschoolers, social centers. Overall, funding through M19 LEADER has a positive impact on eligible communities.

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SHORT FOOD SUPPLY CHAINS AND YOUNG PEOPLE'S ATTITUDE TOWARDS HEALTHY EATING

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Abstract

The purpose of this paper is to identify: short supply chains (SFSC) in Sibiu County, Romania, in the context of the need of transformation for the current food chains; young people's attitude towards food and a healthy lifestyle and their behavior in the current context of the Covid pandemic 19. Data were collected from public authorities, local organizations and websites of manufacturers and processors. A questionnaire was developed and was applied online between October 30 and November 20, 2021, among students (bachelor's and master's) from faculties with an agri-food profile. It was completed by a number of 222 people, and the data were synthesized, tabulated and analyzed. In Sibiu County, 17 types of short food supply chains (SFSC) have been identified, which can be examples of good practice in the necessary transformation of the current food system towards sustainability. Young consumers have a positive attitude towards food and a healthy lifestyle, without having significant behavioral changes in the current context of the pandemic. The results of this study may have implications for establishing marketing strategies for young people.

Key words: *short food supply chain, food, attitude, consumption, young people, Covid-19 pandemic, Romania*

INTRODUCTION

Sustainability is one of the major societal challenges, especially in the food supply chain, from production to consumption [22]. Food sustainability contributes to global sustainable development, being able to improve the efficiency and sustainability of the use of the resources involved, while reducing food waste [8].

The transition to a more sustainable food system requires changes and innovations along the food value chain. These changes are mainly aimed at cooperation between different actors in the food system and innovative production, processing, and distribution technologies.

Food security and safety are closely linked to the sustainability of the food system and environmental protection. The food system directly influences the production and consumption of food, but also the way consumers perceive the quality of food and its effect on human health [31].

Promoting a sustainable and resilient food system is a priority for many international organizations [20, 22], simultaneously with the existence of a favorable political environment to support it [27].

There is a growing trend towards a diet based on local, fresh, seasonal products based on environmentally friendly technologies with a low economic, social and environmental impact [17]. Various authors report that there is a tendency to change diets towards a plant-based diet and dairy products, especially observed among the generation of millennials (24-39 years old) and people with higher incomes [2]. This trend of transforming the current food system towards sustainability also depends on the attitude and eating habits of consumers, in line with the concerns of the

U.E. to meet the targets set for the 2030 Sustainable Development Goals (SDGs), in particular SDG 2 “Zero Hunger” and SDG 12 “Sustainable consumption and production”. Achieving these goals requires concrete action at the local, national and global levels by all actors involved in the food chain, from production to consumption [34].

Young Europeans are concerned about the sustainability of the food system, proposing 6 future courses of action: the use of regenerative farming practices for at least 25% of EU agricultural land and supporting farmers in the transition to sustainable agriculture; defining uniform regulations on food labeling, presentation of their nutritional composition and environmental impact; developing a policy of social inclusion that allows access to the entire population of quality food and nutrition; life cycle analysis of food, assessment of its impact on the environment and calculation of the real cost; implementing strategies to reduce food waste and the production of packaging waste in the retail sector and addressing them in the context of the bioeconomy; carrying out nutrition education programs closely related to the care of human health and the environment [23].

Recently published studies on young Romanian consumers show that in the choices made by them, social norms and behavioral control prevail. They affect their behavior which has a major impact on the future intention and behavior of sustainable food choices. That is why it is important for young people to have a positive attitude towards sustainable products and brands [3, 28].

Cantaragiu (2019) pointed out that there are some significant differences in the behavior and attitude of Romanian consumers in terms of food consumption and food waste, which vary by gender [11].

In Romania in the last two years the level of food expenditures has increased, although the food consumption per capita has remained relatively at the same level [17]. Although the level of household income in Romania has increased, it is still well below its average in the European Union, and a large part of it is intended for food consumption expenditure [30]. Consumers' food choices are influenced by many psychological factors (perception, motivation, attitude, needs and preferences), educational, economic (income level), cultural and lifestyle [6, 10].

The Covid-19 pandemic has had a deep impact on consumers' attitudes regarding food choices, purchase habits. Online platforms have appeared helping the development of the virtual markets and sustained both the producers and consumers [24].

In this context, this paper has two objectives:
(i)Identifying existing SFSCs in Sibiu County, Romania;
(ii)Identifying young people's attitudes towards food and healthy living and behaviour in the current context of the Covid pandemic 19.

MATERIALS AND METHODS

In order to achieve the objective (i), the data were collected from local public authorities and organizations involved in the creation of SFSC in Sibiu County, Romania (Sibiu County Council, Sibiu County Directorate for Agriculture and Rural Development, Mountain Area Agency - Sibiu branch, NGO-producers' associations, websites of local producers and processors).

In order to achieve the objective (ii), a questionnaire was developed which was applied online between October 30 and November 20, 2021, among students of bachelor's and master's programs at faculties with agri-food profile in the university centers of Sibiu, Bucharest, Cluj, Targoviste, Galați and Timișoara. The questionnaire was developed based on other studies in the literature [20, 29].

The size of the sample of respondents was 222, being determined with Cochran's corrected formula [14] (Cochran W. G., 1977), $n_1 = n_0/(1 - n_0/N)$, where: $n_0 = Z^2pq/e^2$, for Z tabeled 1.96 for $\alpha = 0.05$, 95% confidence interval, an accuracy of 0.05 (5%) și N = 528.

The questionnaire was distributed to students through the Google Classroom platform and was structured in 20 items: socio-demographic data about respondents; data on young people's eating habits: attitude towards eating and a healthy lifestyle; behavioral changes during the Covid 19 pandemic and the main aspects of life.

No personal identification data was collected to ensure the anonymity of the participants. The data were synthesized and analyzed. The Excel software (version 365, Microsoft Corporation, Redmond, WA, USA) was used to better view and process the collected data.

RESULTS AND DISCUSSIONS

Identification of SFSCs existing in Sibiu County (Romania)

The promotion of LP and those recorded on various quality schemes began around the year 2000, through numerous and various approaches.

Among the types of SFSC identified in Sibiu County, which contribute to consolidating the position of farmers and their cooperation, we mention:

-Weekly markets of the producers (”Transilvania” market, “Huet” market of ecological products). In 2021, 200 local producers were accepted in the ”Transylvania” market, of which it sells: fruits and vegetables, 81 people (40.5%); dairy, 27 people (13.5%); butchers, 17 people (8.5%) [16]. In 2018, 180 local producers were accepted in this market, being 11.1% less than in 2021 [13];

-***Markets of local producers*** organized in villages and farms open to visitors are both forms of SFSC and elements of the local gastronomic tourism offer. They were identified in Rășinari [12];

-***Markets of local producers in the churchyard***. As a novelty, starting with the year 2021 in Sibiu and in the metropolitan area, on the days of religious holidays, producers' markets are also organized in the churchyard. It is another form of direct communication between farmers and buyers.

-Phone app called "Road Market"[32];

-"Country Fair" at the Open Air Museum in Dumbrava Sibiului, for gastronomic events and exhibitions with food sales;

-Gastronomic festivals (“Cheese and Brandy” Festival, Bazna Pork Festival; Cabbage Festival; Peony Festival);

-Brunch and other alternative gastronomic events [5];

-Thematic educational trails: “Cheese Road” in the Mărginimea Sibiului area; Slow Food Trail [4].

-Shops of local producers (“Albota Grocery”, “The Old German Man”, “Eco-Prod Tradițional”, “La Mimi”, “Biocoop”, “Mangalița from Racovița”);

-Food Hub**,** which identified 26 individuals or local businesses that offer for sale: dairy products, meat products, eggs, fruits and vegetables, herbs, edible flowers, bee products, artisanal bakery products, products processed preserves, product packages, beverages and confectionery, pastry;

-Local gastronomic points (PGL)

At the national level in the period 1918-2021, 171 PGLs were established, of which 65 (38%) were established in 2021 as a result of numerous courses organized by the Mountain Zone Agency.

In Sibiu County in 2021 are registered 15 LPG, of which 12 are in the mountain area [18]. They represent new opportunities, both for family members of farmers and for tourists passionate about gastronomy;

-Projects to promote local products under the "Sibiu Tastes" brand. A number of 210 local producers are grouped by micro-regions: Sibiu - 52 producers; Valea Târnavelor-12 producers; Drought Land - 34 producers; Hârtibaciului Valley - 42 producers; The border of Sibiu - 43 producers and Țara Oltului - 27 producers [15];

-***Registration on the quality scheme and the “mountain product” platform***: 28 producers from Sibiu county located in 19 localities in the mountain area, with: vegetables-fruits, vegetable products, dairy products, meat products, bee products, eggs [1].

A schema of short food supply chains in Sibiu county is presented in Fig.1.

The distribution of the local gastronomic points, of the producers registered in the food hub and of those with “mountain products” is presented in Fig. 2.

Thus, in Sibiu County there is a trend of organizational innovation along the food chain, which leads to the transformation targeted by the goals of the European Green Pact [19, 21]. This is driven by new technologies and evolving consumer requirements. Strengthening the position of farmers and their cooperation in food chains are strategic objectives of the Community Agricultural Policy (CAP) 2023-2027 [26].

A short-term challenge will be to better align consumer needs with short food supply chains and increase confidence in the quality of local products [9].

Fig.1. Types of Short Food Supply Chains in Sibiu County
Source: Own design.

Presentation of the socio-demographic profile of the respondents

The socio-demographic profile of the respondents is presented in Table 1. Of the 222 people, who completed the questionnaire, 66.20% were female, and 75 (33.80%) were male.

The respondents are young people, aged between 18 and 34 (86.93%), currently 199 people (89.63%), being students or masters of a faculty of agricultural profile, food industry or environmental protection.

The respondents are generally unmarried (78.8%), and in terms of employment status being students (69.4%) or full-time employees (23%).

The domicile of the respondents is in proportion of 55.4% (123 persons) in a village or commune, respectively, in proportion of 25.7% (57 persons), in a small or medium city. Depending on the size of the locality of residence, it is observed that 64.86% (144 people) stated that they live in a community of less than 50,000 inhabitants.

Depending on the NUTS regions of Romania, 56.3% of the respondents live in the Central Region (Alba, Brașov, Covasna, Harghita, Mureș and Sibiu counties), and 18.5% of them come from the South West Oltenia Region (Dolj, Gorj, Mehedinți, Olt, Vâlcea counties). The form of ownership of the dwelling house is private in the case of 83.3% (185 persons) of the respondents, 62.2% (138 persons) of them living with their parents, and 19.8% (44 persons) with their spouse. In general, 74.8% (166 people) of the respondents' households did not have adolescents or children under the age of 14. Respondents' households consist of 3 or 4 members for 166 people (60.36%). However, there is also a share of 22.10% of respondents (49 people) whose households consist of 5 or more members. The average monthly income per household is in the case of 173 of the respondents (78.82%) between 2,000 and 5,000 lei. (The exchange rate of the National Bank of Romania on January 5, 2022 is: 1 Euro = 4.9464 Lei).

Respondents' perception of their own financial situation shows that 133 people (59.5%) consider that they have a good financial situation, while 65 people (29.3%) stated that their financial situation is neither good nor bad.

The distribution of the respondents according to sex, income/household and number of persons/household is presented in Table 1. It is observed that females with incomes between 2,000 and 6,000 lei represent 56.3% of the total respondents.

Table 1. Cross tabulation between gender, average household income and number of persons/household

Average household income (lei)		**Number of persons in a household**						**Total**
		1 person	2 persons	3 persons	4 persons	5 persons	6 persons	
2,000-4,000	Total	5	17	31	31	18	10	112
	Male	3	3	9	10	3	2	30
	Female	2	14	22	21	15	8	82
4,001-6,000	Total	4	8	13	24	8	6	63
	Male	1	2	6	4	3	4	20
	Female	3	6	7	20	5	2	43
6,.001-8,000	Total	0	2	7	9	3	4	25
	Male	0	0	3	4	2	3	12
	Female	0	2	4	5	1	1	13
8,001-10,000	Total	1	0	3	6	0	0	10
	Male	0	0	3	4	0	0	7
	Female	1	0	0	2	0	0	3
10,001-15,000	Total	0	2	5	5	0	0	12
	Male	0	1	2	3	0	0	6
	Female	0	1	3	2	0	0	6
Total	Total	10	29	59	75	29	20	222
	Male	4	6	23	25	8	9	75
	Female	6	23	36	50	21	11	147

Source: Own results based on questionnaire.
Note: The exchange rate of the National Bank of Romania on January 5, 2022 was 1 Euro = Lei 4.9464.

The attitude of young people towards food and a healthy lifestyle

The attitude of young people towards a healthy lifestyle and care for food (Figure 2) is proved by the fact that: 89.2% of respondents (198 people) stated that they try to eat healthier, 79.72% (177 people)) of the respondents usually cook, 68% (151 people) say that the food should be ordinary and easy to prepare, 58% (129 people) try to avoid artificial flavours and preservatives, 41.44% (92 people) try to avoid plastic packaging when buying food, and 31.98% (71 people) try to eat less meat.

It is known that animal production uses approx. one third of the global surface and generates 14% of all greenhouse gas emissions. At the same time, the water footprint of any animal product is higher than that of a vegetable with an equivalent nutritional value [7]. Sarri et al. (2021) showed that reducing meat consumption and a change in the behaviour of meat consumers allow the current food supply system to be transformed into a more sustainable and environmentally friendly one [33].

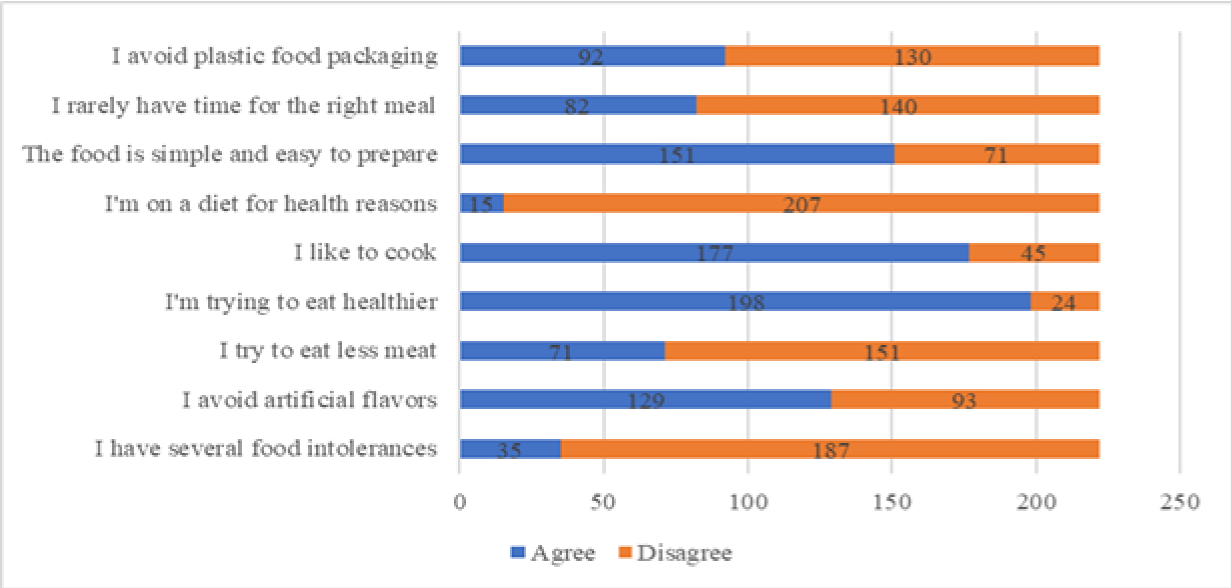

Fig. 2. The attitude of young people towards food (n = 222)
Source: Own results and design.

The attitude of young people towards food shows their concern for environmental sustainability, starting from the belief that a diet based on fresh vegetables and fruits, less meat and care for food packaging put less pressure on the resources used in the food chain.
Studies published in the speciality literature identify the main attributes of foods according to which they are chosen.
Thus, a study conducted among consumers in three Asian countries shows that the value of food is perceived in terms of safety, taste and health.
The order of these quality attributes varies by country, and knowing consumer preferences can help producers adopt specific marketing strategies [25].
Based on the answers received from the questioned persons, we identified the main aspects presented below.

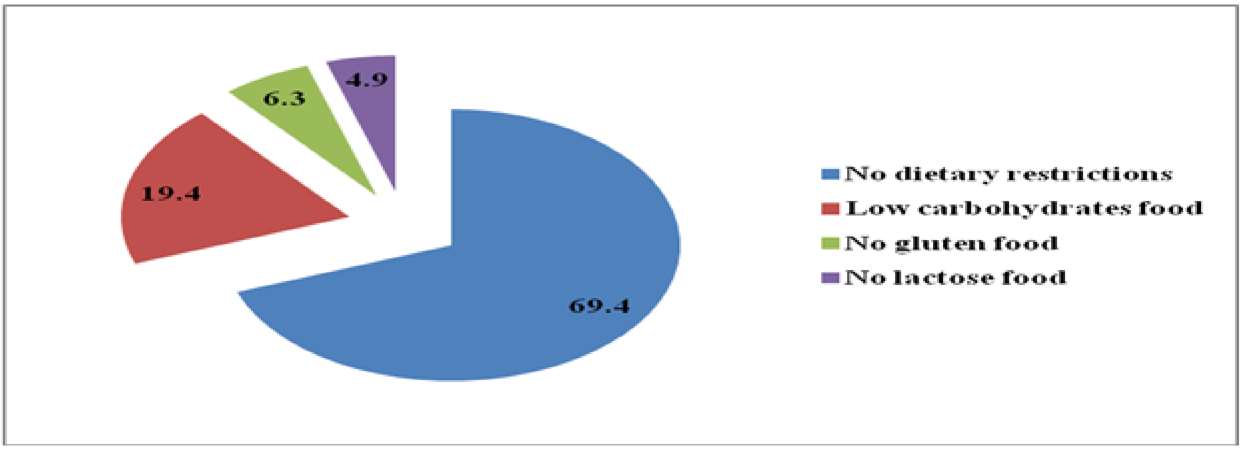

Fig. 3. Respondents structure based on diet restrictions (%)
Source: Own results and design.

In general, young people have no dietary restrictions, representing 69.36% (154 people) of total respondents.

But, it deserves to note that there young people who have diet restrictions that they have to respect. For this reason, there were identified the following aspects regarding the restrictions of a few types of food imposed by health problems of the respondents: 19.36% of people (43) eat foods low in carbohydrates, 6.30% (14 people) do not eat gluten foods, and 4.95% (11 people) do not eat lactose products due to lactose intolerance (Figure 3).

In the choice of food, young people pay attention to sugar content 64.86% (144 people), 59% (131 people) to the presence of genetically modified organisms, 54% (120 people) to additives, 53.60% (119 people) to food preservatives, 52.7% (117 people) to the number of calories, 50% (111 people) to the salt level (Figure 4).

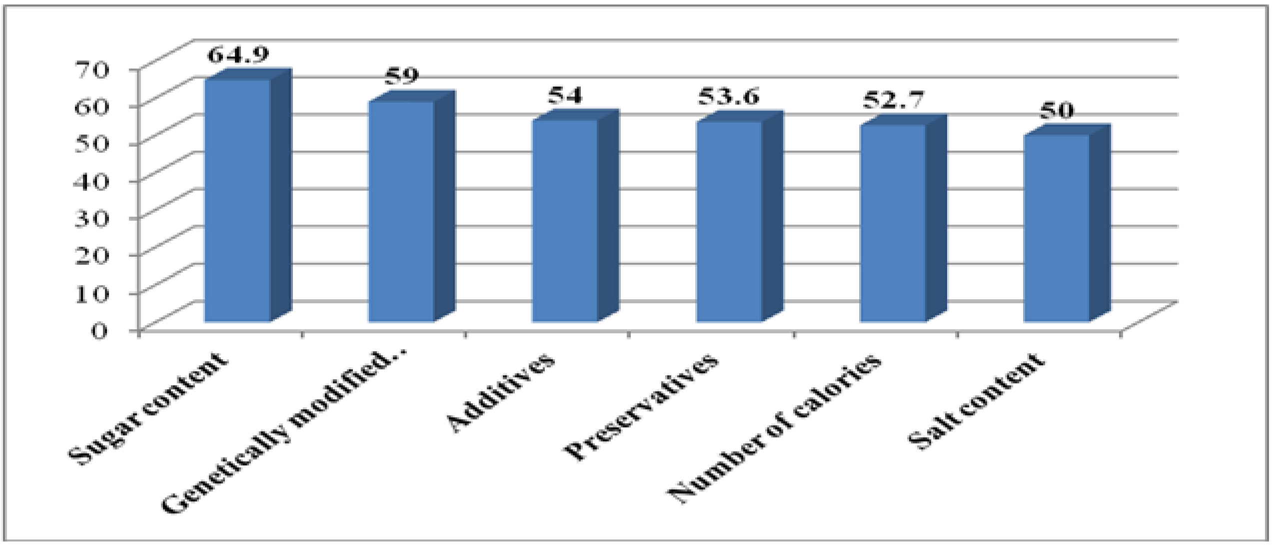

Fig. 4. The share of respondents who pay attention to various aspects of food quality
Source: Own results and design.

Behavioural changes during the Covid 19 pandemic and the main aspects of life

The Covid 19 pandemic did not cause major changes in young people's eating habits, with 56.8% of respondents stating that they had not changed their diet in the last 12 months. At the same time, 24.2% of young people resorted to a low-calorie diet, and 16.3% chose to eat more fresh fruits and vegetables. Only 2.7% of those surveyed said they follow a lacto-vegetarian diet (Fig. 5).

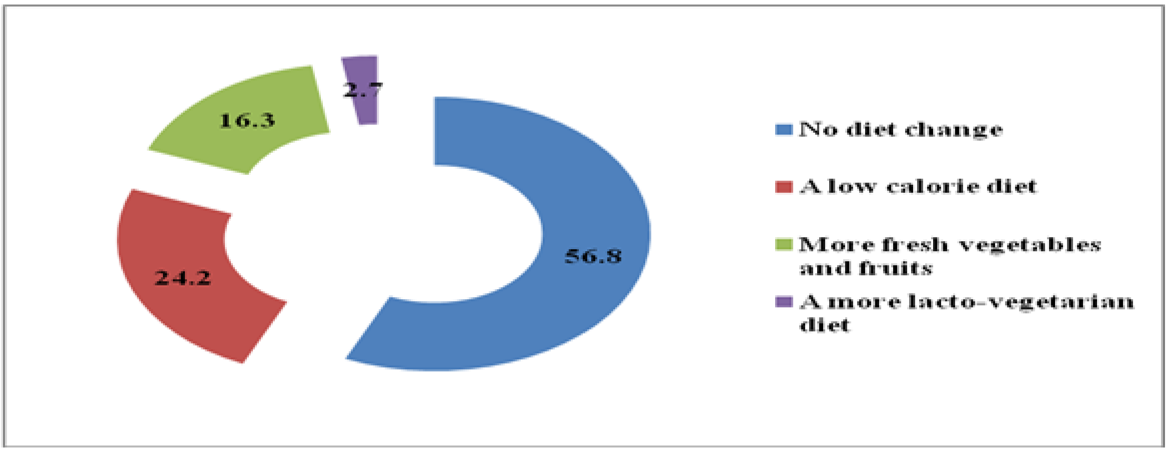

Fig. 5. Respondents' changes in food preference during the Covid-19 pandemic
Source: Own results and design.

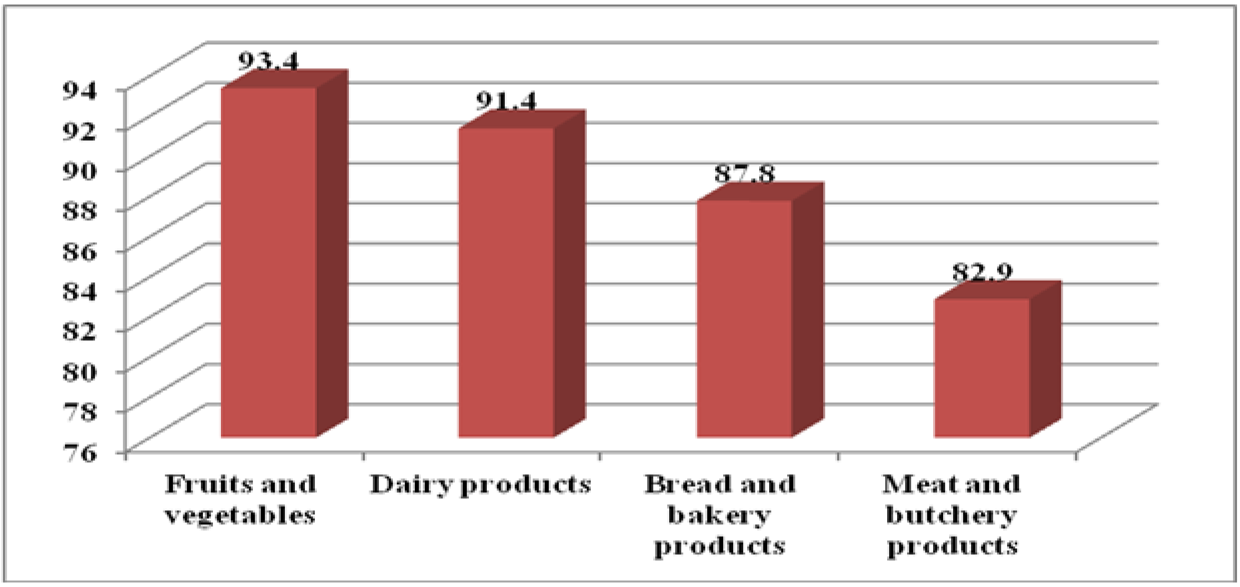

Fig. 6. Respondents' answers regarding food consumed on a regular basis
Source: Own results and design.

The main categories of food consumed by young people on a regular basis are: fruits and vegetables 96.39%, dairy products (91.44%), bread and bakery products (87.83%), meat and butchery products (82.88%) (Fig. 6).

The young people surveyed are not used to ordering food online.

The exception is cooked food, which was ordered online in the last 12 months by 41.89% of respondents.

It is noted that 58.1% of respondents stated that they have not ordered food online in the last 12 months, trying to cook at home.

The main general objectives for the life of young people are presented in Figure 6, these being: to have a comfortable and respectable life (61.7%), to have a happy relationship (43.7%), to be successful (42.3%), to advance in a career (41.4%) and learn new things (37.4%) (Figure 7).

The current Covid 19 pandemic has caused changes in everyone's behaviour. The young people surveyed stated that: they reduced their interaction with others (63.10%), they felt stress and anxiety (32%), they cancelled or changed their holiday plans (42.8%) and they tried to spend less (36.5%), developed more open air activities (sport, walking etc) an intensified virtual communication on mobile phones (Fig. 8).

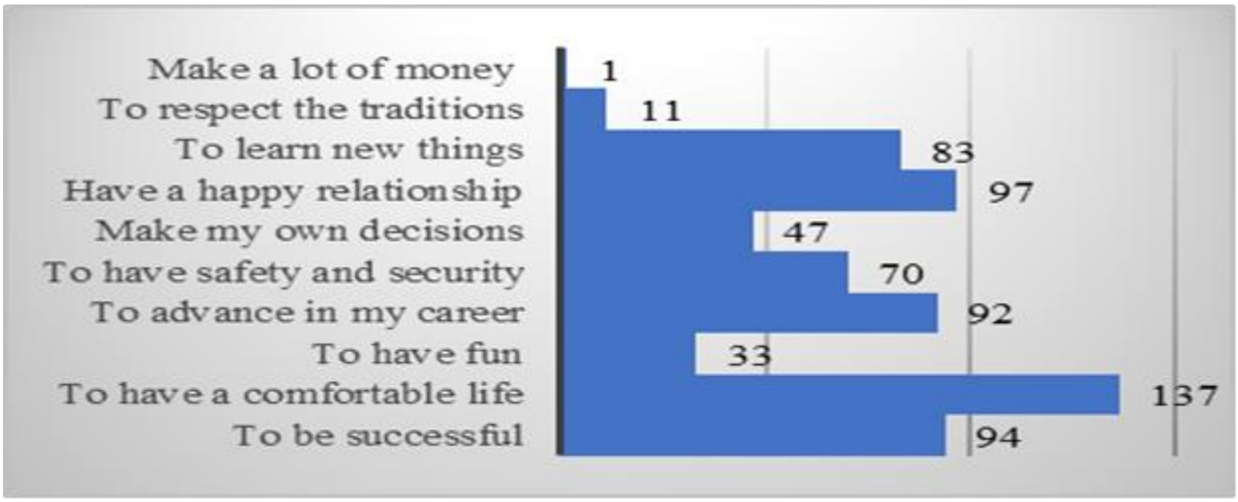

Fig. 7. The general goals of young people for life (n = 222)
Source: Own results and design.

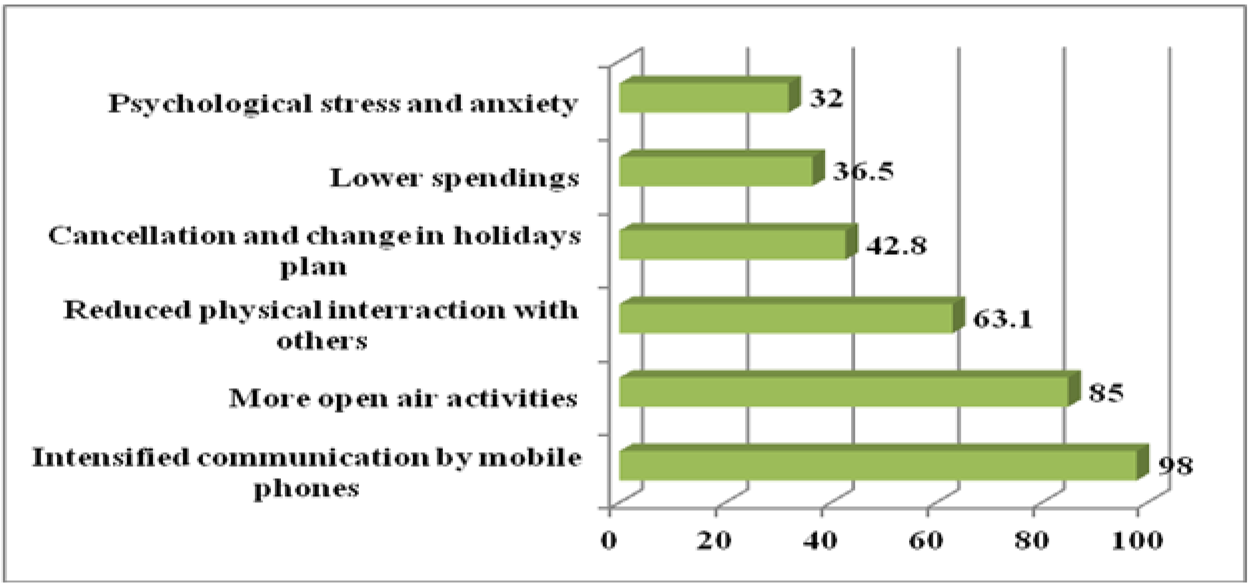

Fig. 8. The effects of Covid-19 on young people different aspects of life
Source: Own results and design.

Only 37.4% of respondents made more purchases online than before the pandemic, and 23% of them perceived that their financial situation had worsened.

CONCLUSIONS

This paper summarizes the information on the identification of existing short food chains in Sibiu County, Romania and the attitude of young people towards food and a healthy lifestyle. The two objectives are in line with European Union documents (European Union Green Pact, Farm to Consumer Strategy, Biodiversity Conservation Strategy) and the United Nations 2030 Sustainable Development Goals.

The main organizations identified in Sibiu County that support local food systems and short food supply chains are: Sibiu County Council, Mountain Area Agency - Sibiu branch, Food Hub, Adept NGOs, "Mihai Eminescu Trust", My Trasylvania and Producers Association of traditional products “Mărginimea Sibiului”.

The following types of short food supply chains have been identified in Sibiu County: weekly producers’ markets, farms open to visitors,

“Road market” mobile phone application, gastronomic events organized in the “Country Fair” from the Open-Air Museum in Dumbrava Sibiului, gastronomy festivals, delivery of products to the consumer's door, educational themed trails, producers' shops, Food Hub Sibiu, local gastronomic points, shops of local processors, pages on social networks, projects to promote local producers, local owned brands, product registration on national and European quality schemes.

Short food chains need to be flexible and responsive to new food trends. They help reconnect the consumer with the food source, adding value to the food and building trust. Food quality, provenance, freshness, taste, flavour, traceability, and reliability are a mix of factors that consumers make decisions about when buying food in short food chains.

Young people have a positive attitude towards food and a healthy lifestyle, demonstrated by their care for food composition, emphasis on a diet based on fresh fruits and vegetables, local products and reduced meat consumption. Quite a few young people are accustomed to ordering food online, and if they choose to do so, they order cooked food. Most stated that during the current Covid 19 pandemic they reduced their interaction with others and felt stress and anxiety. Young people want to have a comfortable and respectable life, happy relationships, success and to advance in their career.

The limitations of this study are given by the size of the sample of respondents, which does not specifically represent the eating habits and attitudes of young consumers in Romania.

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FAIR FOOD TRADE - BIBLIOMETRIC ANALYSIS

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Abstract

Fair trade is a growing topic among researchers, which has grown in recent decades. This paper aims to identify the importance of fair trade as a topic of scientific research. To achieve this goal, a bibliometric analysis was performed, consisting of a quantitative analysis of statistical data through which the research results are disseminated and public performances are presented. Through this analysis it is possible to perform multiple analyzes including the identification of scientific publications in a particular field and citations of authors or articles. With the help of the VosView program, there has been a strong link between fair trade and food security, consumption, standards, quality, certification, etc.

Key words: *fair trade, bibliometric analysis, consumption, Romania*

INTRODUCTION

The development of retail trade and supply chains has taken place globally, with the consequence being bargaining power and relations between actors, which can lead to unfair trade practices. These can occur when one party may experience informational advantages over the other party (know-how) [1], [6].

Fair trade is an increasingly studied topic in recent decades in society, with an emphasis on ethical trade and sustainability. Fair trade has emerged since the twentieth century, coming to the forefront of trade in handicrafts, when social, economic and political changes took place. Named this trade alternative, it aimed to avoid the pitfalls of responsible growth models [12].

Issues related to sustainability, development, consumers and fair trade are increasingly being addressed by alternative actors. The alternative supply chain leads to new supply schemes, support for fair trade and information that the idea of consumption is not only a goal of the economy, but also a political issue [5].

Fair trade has become a popular term, covering a wide range of proposals, from safeguards to marketing opportunities. Fair trade is considered the counterpart of free trade being argued by the free trade of markets, which presupposes equal rights to participate globally [2].

Fair trade aims to support marginalized producers and workers in achieving economic and agri-food security. When dealing with fair trade, a major issue is price, which can impede the equilibrium of the equilibrium market and create a supply surplus [3], [8].

According to Pelsmacker, in 2005, consumers' concerns about the ethical behavior of companies purchasing products were reflected in their buying behavior. Ethical consumption is the only consumer who buys the product of their choice and has multiple sizes [9].

One of the key elements for ensuring sustainable agriculture is adequate agricultural land, which is under enormous pressure due to global environmental changes, including climate change, land degradation and rapid urbanization, as well as a growing population. Land use analysis is a key factor in land use planning and a prerequisite for the optimal development of land resources [4].

One of the main elements of Fair Trade is a movement, a new concept of regulating the food market. It aims to obtain fair prices and stabilize the supply of organic products in the global south and north and to promote links with the market for responsible consumption [10], [11].

Sustainable agriculture integrates three main objectives: environmental health, economic profitability and social and economic equity. It must also be economically viable and socially responsible, and ecology is the key to sustainable development [7].

MATERIALS AND METHODS

Alan Pritchaed has used the term "bibliometrics" since 1969, being considered a statistical and mathematical method applied to books and other publications.

With the help of the Web of Science database, the database will be exported in text format with scientific articles on a specific topic, and with the help of VosViewer software, maps will be generated that include keywords in publications and their use according to year, but also maps with the countries that give special interest depending on the subject approached. It identifies related keywords related to the main topic, the directions of research and the degree of cooperation between the countries that addressed the topic.

Bibliometric analysis is used to identify the performance of articles and their results, as well as journals, how to collaborate and the constructive elements of research.

RESULTS AND DISCUSSIONS

According to the Web of Science database, in the period 1992-2021, 737 specialized papers were written, the main categories targeting food science technology (114 papers), geography (104 papers), environmental studies (102 papers), environmental science (96 papers), business (92 papers), economics (88 papers), green sustainable scientific technology (78 papers) (Figure 1).

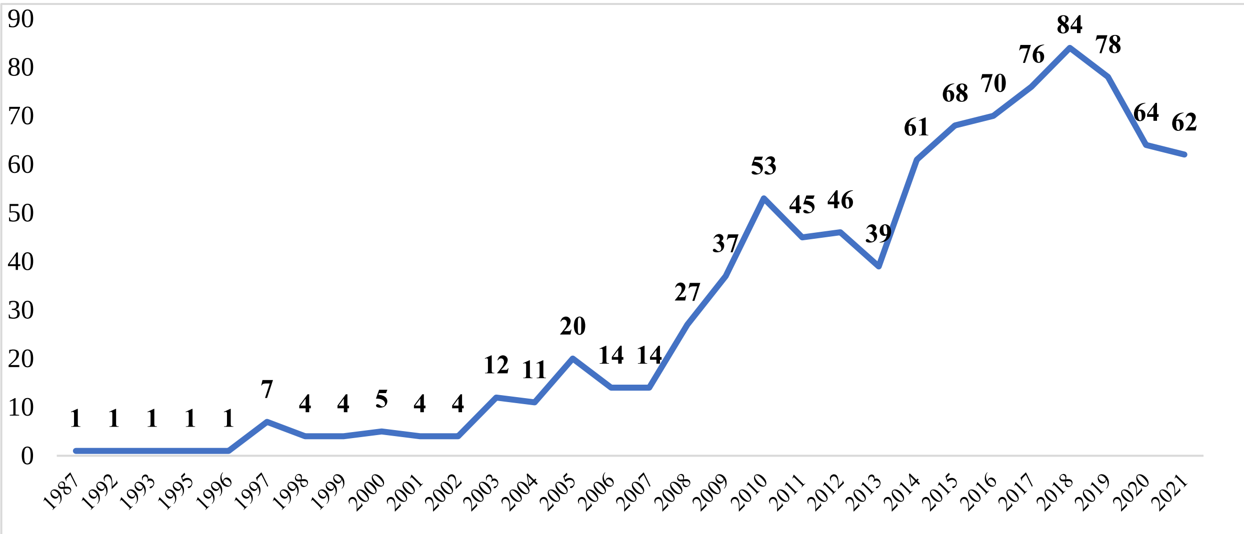

Fig. 1. Annual publication dynamics
Source: Own processing based on WoS data.

Other categories are represented by development studies, sociology, multidisciplinary agriculture, ecology, ethics, management, etc.

According to the data presented in graph number 1, the specialized works that have as main subject the commercial practices start from 1987, taking shape from 2003. It is observed that a special interest to this subject is given in 2010, when the number of 53 works is reached. Specialized.

The maximum of research from 1987-2021 is reached in 2018 when 84 specialized works were written. Even if the number of works decreases in the coming years, the subject remains an important one for both the population and the government (Figure 1).

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The main terms related to food fair trade are: consumption, availability of payment, quality, certification, sustainability, coffee, information, government, market, impact, attitudes, agriculture, preferences, farmers, organic food, consumer, globalization, standards, behavior, choice, values, availability of payment, ethical consumption, organic, politics, poverty, sustainable development, Nicaragua, planned behavior, incorporation, local food, determinants, management, food security, ethics, etc. (Figure 2).

These terms are grouped into clusters. The first cluster refers to consumers and includes keywords such as: food, quality, globalization, economy, politics, etc. The second cluster includes terms such as consumers, organic food, consumption, attitude, information, value. The third cluster refers to agriculture and includes terms such as environment, food security, certification, conservation, biodiversity, climate change. The fourth cluster refers to products and includes terms such as food chain, sustainability, nutrition, aquaculture (Figure 2).

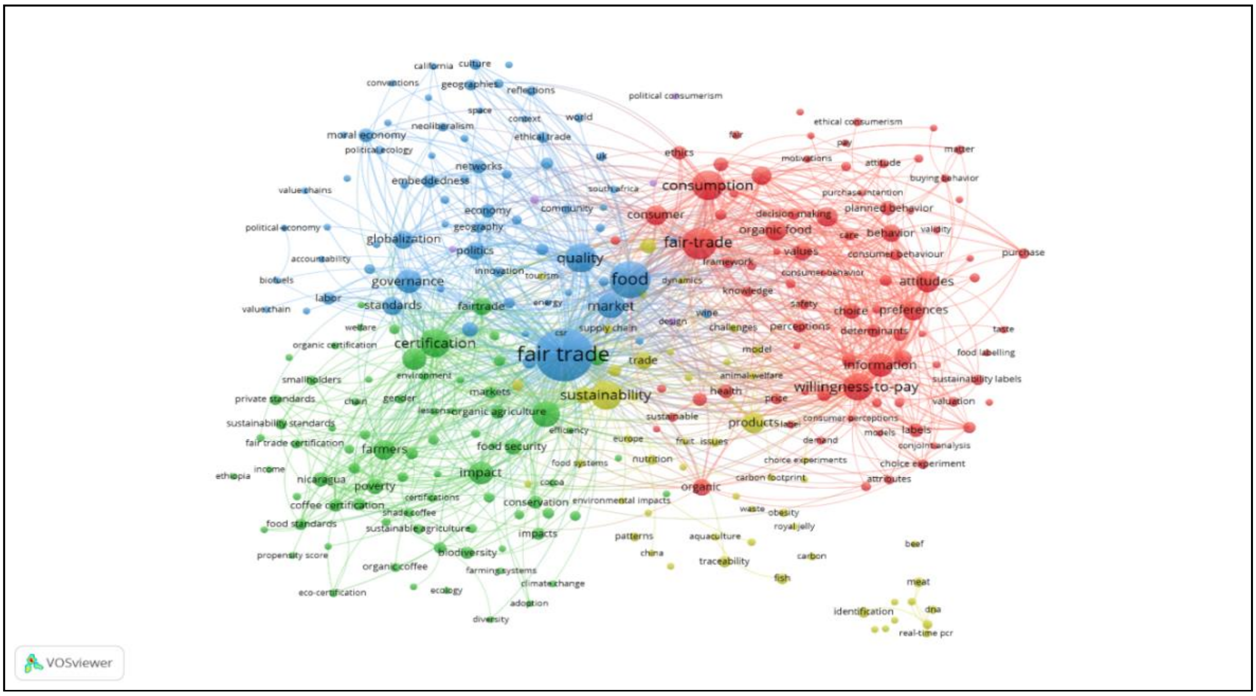

Fig. 2. Keyword link
Source: Own processing based on WoS data.

Figure 3 shows the keywords used over time in specialized works. Thus, in the period 2012-2013 they were concerned with the economy, geography, globalization, economic policy, ethical trade, reflections, culture, incorporation, challenges. In 2014 and 2015, the main topics were consumers, nutrition, quality, health standards, behavior, environment, organic farming (Figure 3).

During 2016-2017, researchers focused on farms, private standards, labels, impact, attitude products, nutrition, preferences, poverty, smallholders.

The year 2018 focused on topics such as payment availability, sustainable standards, certification, environmental certifications, motivation, purchasing behavior, food system, innovation, purchasing intentions (Figure 3).

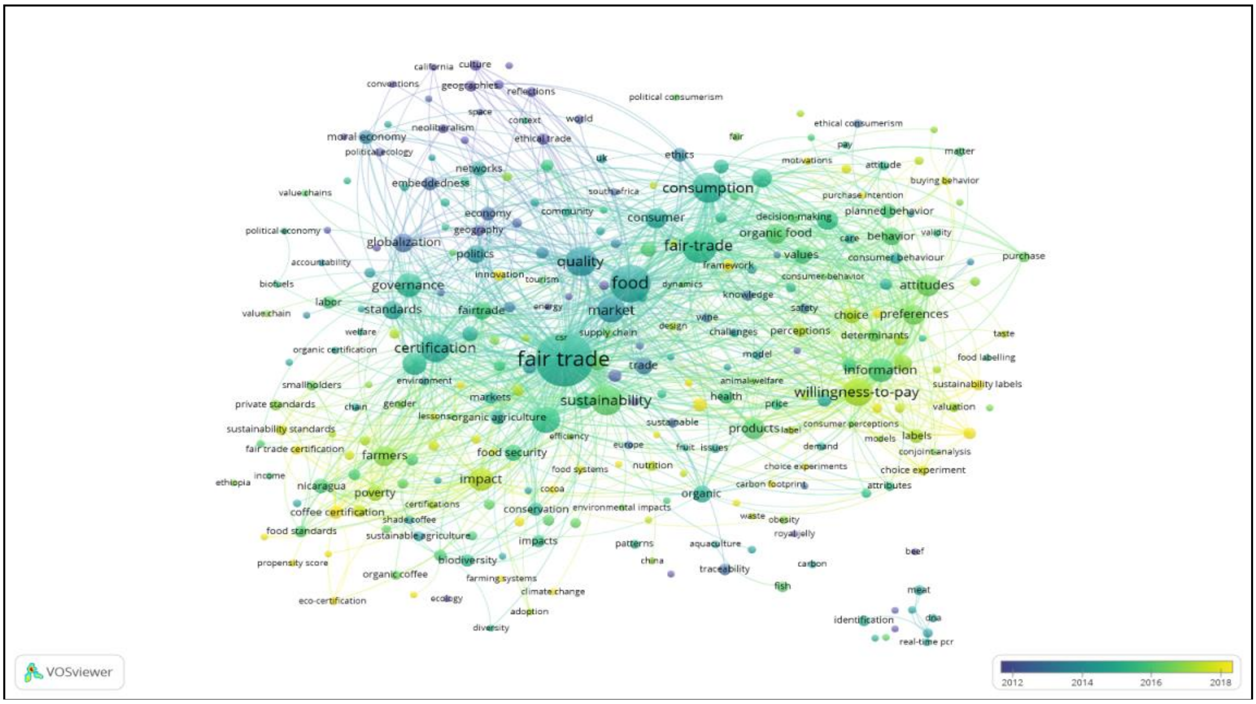

Figure 3. Keyword link by year
Source: Own processing based on WoS data.

Map number 4 shows the frequency of co-authors by country and the degree of relationship between countries by subject. The colors of the countries show the directions of development, the size of the clusters, the interest approached to the studied topic, and the distance of the connections as well as their thickness, the cooperation relationship (Figure 4.).

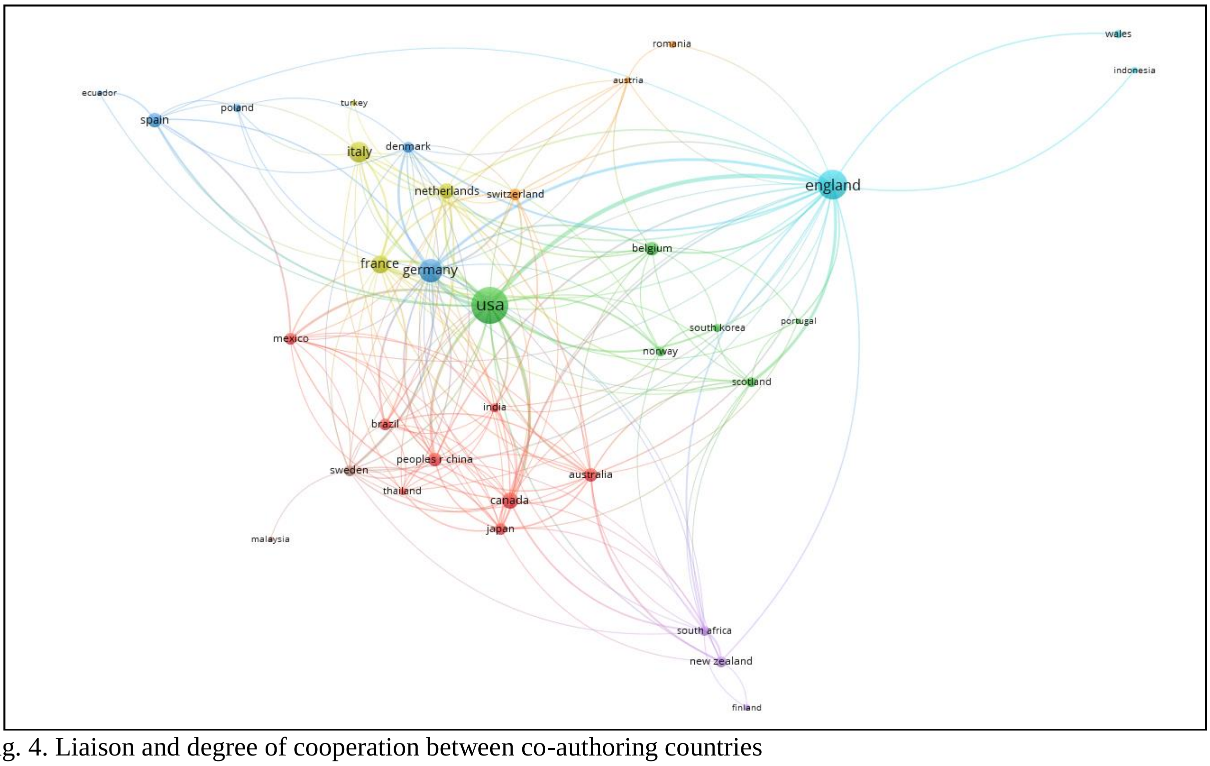

Fig. 4. Liaison and degree of cooperation between co-authoring countries
Source: Own processing based on WoS data.

Map number 4 shows the frequency of co-authors by country and the degree of relationship between countries by subject. The colors of the countries show the directions of development, the size of the clusters, the interest approached to the studied topic, and the distance of the connections as well as their thickness, the cooperation relationship. The United States of America, together with England, Germany and France, pay special attention to the subject under consideration. For France, Germany and the USA, the degree of cooperation is high, also in the case of Romania with Austria (Figure 4).

CONCLUSIONS

The paper analyzed the importance and frequency of addressing the issue of fair trade in food. The research shows the interest given to the studied subject illustrated by the dynamics of publications from 1987-2021. It can be seen that since 2005, the publications have doubled compared to the previous year, the maximum number of works being identified in 2018 (84 works), the trend being increasing until this year

Fair trade is linked to key words such as food security, certification, food standard, economic policy, moral economy, an economy that is moving towards an ethical and clean trade, which can be transformed into an alternative trade.

Another direction of research is illustrated by addressing topics such as quality, organic food, nutrition, behavior, consumer, fair consumption, safety shows a growing concern of researchers about the food chain, illustrating the importance of fair trade in society.

Terms such as environment, climate change, sustainability, biodiversity, challenges, waste, organic farming, food system illustrate researchers' concern for the environment and the focus on sustainable agriculture.

Thus, fair trade is a topic that is increasingly addressed by researchers globally, the countries that approach this topic more and more often are the USA, Germany, France, England.

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BIODYNAMIC PREPARATIONS FOR ALTERNATIVE PLANT CULTIVATION SYSTEMS; CASE STUDY IN WHEAT

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Abstract

The study evaluated the variation of some physiological indices and productivity elements in wheat, in response to treatments with biodynamic preparations. Two preparations were used, applied singly and in combination, at the recommended dose (P500 and P501) or at half the dose (P500/2; P501/2), in five experimental variants (V1 – P5001; V2 – P500/2; V3 – P500; V4 – P500+P501; V5 – P500+P501/2). A control variant with untreated plants V6(Ct) was used for comparison. Plant height (PH, cm), biomass weight (BW, g) and grain number on ear (GNE, No) were evaluated. Plant height (PH) values ranged from 49 to 69 ±1.66 cm, biomass weight (BW) relative to one plant (mean values) ranged from 3.36 to 7.50 ±0.38 g, and grains number in ear (GNE) ranged from 20 - 38 ± 1.58. The GNE variation according to BW was described by a spline model, in conditions of $\overline{\varepsilon} = 0.00162$ *. The regression analysis facilitated the obtaining of an equation that described the variation of GNE as a function of PH and BW in statistical safety conditions,* $R^2 = 0.998$*,* $p < 0.001$*. According to PCA, PC1 explained 97.486% of the variance, and PC1 explained 2.0343% of the variance. It was found that in the case of variant V1 (product P501) there were negative increases, which shows that administered alone the product did not have a favourable effect on wheat plants, under the study conditions. The highest values of the increase in indices and the elements taken into account were recorded in the V4 variant, which was a combination of products (P500+P501).*

Key words: *biodynamic agriculture, cultivation systems, GNE, model, PCA, wheat*

INTRODUCTION

The foundations of biodynamic agriculture were laid by the philosopher Rudolf Steiner in 1924, through the philosophical theses presented and promoted [16].
Worldwide, biodynamic agriculture is quantified as being practiced in 55 countries and occupies, according to a recent study [17] an area of 251,842 ha. On the first places are Germany (84,426 ha), Australia (49,797 ha), France (14,629 ha), Italy (10,781 ha) and India (9,303 ha), USA (9,001 ha), Netherlands (8,681 ha). According to the same study, Romania has an area of 200 ha cultivated in a biodynamic system.
The principles of dynamic agriculture have been taken over and promoted in different parts of the world, biodynamic agriculture being promoted as an (advanced) variant of organic agriculture [2], as an alternative agriculture [18].
Certification of biodynamic agriculture, in relation to organic agriculture (or other ecological, biological, forestry farming systems) involves the use of biopreparations with the role of improving the soil and ensuring crop yields [2].
The cultivation of plants in a biodynamic system has been studied in different species of interest, such as vegetables, cereals, potatoes, medicinal plants, vines, fruit trees [11], [15], [12], [20].
Some studies have performed comparative analysis of biodynamic systems with conventional systems [11]. Soil quality in biodynamic culture systems was also evaluated [12], [13].
Biodynamic management has positive ecological, economic and social effects over time. Thus, positive effects on agro ecosystems, plant production and food quality have been reported [1], to which can be added beneficial effects on the human life (growers and consumers of biodynamic products).
Various studies have reported the quality of

plant food resources from biodynamic cultivation systems, or integrated management (organic, biodynamic), with different examples of lettuce [9], garden watercress [14], giant pumpkin [10], viticultural products [7].
The present study evaluated the influence of treatments with biodynamic preparations on some physiological indices and elements of wheat productivity.

MATERIALS AND METHODS

The study analyzed the influence of two biodynamic preparations on wheat culture, in terms of physiological indices and productivity elements.
Two products were used, applied singly and in combination, at the recommended dose (P500 and P501) or at half the dose (P500/2; P501/2). P500 was applied to the soil and P501 was applied to plants in two treatments. Five treated variants resulted (V1 - P5001; V2 - P500/2; V3 - P500; V4 - P500 + P501; V5 - P500 + P501/2). A control variant, V6 (Ct), was used to compare the results.
Plant height (PH, cm), biomass weight relative to plant (BW, g) and grains number in ear (GNE, No) were determined.
The experiment was organized under controlled conditions, Belinț locality, Timiș County, Romania. Aspects from the experiment are presented in Photo 1.

a B c

Photo 1. Wheat plants under biodynamic cultivation conditions; a - plants in growing boxes; b - details on plants; c - detail on the root of the plants
Source: Original images, photos of the authors.

The experimental data obtained were analyzed by usual statistical analyzes in order to evaluate the statistical safety, the presence of the variance, the level of correlation, and the GNE variation depending on the physiological index of the plants, the degree of similarity of the variants in relation to the evaluated index. For this, EXCEL, PAST software [8] and Wolfram Alpha software (2020) [21] were used.

RESULTS AND DISCUSSIONS

The treatments applied with the biodynamic products, led to a specific variation of the wheat plants. Plant height (PH) values ranged from 49 to 69 ±1.66 cm, biomass weight (BW) relative to one plant (mean values) ranged from 3.36 to 7.50 ±0.38 g, and grains number in ear (GNE) ranged from 20 - 38 ±1.58. The complete set of recorded values is presented in Table 1. The graphical

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distribution, average values, of GNE in relation to PH and BW is shown in Fig. 1.

Table 1. Values of physiological indices and elements of wheat productivity, in conditions of biodynamic culture

Treatment	Trial	Plant height (PH)	Biomass weight (BW)	Grains number in ear (GNE)
		(cm)	(g)	(No)
P501	V1	49	3.36	20
P500/2	V2	55	3.75	24
P500	V3	64	6.47	32
P500+P501	V4	69	7.50	38
P500+P5001/2	V5	61	5.25	34
Control	V6(Ct)	53	3.50	23
Standard Error (SE)		±1.66	±0.38	±1.58

Source: Original data from the experiment.

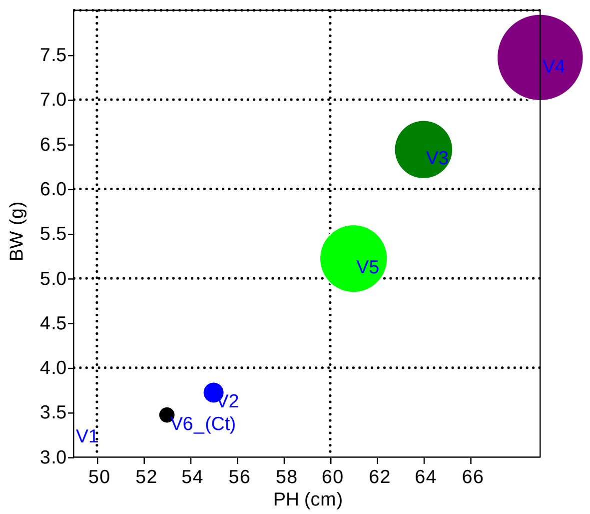

Fig. 1. Average grain number in ear (GNE), depending on plant height (PH, x-axis) and biomass weight (BW, y-axis) in wheat, under biodynamic treatment
Source: Original figure, generated based on data.

The ANOVA test highlighted the presence of the variance in the set of experimental values obtained, and confirmed the statistical certainty of the recorded results (F> Fcrit, p <0.001), Table 2.

Table 2. ANOVA Test, Single Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	25,913.19	2	12,956.59	400.497	6.56E-32	7.93391
Within Groups	1,649.912	51	32.35122			
Total	27,563.1	53				

Alpha = 0.001
Source: Original data, obtained by calculation.

The GNE variation (No) was analyzed in relation to each of the two physiological indices, based on the applied treatments. The variation according to BW was described by a spline model, and the calculated values, according to equation (1), are presented in Table 3. The GNE variation in relation to BW, given by the spline model, is shown graphically in Figure 2.

$$\bar{\varepsilon} = \left(\sum_{i=1}^{n} \varepsilon_i\right)/n = \left(\sum_{i=1}^{n}\left|\frac{ys_i - y_i}{y_i}\right|\right)/n \qquad (1)$$

Table 3. Statistical values related to GNE in relation to BW (g) in wheat plants, under the study conditions, obtained from the spline model

Trial	GNE				
No	x_i	y_i	ys_i	e_i	$I_{i/1}$
V1	3.36	20	20.758	0.03790	1.000
V2	3.75	24	24.346	0.01442	1.173
V3	6.47	32	32.925	0.02891	1.586
V4	7.5	38	37.651	-0.00918	1.814
V5	5.25	34	33.239	-0.02238	1.601
V6(Ct)	3.5	23	22.082	-0.03991	1.064

$\bar{\varepsilon} = 0.00162$

Source: Original data, obtained by calculation.

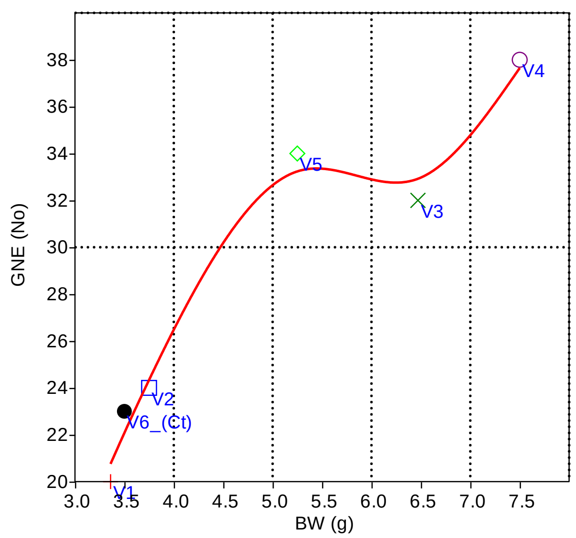

Fig. 2. GNE in relation to BW in wheat plants, under the influence of treatments with biodynamic products
Source: Original graph, generated based on calculated data.

Regression analysis was used to evaluate the variation of GNE (No) in relation to both studied physiological indices, PH (cm) and BW (g) of wheat plants, under the influence of treatments with biodynamic products. A mathematical model, equation (2) and graphical models, a 3D model (Figure 3) and an isoquant model (Figure 4) were obtained, which represented the GNE variation in relation to the two physiological indices considered, as direct action and interaction.

$$\mathrm{GNE} = \mathrm{a}\, x^2 + \mathrm{b}\, y^2 + \mathrm{c}\, x + \mathrm{d}\, y + \mathrm{e}\, xy + \mathrm{f} \qquad (2)$$

where: GNE – Grains number in ear (GNE, No);
x – plant height (PH, cm);
y – biomass weight (BW) (g/plt);
a, b, c, d, e, f – coefficients of the equation (2);
a = -0.1093913; b = -7.6251822
c = 4.1200014; d = -58.3407161
e = 2.2049040; f = 0

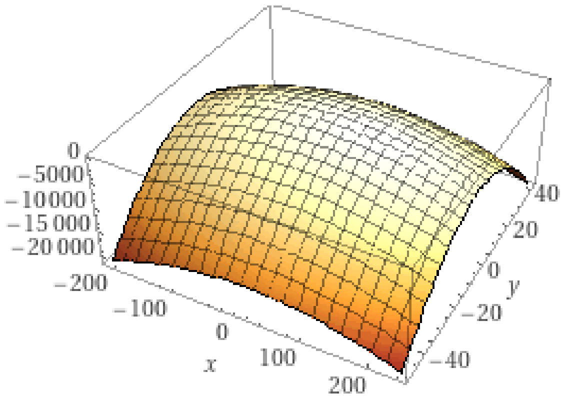

Fig. 3. 3D graphical representation of GNE variation according to plant height, PH (cm) (x-axis) and biomass weight, BW (g) (y-axis), wheat crop, under the influence of biodynamic preparations
Source: Original graph, obtained based on data.

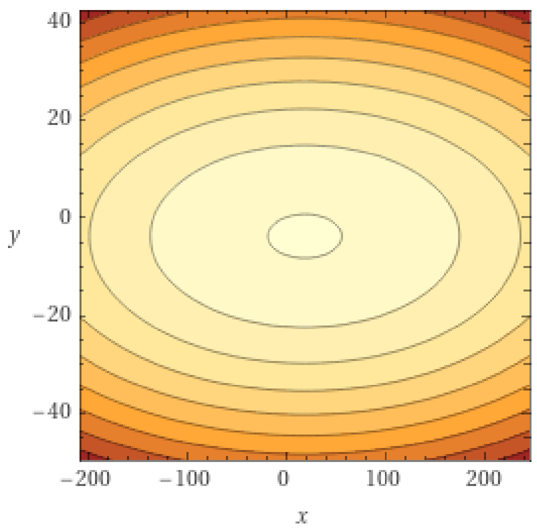

Fig. 4. Graphic representation in isoquants form of GNE variation depending on plant height, pH (cm) (x-axis) and biomass weight, BW (g) (y-axis), wheat culture, under the influence of biodynamic preparations

Source: Original graph, obtained based on data.

According to PCA (correlation) was generated the diagram from Figure 5, which represents the distribution of experimental variants (given by biodynamic preparations) and considered indices and elements (PH, BW and GNE). PC1 explained 97.486% of variance, and PC1 explained 2.0343% of variance.

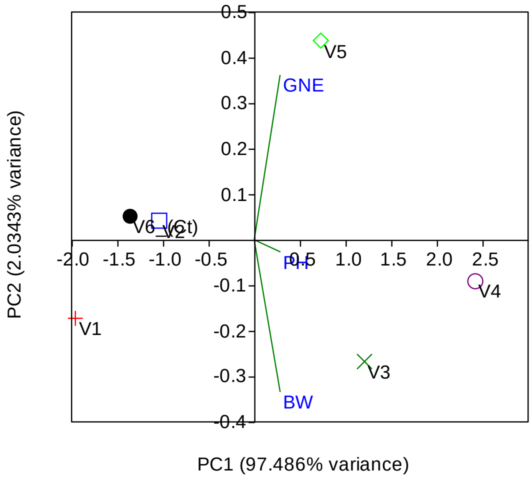

Fig. 5. PCA diagram, for the distribution of experimental variants
Source: Original diagram, obtained based on data

The cluster analysis facilitated the obtaining of the dendrogram from Figure 6, in conditions of statistical safety (Coph.corr = 0.846), in which the variants were associated on the basis of similarity in generating the results of the evaluated indices and parameters.

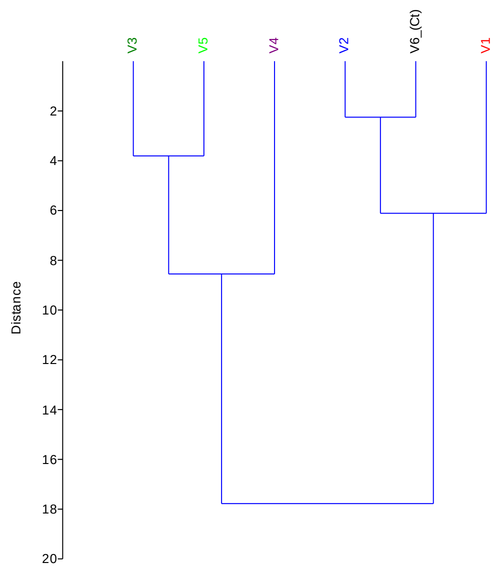

Fig. 6. Grouping dendrogram of experimental variants, based on Euclidean distances, wheat plants, under the influence of biodynamic preparations

Source: Original diagram, generated based on data.

Two clusters were formed, C1 and C2. Within the C1 cluster, the V3, V4 and V5 variants were associated with the best values recorded for PH, BW and GNE. The highest level of SDI values was recorded in variants V2 and V6 (SDI = 2.2500), followed by variants V3 and V5 (SDI = 3.8064). The complete set of SDI values is presented in Table 4.

Table 4. SDI values, wheat culture, under the influence of biodynamic preparations

	V1	V2	V3	V4	V5	V6_(Ct)
V1		7.2216	19.4590	27.2240	18.5360	5.0020
V2	7.2216		12.3450	20.1510	11.7580	2.2500
V3	19.4590	12.3450		7.8779	3.8064	14.5200
V4	27.2240	20.1510	7.8779		9.2229	22.2930
V5	18.5360	11.7580	3.8064	9.2229		13.7140
V6_(Ct)	5.0020	2.2500	14.5200	22.2930	13.7140	

Source: Original data, results from the analysis of experimental data.

In relation to the control variant (V6), the increase (expression in %) was calculated, given by the treatments applied with biodynamic preparations, at the indices and parameters taken into account (PH, BW and GNE). The values obtained are represented graphically in Figure 7.

It was found that in the case of variant V1 (product P501) there were negative increases, which show that the single product P501 did not have a favourable effect on wheat plants, under the study conditions. The highest values of the increase, at the indices and elements taken into account, were recorded in the V4 variant, which was a combination of products (P500 + P501).

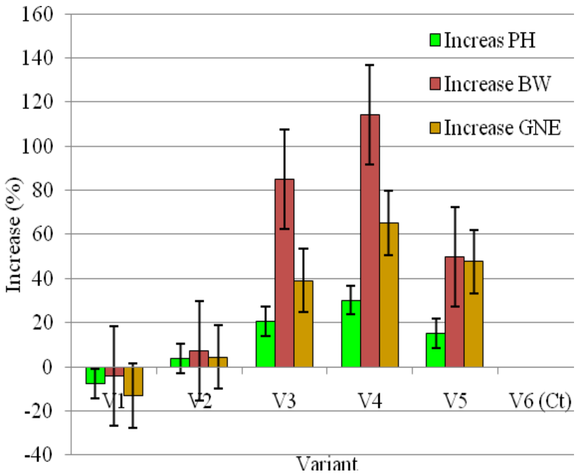

Fig. 7. Variation of increase (%) of physiological indices and productivity elements (PH, BW, GNE) in wheat, under the influence of biodynamic preparations
Source: Original graph, generated based on experimental data.

As an alternative plant cultivation system, biodynamic agriculture aims to produce quality food, in the context of protecting the soil and the environment, with benefits for growers and consumers.

Regulated agricultural practices, specific to this biodynamic culture system, ensure a balanced growth of quality plants and production. The increase in production must be understood both in terms of quantity, but especially in terms of quality.

In the context of the present study, the favourable influence of the products used was quantified at the level of biomass production as well as grain production (evaluated by the number of grains in the ear).

With the exception of variant V1 (P501) in which the differences were negative compared to the control variant, in all the other variants treated, positive increases of the indices and elements considered were registered. The increase in biomass production (BW, g), as an average value per plant, was in descending order of 4.00 g (V4), 2.97 g (V3) and 1.75 g (V5). Spike grain growth (GNE, no) was 15 grains (V4), 11 grains (V5) and 9 grains (V3). In the case of variant 2, although growth increases were recorded, they were insignificant.

The biodynamic preparations used (P500, P501) were more effective for combined application, which has been reported in other plant species [10].

According to specific of plant nutrition [19], and interest in quality agricultural and horticultural products, various studies have evaluated local germplasm resources, with high ecological plasticity and sustainable technologies [3], [4]. Also, non-invasive methods for assessing vegetation status and plant health have been used [5], [6], and can be promoted in sustainable plant culture systems, such as biodynamic systems.

CONCLUSIONS

P500 and P501 preparations, recommended for biodynamic agriculture, had a specific influence on wheat plants, in relation to the singular or associated application and the evaluated indices. The associated application has been shown to have better effects than the single application.

The favourable effects of the two products in six experimental variants (control variant V6) were quantified at the level of plant size (PH), biomass production (BW) and grain number in ear (GNE). The results obtained showed increases of up to 30.19% for PH, 114.28% for BW, and 65.22% for GNE, compared to the control variant (V6).

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NONCHEMICAL VERSUS CHEMICAL PROTECTION IN POTATO BLIGHT

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Abstract

The purpose of the paper was to broadly present the specific issues connected to potato cultivation. There are approached aspects of those issues that are not examined enough or the issues which are not yet solved, namely plant nutrient disorders caused by plant protection. There is a specialised field of work concerned with the above topic, but the efficient solutions are few. The majority of solutions recommend chemical intervention, but this does not compile with the recent orientations regarding the EU new Common Agricultural Policy reform expresses in Green Deal that points out the need as production technologies to be environmentally friendly and products to be healthy for assuring food safety. For this reason, in the paper it is presented a biological environmental protection solution in potato cropping for Ila variety compared to chemical protection applied to Kloepatra variety.

Key words: *micro-elements, Ila variety, fungicide contact, systemic*

INTRODUCTION

Potato is an important food crop in the world and in Europe as well.

In 2020, potato was cultivated on 1.7 million ha from which there were harvested 55 million tons. Of the total surface, 76.8% is cultivated in Poland, Germany, France, Romania, Netherlands and Belgium [8].

In Romania, potato is a basic food a reason for which the plant is cultivated on an important surface and production was efficient to cover costs and assure a profit to producers till the moment on climate change started to affect yields and the potatoes imported from Poland to compete on the Romanian market [17, 18].

In 2020, in Romania there were cultivated on 166,000 ha representing 10 % of the EU area with potatoes, and in 2020, potato production accounted for 2,683 thousand tons, representing 5% of the EU output [8].

Potato crop is being affected by different pathogens such as: fungi, viruses and nematodes, which could cause important yield losses, if proper protection measures are not applied.

There are known various methods for disease management in potato crop, such as: chemical control, biological control, the use of resistant varieties, cultural control and physical control. As resistant varieties are the best, but they are break down their resistance over the years. For this reason, chemical management is considered the best alternative, but it has a negative impact on soil, water and final product quality due to the residues released and certain pathogens have showed resistance to a few classes of fungicides and bactericides. The biological control is more and more required as it is based on naturally occurring living organisms which could manage the diseases but also they could increase potato yield [13]. Potato blight is one of the most important diseases being caused by a fungus *Phytopthora infestans* which causes damages to many farmers from many European countries if the corresponding management control is not applied [6].

Many farmers are still dependent on chemical treatments using the products carried out by manufactures and distributed in the market of chemicals for agriculture [5].

For antifungal protection, the manufacturers and the trade offer many superior/high quality fungicides. The recommendations for the application and use of the chemicals offered don’t mention that improper application may result in various nutrient disorders, thus affecting plant fertility. There are also scarce mentions of the heavy metals applied with the pesticides, as micro-elements, to what extent they are incorporated in the plant and to what extent is the plant enriched, leading to significant nutrient disorder.

Recently, many studies were oriented to the application of various biological methods against potato blight [7, 9].

Many scientists and practitioners affirm that that the presence of micro-elements in the soil and the micro-element content of the fungicide (Cu, Mn, Zn, B) are very important when antifungal protection management has to be applied to potato crop [1].

Blight prevention is often based on Cu-based chemicals.

The systemic contact element most frequently used in the combination of contact materials is also Cu.

Under conditions of intensive cultivation, it is necessary to provide protection against 10-12 fungi. The micro-element applied to the foliage through fungicides is incorporated in large quantities in the foliage, significantly altering the plant's nutrient ratio. For a long time, no attention was paid to this condition which acted to reduce the production/the yield.

In this context, the purpose of this paper was to present an original research work experiment regarding the antifungal protection in potato crop, taking into consideration that the presence of micro-elements in the soil and the micro-element content of the fungicide which could determine the emergence of blight-resistant varieties.

MATERIALS AND METHODS

The emergence of blight-resistant varieties, e.g. Ila, [4] was supposed to be connected to the micro-element enrichment caused by pesticides, to the alteration effected to an exaggerated extent on macro-elements [4].

The supplementation of nutrients on the areas under analysis was carried out based on a soil analysis report.

In the experiment, there were used two potato varieties: Ila cultivated on 1 ha and Kleopátra cultivated on 2 ha.

We have applied a similar quantity for each variety, thus the area can be considered homogeneous.

The varieties were planted in immediate proximity. The difference is that the Ila variety, because of its high blight resistance, was not treated with fungicides, while the other varieties were treated each according to their needs.

The cultivation was intensive [15] on a several ha area with the involvement of several farmers from Mórahalom, in Csongrád-Csanád county, in the Southern Great Plain region of Southern Hungary.

The foliage from the varieties used in this experiment on an area of 1 ha was comparatively analyzed in the stage of phenophase: the beginning of the flowering period.

RESULTS AND DISCUSSIONS

Non chemical protection - Ila variety

The results of the foliage analysis for potatoes of Ila variety, grown without any chemicals, are available in the attached Table 1 [19].

At a first glance, the excess of N seems to be a professional error, as a result of which the foliage grew up to 150-160 cm, there was a vegetative growth, and a relative lack of K was measured.

Chemical protection - Kleopatra variety

The results of the foliage analysis for potato plants that were protected by chemicals are presented in Table 2.

Kleopatra [4] was treated three times with Cu-based anti-blight pesticides. The foliage was around 50-60 cm, the rows did not fuse, the plant analysis showed an absolute and relative lack of N and P, the supply of K was excessive, the Cu level was 46 times higher than intended.

When the Ila and Kleopatra varieties were grown one next to the other, under similar soil and nutrient conditions, the foliage of the Kleopatra variety during phenophase did not fuse, its stalk grew up to 50-60 cm, while the Kleopatra stalk grew up to 150-160 cm, Ila was not treated with pesticides, **the only difference being the plant protection.**

Table 1. Results of plant analysis in Ila potato variety, untreated with any chemicals

Sample code	Dry matter %	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	Mo	B
			Dry matter in %				Ppm	ppm	ppm	ppm	ppm	ppm	ppm
0001	0.0	5.48	0.51	4.86	1.46	0.53	0	160	59	20.7	9.9	0.00	26.00
Average:		5.48	0.51	4.86	1.46	0.53	0	160	59	20.7	9.9	0.00	26.00
Nutrient ratios:				N/P	N/K	K/P	Ca/P	K/Ca	K/Mg	Ca/Mg		P/Zn	
				10.7	1.1	9.5	2.9	3.3	9.2	2.8	KKOK N/Cu	246	

Graphic assessment of the analysis results	< Satisfactory supply >	
N	4.50	6.50
5.48		
P	0.30	0.50
	0.51	>
K	4.50	6.00
4.86		
Ca	0.70	3.00
1.46		
Mg	0.30	0.80
0.53		
Mn	30.00	280.00
59		
Zn	25.00	40.00
20.7		
Cu	7.00	10.00
9.9		

Source: Own results.

Table 2. Results of plant analysis in Kleopatra potato variety, protected by chemicals

Sample code	Dry matter %	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	Mo	B
			Dry matter in %				ppm	ppm	ppm	ppm	ppm	ppm	ppm
0001	0.0	3.59	0.21	6.21	2.78	0.63	0	294	96	35.0	460.0	0.00	18.90
Average:		3.59	0.21	6.21	2.78	0.63	0	294	96	35.0	460.0	0.00	18.90
Nutrient ratios:				N/P	N/K	K/P	Ca/P	K/Ca	K/Mg	Ca/Mg		P/Zn	
				17.1	0.6	29.6	13.2	2.2	9.9	4.4	TO N/Cu	60	

Graphic assessment of the analysis results	< Satisfactory supply >	
N	4.50	6.50
3.59		
P	0.30	0.50
0.21		
K	4.50	6.00
	6.21	>
Ca	0.70	3.00
	2.78	
Mg	0.30	030
	0.63	
Mn	30.00	280.00
96		
Zn	25.00	40.00
	35.0	
Cu	7.00	10.00
	460.0	>

Source: Own results.

After carrying out an analysis of the plant foliage, we obtained the results presented in Table 3.

Table 3. The content of N, P, K and Cu in the plant foliage

Variety	N/ dry matter in %	P/ dry matter in %	K/ dry matter in %	Cu ppm
Optimal value limits	**4.5-6.5**	**0.3-0.5**	**4.5-6.0**	**7-10**
Kleopatra: /after five Copper sprays/	**3.59**	**0.21**	**6.21**	**460**
Ila without spraying	**5.48**	**0.51**	**4.5**	**9.9**

Source: Own results.

For the Kleopatra variety, the large Cu quantity prevented the absorption of N and P /antagonist effect/.

It also prevented the absorption of Zn, to a lesser extent than for the two aforementioned elements.

Following the change in nutrient ratios, the enzyme ratios in the plant also changed. The result was a smaller assimilated foliage area, a lower yield.

For the Ila variety, the stalk that grew too high is related to the fact that the quantity of N absorbed is higher than necessary. As a result of the excess of N, [16] the stalk was etiolated and it became sensitive to fungal infections, because a soft tissue was obtained. Another disadvantage is that the quality of the tuber has also decreased.

The applicable nutrient was determined based on the results of the soil analysis, according to the data generally accepted by the literature as shown in Table 4.

Table 4. Nutrient application based on the results of the soil analysis

A yield of 1 t required per nutrient kg	N	P_2O_5	K_2O
	5	2.2	8.2

Source: Own results.

The nutrient supplementation was carried out by 26 potato growers on an area of more than 280 ha. During phenophase, we requested 47 sets of plant analyses, the results of which were presented above. We obtained the results above in all cases, without exception.

The only difference was that a chemical combination increased the Cu level [2] to a larger extent than the other, but the larger Cu quantity prevented in all cases, without exception, the absorption of N and P and the development of the relevant assimilation area.

The Cu level measured in plants was between 200-640 ppm, compared to 7-10 ppm, which is the permitted limited for plants, i.e. 20-64 times higher.

It can also be concluded that some systemic chemicals significantly increase Cu absorption in plants.

The excessive Cu level decreased the N level by a third and the P level by half. Furthermore, the K level of the plants increased.

There is no doubt that the Cu-based pesticides applied offer an excellent protection against infection.

We did not carry out any measurements to determine whether the Cu level increased in the tuber, and if so, how much.

Four of the growers did not use Cu-based fungicides until the potato plants bloomed, on a total area of 72 ha. The protection of the plants on this 72 ha area was based on Mn-based fungicides or purely systemic chemicals.

Regardless of the land or of the variety, in all cases, without exception, the outcome was that the potato stalk grew up to 130-160 cm [3]. Furthermore, plant analysis, regardless of variety, showed a Cu content within the 9-17 ppm range. This small fluctuation may also be due to the differences between varieties. Based on the measurements carried out, as regards the use of Mn-based pesticides, no significant excess of Cu was seen, but an excess of N was measured in all cases.

As for the treatments, where the Cu level was not increased multiple times, the fertilisation using N carried out according to previous experiments resulted in excessive N.

The analyses were carried out on soils with the pH in the 7-8.6 range [10]. These are mainly soils poor in micro-elements, Mn, Zn, B. After the use of Mn-based fungicides, the plant's Mn level increased to an optimal level, therefore it had a fertilising effect on the foliage. It had a highly favourable effect on the yield.

In our case, Mn-based pesticides led to a significant vegetative growth of the potato stalk.

Therefore, the type of soil could influence and its content in minerals could cause plant nutrient disorders if the application of pesticides is unilateral. It is the case of alkaline soil containing Cu and of the acid soil containing Mn [11,12].

Also, Cu absorption could speed up in case of a combination of absorbable and contact materials [14].

Regardless of variety, the plant analysis revealed an excess of N, which is why the stalk grew taller than necessary. The Mn-based pesticide acted as a fertiliser for the foliage, and the Cu caused a ion antagonism that prevented the absorption of N and P.

CONCLUSIONS

1.To avoid the over-dosage of certain elements, plant protection must be based on nutrient analysis.

2. A quantity of 5 kg of N is not required for 1 t, a smaller quantity is sufficient.

3. The number of roots recommended so far must be reviewed.

4.The part of the pesticides containing heavy metals can be incorporated in the plant foliage, thus changing the plant's element ratio. This doesn't cause any growth disorders, unless the nutrient ratios are significantly altered.

5.In cases where the plant cannot absorb the desired quantity of an element in the soil because the soil doesn't contain enough of it, the part of the pesticide containing micro-element acts as a fertiliser for the foliage, improving the supply of nutrients.

6.If the elements applied to the foliage as pesticide are in sufficient quantities, this leads to excessive fertilisation, and some micro-elements are absorbed into the plant to an unwanted extent. The ratio of the elements thus altered, as a result of the ion antagonism, may lead to a reduced yield. In our case there was an over-dosage of Cu.

7.The unilateral application of pesticides, which cause plant nutrient disorders, may be also determined by the type of soil. It is the case of alkaline soil containing Cu and the acid soil containing Mn.

8.The combination of absorbable and contact materials could speed up the plant's Cu absorption.

9.In each case, with just one treatment, a quantity as much as forty times higher than the desired quantity may be introduced.

10.In my opinion, plant protection starts will an optimal supply of nutrients. The results of the soil analysis and plant analysis show what the plant is lacking, based on which the proper pesticide may be selected.

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STUDY ON THE EVOLUTION OF THE SIZE OF AGRICULTURAL HOLDINGS IN ROMANIA AND THE U.E. IN THE PERIOD 2007-2018

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Abstract

The article aimed to analyze the evolution of agricultural areas related to agricultural holdings in Romania and EU countries, from the moment of Romania's accession to the European Union until 2018. At the same time, it was aimed to establish the place occupied by Romania in relation to the other member countries, but at the same time compared to the EU average The study followed not only the classification of agricultural holdings according to agricultural area, but also the eligible areas, as well as the growth rate of agricultural holdings according to the economic size and according to the standard production. The research methodology involved collecting information through databases, processing them and interpreting them using statistical methods, so that by formulating conclusions we can identify not only how farms have evolved over the period, but at the same time identify the causes which were the basis of the existing gaps in Romania compared to the European Union countries.

Key words**:** *agricultural holding, agricultural area, growth rate, economic dimension*

INTRODUCTION

The downsizing of agricultural holdings is one of the important problems of research in the field of agricultural policies, but at the same time of farmers and of the deciding factors, considering first of all its orientation towards the market [19]. If initially the concerns were to increase the size of agricultural holdings in order to ensure their profitability, current trends, to practice an agriculture that is not only profitable, but at the same time to protect the environment and human health, bring us new challenges in regarding the finding of appropriate methods for establishing the optimal size of agricultural holdings.

Regarding the use of this concept, at the level of the European Union it is a "professional farm" and refers to a farm that has a large enough area to provide the farmer with the income necessary to meet his needs and his family [3].

Romanian agriculture, as a basic branch of the national economy [23] has undergone substantial changes in the last 30 years in terms of ownership, land use, etc. which led in a first stage to the fragmentation of the properties. The need to determine the optimal size of agricultural holdings, even if it presents a certain degree of difficulty, especially due to the large number of production factors that determine the results, is equally current, regardless of legislative, economic or social changes.

The size of the agricultural holding is equally important in the choice of technology, of the factors of production [18], but also of the way of using the land [5], of the sustainability indicators of the farm [6], of the sustainability of the production obtained especially in organic farming [22], but also in terms of food security which remains the most important component of global security [7, 20]. All these elements are correlated, as we show even earlier with the need to ensure the profitability of the activity carried out [21]. The world is facing an increase in food demand due to the growth of the world's population, as a result of globalization [2], and climate change is beginning to put increasing pressure on resources, so the need for food supply will be increasing. bigger. Therefore, the role of agriculture and its efficient practice is an important objective of economic and political interest.

We find, therefore, that the size of an agricultural holding is a complex, necessary indicator, and its calculation presupposes the existence of an important number of information, regarding: surface, livestock, equipment, their degree of load, labor force, results economic, etc.

Therefore, in this paper we intend to analyze this indicator, both in Romania and in the European Union.

MATERIALS AND METHODS

The research methodology involved on the one hand the bibliographic study on the need to determine the optimal size of agricultural holdings, and on the other hand on the collection of existing information in national and international databases on the evolution of the number of agricultural holdings, by categories and classes. of size. The data were processed and analyzed with the help of statistical indicators for the analysis of the evolution of the size of agricultural holdings: simple moving average and annual growth rate.

According to the literature, mobile media is calculated as follows:

$SMA_1=\Sigma pi(1…n)/n;$

$SMA_2=\Sigma pi(2… n+1)/n$

$SMA_3=\Sigma pi(3… n+2)/n$ [1]

where:

pi - the values of the analyzed phenomenon from p_1 at p_n

pi - the values of the analyzed phenomenon from p_2 at p_{n+1}

pi - the values of the analyzed phenomenon from p_3 at p_{n+2}

The annual growth rate was calculated according to the formula:

$$\%r = ((sqrt(\prod p1/po)^{1/n})-1)*100$$

where:

$\prod p_1/p_o$ – represent the indicators of the chained growth; the number of years of the period

The data thus determined were systematized with the help of tables and graphs and were the basis for formulating conclusions regarding the evolution of the number of agricultural holdings, as well as their size.

RESULTS AND DISCUSSIONS

Increasing the size of agricultural holdings in order to increase their profitability has been a permanent concern in the policies of the European Union, which have sought both the concentration of production and the reduction of economic gaps. At the level of the European Union, this process has been hampered by the economic crisis since 2007, when Romania became a member of the union. For Romania, another year of transition was 2009, the year in which a series of economic and social processes ended.

Analyzing the evolution of agricultural areas at the level of agricultural holdings in European Union countries, it is found that the highest growth rate was recorded by Bulgaria (11.07%) which started from an average area of 43.2 ha (2007) and reached 67.9 ha (2018). A growth rate of almost 11% was also recorded in Croatia, a country that in 2018 had an average farm area of 48.5 ha. However, the largest areas are registered by agricultural holdings in Slovakia (445 ha), the Czech Republic (192.2 ha), England (158.6 ha) and Denmark (111.5 ha). Both the Czech Republic and Slovakia recorded declining rates of average areas, even if they had low values (1.32% and 2.44% respectively), while Denmark and England had growth rates of 1.8% and 0.23% respectively.

In Romania, although the trend has been increasing, the growth rate from 2007 to 2018 being 7.25%, it is found that the average area is among the smallest in the European Union. After Romania, there are only countries such as Cyprus (10.7 ha), Slovenia (10.5 ha), Greece (9.6 ha) and Malta (2.6 ha), ie countries that either do not benefit from favorable climatic conditions, or countries where agriculture does not it is one of the basic branches of the economy. There are other countries in which the growth rate had negative values (Hungary - 1.74%; Slovakia - 2.44%; Portugal - 1.02%).

Table 1. Evolution of the surface/agricultural exploitation in the period 2007-2018

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual growth rate
	Ha	ha	ha	ha	ha	ha	ha	Ha	ha	ha	ha	ha	%
Austria	31	31.5	31	30.7	30.7	31.6	32.7	28.6	29	29.1	32.8	33.2	*0.63*
Belgium	43.2	44.1	48.4	48.4	48.4	50.4	51	51.2	51.2	49.5	50.1	51.9	*1.69*
Bulgaria	21.4	22.9	34.7	35	35	37.5	37.9	41.9	44.5	44.6	65.9	67.9	*11.07*
Croatia	15.7	14.4	19.1	16.9	16.9	17	54.4	56.1	49.7	51.5	52.7	48.5	*10.78*
Cyprus	7.6	8.1	9.3	8.6	8.6	8.3	8.9	11.4	10.3	10.1	9.5	10.7	*3.19*
Czech Republic	222.5	224.9	224.5	228.8	228.8	199.2	202	201.8	187.8	189.7	193.3	192.2	*-1.32*
Denmark	91.6	92	93.1	96.5	96.5	96.6	97.9	94.9	103.4	110	111.1	111.5	*1.8*
England	154.5	150.9	157.8	155.6	155.6	157.3	164.5	163.8	159.6	159.1	153.9	158.6	*0.23*
Estonia	109.3	112.9	122.4	125.5	125.5	134.1	137	128.7	137.2	134.6	138.7	140	*2.28*
Finland	51.4	52.2	55.1	54.4	54.4	56.9	57.7	58.4	63.8	64	64.6	67.2	*2.47*
France	84.7	84.5	87.2	87.7	87.7	86.8	86.4	86.6	89	87.7	87.8	88.1	*0.36*
Germany	78.4	77.7	85.5	84.8	84.8	87.9	88.9	88.6	89.7	88.7	91.1	91.3	*1.39*
Greece	7.6	7.5	8.5	9.1	9.1	9.5	9.8	10	9.9	10.4	10	9.6	*2.21*
Hungary	54.4	56.1	51.5	52.7	52.7	48.5	48.7	49.2	47.2	45.1	44.8	44.8	*-1.74*
Ireland	45.9	45.9	44.1	43.4	43.4	49.3	49.5	50.1	48	48.2	48.9	48.8	*0.55*
Italy	14.8	14.8	15.9	15.9	15.9	16.6	17	20.5	20.7	21	21	21.6	*3.51*
Latvia	68.6	67.7	70.3	71.8	71.8	70.7	69.1	65.1	69	67.7	66.9	66.1	*-0.33*
Lithuania	43.9	43.5	47.9	46.7	46.7	46.4	48.6	47.5	47.5	49.4	49	49.5	*1.09*
Luxembourg	76.5	76.3	78.5	78.5	78.5	83.9	82.9	82	84.3	83.1	84.6	85.7	*1.03*
Malta	3.1	3	2.7	2.6	2.6	2.7	2.7	2.8	2.6	2.7	2.6	2.6	*-1.61*
Netherlands	34.5	34.7	36.4	36.7	36.7	37.6	36.5	36.9	38.9	38.8	38.3	39.3	*1.2*
Poland	18.3	19.6	18.5	18.6	18.6	18.7	18.8	18.4	19.1	19.6	19.9	19.6	*0.63*
Portugal	25.2	25.5	24.6	25.1	25.1	26.5	26.4	26.8	23.5	23.4	22.8	22.5	*-1.02*
Romania	8.2	8.5	10.3	10.2	10.2	9.3	9.3	9.2	8.8	9.3	9.7	17.7	*7.25*
Slovakia	584	585.3	508.8	552.9	552.9	474.8	550.9	532	458.7	458.8	430.9	445	*-2.44*
Slovenia	10.8	10.8	11.4	11.1	11.1	10.9	10.6	9.8	10.2	10	10.1	10.5	*-0.32*
Spain	36.3	37.3	36	36.5	36.5	40	41	40.9	46.2	46.5	46.7	46.5	*2.27*
Sweden	90.7	90.4	98.6	98.9	98.9	101.6	102.8	106.8	106.6	106.8	105.1	106.6	*1.48*
EU Average	29.4	29.9	32.4	32.5	32.5	33	33.1	33.9	34.5	34.7	35.1	39.9	2.81

Source*:* own processing [4].

The average growth recorded at the level of agricultural holdings in the European Union was 2.81% due to the increase of the average area by about 10 ha during the 12 years analyzed, which is the effect of the agricultural policy measures taken at Union level.

Regarding the eligible agricultural area/ agricultural holding in Romania, although there was a continuous growth trend from 2007 to 2018, (the increase from 2018 compared to 2017 being 81%), we find that the average area is still low compared to the average of the European Union, being between 26% of the average in 2015 and 44% of the average in 2018.

Table 2. Evolution of the eligible agricultural area / agricultural exploitation in the period 2007-2018 in Romania

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	ha	ha	ha	ha	ha	ha	ha	Ha	ha	ha	ha	ha
EU Average	29.4	29.9	32.3	32.5	32.5	33.0	33.1	33.8	34.5	34.6	35.1	39.8
Romania	8.2	8.5	10.3	10.2	10.2	9.3	9.2	9.2	8.8	9.3	9.7	17.6

Source: own processing [8-17].

At the same time, the standard production of agricultural holdings in Romania, expressed in thousands of Euros, is well below the average registered in the European Union. If in 2007 it was 79% below the union average, by 2018 it had recovered only 3%.

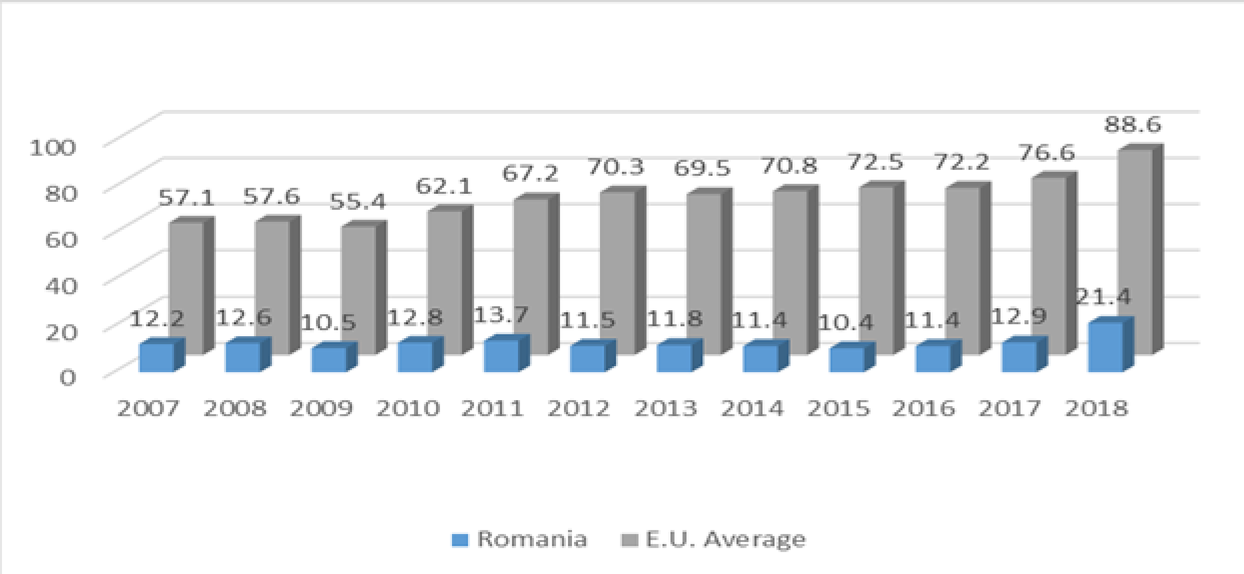

Fig. 1. Situation of standard production in Romania, 2007-2018 (thousand Euro)
Source: own processing [8-17].

Analyzing the growth rate of the size of agricultural holdings in Romania, depending on the size classes (according to the RICA methodology) it is found that only for the interval 2,000 - 8,000 Euro there was an increase of 0.13%, while for all other size classes they have decreased. The most important decrease was 2.13% for the size class between 25,000-50,000 Euro (Table 2, Graph 1).

Table 3. Growth rate of the size of agricultural holdings in Romania, in the period 2007-2018, by size classes (ha)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2,000 - < 8,000 EUR	5.7	6.0	6.0	5.9	6.1	5.1	5.2	5.1	4.5	4.7	4.8	5.8
8,000 - < 25,000 EUR	15.7	16.2	15.3	15.4	15.5	15.1	15.4	15.4	13.7	13.9	14.3	14.4
25,000 - < 50,000 EUR	35.8	36.4	32.6	33.2	33	30.5	30.7	30.5	28.7	28.4	28.2	28.3
50,000 - < 100,000 EUR	60.2	60	57.5	57.6	57.7	55.4	26.5	56.7	53.5	54	53.6	54.9
100,000 - < 500,000 EUR	105.3	104.5	102.7	103.9	103.9	103.6	104.3	103.6	100.6	100.4	100.8	102.1
= > 500,000 EUR	316.8	326.3	308.5	303.1	305.8	295.7	298.6	295.7	270.8	272.9	271	272.4

Source: own processing [8-17].

On the other hand, large agricultural holdings are those that record incomes that place them in the size classes of over 100,000 Euros, respectively 500,000 Euros.

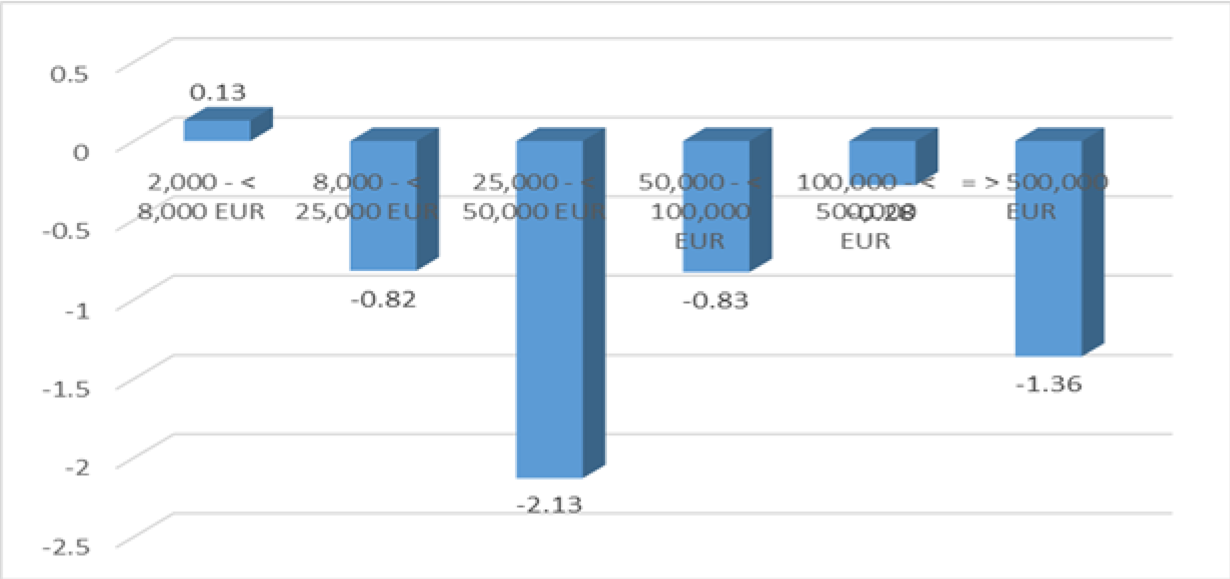

Fig. 2 . Evolution of the Growth Rate of the size of agricultural holdings in Romania, by size classes (2007-2018)
Source: own processing [8-17].

An analysis of the growth rate of the economic size of the agricultural holdings at the EU level emphasizes decreases for all the size classes, except the one of the holdings with incomes ranging between 100,000 – 500,000 Euro which have an increase by 0.71%.

Table 4. Evolution of the growth rate of the economic dimension of agricultural holdings in the European Union (thousand Euro)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2,000 - < 8,000 EUR	9.0	8.7	6.8	7.7	8.4	7.0	6.8	6.8	5.6	5.7	6.4	6.9
8,000 - < 25,000 EUR	23.2	22.2	17.8	18.7	20.3	18.6	18.8	19.6	18.1	17.4	18.5	18.6
25,000 - < 50,000 EUR	50.3	48.5	38.2	41.6	46.2	44.2	43.8	42.8	39.2	39.1	41.9	41.3
50,000 - < 100,000 EUR	89.6	89.0	72.3	81.5	87.5	83.6	82.2	81.9	75.6	74.0	76.5	79.2
100,000 - < 500,000 EUR	232.2	233.2	195.8	224.6	243.3	238.6	239.0	237.1	214.8	208.7	220.4	227.8
= > 500,000 EUR	1,023.6	1,107.7	932.6	1,029.2	1,117.2	1,133.1	1,138.2	1,109.6	1,013.3	1,037.2	1,075.0	1,106.7

Source: own processing [8-17].

Table 5. Evolution of the growth rate of the economic dimension of agricultural holdings in Romania (thousand Euro)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2,000 - < 8,000 EUR	6.4	6.6	6.0	7.2	7.6	5.7	5.9	5.6	4.8	5.0	5.9	6.8
8,000 - < 25,000 EUR	29.8	17.8	14.5	17.6	19.6	14.8	15.8	16.7	13.1	14.4	17.1	18.1
25,000 - < 50,000 EUR	131.1	61.2	40.4	52.0	57.2	42.5	42.5	43.8	37.0	41.2	46.5	45.6
50,000 - < 100,000 EUR	141.8	76.1	77.1	101.3	112.5	82.3	91.7	86.3	73.3	84.1	88.3	90.5
100,000 - < 500,000 EUR	360.2	279.4	233.7	298.6	367.7	248.7	259.8	252.7	229.8	248.5	276.3	297.3
= > 500,000 EUR	1,509.8	5,281.3	1,545.5	2,149.6	1,913.8	1,397.3	1,332.3	1,263.0	1,280.2	1,492.7	1,507.3	1,405.2

Source: own processing [8-17].

At the level of agricultural holdings in Romania, the rate of decrease is maintained for all size classes, except for agricultural holdings that register incomes between 2,000 - 8,000 Euro, at which the growth rate is 0.5%, this being an unprecedented situation in other countries of European Union and which is due to the high degree of fragmentation of ownership, the level of capitalization or training of owners.

It is observed that the size of agricultural holdings is determined both by the factors of production and by the standard production. For large farms, which although not numerous in weight, it is specific that they employ a significant amount of agricultural resources, generating important production in terms of quantity and at the same time high income.

On the one hand, small farms specific to countries with a fragmented structure are beneficial to the development of sustainable agriculture, social agriculture being part of the objectives of rural cohesion policies.

CONCLUSIONS

The direction of development of agricultural structures of the European Union are the result of measures established by the Common Agricultural Policy, but also of national regulations that have contributed over time to changes in farm structure and land use, with direct effect on farm size.

The present study shows that the increase in the average size of agricultural holdings in the European Union has been influenced by the measures taken at the time of the transition from granting direct area payments to coupled direct payments. This justifies our assertion that structural effects are important elements in influencing the size of agricultural holdings, and that these effects also depend on the national particularities of the Member States, as the analysis shows.

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ATTITUDES OF BULGARIAN FARMERS FOR ADOPTING ECO-INNOVATIONS

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Abstract

With the growing needs of society for food safety and quality, as well as habitat protection, soil and water quality improvement, the role of eco-innovations in agriculture can be considered to provide ecosystem services and environmental protection. The attention paid by institutions to food safety and quality encourages innovative solutions. The aim of this paper is to present the attitudes of farmers to implement eco-innovative solutions such as organic farming and agri-environmental practices. A survey was conducted among 64 organic farmers dealing with perennial crops, pastures, and beekeeping in Bulgaria. The data from the survey was used to build logistic regression to analyze the factors affecting the decisions to implement eco-innovative solutions. The results reveal that three most important factors affect willingness to adopt eco-innovations are: positive perception of the impact of eco-innovation on environment quality, positive change in income as a result of organic farming, and adequate state policy and regulation of the agricultural sector.

Key words**:** *eco-innovation, organic farming, ecosystem services*

INTRODUCTION

Eco-innovations in agriculture are processes, products, services, methods (biological), practices (agri-environmental) that are new to agriculture and through which the environment is protected, and a more responsible and efficient use of resources is achieved. The introduction of eco-innovation is a way to promote the provision of agro-ecosystem services (Fig.1). The introduction of eco-innovation on farms poses many theoretical and practical questions, including: (1) what are the factors that form farmers' attitudes for implementing eco-innovations, (2) how eco-innovations affects the development of their farm (including changes in the value of land, change in production costs, total income, etc.), and (3) how and in what way these changes affect the ecosystem services provision.

Increasing social and political pressures to tackle climate change and protect the environment also affect the "greening" of agriculture, including the promotion of agri-environmental practices and organic farming as transition to sustainable agriculture, diversification and multifunctionality of farms.

Agroecology is one of the most successful ways of transitioning to sustainable agriculture [3, 4, 14, 10]. The term agri-environmental innovation is increasingly being used in the scientific literature [13].

The application of agri-environmental practices is considered by some authors even as a socially responsible innovation, not just eco-innovation [8], as it addresses issues related to food security, rural poverty, climate change and their impact on supply for food.

On the other hand, the valuation of public goods and the provision of a market for their realization can be achieved by increasing the share of organic farming. Some studies show that even if the size of tangible agro-ecosystem services in terms of yields is lower in organic farming compared to conventional farming, the balance of all ecosystem services is better in organically managed agro-ecosystems [15]. Therefore, in addition to agri-environmental practices and schemes, organic production is one of the ways to provide agro-ecosystem services.

Innovation in agriculture may depend on a wide range of determinants related to the

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characteristics of innovation (attributes), the structure of the farm and the attitude of the farmer.
Increasing consumer concerns about food safety and environmental impact lead to agricultural innovation being linked to greener production technologies.

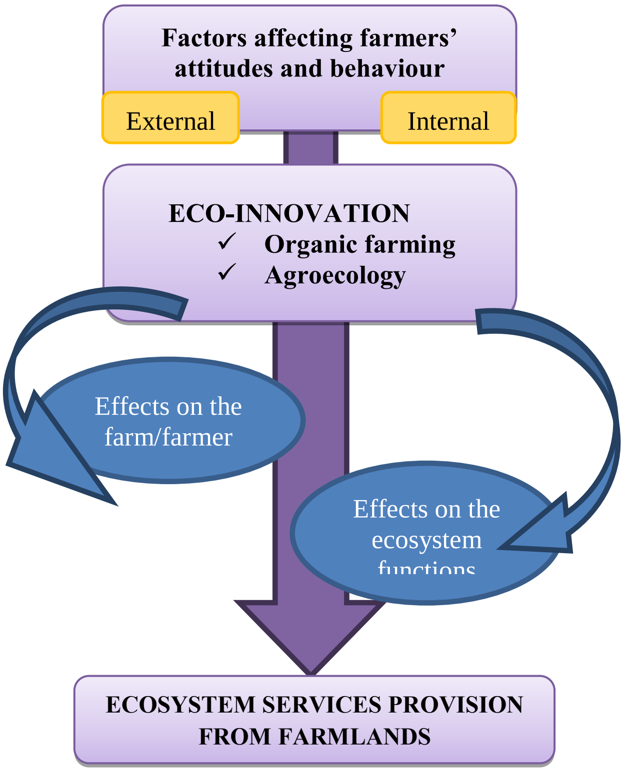

Fig.1. The connection between adoption of eco-innovation and provision of ecosystem services
Source: Own representations.

Economic variables have traditionally been considered in studies on the implementation of agri-environmental practices, revealing flexibility in investment management and the ability to expand and diversify activities [2]. However, the strong individual heterogeneity of farmers suggests that individual attitudes and preferences also play an important role, although they are less likely to be included in empirical research.
Some authors see the process of adoption of a practice as a process based on complex theoretical models [5]. Research on the introduction of agricultural practices is referred to the Rogers' theory of diffusion of innovation. Some authors report [6, 9], that measures aimed at environmental protection are far too different than those for commercial goals. The reason for that is the fact that environmental measures bring benefits to society, making them public goods in the most general sense, and putting the benefits to the individual at a second place. Moreover, environmental practices have long-term societal benefits, as opposed to short-term goals for maximization of the benefits for the individual farmer.
Some researchers have focused on examining attitudes toward implementing a measure in terms of farmers' individual utility, while others have found [11, 1, 13], that maximizing benefits may not be the only factor and that other factors might be relevant.
Using only economic factors for explaining farmers' motivation to adopt eco-innovations fail to explain the heterogeneity of farmers' preferences. Thus, several other factors can influence the decision to implement an eco-innovative practice.

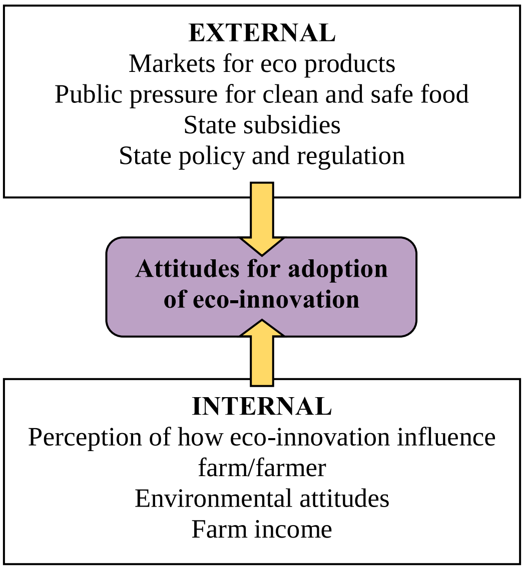

Fig. 2. External and internal factors on attitudes for eco-innovations
Source: Own representations.

Based on the theoretical overview, several characteristics and factors can be grouped that affect the attitude of farmers for implementing eco-innovations (Fig. 2).

MATERIALS AND METHODS

The method of structured interview was chosen to gather the information needed to analyze the attitudes of farmers to implement eco-innovation to provide agro-ecosystem services. For the purposes of the present study, the focus is put on organic farmers. A questionnaire with 23 questions was prepared. The survey was conducted in September-November 2020. The main objective is to assess how the implementation of an eco-innovation (such as organic farming) affects the farm, as well as to assess the barriers or drivers that encourage or dissuade the farmer from this activity. To cover the various agro-ecosystem services, three main areas have been selected: perennial lands, apiaries, and pastures. The survey was conducted with 64 farmers.

The connection between change in income from biological activity as an eco-innovation and the attitudes toward the environment was assessed using Chi square with one factor variable - change in income from organic farming. Then, logistic regression was used to assess the factors affecting farmers' willingness to adopt eco-innovative practices such as agroecology and organic farming. For analyzing the factors affecting implementation of eco-innovative practices, participation equals 1, non-participation equals 0. Correlation analysis was also performed to check if the independent variables have poor correlation with each other [7]. The performance of the correlation matrix and analysis will provide a statistical stability of the model. After that, a forward regression is used, where the independent variables with the highest significant impact are included in the model. All calculations are performed in the statistical program SPSS.

RESULTS AND DISCUSSIONS

Connection between income and environmental attitudes

The attitude towards the environment is a subjective factor that can influence the future behavior of the farmer. It is assumed that the positive economic result of involvement in eco-innovative activities such as organic farming or agroecology would create a positive attitude of farmers towards environmental protection.

As farmers are driven mostly by the economic performance of new practices/production methods, one of the factors to influence the adoption of environmental activities is to secure a positive change in farmers' income. Although, studies have shown examples where farmers behaved as environmental stewards of the land rather than striving for higher economic results, it is believed that examples like these are rather the exception not the rule.

To test this assumption, the strength of the relationship between the attitudes towards the protection of environment on one hand, and the positive change in the income from organic farming on the other, are analyzed. To analyze this relationship, Chi square analysis was used with one factor variable – positive change in income from organic farming (Table 1).

Table 1. Relationship results between change in income and environmental attitudes

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	48.301[a]	1	.000		
Continuity Correction[b]	44.661	1	.000		
Likelihood Ratio	55.944	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	47.546	1	.000		
N of Valid Cases	64				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.98.
b. Computed only for a 2x2 table

	Value	Approx. Sig.
Phi	.869	.000
Cramer's V	.869	.000
Contingency Coefficient	.656	.000
Pearson's R	.869	.000[c]
Spearman Correlation	.869	.000[c]
N of Valid Cases	64	

Source: Own calculations.

Cramer's V coefficient is the most suitable for measuring the relationship.

It is assumed that if it is less than 0.3 the relationship is weak; if it is between 0.3 and 0.7 - the relationship is average; if it is above 0.7 the relationship is strong. It is interpreted only if it is statistically significant - the level of significance is <0.05.

A statistically significant relationship was found with the factor variable. All necessary requirements are met including that there should be no theoretical frequencies less than 1 in the cross-table (the minimum theoretical frequency is 8.98> 1). The sample size should be at least 50 respondents (in this study it is 64).

The coefficient is 0.869, which makes the relationship between the positive attitude towards the environment and the positive change in the income from organic farming statistically significant and strong in degree.

Logistic regression: Organic farming and agroecology

To test the factors affecting adoption behavior of farmers for two eco-innovative activities (organic farming & agroecology) logistic regression was performed.

Based on the theoretical assumptions for different factors, as well as following the steps for performing logistic regression, the variables that remain in the regression equation are:

(A) Organic farming:

-Positive perception of the impact of eco-innovation on environmental quality (X1);

-Positive change in income as a result of organic farming (X2);

-State policy and regulation of organic sector (X3).

(B) Agroecology:

-Positive perception of the impact of eco-innovation on environmental quality (X1);

-Positive change in income as a result of agroecology (X2).

The regression equation for both organic farming and agroecology is:

$$\text{Logit}(\pi)=\text{Ln}(\pi/(1-\pi)) = \beta0+\beta1X1+ \beta2X2\ldots+ \beta nXn$$

where: X1, X2,.....Xn are independent variables, Bo, B1, ...Bn are the parameters of the model.

The data from Table 2 shows that all independent variables are statistically significant.

The value of the exponent of the regression coefficient Exp (B) shows the increase in the chance of adopting organic farming as eco-innovation.

Table 2. Logistic regression organic farming

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
X1	3.317	1.485	4.990	1	.025	27.570
X3	3.379	1.721	3.854	1	.046	29.349
X2	3.047	1.484	4.213	1	.040	21.043
Constant	-14.113	4.141	11.613	1	.001	.000

Source: Own calculations.

If the farmer believes that the effect of eco-innovation on the environment is positive, there is a 27.57 chance to adopt organic farming. Similarly, a positive assessment of government policy on the organic sector increases the chance of implementing organic farming by 29.34, and a positive change in income increases the chance by 21.04.

If the income from organic farming has changed positively (increased), if eco-innovation has a positive impact on the environment, and if the respondent believes that the state policy promotes organic farming, the chance that the farmer has the motivation to engage in organic farming increases significantly. The results for all three independent variables confirm the initial assumptions about their influence on the resultant variable.

Table 3. Logistic regression agroecology

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
X1	2.179	.862	6.395	1	.011	8.840
X2	1.719	.724	5.633	1	.018	5.579
Constant	-4.606	1.318	12.211	1	.000	.010

Source: Own calculations.

Calculations show that all independent variables are statistically significant (Table 3) regarding agroecology regression model. The value of the exponent of the regression coefficient Exp (B) shows that if the farmer believes that the there is a positive impact of eco-innovative practices such as agroecology on farm income then there is 5.58 chance to implement agri-environmental practices. Similarly, if the effect of eco-innovation on the environment is positive, then the chance of implementing agri-environmental practices is 8.84. The interpretation of the variables gives us reason to say that if eco-innovation has had a positive impact on the environment and income, then the chance that the owner will be motivated to engage in the implementation of agri-environmental practices increases significantly

CONCLUSIONS

The goal of this report was to present the factors affecting farmers' willingness to implement eco-innovations like organic farming and agroecology. For this purpose, two types of analysis were performed. First, the connection between the positive change in income from organic farming and the environmental attitudes was tested. It was assumed that farmers who have experienced positive economic result from organic farming would be more inclined to have a positive attitude towards environmental protection overall. The result of the Chi square analysis showed strong relationship between these two variables.

The logistic regressions for both organic farming and agroecology showed that farmers' perception about the positive effect of eco-innovations on income and environment are factors that will increase their willingness to adopt such activities. For organic farming a third factor in the regression equation was the state policy and regulation of the organic sector. One of the main factors that are a barrier to eco-innovation is the constantly changing regulatory requirements and uncertainty in state support for organic production in Bulgaria. Therefore, it is not a surprise to see this factor here. The state support is still a key factor in promoting eco-innovation in agriculture, including organic farming. Unlike agri-environmental practices, organic farming as an agricultural model combines the economic benefits for the farmer with the environmental and social benefits. Organic farming is a sector that in Bulgaria is still heavily dependent on state support, due to less developed markets for organic products and the specifics of the purchasing power of Bulgarian citizens. Overall, increasing societal concerns about environmental pressures from agricultural activity together with increasing support from state agencies (financial, technical, expert consultations, etc.) can lead to increasing interest within farmers to adopt eco-innovations.

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METHODICAL APPROACHES TO THE ASSESSMENT OF THE FORMATION OF SUSTAINABLE (BALANCED) AGRICULTURAL LAND USE

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Abstract

The study considers the approach to the assessment of the formation of balanced agricultural land use by agricultural enterprises. Key efficiency indicators were proposed to use in the assessment of the effectiveness of sustainable agricultural land use measures, namely the environmental sustainability factor – to assess the environmental stability, the yield per unit area and gross value added – for economic and social sustainability assessment. In particular, the study presents the results of the calculations of the actual and potential economic and social efficiency of land use in agricultural enterprises, as well as the calculation of those for non-traditional land use on the example of Kyiv oblast. It was found that reducing the area under sunflower does not worsen economic and social sustainability, but rather improves it. The calculated indicators of economic and social sustainability of land use reveal that Kyiv oblast should adhere to the norms of ratio of the crops sowing scheme and the area under niche crops increase.

Key words**:** *crops, land use, plowing, balancing, sustainability*

INTRODUCTION

In the context of overcoming soil depletion and desertification around the world, sustainable development that meets the needs of the current generation and does not damage next generations resources, namely agricultural land, is the basis for the development of any society. Many Ukrainian scientists, educators, and experts use the term “sustainable development” as the one that is more in line with the essence of development as a process of change with maintaining ecological, economic and social balance.

Economic and environmental interests of society is the basis of sustainable (balanced) development. The imbalance between the two types of interest affects the deterioration of life quality, both for modern and next generations.

If we consider sustainable (balanced) land use, it can be applied equally to ensuring the protection and maintenance of land potential for next generations, and to providing current social and economic opportunities. Keeping the balance will remain an ongoing task for society.

According to Article 1 of the Law of Ukraine On Land Management as amended in 2003 [10], sustainable land use is a form and corresponding methods of land use that provide optimal parameters of environmental and socio-economic functions of territories (and more specifically, in our interpretation, functions of the land). However, amendments to this article made in 2015 determined that sustainable land use is the long-term use of land without changing its purpose, deterioration of land quality characteristics and with provision the optimal parameters of environmental and socio-economic functions of the territories. That is, the Law narrows the concept of "sustainable land use" from a understanding the territory as a land plot.

V.M. Tretiak and V. Yu. Sventukh consider this concept in a broader interpretation [20]. The scientists interpret sustainable development as a process that involves a new type of civilization functioning, based on radical changes in its historically formed parameters (economic, social, environmental). According to the scientists, the consumer attitude of land users to land is often observed in a market economy. Therefore, underestimation of environmental factors in its use is unacceptable, especially under conditions of the land market introduction in Ukraine. The scientists do not agree with the first part of the statement that "sustainable (balanced) land use cannot be interpreted as land use determined by long-term use of land without changing its purpose".

In addition, according to V.M. Tretiak and V.Yu. Sventukh [20], whom we follow, any radical changes in land relations necessitate scientific support of strategies and tactics for the development of sustainable land use. Therefore, the development of conceptual aspects of the problem and specific ways of its solution are of particular significance.

That is, sustainable (balanced) land use is a system of land, other natural resources and biodiversity use and protection organization along with appropriate land relations, corresponding to social development relations. The system involves achieving the optimal ratio between social, environmental and economic factors of land use, normalization the quality of land and other natural resources (neutral degradation), meeting the material and spiritual needs of modern and next generations.

Since the land and natural resources located on it are not only of territorial but also of food and public welfare importance for a country, the development of approaches to the formation of balanced (sustainable) land use should be given much more attention, especially now under combating land degradation and desertification all over the world.

MATERIALS AND METHODS

Scientific papers by Ukrainian and foreign scientists related to the problems of sustainable (balanced) land use were used in the process of covering the research issue.

The official database and reports of the State Service of Ukraine for Geodesy, Cartography and Cadastre, the State Statistics Service of Ukraine made the statistical base of the study. In particular, they were used in presenting the structure of land in Ukraine and for calculating the actual and potential economic and social efficiency of land use by agricultural enterprises.

The ecological and economic estimation of a difference of efficiency level of agricultural lands use in Ukraine and the Kiev area was carried out applying the system analysis and synthesis with the statistical analysis and the subsequent demonstration of results using the graphic method. Research experience of domestic schools of soil science and agroecology was generalized on the basis of the monographic method. The results were used to propose ways of institutional improvement of ways to overcome ecological and economic as well as social crisis of agricultural land use.

RESULTS AND DISCUSSIONS

Modern ecological, economic and social problems are a serious obstacle to the further economic development of both the rural area and the state as a whole. The depleting use of agricultural land, which exceeds the possibilities of their restoration is a characteristic feature of modern land management. Therefore, there arises a problem of running a balanced and efficient agricultural enterprise, which allows to increase production along with maintaining and improving the state of land resources in agriculture. In practical terms, solving these problems involves applying production methods based on the implementation of agricultural organization systems. The methods follow the principles of balanced environmentally safe land use and they can increase production, as well as solve environmental and economic problems of agricultural areas.

The problem of agricultural land efficient use has not been solved, since land relations still do not meet the needs of sustainable (balanced) development of agricultural land use, which involves the coordination of economic, environmental and social factors. The successful solution of this problem will largely depend on the investment and innovation attractiveness of the agricultural sector in rural areas, which can further dramatically increase productivity and introduce environmentally friendly technologies into production.

It should be noted that the order of the Cabinet of Ministers of Ukraine of October 22, 2014 № 1024-p approved the Concept to combat land degradation and desertification [13] until 2020 and approved the National Action Plan to combat land degradation and desertification for its implementation [14], which postponed the implementation of measures untill 2025.

However, as of 2021, a set of measures aimed to combat land degradation and desertification in Ukraine have been implemented. These include: landscaping of arable land by removing their slopes, lands of water protection zones, erosion-hazardous and other unsuitable lands; creation and restoration of hayfields and pastures in accordance with scientifically substantiated indicators taking into account regional features, natural and climatic conditions; acceleration of works on conservation of degraded, technogenic-contaminated and unproductive lands, reclamation of damaged lands.

To assess the state of the National Action Plan implementation [14], consider changes in the structure of land use (Table 1).

Table 1. Lands Structure in Ukraine for 2002 - 2020

Main types of land	% of the total territory of Ukraine					± in 2020 against 2002, %
	2002	2005	2010	2015	2020	
Agricultural lands, total	69.3	69.1	68.9	68.8	68.5	-0.8
• arablelands	53.9	53.8	53.8	53.9	54.3	+0.4
• perennial plantings	1.5	1.5	1.5	1.5	1.4	-0.1
• hayfields	4.0	4.0	4.0	4.0	3.8	-0.2
• pastures	9.2	9.1	9.1	9.0	8.7	-0.5
• fallows	0.6	0.7	0.5	0.4	0.3	-0.3
Forests, including:	17.3	17.4	17.6	17.6	17.7	+0.4
covered with forest vegetation	15.9	16.0	16.0	16.1	16.1	+0.2
Built-up land	4.1	4.1	4.2	4.2	4.1	0
Wetlands	1.6	1.6	1.6	1.6	1.6	0
Open lands with little vegetation	1.7	1.7	1.7	1.7	1.5	-0.2
Other lands	2.1	2.1	2.0	2.1	2.6	+0.5
Total land (upland)	96.0	96.0	96.0	96.0	96.0	0
Inland waters	4.0	4.0	4.0	4.0	4.0	0
Total	100	100	100	100	100	0

Source: designed using the data of 6-landform statistical reports of the State Land Cadastre and the National Report on the state of the environment of Ukraine.

Analysis of the table reveal that the adoption of the new current Land Code [9], starting from 2002, resulted in:

• the area of arable land and forests and other wooded areas in the country increased by 0.4%;

• the area of hayfields and pastures decreased by 0.4% and 0.5%, respectively.

However, the pace of changes in the structure of lands does not meet the objectives of the basic principles (strategy) of the state environmental policy of Ukraine for the period up to 2020 [11], which provided for the following tasks:

• reduction of arable land area by 5-10%, on average, by 2020;

• increase of afforestation area up to 17% of the country's territory by 2020;

• increase in the area of hayfields and pastures up to 15.8% of the country's territory by 2015.

In general, the land fund of Ukraine has an extremely high level of the living space development with about 72.6% of lands involved in economic use and only 27.4 % of all lands of Ukraine classified as ecologically stabilizing lands in 2020.

The level of lands tillage of the territory of Ukraine is extremely high and it made 54.3% in 2020, while in industrial European countries this figure does not exceed 35%. The actual forest cover of the territory of Ukraine is 17.7%, which is not enough to ensure ecological balance, compared to the average figure of 25-30% for European countries [15].

It should also be noted that in Ukraine there are more than 1.1 million hectares of degraded, inefficient and anthropic contaminated lands subject to conservation. 143.4 thousand hectares of fault land need recultivation and 315.6 thousand hectares of unproductive land need reclamation. Water erosion is among the most significant factors reducing land productivity and increasing degradation of agricultural landscapes. The total area of agricultural land affected by water erosion is 13.3 million hectares (32%), including 10.6 million hectares of arable land. The eroded lands contain 4.5 million hectares with medium and heavily washed soils, including 68,000 hectares that have completely lost their humus layer. The quality of land resources is also affected by other negative factors, including salinity, solonetzicity, waterlogging, acidity, stoniness. In addition, intensive agricultural land use leads to reduced soil fertility due to the land (specifically chernozems) compaction, loss of lumpy structure, water permeability and aeration capacity with all the environmental consequences [15].

According to official data of the National Report on the state of the environment of Ukraine [5; 6], the coefficient of ecological stability for the territory of Ukraine in 2012 was 0.41 and land use was characterized as steady ecologically unstable, a similar situation is observed in the territory of Kyiv oblast where the coefficient makes 0.47. As of January 1, 2020, these indicators deteriorated and amounted to 0.40 and 0.43, respectively. The coefficient of ecological stability of land use on the territory of Ukraine and Kyiv oblast shows that the territory of the country and the oblast time has been unstable for a long and is deteriorating every year.

Therefore, the provisions of current legislation are not implemented in the context of the environmental component of sustainable (balanced) land use. The situation is also aggravated by the constant reduction of the funds for implementing a system of land protection measures in Ukraine. In addition, the form of statistical reporting has changed recently and these data are accounted for as components with different cost items, which complicates their assessment.

The analysis of the land use process introduced in Ukraine, especially the agricultural sector, reveals its unbalanced level. It is also confirmed by the volume of soil degradation processes. Ensuring an acceptable level of agri-environmental safety while maintaining the trend of increasing agricultural enterprises profits, namely crop profile, requires a considerate attitude to the use of agricultural land – the main resource potential [16, 18]. It can be assumed that the formation of financial and economic components of agricultural entrepreneurs profits should depend not only of yield and products quality, but on indicators of soil quality the agricultural land acquires due to its agriproduction use [17]. Since land is the basic resource in agriculture and crop production, [3], the characteristics of the agricultural land use and their agrochemical state have a direct impact on productivity. On the other hand, the restoration and preservation of land fertility and the implementation of measures to fertility increase contribute to the increase in both yields and productivity in agricultural production [4].

The structure of sown areas is an important characteristic of land use intensity level in crop production since it indicates the predominance of economic interests over environmental ones. In particular, according to official data from the State Statistics Service of Ukraine, the area under wheat increased from 5.3 million hectares in 2000 to 6.1 million hectares in 2010, and in 2020 this figure was 6.4 million hectares. The situation is similar with the area under sunflower crops: in 2020 it amounted to more than 6.5 million hectares, in 2010 – 4.6 million hectares. Significantly higher growth rates are shown in the areas of rapeseed and corn crops for grain, which increased by about 4 times - from 0.2 million hectares in 2000 to almost 1.1 million hectares in 2020 and from 1.4 to 5.4 million hectares, respectively. Instead, the area under fodder crops underwent dramatic reductions during 2000-2020, as an example, the area under fodder maize crops decreased by more than 6 times from 1.9 million hectares to 0.3 million hectares, grass crops – by three times, from 3.0 million hectares to 0.9 million hectares. Also, the growing level of anthropogenic pressure in agroecosystems should be taken into account. The pressure is caused by increasing yields of most crops. In particular, wheat yields increased from 19.8 cwt/ha in 2000 to 38.0 cwt/ha in 2020 in Ukraine and respectively in the Kyiv oblast from 26.0 cwt/ha to 42.8 cwt/ha; corn for grain – 30.1 cwt/ha in 2000 to 56.2 cwt/ha in 2020 in Ukraine (in some years even more than 70 cwt/ha, namely in 2017 and 2018) and, respectively, in Kyiv oblast – from 43.0 to 48.5 cwt/ha; sunflower – from 12.2 to 20.2 cwt/ha in Ukraine, and, respectively, in Kyiv oblast from 11.7 cwt/ha to 24.5 cwt/ha; rapeseed from 8.4 to 23.0 cwt/ha in Ukraine, respectively, in the Kyiv oblast – from 10.0 to 24.6 cwt/ha in 2020 [8].

In addition, the increase in the amount of mineral fertilizers in the measurement of nutrients provided a significant impact on the results mentioned. It increased by 1.9 times at the national level and by more than 1.8 times in the Kyiv oblast in 2020 (Fig. 1).

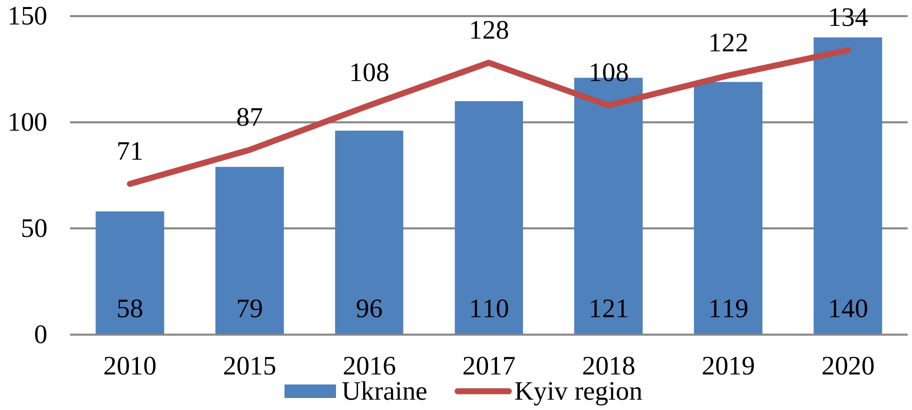

Fig. 1. Application of mineral fertilizers for crops per 1 ha of sown area, nutrient kg
Source: designed by the authors using statistical data of the State Statistics Service of Ukraine.

However, the volume of organic fertilizer application in Ukraine remains at a steady minimum level – 0.5 ton/ha introduced for crops. However, some positive dynamics of this indicator in the Kyiv oblast has been recorded over the past two years – 1.2 tons in 2019 vs 1.3 tons/ha of sown area in 2020 (+1 cwt/ha) (Fig. 2).

Due to high ploughing-up of agricultural lands, the erosion of arable lands increases every year and the humus content in the soils has significantly decreased due to the shortage of organic fertilizers.

The unbalanced way of using agricultural land in commodity crop production results in decrease in fertility and, consequently, in profits loss and economic losses for both modern and next generation due to soil depletion.

Determining indicators of sustainable (balanced) land use is an important trend in its formation. Indicators of sustainable development of land use are the figures extracted from the primary data of the state land cadastre, social and economic statistics, which are used to interpret the current situation and monitor the dynamics of change. On the one hand, the figures, should provide a quantitative description of the achievement of sustainable land use goals [14], on the other hand, they should be used to generalize and clarify key aspects of its stability.

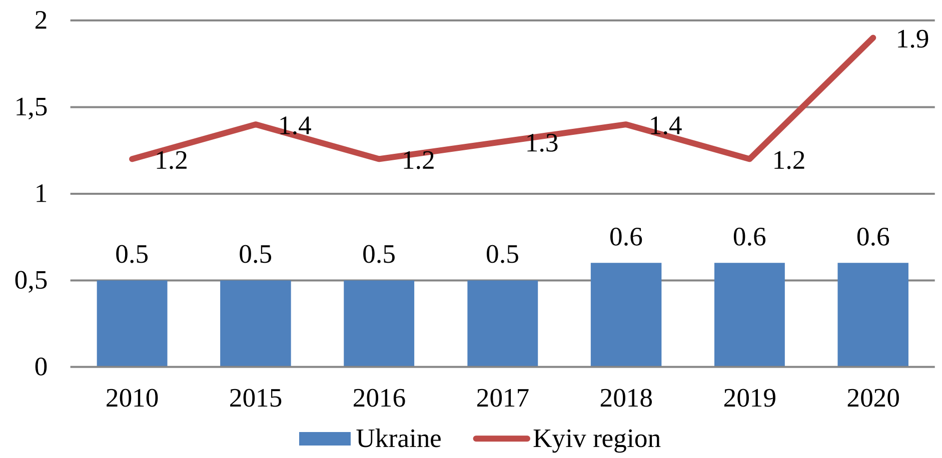

Fig. 2. Application of organic fertilizers for crops per 1 ha of sown area, nutrient t
Source: designed by the authors using statistical data of the State Statistics Service of Ukraine

The set of key factors of land use balance is comprised of factors that affect the indicators of the ecological state of land use and are characterized by both natural and cost indicators. Indicators of ecological efficiency of land use can comprise the coefficient of ecological stability of land use and the coefficient of ecological impact of lands on surrounding lands [21], indicators of land use, land use structure, degree of land use intensity [1] and others. Criteria for economic efficiency of land use often include their profitability, the structure of management (land use) forms and ownership, the coefficient of economic stability of land use [1]. Addressing the issue of resistance measuring is the key issue of research on sustainable (balanced) land use.

Accurate measurement of stability is impossible due to the specifics of the dynamic concept, which considers the facts under specific conditions of place and time [2]. However, the lack of tools for accurate measurement of sustainable land use does not prevent the choice of special parameters or criteria that allow to draw certain conclusions about the development patterns, its downward or upward trend [7].

Although the coefficient of ecological stability can be used as the main indicator for measuring the ecological sustainability of agricultural land use, these indicators need to be substantiated for economic and social sustainability.

Yield per unit area, characterizing the intensity of land use isa key indicator of economic stability, while the gross value added indicates social stability. The value added obtained in land use consists of the components that correspond to the division of economic resources into four types? namely natural (land); capital (capital goods); work (ability to work); entrepreneurial skills. The components of value added according to the four economic resources include land rent and lease (contribution of natural resources, «land»); depreciation (estimation of the consumed capital in the process of product creation), wages (labor contribution) and profit (estimation of the contribution of the business factor). Accordingly, its growth is a social indicator and is characterized by the creation of additional jobs, budget revenues, and partly by the financial condition of the population and local communities.

Calculations of the actual economic and social efficiency of land use by agricultural enterprises in 2020 were made by the example of Kyiv oblast, using the official statistical data of the State Statistics Service of Ukraine (Table 2).

Table 2. Calculation of the actual economic and social efficiency of land use by agricultural enterprises of Kyiv oblast in 2020

Crop	Actual yield, t/ha	Actual sown area, k/ha	Gross production, k tons	Crops growing cost in 2020, UAH/ha	Average price in 2020, UAH/ ton	Gross production cost, thousand UAH	Total costs, thousand UAH	Gross income, thousand UAH	Income per unit area, UAH / ha	Labour pay 2020, UAH / ha	Gross value added, UAH / ha
Winter wheat	4.28	181.2	776	14,583	4,975	3,858,524	2,642,408	1,216,116	6,711	961	7,672
Barley	3.79	66.3	251	6,793	4,552	1,143,888	450,387	693,501	10,460	562	11,023
Corn	4.85	381.4	1850	21,217	4,575	8,462,974	8,092,181	370,793	972	1,159	2,131
Sugar beet	40.61	20.0	812	54,148	884	717,579	1,082,957	-365,379	-18,269	1,650	-
Sunflower	2.45	185.4	454	17,437	10,473	4,757,015	3,232,898	1,524,117	8,221	1,069	9,290
Total		834.3	4143	114,178	25,459	18,939,980	15,500,831	3,439,149	4,122	1,060	5,182

Source: designed by the authors using statistical data of the State Statistics Service of Ukraine

Given the thriftless agricultural land use by enterprises, the optimal ratio of the structure of sown areas for Kyiv oblast was calculated (Table 3), according to the Resolution of the Cabinet of Ministers of Ukraine of February 11, 2010 № 164 [12]. Analysis of the table data shows non-compliance with the norms of sunflower sown areas. In particular, actual sunflower sown areas makes 185,4 thousand hectares with the optimal sowing area of 834.3 thousand hectares that is inadmissible from the agroecological point of view. It should also be noted that according to the scientifically substantiated crop rotation, sunflower should be sown at the previous place not earlier than in 7 years to avoid crop-specific weeds, diseases, as well as deterioration of nutrient and water regimes of the soil [12].

Table 3. Standards for the optimal crops ratio in crop rotations in different natural and agricultural regions

Crop	Actual sown area, k/ha	Norms for optimal sown areas structure ration of the total area		
		%	Min, thousand ha	Max, thousand ha
Winter wheat	181.2	25-95	208.6	792.6
Barley	66.3			
Corn	381.4			
Sugar beet	20	3-30	25.0	250.3
Sunflower	185.4	0.5-9	4.2	75.1
Total	834.3			

Source: calculated by the authors using the source [12].

The calculation of economic and social efficiency of land use by agricultural enterprises according to the norms of the optimal ratio of crop structure in Kyiv oblast is presented in table 4. It is worth noting that the calculation used the maximum 75.1 thousand hectares of sowing area of sunflower calculated in Table 3, and the area that was exceeded (110.3 thousand hectares) was transferred for grain crops (barley). Tables 2 and 4 data show that, reduce in the area under sunflower does not worsen economic and social sustainability, but rather improves it. In particular, the obtained data on the crop yields according to actual data is 4,122 UAH/ha, while changing the structure of sowing results in 4,418 UAH/ha, which 296 UAH/ha more. The calculations of gross value added have a similar situation and show that the social efficiency of land use by agricultural enterprises in changing the structure of sunflower sown area improves gross value added by 229 UAH/ha, namely from 5,182 UAH/ha to 5,412 UAH/ha.

Table 4. Calculation of potential economic and social efficiency of land use by agricultural enterprises according to the standards of optimal ratio of crop structure in Kyiv oblast

Crop	Potential yield, t/ha	Crops sowing area, according to the norms for optimal ratio of the crop [12], thousand ha	Gross production, thousand tons	Crops growing cost in 2020, UAH/ha	Average price in 2020, UAH/ ton	Gross production cost, thousand UAH	Total costs, thousand UAH	Gross income, thousand UAH	Income per unit area, UAH / ha	Labour pay 2020, UAH / ha	Gross value added, UAH / ha
Winter wheat	4,28	181,2	776	14,583	4,975	3,858,524	2,642,408	1,216,116	6711	961	7,672
Barley	3,79	176,6	669	6,793	4,552	3,047,142	1,199,761	1,847,381	10,460	562	11,023
Corn	4,85	381,4	1,850	21,217	4,575	8,462,974	8,092,181	370,793	972	1,159	2,131
Sugar beet	40,61	20,0	812	54,148	884	717,579	1,082,957	-365,379	-18,269	1,650	-
Sunflower	2,45	75,1	184	17,437	10,473	1,926,591	1,309,323	617,267	8,221	1,069	9,290
Total		834,3	4,291	114,178	25,459	18,012,810	14,326,631	3,686,179	4,418	993	5,412

Source: calculated by the authors using statistical data of the State Statistics Service of Ukraine and the source [12].

Also, according to some previous studies [19], other crops, in particular non-traditional ones, should be introduced into the crops structure as it will increase not only the profitability of land use and added value, but will improve environmental sustainability as well. According to research [19] some cereals such as buckwheat and peas are niches crops, some are technical - soybeans, vegetable and berry crops and others make non-traditional land use. Given that Kyiv oblast is the capital region, it has a demand for fruit and berry crops products, and Table 5 presents the calculation considering the increase in these crops area as components of non-traditional land use.

Table 5. Calculation of potential economic and social efficiency of land use by agricultural enterprises using crops of non-traditional land use

Crop	Potential yield, t/ha	Crops sowing area, according to the norms for optimal ratio of the crop [12],	Gross production, thousand tons	Crops growing cost in 2020, UAH/ha	Average price in 2020, UAH/ ton	Gross production cost, thousand UAH	Total costs, thousand UAH	Gross income, thousand UAH	Income per unit area, UAH / ha	Labour pay 2020, UAH / ha	Gross value added, UAH / ha
Winter wheat	4.28	181.2	776	14,583	4,975	3,858,524	2,642,408	1,216,116	6,711	961	7,672
Barley	3.79	66.3	251	6,793	4,552	1,143,888	450,387	693,501	10,460	562	11,023
Corn	4.85	381.4	1,850	21,217	4,575	8,462,974	8,092,181	370,793	972	1,159	2,131
Sugar beet	40.61	20.0	812	54,148	884	717,579	1,082,957	-365,379	-18,269	1,650	-
Sunflower	2.45	75.1	184	17,437	10,473	1,926,591	1,309,323	617,267	8,221	1,069	9,290
Fruit and berry	9.37	110.3	1,034	3,887	19,372	20,023,948	428,739	19,595,209	177,633	525	178,158
Total		834.3	4,906	118,065	44,831	219,960,244	98,501,534	121,458,709	145,582	988	208,273

Source: calculated by the authors using statistical data of the State Statistics Service of Ukraine and the source [12].

Tables 4 and 5 data show that the increase in the area of fruit and berry crops will increase the profitability by 141,459 UAH/ha and reach 145,582 UAH/ha; gross value added will increase by 203,091 UAH / ha, and make 208,273 UAH/ha.

The integrated index (I_{INT}) of balanced land use can be calculated by the formula using indicators of environmental, economic and social sustainability:

$$I_{INT} = I_{ecol.st.} \times I_{econ.st} \times I_{soc.st} = 1.08$$

where $I_{ecol.st}$ – index of ecological sustainability of land use calculated by the formula:

$$I_{ecol.st.} = C_{ecol.st.act} / C_{ecol.st.norm} = = 0.43/0.47 = 0.97$$

where $C_{ecol.st.norm}$ – normative coefficient of ecological sustainability, equal to 0.67;

$C_{ecol.st.act.}$ – the actual environmental sustainability in the current state of land use.

$I_{econ.st.}$ – index of economic sustainability of land use calculated by the formula:

$$I_{econ.st.} = P_p / P_a = 4{,}243/4{,}122 = 1.07$$

where P_p – profitability of potential economic efficiency of land use;

P_a – profitability of the actual economic efficiency of land use.

$I_{soc.st.}$ – index of social sustainability of land use calculated by the formula:

$$I_{soc.st.} = GVA_p / GVA_a = 5{,}236/5{,}182 = 1.04$$

where GVA_p – gross value added of potential social efficiency of land use;

GVA_a – gross value added of the actual social efficiency of land use.

If the obtained indices of ecological, economic and social sustainability exceed 1, the land use is considered as sustainable (balanced). However, if one of these indices is under 1, the component has a negative impact on the balance of land use.

CONCLUSIONS

The formation of sustainable (balanced) land use is an important current issue, both for Ukraine and the world countries.

Nevertheless, the study found that there is excessive depletion of agricultural resources in Ukraine, which in turn contributes to high plowing, intensification of soil degradation and inefficient land use due to non-compliance with legislation. As of 2021, the pace of changes in the structure of lands does not meet the objectives of the basic principles (strategy) of the state environmental policy of Ukraine developed for the period up to 2020. In particular, the objectives provided for a reduction of the area of arable land by 5-10% on average of while the actual increase has made by 0.4%. The area increase of hayfields and pastures increased to 15.8% of the country's territory, however, it actually decreased by 0.7%. Ecological sustainability of land use on the territory of Ukraine is referred to as characterized by steady ecologically unstable.

Given that, sustainable (balanced) land use is a system of organization of land and other natural resources, biodiversity and related land relations use and protection that is in line with social development relations it achieves the optimal relationship between social, environmental and economic factors of land use. In addition, it can normalize the quality of land and other natural resources (neutral degradation); meet the material and spiritual needs of present and next generations. Therefore, the authors proposed a methodological approach to assessing the formation of sustainable agricultural land use. In particular, key efficiency indicators were proposed to assess the effectiveness of measures to form a sustainable agricultural land use, namely the environmental stability factor – to assess the environmental sustainability, economic and social sustainability to be assessed through the yield per unit area and gross value added which characterizes the creation of additional jobs, budget revenues, as well as partially financial condition of the population and local communities.

In particular, on the example of Kyiv oblast, calculations of the actual and potential economic and social efficiency of land use by agricultural enterprises were made. Also calculation of land use with the use of non-traditional land use crops. The result of such calculations was that reducing the area under sowing resource-saving sunflower does not worsen economic and social sustainability, but rather improves it. In the process of calculated indicators of economic and social sustainability of agricultural land use, an integrated index (I_{INT}) of balanced land use was determined, which allowed to establish that Kyiv oblast needs to comply with the structure of crops and increase areas under niche crops, such as fruit and berry crops.

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STUDIES ON PRODUCTION, CONSUMPTION AND TRADE BALANCE SITUATION OF MEAT IN ROMANIA

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Abstract

Meat consumption in Romania is increasing, but domestic production is stagnant. Although animal husbandry is a basic branch of the Romanian economy, its share in agricultural production has had a downward trend in recent years. This important component of agriculture has a high potential for development, which is supported by a number of factors, including access to raw materials, the upward trend in domestic meat consumption, the record level of trade in meat, the prospect of further European economic convergence, and the consequences of the pandemic-induced shock. Domestic meat consumption has shown an upward trend in recent years, supported by an increase in household income. Meat production in Romania is below meat consumption, in the analyzed period 2015 - 2019, so it cannot ensure the necessary consumption of meat from its own production. In 2015, the production of meat per capita has a value of 54.75 kg, and the value of meat consumption per capita is 66.02 kg. In 2019, the production of meat per capita has the lowest value, of 54.72 kg, the consumption of meat per capita has the highest value of this analyzed period, of 69.85 kg. Meat consumption has been steadily rising, but Romania's GDP, urbanization and the FAO Food Price Index have had very little influence on it. In terms of meat consumption in the European Union, it is found that Belgium has the lowest value of 54.71 kg/capita (it is the fourth largest meat producer in the EU with 158.94 kg / capita), and the highest meat consumption is in Spain with 98.79 kg / capita, and Romania is ranked twenty-fourth. Meat production / capita in the European Union has the highest value in Denmark with 326.14 kg/capita and the lowest value is in Malta with 27.32 kg /capita, Romania ranks seventeenth.

Key words: *food, meat, production, consumption, trade balance, FAO Meat Price Index*

INTRODUCTION

In the last three decades, the perception of food by the Romanian consumer has evolved rapidly in response to socio-economic changes. As Romania is going through a transition phase, both economically and socially, the socio-economic status and the distribution of the type of population have generated specific patterns of food consumption [5]. Meat is a staple food, used to feed the population and is an important source of nutrients. Meat consumption worldwide is influenced by the traditions of each country [4]. Meat is an essential product for consumption in food, but depending on consumption it can show us the standard of living. The meat trade has resulted in a strong connection between states, which has helped grow economies [3]. Meat production is crucial for achieving self-sufficiency targets for important agricultural products from the perspective of Romania's food security, as defined by a recent national strategy [1]. Domestic consumption of pork is not satisfied with its own production in Romania. Support is needed for pig farmers to increase production capacity in order to meet the domestic market and reduce import dependence. [7]. The number of sheep and goats is constantly growing, as is the production and export of sheep meat [9]. Income / family and piece of meat are the major factors that limit the amount of meat consumed and the frequency of purchase. The timing of availability and the origin of the meat have become increasingly important criteria on which the purchase decision is based, in addition to the quality of the meat. All consumers prefer to eat Romanian meat that is tasty and has a pleasant aroma. In conclusion, consumers' expectations of meat producers are linked to a wide variety of high-quality meat [6]. Romania's generous natural resources and animal husbandry can provide adequate raw materials for the manufacturing industry to meet the needs of domestic consumption and to obtain substantial export earnings. At the moment. The Romanian meat market is dependent on meat imports, in the form of carcasses or processed products. It was mainly live or semi-finished animals that were exported, which led to a trade imbalance and low incomes for the domestic meat industry [10]. The agricultural and food sectors around the world are affected by globalization, changes in the rules governing international trade, and national and international agricultural and competition policies. These sectors face, on the one hand, an abundance of food markets and, on the other hand, an increase in consumer requirements for the quality of the final product [8]. Romania is dependent on imports in terms of the food market. If Romania's agriculture is properly exploited, it can ensure domestic demand, but it can also generate profit for Romanian farmers [2].

MATERIALS AND METHODS

In this paper a study was made on the production of meat from the main species of animals slaughtered in our country, also presents the balance of meat from these species of animals in Romania, in the period 2015 - 2019. Highlights the situation of meat consumption in our country. It will be examined whether meat consumption has been influenced by GDP, the degree of urbanization and the FAO meat price index.

For the correlations between (1) GDP and meat consumption, (2) the degree of urbanization and meat consumption and (3) FAO meat price index and meat consumption, the equation will be used:

$$r = \frac{\sum(x_i - \overline{X})(y_i - \overline{Y})}{\sqrt{\left(\sum(x_i - \overline{X})^2\right)\left(\sum(y_i - \overline{Y})^2\right)}},$$

where: $\bar{X}$ and $\bar{Y}$ - are the averages for samples, average (matrix1) and average (matrix2).

In the analysis, the values of the correlation coefficient (r) and of the coefficient of determination will be presented (R^2).

Polynomial function: the n order polynomial model:

$y = a_0 + a_1x^1 + a_2x^2 + \ldots + a_nx^n$.

RESULTS AND DISCUSSIONS

Table 1 shows the situation of meat production from the analyzed species: beef, other meat, mutton and goat meat, pigmeat and poultry meat, in the period 2015-2019, in Romania. Total meat production increases from 1,092 thousand tons in 2015, reaches a maximum value of 1,152 thousand tons in 2018, and in 2019 reaches a minimum value of 1,063 tons of meat. Regarding the dynamics of meat production, it is observed that the highest increase, reported in 2015, was 5.49% in 2018, and in the last year of analysis the value of production decreases by 2.66% compared to 2015. Table 2 shows the balance of meat from the analyzed species from 2015 to 2019, where the total import of meat was 2,538 thousand tons of meat, and the total export of this period was 854 thousand tons of meat

Table 1. Meat production situation, in the period 2015 - 2019, in Romania

Species	*Unit 1,000 Tonnes*					*Dynamic (%)*			
	2015	**2016**	**2017**	**2018**	**2019**	**2016/2015**	**2017/2015**	**2018/2015**	**2019/2015**
Bovine Meat	119	116	111	99	102	-2.52	-6.72	-16.81	-14.29
Meat, Other	12	12	12	11	0	0.00	0.00	-8.33	-100.00
Mutton and Goat Meat	80	87	83	81	55	8.75	3.75	1.25	-31.25
Pigmeat	470	501	492	481	399	6.60	4.68	2.34	-15.11
Poultry Meat	411	419	436	480	507	1.95	6.08	16.79	23.36
Total	**1,092**	**1,135**	**1,134**	**1,152**	**1,063**	**3.94**	**3.85**	**5.49**	**-2.66**

Source: Own calculation according to data www.fao.org/faostat/en/#data.

Table 2. Trade balance of meat, by species in Romania, in the period 2015 - 2019

Species	Export (1,000 Tonnes)					Import (1,000 Tonnes)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Bovine Meat	12	16	20	15	11	40	39	21	23	27
Meat, Other	7	7	11	13	11	11	6	4	6	5
Mutton and Goat Meat	7	5	8	10	10	0	0	1	1	0
Pigmeat	51	68	74	58	45	264	282	333	401	397
Poultry Meat	77	79	69	77	93	123	137	146	141	130
Total	**154**	**175**	**182**	**173**	**170**	**438**	**464**	**505**	**572**	**559**
	854					**2,538**				

Source: Own calculation according to data www.fao.org/faostat/en/#data

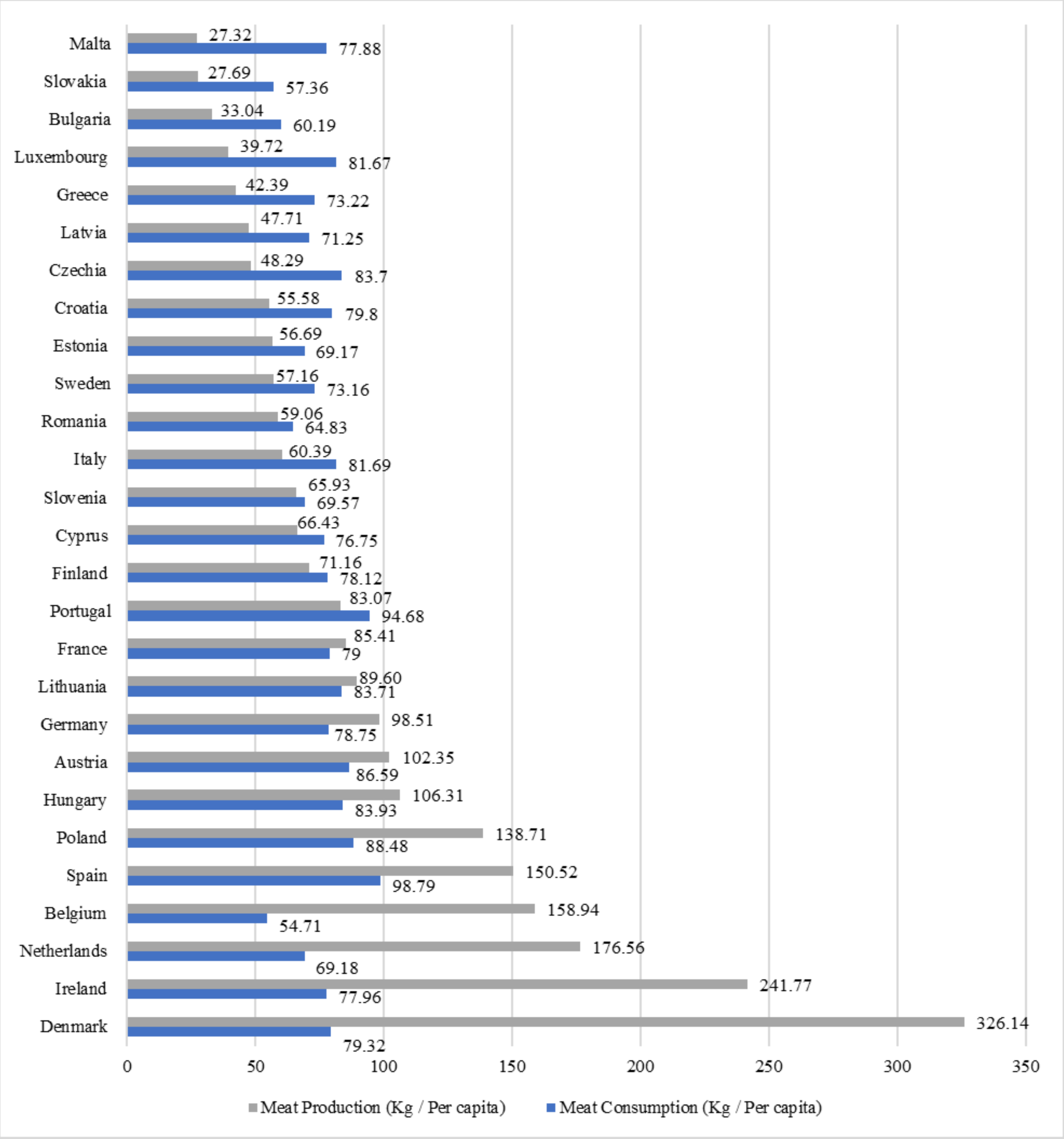

Fig. 1. Meat production and meat consumption at EU level, in 2018 (kg/capita)
Source: Own construction according to FAOSTAT data.

Figure 1 shows that the highest meat production per capita in the European Union

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is in Denmark with 326.14 kg/capita, and the lowest production is Malta with 27.32 kg/ capita. In this ranking, Romania is on the seventeenth place, with a production of 59.06 kg/capita.

In terms of meat consumption in the European Union, Belgium has the lowest value, at 54.71 kg/capita, although it is the fourth largest meat producer on the market in the European Union, in terms of meat production, with 158.94 kg/capita. The highest meat consumption is in Spain, with 98.79 kg/ capita, this country ensures its own production, which has a value of 150.52 kg/ capita. Romania ranks twenty-fourth in terms of meat consumption, with a value of 64.83 kg/capita, and has a higher value than domestic production, which shows that the need for consumption is assured from imports (Figure 1).

Table 3. Degree of urbanization, meat consumption, meat production, GDP and FAO meat price index, in Romania, in the period 2015 - 2019

	Value GDP (US$/capita)	Meat Production (kg/capita/year)	Meat Consumption (kg/capita/year)	Degree of Urbanisation (%)	FAO Meat Price Index (2014-2016=100)
2015	8,928.14	54.75	66.02	53.84	98
2016	9,417.69	57.33	68.23	53.72	97
2017	10,160.47	57.70	67.87	53.70	100
2018	10,691.70	59.06	64.83	53.82	103
2019	11,209.22	54.72	69.85	53.97	110

Source: Own calculation according to data www.fao.org/faostat/en/#data

Figure 2 shows the dynamics of the meat balance, which shows that imports increased from 439 thousand tons of meat in 2015, to a maximum of 572 thousand tons in 2018, and in 2019 decreases to 559 thousand tons of meat. Regarding the export situation, it has the value of 154 thousand tons of meat in 2015, reaches the maximum value of 182 thousand tons of meat in 2017, and in 2019 decreases to the value of 169 thousand tons of meat. It is observed that Romania imports 3 times more meat than it exports.

Figure 3 shows that Romania has an average annual meat consumption per capita considerably lower than the European average, for the entire analyzed period 2015 - 2019. At European level, consumption has steadily increased from 75.33 kg/capita, in 2015, at the value of 79.27 kg/capita in 2019. In Romania, the average meat consumption per capita fluctuated, from the value of 66.02 kg/capita, in 2015, to the lowest value of 64.83 kg/capita in 2018, and in 2019 it reaches the maximum value of 69.85 kg/ capita. Globally, meat consumption per capita is much lower than in European meat consumption, and is approximately constant, with a value of 42.21 kg/capita in 2015, and in 2019 it increases slightly to 43.15 kg/capita.

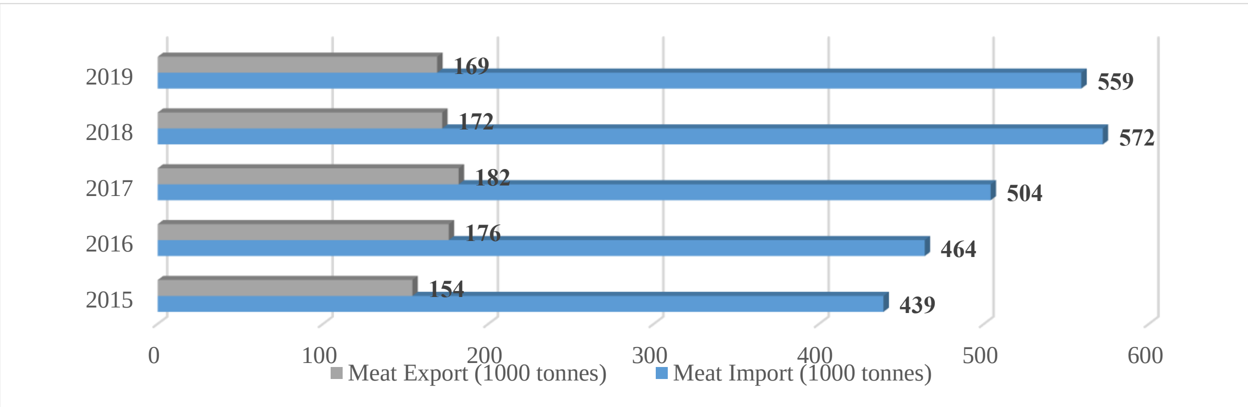

Fig. 2. Trade balance of meat in Romania, in the period 2015 - 2019
Source: Own construction according to FAOSTAT data.

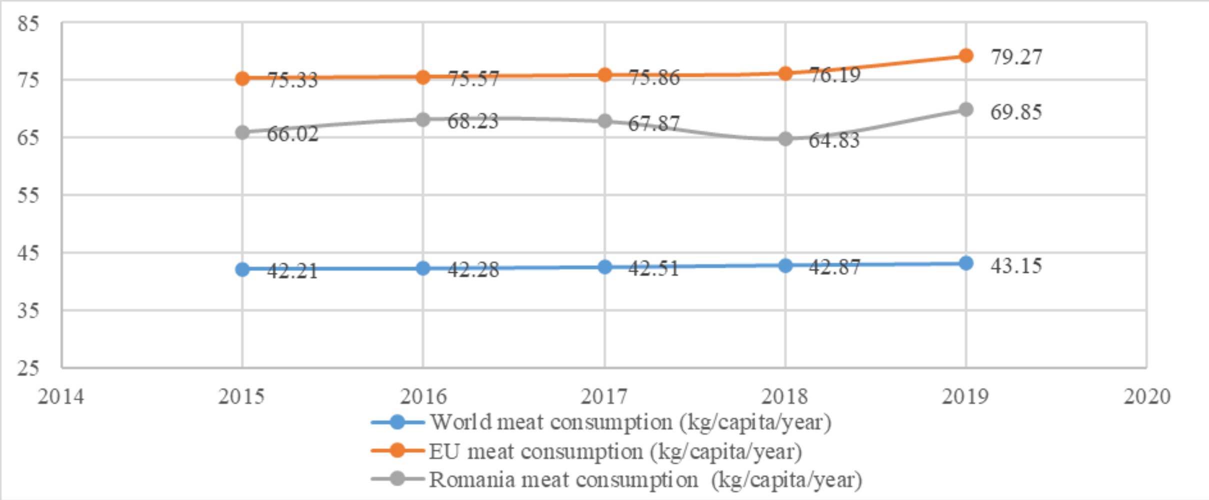

Fig. 3. Average meat consumption in the world, in the EU and in Romania
Source: Own construction according to FAOSTAT data.

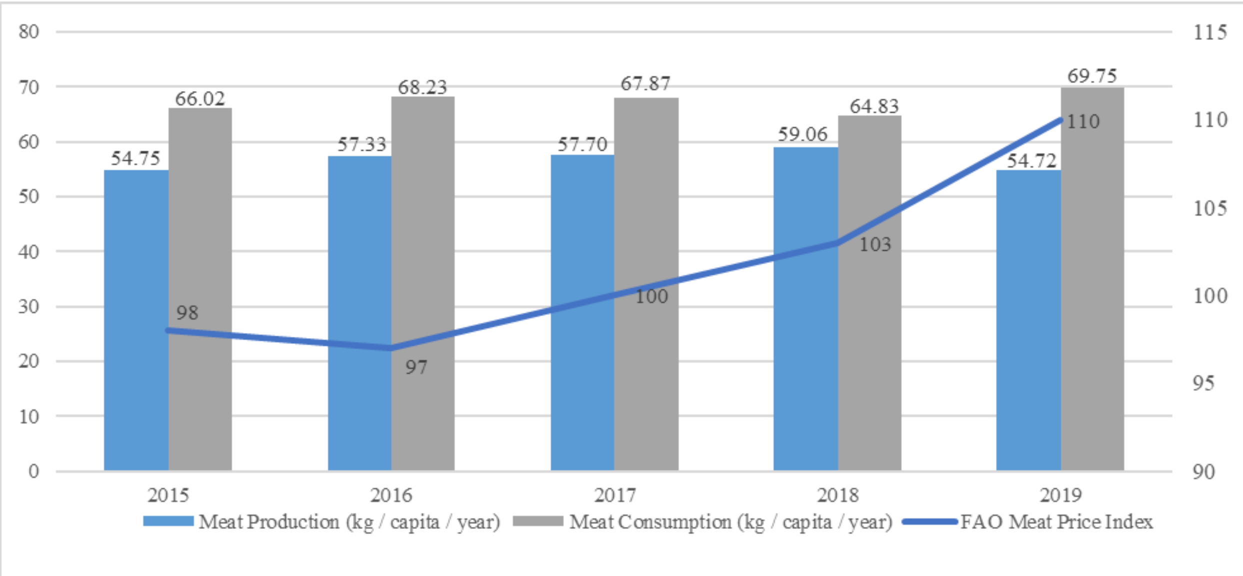

Fig. 4. Meat consumption, meat production and FAO meat price index, in Romania, in the period 2015 – 2019
Source: Own construction according to FAOSTAT data.

Figure 4 shows that meat production in Romania is below meat consumption, throughout the analyzed period, so it cannot ensure the necessary consumption of meat from its own production.

In 2015, the production of meat per capita is 54.75 kg, and the value of meat consumption per capita is 66.02 kg, and the value of the FAO Meat Price Index is 98.

In the following year, 2016, the production of meat per capita increases to 57.33 kg, and per capita meat consumption reaches 68.23 kg and the FAO Meat Price Index has a slight decrease to 97.

At the level of 2017 and 2018, the production of meat per capita was approximately constant, with the value of 57.7 kg, respectively 59.06 kg. Meat consumption per capita in 2017 was 67.87 kg, and in 2018 its value decreased to 64.83 kg, while the FAO Meat Price Index increased from 100 in 2017 to of 103 in 2018.

In 2019, the production of meat per capita has the lowest value, of 54.72 kg, the consumption of meat per capita has the highest value of this analyzed period, of 69.75 kg, also the FAO Meat Price Index has the highest high value of 110.

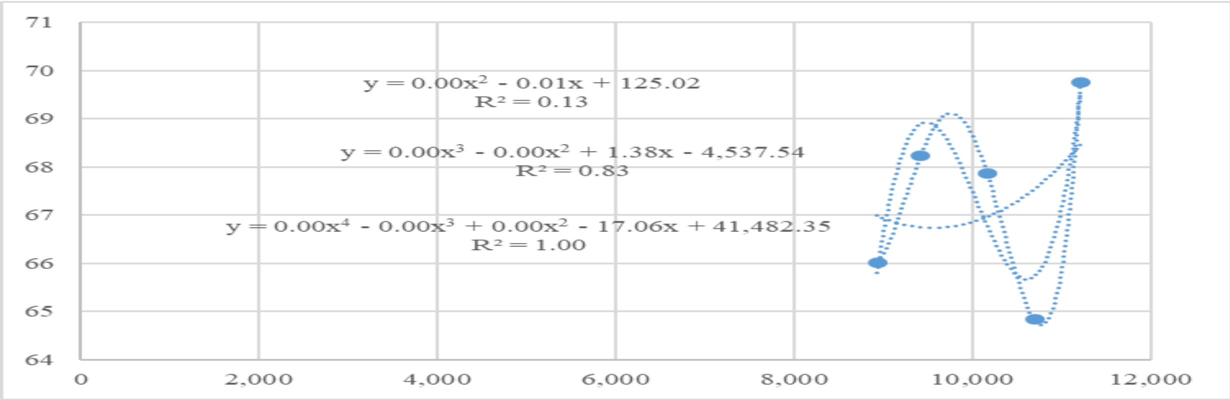

Fig. 5. Correlation between GDP and meat consumption
Source: Own construction

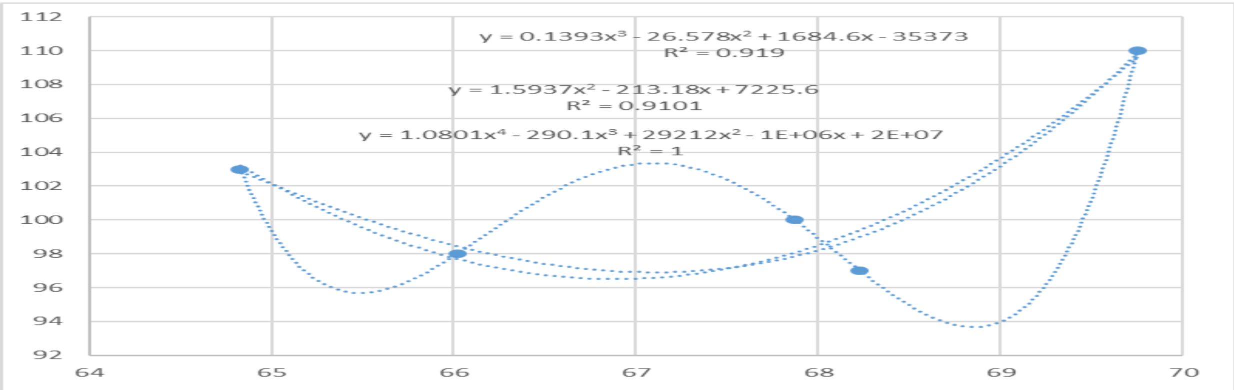

Fig. 6. Correlation between the degree of urbanization and meat consumption
Source: Own construction.

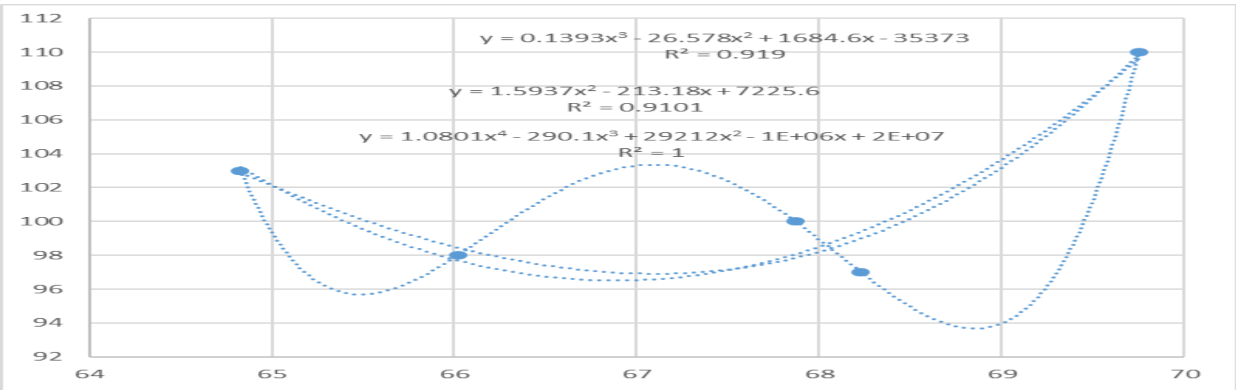

Fig. 7. Correlation between FAO Meat Price Index and meat consumption
Source: Own construction.

The result of the correlation between GDP and meat consumption is 0.3, which results in a weak dependence between the two variables, so we can say that the value of GDP had a weak influence on the evolution of meat consumption in Romania. Starting with the third degree polynomial function, an increasingly close connection is observed between the two variables (Figure 5).

Following the correlation between the degree of urbanization and meat consumption, the value was 0.21, so we can say that the degree that the evolution of meat consumption was not influenced by the degree of urbanization in Romania. Starting with the third degree polynomial function, an increasingly close connection is observed between the two variables (Figure 6).

Following the correlation between the FAO Meat Price Index and meat consumption, the value of 0.4 resulted, so a direct correlation with a weak dependence, which shows that although the price of meat has increased, so has the consumption of meat in Romania. Starting with the second degree polynomial function, a closer connection is observed between the two variables (Figure 7).

CONCLUSIONS

Total meat production increases from 1,092 thousand tons in 2015, reaches a maximum value of 1,152 thousand tons in 2018, and in 2019 reaches a minimum value of 1,063 tons of meat.

The trade balance of meat from the analyzed species from 2015-2019 shows that the total import was 2538 thousand tons of meat, and the total export was 854 thousand tons of meat.

Meat consumption in Romania is increasing, but domestic production is stagnant. Meat production in Romania is below the European meat consumption, throughout the analyzed period, so it cannot ensure the necessary consumption of meat from its own production. In 2015, the production of meat per capita has a value of 54.75 kg, and the value of meat consumption per capita is 66.02 kg. In 2019, the production of meat per capita has the lowest value, of 54.72 kg, the consumption of meat per capita has the highest value of this analyzed period, of 69.85 kg. The correlations show that meat consumption has increased steadily, but Romania's GDP, urbanization and the FAO Food Price Index have had very little influence on it.

In terms of meat consumption in the European Union, it is found that Belgium has the lowest value of 54.71 kg/capita (it is the fourth largest meat producer in the EU with 158.94 kg/capita), and the highest meat consumption is in Spain with 98.79 kg/capita, and Romania is ranked twenty-fourth with 64.83 kg/capita.

Meat production/capita in the European Union has the highest value in Denmark with 326.14 kg/capita and the lowest value in Malta is 27.32 kg/capita, Romania ranks seventeenth with 59.06 kg/capita.

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DIGITALIZATION IN FARM MANAGEMENT

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Abstract

The paper analyzes the influence of digitalization on managerial activity in agriculture and highlights how the use of farm management software has an impact on overall economic efficiency. Romania is at the level of the European Union the country with the largest number of agricultural holdings. Farm management is one of the factors of production that can favor a positive result of the activity carried out, and innovation in this field can bring added value to the activity both in terms of organizing production processes and forecasting and especially the control performed. The study highlights and proposes Geofolia software as an example of a useful tool in digitalizing agricultural activity and how to manage the farm indicating the advantages and the need for such a tool as part of the overall process of globalization. The statistical data used in the study is represented by the National Institute of Statistics, Eurostat and Faostat, the methods used being diagnostic analysis, statistical data analysis and case study. The results of this study are indicating that farm management needs to adapt to the global trend of innovation in organizational and informational systems in order to ensure efficiency, the advantages of a farm management software being ways to increase competitive advantage in a global market.

***Key words*:** *digital farming, agribusiness, sustainability, farm management software, Geofolia*

INTRODUCTION

Digital farming is a new approach in the management of agricultural activity in order to increase the efficiency of information use, increase labor productivity and use of available resources with the help of more accurate and easy to access evidence and control tools [14].
Digital agriculture can leverage the smart use of data and communication to achieve system optimization, the tools being multiple and varied including cross-cutting technologies such as computational decision and analytics tools [11] because there are almost no limits to the diversity and innovation of digital technologies in the agricultural sector [10].
As a strategic option, the computerization of agricultural holdings involves the design of the necessary changes in their activities and the initial high costs are offset by the direct effects on economic results [3, 12].
As organizations deal with today's challenges - the worldwide economic climate, changing technology, everincreasing globalization, and so forth - managers play an important role in identifying critical issues and crafting responses [18], the existence of a wide range of information sources and transmission media allowing management and staff, especially to make informed decisions, based on an updated picture of the situation and knowledge of alternatives and their possible consequences [7].
Digitalisation allows greater business integration, beyond the information flows management within companies, for a variety of business functions [15] and therefore it will change every part of the agrifood chain. Management of resources throughout the system can become highly optimized, individualized, intelligent and anticipatory. It will function in real time in a hyper-connected way, driven by data. Digital agriculture will

create systems that are highly productive, anticipatory and adaptable to changes such as those caused by climate change [19].

Informational systems increasingly condition the overall efficiency of the activity of any economic entity, including agricultural holdings [20] because information technology and access to information, goods and services across the globe are changing the world [1].

One of the most important solutions being put forward in policy and agribusiness circles is that of digital farming. It is presented as a suite of innovations that serve solution for the current sustainability crisis facing the food and farming sector. The initial proposals for the ongoing reform of the European Union's Common Agricultural Policy, aim at modernising European agriculture through knowledge sharing, innovation and digitalisation [6]. In the field of control system, the information system is of great importance, because with its help comparisons can be made between achievements and proposed objectives or horizontal comparisons can be made between farms [4] in order to achieve the economic optimum, the optimization of economic activity being a process that takes place gradually, starting with a certain stage of development regarding production forces and production relations, using working tools [2] .

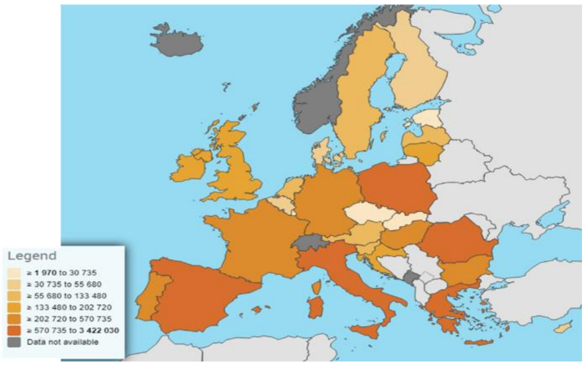
Better agribusiness decisions play a vital role in the success of farm businesses. Informing and automating these decisions through the incorporation of innovative digital technologies is one way to remain competitive in a global field that has become increasingly high-tech. The key to incorporating a successful digital technology solution into an agricultural enterprise, from the tractor and weather station to the office computer, is the selection and use of appropriate software tools [17].

MATERIALS AND METHODS

In this paper the statistical data used in the study were provided by the National Institute of Statistics (NIS), EUROSTAT and FAOSTAT, the methods used being diagnostic analysis, statistical data analysis and case study. The study took into consideration one of the farm management software, namely Geofolia, exemplifying through images and data sets introduced in the Agricultural Management seminars in order to see its functionality.

RESULTS AND DISCUSSIONS

It is known that Romania is the country in the European Union with the largest number of agricultural holdings (Map 1). The efficiency of the agricultural sector and the increase of added value can only be achieved with the help of an performance-oriented management.



Map 1. Farms number in European Union, 2016
Source: [8].

Table 1. Active enterprises in Agriculture, forestry and fishing in Romania

Type	Indicator	2017	2019	2019/2017 (%)
Total	Number of enterprises	115,585	115,279	-0.26
	Average number of employees	144,013	139,830	-2.90
Commercial companies	Number of enterprises	19,174	18,982	-1.00
	Average number of employees	129,204	127,543	-1.29
Authorized Physical Persons	Number of enterprises	95,712	95,609	-0.11
	Average number of employees	9,788	7,721	-21.12
Other legal entities	Number of enterprises	699	688	-1.57
	Average number of employees	5,021	4,566	-9.06

Source: Own calculation using NIS Tempo on line data base [13]

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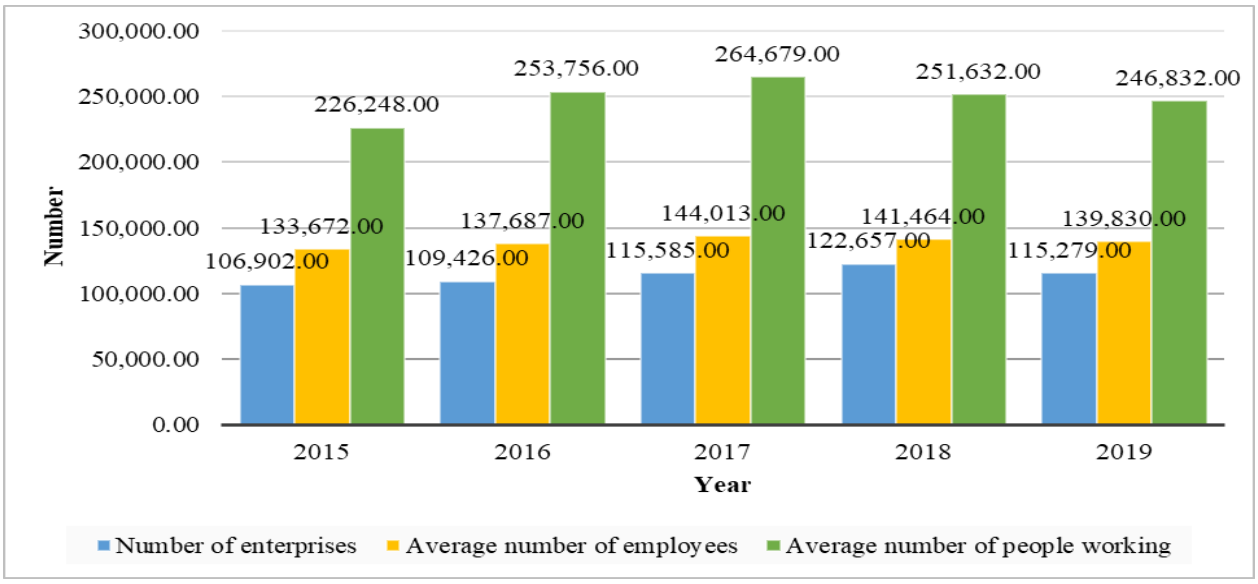

Fig. 1. The evolution of active enterprises in Agriculture, forestry and fishing in Romania
Source: Own calculation using NIS Tempo on line data base [13].

Of these holdings, a small percentage has a sustained activity and an economic dimension necessary for commercial activity. At the level of 2019 for the Agriculture, forestry and fishing sector (Table 1) there were 115,279 enterprises (slightly lower by 0.26% compared to 2017).

Regarding the number of employees, a significant decrease is recorded within the category Authorized Physical Persons but overall the number of employees increased in 2020 related to 2015 by 4.6% (Fig. 1).

Globally, the value of agricultural production in the period 2015-2018 fluctuated depending on weather conditions and climate change, which increasingly affect the agriculture of all countries, standing in 2018 at 3,550.2 billion $ (Fig. 2).

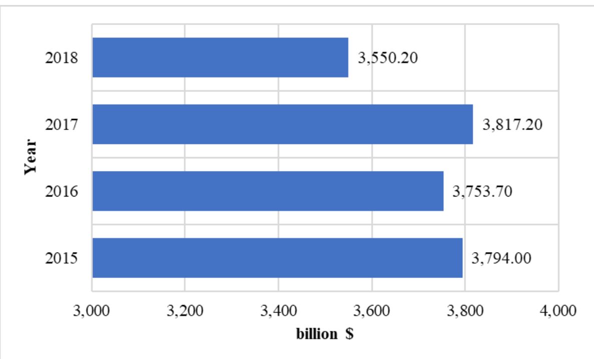

Fig. 2. The value of the world agricultural production 2015-2018 ($ billion)
Source: Source: Own calculation using FAOSTAT data base [9].

These numbers were also influenced by the technologies used in agricultural activity, by plant and especially animal diseases that affected this sector but also by the agri-food policies adopted by each country.

The value of agricultural production for 2020 in Romania was Lei 81,400 million, with a distribution depending on the specifics, characteristics and quality of the soil and the potential of each county (Map 2), the highest value being held by Timiș County with Lei 4,057 million.

Map 2. The value of the production for the agricultural sector in Romania by counties (Lei million) - 2020
Source: Own calculation/charting using NIS Tempo on line data base [13.]

The innovation and the level of innovative activities in the agriculture has to keep up with the other sectors from economy. FarmTech and AgriFood Tech need to develop in order to insure performance for the agricultural holdings and the companies related to agri-food field. In 2019 global farm tech funding reaches its highest level since from 2012, investment growth beeing consistent over the years, investments in farm management softwares recording in 2019 a percentage of 19% from the total (Fig. 3).

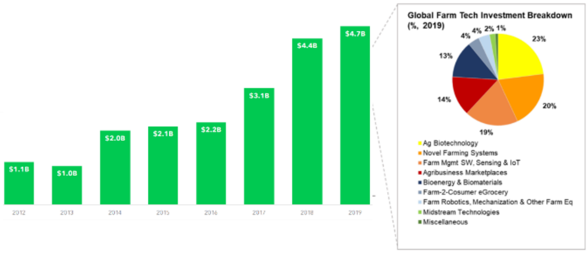

Fig. 3. Global Agritech Funding ($ billion, 2012-2019)
Source: [5].

The number of active smart farming services are increasing all over the world especially regarding smart shared assets (Fig. 4) needed in a digitalised era.

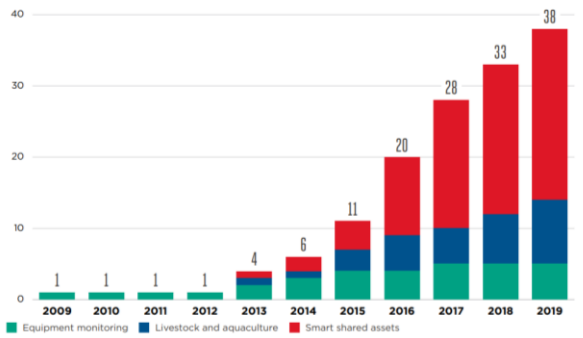

Fig. 4. Number of active smart farming services by sub-use case, 2009–2019, world
Source: [16].

Digital farming represent the use of digital technologies in order to incorporate farm production from the field to the market. The innovations required will provide resources and knowledge for the agricultural industry helping in taking more informed decisions and in increasing productivity.

Digital agriculture market is forecasted to grow at a growth rate of 9.60% in the period of 2020 to 2027. The demand for agricultural food products which is growing will act as a driving factor to the growth of the digital agriculture market.

From potential agriculture digitalisation variants it was selected Geofolia software. GEOFOLIA is a farm management software developed by the ISAGRI company. Through this program farmers can achieve an integrated management of the agricultural system, can ensure a clear record of the processes carried out on the farm and can make analyzes and comparisons between different situations and identify areas for intervention. It is a software with an extensive coverage between farmers, only from the North-East area mentioning Semtop Group, Agricola Târgu Frumos, Agralmixt SRL, Agrocomplex Lunca Pașcani or Comcereal Vaslui For students who intend to learn or develop their skills to manage a farm using modern tools, the software can provide a modeling and simulation of the activity of a farm, being the managers of their own entities, with their own decisions regarding the structure of crops, applied technologies and capitalization of production. Through this software they can understand the practical operation of farms, given that many companies in the field use this application and they can determine the economic efficiency of the farm and immediately observe the changes as a result of new parameters. Geofolia makes connections with Agrotechnics, Agrochemistry, Phytotechnics, Phytopathology, Topography and Mechanization combined but also with Management, Production Systems, Accounting, Rural Economics or Economic Analysis, necessary elements for a manager of an agricultural holding.

The program uses Bing maps to highlight cadastral parcels, being a program developed in collaboration with Microsoft Company.

It can create records for several years and make comparisons between different situations, works and plots. The creation of the land parcels and the operations of modifying them are intuitive and with a friendly menu which facilitate understanding (Photo 1).

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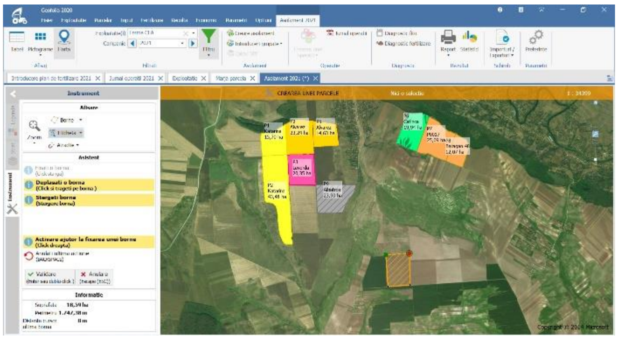

Photo 1. Cadastral land parcels in Geofolia
Source: Own records using Geofolia farm management software

The software allows the addition of specific operations for each land parcel (plowing, sowing, herbicide, etc.) and it can also make group introductions if a work is performed on several land parcels in the same period. Each work has a certain fuel consumption and, possibly, a certain input consumption that must be specified in order to quantify the total costs (Photo 2).

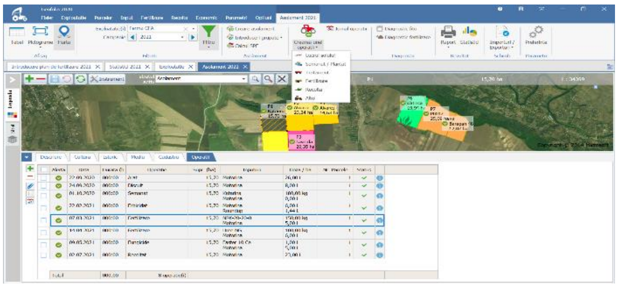

Photo 2. Records of the agricultural works in Geofolia
Source: Own records using Geofolia farm management software.

With the help of this software it can be identified, established and viewed the fertilizer doses for each land parcel and crop, the reports on the fertilization plan required in relations with third parties (eg APIA) being easy to generate based on the data entered (Photo 3).

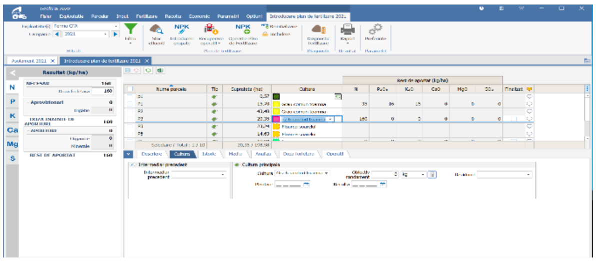

Photo 3. Records on the used fertilizers in Geofolia
Source: Own records using Geofolia farm management software.

One of the documents required by various institutions is the Register of phytosanitary treatments (Photo 4). This document can be generated through the application that keeps the history for all land parcel for several years.

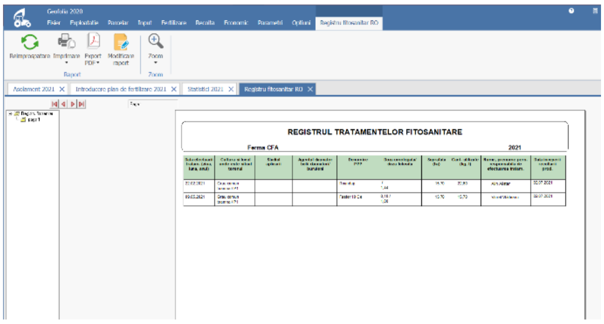

Photo 4. Register of phytosanitary treatments in Geofolia
Source: Own records using Geofolia farm management software.

Also within the reports it can be prepared situations that can be used to record works, plots, traceability of agricultural products, technology sheet for a particular crop, these can be done after entering the initial data (Photo 5).

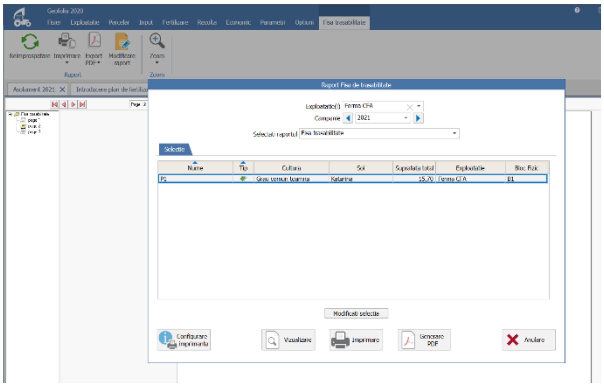

Photo 5. Generating reports in Geofolia
Source: Own records using Geofolia farm management software.

The report of the interventions on each land parcel indicating the chronological sequence of operations such as the equipment used, the related workforce and the inputs managed is another document that can be formatted, downloaded and listed in order to prepare activity files or simple records (Photo 6).

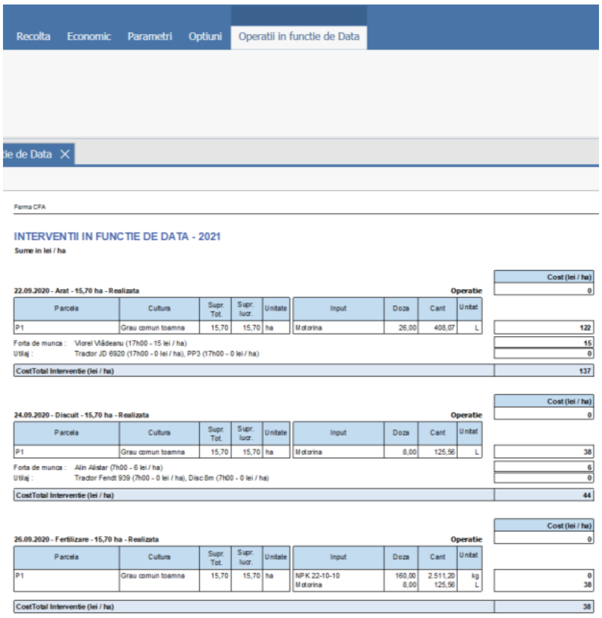

Photo 6. The report of the interventions in Geofolia
Source: Own records using Geofolia farm management software

One of the most important aspects revealed through this software is the economic efficiency of each crop, each land parcel or the whole farm. This element can be identified with the help of comparative data (Photo 7), suggestive graphs related to the allocation of expenses, the realized income or the realized commercial margin wich indicates the economic efficiency of the agricultural activity.

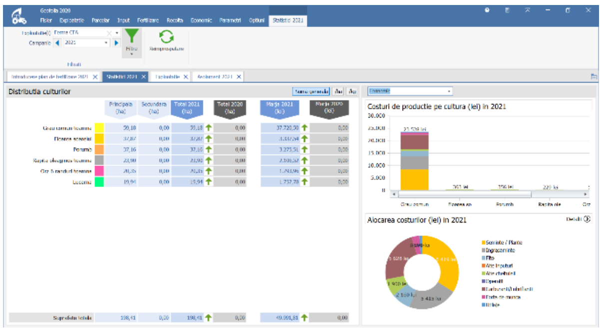

Photo 7. The economic efficiency in Geofolia
Source: Own records using Geofolia farm management software.

The efficiency can also be visualized during the data entry through the graphs associated with each land parcel and which express the situation of fertilization at a given time, the expenses allocated up to that time and the level of profitability established based on the elements introduced (Photo 8).

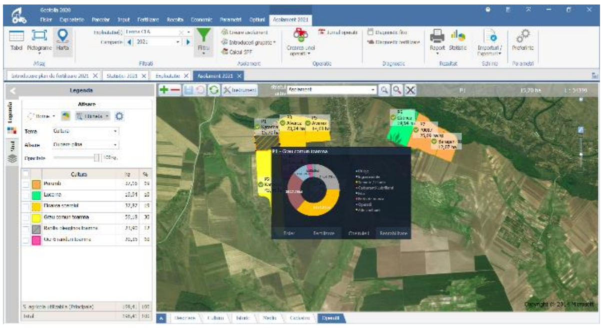

Photo 8. The expenses allocation in Geofolia
Source: Own records using Geofolia farm management software.

The performance and in general the economic results of a farm represent the elements that are analyzed mainly to understand the activity carried out. The software allows the updating of the efficiency elements as the data is entered or modified in such a way that the user can benefit from real-time changes and, consequently, take the necessary measures.

CONCLUSIONS

The digitalisation of agriculture has become an increasingly important „*sine qua non*” element in the development of the agricultural sector as part of the global economy, with the new technologies in the field evolving at a rapid pace.

The phenomenon of „smart farming” has become more and more widespread but it is not just a matter of surface because economic efficiency is increasingly influenced by the speed of information, easy access to data provided through electronic equipment and a efficient management based on an optimal organization of field data in a unitary and interconnected system.

Agricultural production is what supports many of the manufacturing industries and, most importantly, provides food for the population. Digitalization in global farm management and in Romania in particular leads to general economic development and efficient use of resources.

One of the tools that can be used to digitalize farm management is Geofolia software which provides better coordination of farm activities, facilitates the link between field and office work, creates necessary reports and data and provides an overview of the general activity both technically and economically.

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PRODUCTIVITY OF LINES – PARENTAL COMPONENTS OF MAIZE HYBRIDS DEPENDING ON PLANT DENSITY AND APPLICATION OF BIOPREPARATIONS UNDER DRIP IRRIGATION

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Abstract

The article presents field research results on studying the effect of treating maize plants with growth regulating biological products on the formation of productivity of lines – parental components for optimizing the elements of cultivation technology. The experimental scheme included the effect of Bio-gel and Helafit®-combi biological products on the productivity of parental components of different FAO groups and genetic plasms of maize hybrids at different densities of 70,000, 80,000, 90,000 plants ha^{-1}. Studies have shown that for the maximum manifestation of the "weight of 1,000 grains" indicator the optimal density is 70,000 plants ha^{-1}. The increase in yield is positively influenced by the increase in the weight of 1,000 seeds, which is due to the line genotype and the use of the Bio-gel, Helafit®-combi biologically active products. Pre-sowing treatment of maize seeds with Bio-gel and Helafit®-combi increased laboratory seed germination. With the Bio-gel product applied, the laboratory germination increased by an average of 1.5%, with Helafit®-combi used seed germination increased by 2.4%. In our studies, the maximum seed yield in the early-ripening line of the DK 281 parental component was recorded at a density of 90,000 plants ha^{-1}and the treatment with Helafit®-combi and amounted to 3.65 t ha^{-1}. The maximum yield of the DK 247 parental component was observed at a density of 80,000 plants ha^{-1} and the treatment with Helafit®-combi and amounted to 4.89 t ha^{-1}. Mid-late lines DK 411 and DK 445 parental components showed the highest yields at densities of 70,000 plants ha^{-1} and after the treatment with Helafit®-combi which amounted to 4.65 and 6.30 t ha^{-1}, respectively.

Key words: *maize, line – parental component, germ-plasm, weight of 1,000 seeds, seed yield*

INTRODUCTION

Providing the Earth's population with food is one of the global challenges of the 21st century. Globally, agriculture is forced to increase the production of grain – a key human food product, concentrated feed and the main source of plant proteins, carbohydrates and fats. Scientific predictions suggest that with significant population growth on Earth, food production will fall short of such growth and, given the current dynamics of population growth, the food problem may result in a deep international food crisis [6, 10].

At the current rate of population growth, in the future, world grain production per capita will decline. Therefore, humanity must find a solution to the problem, because population growth rates remain too high. The forecasts for the reduction of arable land per capita are also threatening, as the chances for expanding agricultural land are almost exhausted [23].

To date, almost all land resources have been depleted and the reduction of agricultural land continues due to urbanization and soil degradation. This suggests that providing mankind with food is possible only by increasing crop yields [2, 3, 7]. So in the sphere of increasing cereal productivity (the main source of food) there are three main fields: genetic -selection development; creation and improvement of agrotechnologies; location optimization and specialization of production [24].

Throughout the centuries-long history of human civilization on Earth, the main cereals of mankind have been wheat and rice. But at the beginning of the third millennium it was maize that occupied the first position (in terms of gross harvest and yield). Today, world maize production exceeds 1 billion tons of grain and in the coming years yields and gross harvests are expected to increase [12].

Today it is important to create new high-yielding hybrids of maize, the parent forms of which are self-pollinating lines. A self-pollinating line is a group of genetically identical homozygous individuals that are descendants of a single plant. Self-pollinating lines (incucht lines, inbred lines) are obtained as a result of forced plant self-pollination for 6–8 generations. As a result, the source material becomes homozygous, which is unnatural for cross-pollinating plants. Homozygous plants are characterized by reduced viability, impaired growth, low yields, weak root system [8]. The seeds of the self-pollinating lines stay in the ground for one and a half to two times longer til the seedlings appear. The rate of the lines vegetative growth is significantly lower than that of hybrids. The foliage area in them is 2–3 times smaller, the weight of 1,000 grains is significantly lower, the seed germination is reduced. Therefore, the lines need better growing conditions, are more sensitive to adverse factors and always require increased technological support. The yield of seed lines depends significantly on the genotypic characteristics of the FAO group, so it is necessary to improve technological recommendations for the cultivation, breeding and hybridization, taking into account the biological characteristics of the parental forms [18].

In Ukraine, the creation and introduction of new high-tech maize hybrids of intensive type cultivated under irrigation conditions is carried out by the only research institution – the Institute of Irrigated Agriculture of the National Academy of Agrarian Sciences of Ukraine. The Southern Steppe of Ukraine under irrigation provides all opportunities for guaranteed high maize grain yields and it is for these conditions that innovative maize hybrids with high adaptability to agro-environmental conditions of the zone have been created [11, 27]. An important condition for ensuring the production of first-generation hybrids (F_1) is to obtain a sufficient number of parental lines with high sowing characteristics for hybridization sites.

One of the important elements of maize plant productivity which affects the formation of potential and actual yields, is the "weight of 1,000 grains". Therefore, the study of this indicator manifestation, its variability and relationships with other characteristics of lines and hybrids is important in determining priority parameters in the selection of a new generation of high-yielding genotypes and in improving varietal cultivation technology in specific agro-ecological zones [13, 16].

The weight of 1,000 grain along with yield is an effective indicator as a criterion in the selection of adaptive maize genotypes under drought stress [5]. Among other characteristics, the weight of 1,000 grains is more important for the selection of high yielding maize genotypes, this indicator may be present in breeding programs and be effective as a potential characteristic in improving desired maize genotypes [20].

The use of large fraction of maize seed is the most positive component for increasing seed yield [22]. A large seed has large germ and much more nutrients, therefore, it provides good and even sprouts, since the primary (germinal) roots and the first leaf are formed, in practice, only due to the nutrients of maize seed [30].

Maize grain having proper kernel geometry has a higher quality compared to very large or small kernel [15]. Today, an effective means of increasing plant productivity is the use of growth regulating products. Biologically active compounds are able to cause growth regulating, immunostimulatory and adaptogenic effects on plants [19, 28].

Physiologically active substances contribute to the mobilization of the genetic capabilities of the plant organism [21, 25]. It was also discovered that under the influence of such products there was observed an increase in growth processes and the formation of yield structural elements.

The studies by C.N. White and C.J. Rivin [29] found that maize seeds pre-sowing treatment with endogenous gibberellin affects the concentration ratio of gibberellin and abscisic acids in seeds, which affects the regulation mechanism of its germination or dormancy. It is the use of the gibberellin group products that accelerates the germination of maize seeds.

MATERIALS AND METHODS

The experimental part of the research was performed on irrigated lands of the Institute of Irrigated Agriculture of the National Academy of Agrarian Sciences of Ukraine, located on the right bank of the Dnieper; the Dnieper district of Kherson in the area of the Ingulets irrigation system.

The soil of the study area is dark chestnut medium loamy slightly saline with a deep level of groundwater.

Three-factor experiment (Factor A – line – parental component, Factor B – treatment with product, Factor C – plant density, plants ha^{-1}) was carried out using the method of randomized split blocks. The sown area of the plots was 30.0 m², the accounting area was 20.0 m². The research was performed with four repetitions.

The material for the research was different maturity group lines – parental components: DK 445 (parental component of Arabat, Vira, Gileya hybrids); DK 411 (parental component of Chongar, Lamasan hybrids); DK 281 (parental component of the steppe hybrid); DK 247 (parental component of Skadovsky, Oleshkivsky hybrids). The sowing density of all parental forms was 70,000, 80,000, 90,000 plants ha^{-1}. The parental components of maize were treated with two biological preparations: Helafit®-combi and Bio-gel, which are included in the State Register of Pesticides and Agrochemicals Permitted for Use in Ukraine. Plants were treated twice with Helafit®-combi: in the phase of 7–8 leaves and panicle appearance (application rate – 1 L/ha), seeds were treated with Bio-gel (at the rate of 2 L/t) and plants were sprayed (1.5 L/ha) in the phase of 7–8 leaves.

Helafit®-combi contains microelements, ions of biogenic metals, free amino acid, humates, fatty acids, fatty acid esters, polysaccharides, steroid glucosides, vitamins, 3-indoleacetic acid, epibrassinolide, zeatin, alginic acid, hydrochloric acid. The main active ingredients of the Bio-gel organic fertilizer are enzymes, amino acids, vitamins, fulvic and humic acids, trace elements and saprophytic microorganisms.

The Institute weather observations were used to characterize the weather conditions during the research years. Agrotechnic in the experiment corresponded to the technology of growing maize in the South of Ukraine, the requirements of research methods and guidelines for conducting research with maize lines; mathematical processing of experimental data was carried out according to generally accepted methods [26, 28].

Surface drip irrigation was used, the level of pre-irrigation soil moisture being 80% of the lowest moisture content in the 0–50 cm soil layer.

The aim of the research was to establish the weight of 1,000 grains, laboratory germination and yield of lines – parental components of maize hybrids, depending on the density of sowing and treatment with biological products. To solve the problems an experiment was conducted in the selection department of the NAAS in 2018–2020, its scheme is given in Table 1.

The following methods were used in the study: field, measuring-weight, variance and correlation-regression analysis, system analysis and synthesis.

Table 1. The scheme of the experiment

Factor A (line – parental component)	Factor B (treatment with product)	Factor C (plant density, plants ha^{-1})		
DK 281 (FAO 190, Mixed germ-plasm)	control, no treatment	70,000	80,000	90,000
	Bio-gel			
	Helafit®-combi			
DK 247 (FAO 290, Mixed germ-plasm)	control, no treatment	70,000	80,000	90,000
	Bio-gel			
	Helafit®-combi			
DK 411 (FAO 420, Iodent germ-plasm)	control, no treatment	70,000	80,000	90,000
	Bio-gel			
	Helafit®-combi			
DK 445 (FAO 420, Mixed germ-plasm)	control, no treatment	70,000	80,000	90,000
	Bio-gel			
	Helafit®-combi			

Source: Authors' concept of the experiments.

RESULTS AND DISCUSSIONS

One of the important elements of maize productivity which affects the formation of yield and sowing characteristics of seeds is the "weight of 1,000 grains". Therefore, studying the manifestation of this characteristic and its relationship with other characteristics in the lines is of great practical importance for seed production and for determining the priority selection parameters in the selection of a new generation of high-yielding biotypes for specific agro-ecological cultivation zones. The "weight of 1,000 grains" characteristic in the parental components of different genetic plasms and FAO groups was studied under irrigation conditions. Observations conducted in 2018–2020 showed that the weight of 1,000 seeds depends on the line genotype, plant density and treatment with various products.Among the parental components, the highest weight of 1,000 grains was observed in the mid-season Mixed germ-plasm DK 445 (FAO 420) line amounting to an average of 277.3 g. The lowest weight on average was demonstrated by the Mixed germ-plasm DK 247 line and amounted to 229.6 g (Table 2). The genotype of the paternal line had the most significant effect on the weight of 1,000 maize grains. Thus, the DK 445 mid-late line which is the parental form of new innovative hybrids Arabat, Vira, Gileya, showed the highest weight with a density of 70,000 plants ha^{-1}, on average it amounted to 285.9 g. The treatment with Helafit®-combi helped to increase the weight of 1,000 grains by 10.6 g which amounted to 282.7 g. The maximum weight of 1,000 grains was observed in the DK 445 (Mixed germ-plasm, FAO 420) line after treatment with Helafit ®-combi and made 292.6 g at a plant density of 70,000 plants ha^{-1}. With the increase in density to 80,000 plants ha^{-1}, the weight of 1,000 grains of this line tended to decrease by 2% compared to the density of 70,000 plants ha^{-1} and averaged 280.7 g. Treatment with Bio-gel allowed to increase the weight of 1,000 grains to 281.4 g compared to the control (275.7 g). Helafit®-combi increased the weight of 1,000 grains to 285.0 or by 2.2%. The increase in density to 90,000 plants ha^{-1} caused a sharp drop in the weight of 1,000 grains to 265.2 g on average. Treatment with Bio-gel allowed to increase the manifestation of this indicator by 2.1 g or 0.8% to 263.7 g compared to the control. Treatment with the Helafit®-combi product increased this indicator to 270.4 g, i.e. by 8.8 g or 3.3% compared to the control. It was found that the DK 445 line reacted negatively to the density of plants. In the experiment, all lines – parental components produced the maximum weight of 1,000 grains at the density of 70,000 plants ha^{-1} , which was 257.6 g. Increasing the density to 80 plants ha^{-1} resulted in the decrease of weight of 1,000 grains to 252.3 g, and at a density of 90,000 plants ha^{-1} its weight was only 244.6 g.

Table 2. Weight of 1,000 grains, lines – parental components of maize hybrids, g (average for 2018–2020)

Factor A (line – parental component)	Factor C (plant density, plants ha^{-1})	Factor B (treatment with product)			On average by factor	
					A	B
		Control, no treatment	Bio-gel	Helafit®-combi		
DK 281 (Mixed germ-plasm)	70	229.7	233.3	239.3	231.8	257.6
	80	226.3	230.6	238.5		252.3
	90	225.3	229.2	234.3		244.6
On average		**227.1**	**231.0**	**237.4**		
DK 247 (Mixed germ-plasm)	70	232.4	234.2	243.1	229.6	
	80	225.6	227.7	235.0		
	90	216.6	221.4	230,1		
On average		**224.9**	**227.8**	**236.1**		
DK 411 (Iodent germ-plasm)	70	266.9	273.6	280.5	267.3	
	80	254.6	270,7	276,9		
	90	251.3	266.8	264.2		
On average		**257.6**	**270.4**	**273.9**		
DK 445 (Mixed germ-plasm)	70	278.9	286.2	292.6	**277.3**	
	80	275.7	281.4	285.0		
	90	261.6	263.7	270.4		
On average		**272.1**	**277.1**	**282.7**		
On average by factor C		245.4	251.6	**257.5**		
Assessment of the partial differences significance						
LSD_{05}, г		A= 2.2; B=1.3; C=1.5				

Source: Authors' own results.

For the maximum manifestation of the "weight of 1,000 grains" indicator the optimal density was 70,000 plants ha^{-1}. At a density of 90,000 plants ha^{-1}, all lines of different FAO and germ-plasm groups showed minimal results.

Table 3. Laboratory germination of maize hybrids lines – parent components, % (average for 2018–2020)

Factor A (line – parental component)	Factor B (treatment with products)			On average by factor A
	Control, no treatment	Bio-gel	Helafit®-combi	
DK 281 (FAO 190)	96.9	97.2	98.5	97.5
DK 247 (FAO 290)	96.2	97.8	98.2	97.4
DK 411 (FAO 420)	94.5	96.9	97.2	96.2
DK 445 (FAO 420)	93.8	95.4	96.8	95.3
On average by factor B	**95.4**	**96.8**	**97.7**	

Source: Authors' own results.

It was found that the studied Bio-gel and Helafit®-combi products effectively influenced the processes of grain formation, which ensured an increase in laboratory germination of the obtained seeds (Table 3).

Variance analysis shows that the line genotype had the greatest effect on laboratory germination of seeds, the treatment with biological products was less significant, plant density had the minimal effect on seed laboratory germination (Figure 1).

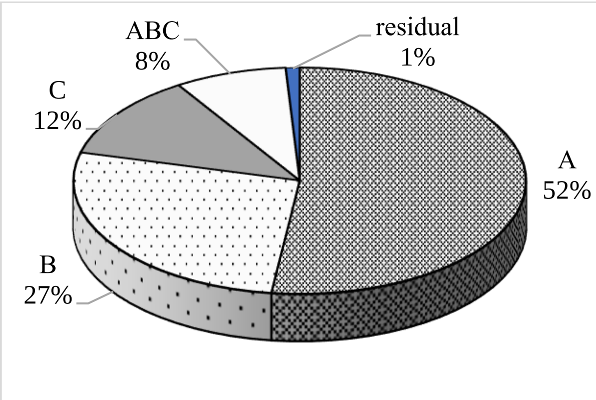

Fig. 1. Variance analysis of the effect of various factors and their interaction on the laboratory germinatiion of maize hybrids lines – parental components, %: A – genotype of the line; B – plant treatment with biologically active products, C – plant density, ABC - interaction of factors; residual

Source: Authors' own results.

Regarding the indicators of the seeds laboratory germination, the following was found: treatment of the lines – parental components with Bio-gel and Helafit®-combi caused an increase in the seeds laboratory germination. The application of the Bio-gel product increased the laboratory germination by an average of 1.5%. Helafit®-combi treatment was more effective because the seed germination in this experimental variant increased by 2.4%. An increase in laboratory germination was observed due to a decrease in the incidence of fusarium fungi (*Fusarium moniliforme* Scheld.).

The analysis of the maize seed germination dependence on the genotype of the parental components shows that the late-maturing lines (FAO 420) DK 411 (germ-plasm Iodent) and DK 445 (Mixed germ-plasm) demonstrated lower germination compared to earlier-maturing lines of mixed plasm 28 FAO 190) and DK 247 (FAO 290). Although the effect of treatment with biologically active products was less significant than the genotypic factor, its positive effect on the lines laboratory germination testifies to the possibility of increasing their germination by such treatment.

In our studies, the maximum seed yield in the early-maturing line – the parental component DK 281 was recorded at a density of 90,000 plants ha^{-1} and after treatment with Helafit®-combi, it was 3.65 t ha^{-1}. The maximum yield of the parent component DK 247 was observed at a density of 80,000 plants ha^{-1} and after treatment with Helafit®-combi, it was 4.89 t ha^{-1}. Mid-late lines – parental components DK 411 and DK 445 showed the highest yields at densities of 70,000 plants ha^{-1} and after treatment with Helafit®-combi, they amounted to 4.65 and 6.30 t ha^{-1}, respectively (Figure 2).

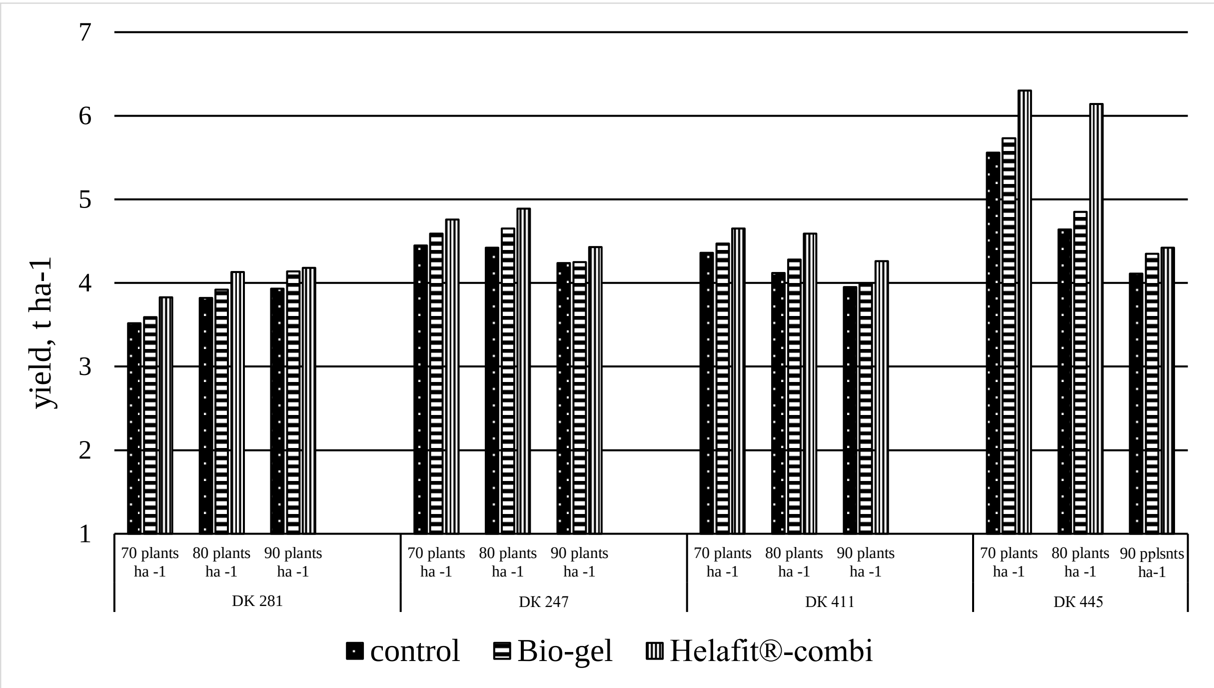

Fig. 2. Seed yield of maize hybrids lines – parental components depending on plant density and treatment with biological products, t ha^{-1} (average for 2018–2020)
Source: Authors' own results.

The highest seed yield was formed in the DK 445 mid-late line (parental component of Vira, Arabat, Hilea hybrids) amounting to 4.11–6.30 t ha^{-1}, which is due to the increased duration of the growing season and optimized technology under drip irrigation.

In the DK 445 and DK 411 mid-late lines there was a sharp decrease in yield at higher sowing density. On average, the highest seed yield over the years was in the DK 445 mid-late line at a density of 70,000 plants ha^{-1}, it was 5.86 t ha^{-1}. At a density of 80,000 plants ha^{-1}, the yield was 5.21 t ha^{-1}, with the thickening of crops to 90,000 plants ha^{-1}, there was a sharp decrease in yield to 4.29 t ha^{-1}. The DK 411 mid-late line also showed the maximum yield at a density of 70,000 plants ha^{-1}, it was 4.47 t ha^{-1}. At a density of 90,000 plants ha^{-1}, the minimum yield was 4.07 t ha^{-1}.

Helafit®-combi was the most effective among the biological products. Thus, in the mid-late group of parental components, the highest seed yield was established in the DK 445 line after applying this product, it was 5.62 t ha^{-1} (the yield increased by 0.85 t ha^{-1} or by 17.8%), in DK 411 line it was 4.50 t ha^{-1} (the yield increased by 0.36 t ha^{-1} or by 8.0%). The line – parental component of the DK 247 mid-early group showed a slightly lower yield – 4.69 t ha^{-1} when applying the same product (the yield increased by 0.32 t ha^{-1} or by 6.8%). The DK 281 early ripening line on applying Helafit®-combi yielded 4.05 t ha^{-1} (the yield increased by 0.29 t ha^{-1} or by 7.2%). The yield increase on applying the Bio-gel biological product was significantly lower.

To determine whether the weight of 1,000 grains of the maize hybrid lines – parental components was related to seed yield, a correlation closeness was calculated. The presence of a rectilinear correlation (r = 0.618 ± 0.13) between the seed yield of the parental maize lines and the weight of 1,000 grains was found (Figure 3).

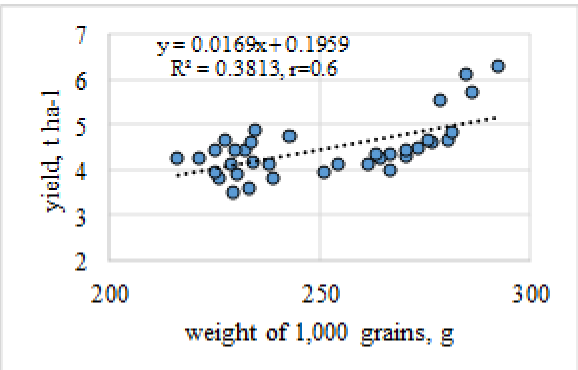

Fig. 3. Correlation-regression model of seed yield and weight of 1,000 grains dependence (average for 2018–2020)
Source: Authors' own results.

Thus, the increase in the weight of 1,000 grains due to both the line genotype and the application of the Bio-gel, Helafit®-combi biologically active products has a positive effect on the seed yield of the hybrids lines - parental components. Increased density of plants has a negative effect on the "weight of 1,000 grains", that is why the optimum plant density for each hybrid line – parental component should be experimentally established in order to maximize the yield of seeds and improve their sowing characteristics.

The economic analysis of seed production lines – parental components has been conducted using the following hybrids at the following plant densities: DK 281 – 90,000 plants ha^{-1}, DK 247 – 80,000 plants ha^{-1}, DK 445 – 70,000 plants ha^{-1}.

The value of gross output per 1 ha, technology costs and net profit depending on the use of biological products have been determined (Table 4).

The value of gross output per 1 ha after treatment with biological products was maximum in the DK 445 line – the parental component and amounted to from 5.37 to 6.09 thousand euro·ha^{-1} depending on the experiment variants, in the DK 247 parental component it was slightly lower – 4.27–4.73 thousand euros ha^{-1}, the DK 411 parental component produced still lower value – 4.21–4.50 thousand euros ha^{-1}, the lowest value of gross output was in the DK 281 line – 3,80–4,04 thousand euros ha^{-1}.

In the DK 281 line, the highest net profit was received after Helafit®-combi treatments – 2.66 thousand euro ha^{-1}. In the DK 247 line, the highest net profit was received after Helafit®-combi treatments – 3.32 thousand euro ha^{-1}. The highest net profits in the DK 411 and DK 445 lines were also obtained after treatments with Helafit®-combi – 3.06 thousand euro ha^{-1} and 4.61 thousand euro ha^{-1}, respectively, which testifies to the product high efficiency.

The data obtained in our research coincide with the data obtained by other researchers in other agro-environmental zones. Plant density is crucial in the complex of agronomic measures for maize cultivation, seed yield depending on it. A significant yield of lines – parental components can be obtained due to high individual productivity and the maximum allowable plant density in specific growing conditions [33].

Table 4. Economic efficiency of cultivating maize lines - parental components depending on the treatment with biological products

Factor A	Factor C	Average yield, t ha^{-1}	Gross output value, thous. euro ha^{-1}	Cost, thous. euro ha^{-1}	Net operating profit, thous. euro ha^{-1}
DK 281	Control, no treatment	3.93	3.80	1.36	2.44
	Bio-gel	4.14	4.00	1.38	2.62
	Helafit®-combi	4.18	4.04	1.38	2.66
DK 247	Control, no treatment	4.42	4.27	1.40	2.87
	Bio-gel	4.65	4.50	1.40	3.09
	Helafit®-combi	4.89	4.73	1.41	3.32
DK 411	Control, no treatment	4.36	4.21	1.43	2.79
	Bio-gel	4.47	4.32	1.43	2.89
	Helafit®-combi	4.65	4.50	1.44	3.06
DK 445	Control, no treatment	5.56	5.37	1.47	3.90
	Bio-gel	5.73	5.54	1.48	4.06
	Helafit®-combi	6.30	6.09	1.48	4.61

Note: The cost of 1 ton of seeds of the parental component is 0.97 thousand euros.
Source: Authors' own results.

High crop productivity can be ensured by rapid and simultaneous seed germination which is an important integral indicator of seed quality [4]. It is well known that increased laboratory germination contributes to the simultaneous and uniform emergence of seedlings [1]. This, in turn, can help increase seed yield and quality [17, 32]. The positive effects of physiologically active substances can be related both to their regulatory and adaptogenic effects on plants [9, 14] and to their effects on genetic potential [31].

CONCLUSIONS

The maximum seed yield of the DK 281 early-ripening line – parental component was recorded at a density of 90,000 plants ha^{-1} and after applying Helafit®-combi, it amounted to 3.65 t ha^{-1}. The maximum yield of the DC 247 line – parental component was observed at a density of 80,000 plants ha^{-1} and after applying Helafit®-combi, it amounted to 4.89 t ha^{-1}. The DK 411 mid-late line – parental component showed the highest yield at a density of 70,000 plants ha^{-1} and after applying Helafit®-combi, it amounted to 4.65 t ha^{-1}. The maximum yield in the experiment was observed in the DK 445 line – parental component, it was 6.30 t ha^{-1} at a density of 70,000 plants ha^{-1} and after applying Helafit®-combi.

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FEATURES OF ACCOUNTING FOR BIOLOGICAL ASSETS OF AGRICULTURAL ENTERPRISES OF UKRAINE

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Abstract

The modern development of the accounting system of agricultural enterprises is under the influence of constant changes, which is justified by the need for further research on theoretical issues of evaluation and accounting of biological assets of agricultural enterprises to make effective management decisions. The article considers the current problems of accounting for the management of biological assets of agricultural enterprises. The study provided an opportunity to establish the composition and classification structure of biological assets, the process of formation of their initial value at the time of receipt and disposal, to determine the features of valuation and accounting in the accounts. The authors use a dialectical and systematic approach, methods of generalization and systematization, analysis and synthesis. An improved method of accounting for current biological assets of animal and crop production using accounts is proposed, which, in contrast to the existing one, will allow detailed accounting of availability and movement by their types and obtain complete accounting information on value for each group. The practical value of research lies in the development of correspondence accounts for the accounting of biological assets, which will allow decisions to be made to improve the efficiency of their management.

Key words**:** *accounting, long-term biological assets, current biological assets, animal husbandry, crop production, agriculture*

INTRODUCTION

Accounting for agricultural enterprises has certain features that are directly related to the technology of growing biological assets, crop and animal products, which is the basis of this sector of the economy. Agriculture is a special field of production, because in the process of manufacturing finished products, along with financial, logistical and labour resources, natural resources are also used: land and living organisms.

The procedure for accounting for the availability and movement of such resources is quite complex because they are constantly changing: plants go through certain stages of development, animals gain weight, gain age maturity. The separation of biological assets at enterprises in the accounting and economic category is an important stage in the development of both the national accounting system and the agricultural sector. The development and implementation of ARS 30 “Biological Assets” [1], which regulates the accounting of agricultural assets only, is a relevant and justified phenomenon. The use of ARS 30 “Biological Assets” has become widespread in Ukraine, but the use of the provisions of this standard in the enterprise is still problematic and needs to be improved. One of the reasons for this is the lack of scientific research and the lack of practical explanations on certain aspects of accounting for biological assets of crops and animal. That is why the study of the peculiarities of accounting for biological assets of agricultural enterprises is becoming increasingly important.

The issue of accounting for biological assets has been considered by many domestic and foreign scientists-accountants, including Andrushko [2], Arbidane et al. [3], Brick [4], Cherep et al. [5], Daly and Skaife [6], Fischer et al. [7], Khushvakhtzoda et al. [9], Kuzmovich [10], Ogiychuk [12], Şevciuc et al. [13], Shepel et al. [14], Simition [15] and others.

These authors cover the issues of accounting for biological assets, formation of costs and revenues, determination of financial results in enterprises, formation of information in financial and statistical reporting, organization of accounting of current biological assets for accumulation, grouping, systematization and analysis of consolidated information on business transactions. receipt, movement and disposal of such assets in the course of economic activity to make sound and timely management decisions.

However, without diminishing the value of the work of the above scientists, it should be recognized that they need detailed study and elaboration of methods of accounting and evaluation of biological assets, their classification and taking into account specific features of agricultural production when displaying information about them. These factors determine the relevance of the chosen research topic. The purpose of the article is to study the features of displaying information about biological assets in the accounting system of agricultural enterprises.

MATERIALS AND METHODS

The study used general scientific methods and specific techniques. A methodological basis is a systematic approach, which allowed to determine the place of the accounting system of biological assets in the management of agricultural enterprises. The study used historical and logical analysis – to consider the theoretical foundations of accounting; methods of induction and deduction – to study the general trends in the development of accounting for biological assets; methods of theoretical generalization and observation – to study the regulatory and legal support of accounting for biological assets in Ukraine.

RESULTS AND DISCUSSIONS

The main normative documents in Ukraine that determine the procedure for conducting business operations with biological assets in agricultural enterprises are ARS 30 “Biological Assets” [1], Methodical recommendations on accounting of biological assets [11] and the International Accounting Standard Accounting (IAS) 41 “Agriculture” [8]. According to ARS 30 “Biological assets”, animals or plants that are in the process of biological transformation can provide agricultural products and/or additional biological assets, as well as bring other economic benefits, defined as biological assets [1]. Given this, the simplest delineation of biological assets is their division into biological assets of animal production and biological assets of crop production (Fig. 1).

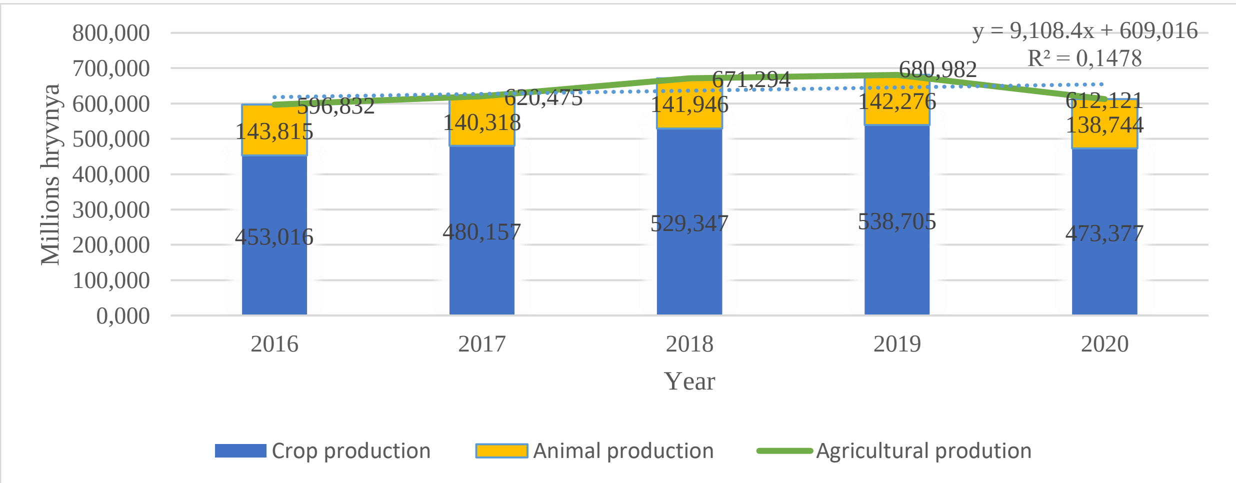

Fig. 1. Dynamics of the value of production of generalized crop and animal products in Ukraine for 2016-2020 (UAH Million)

Source: built by the authors based on statistics [16].

Based on the presented in Fig. 1 of the data shows a significant lead in crop production. In percentages, they range from 75-78%. These two important areas of agricultural activity are inextricably linked. The availability and movement of such resources is a complex, cyclical and dynamic process at the same time, which complicates their accounting.

The organization and methods of accounting have an exceptional impact on the state of biological assets and the efficiency of their use in the production process. This relationship implies the need to study the basic provisions of applicable law in the identification, classification, evaluation of biological assets.

One of the methods of cognition and study of objects related to biological assets is their classification. For ease of perception, the classification of biological assets (BA) is presented in the form of a diagram (Fig. 2).

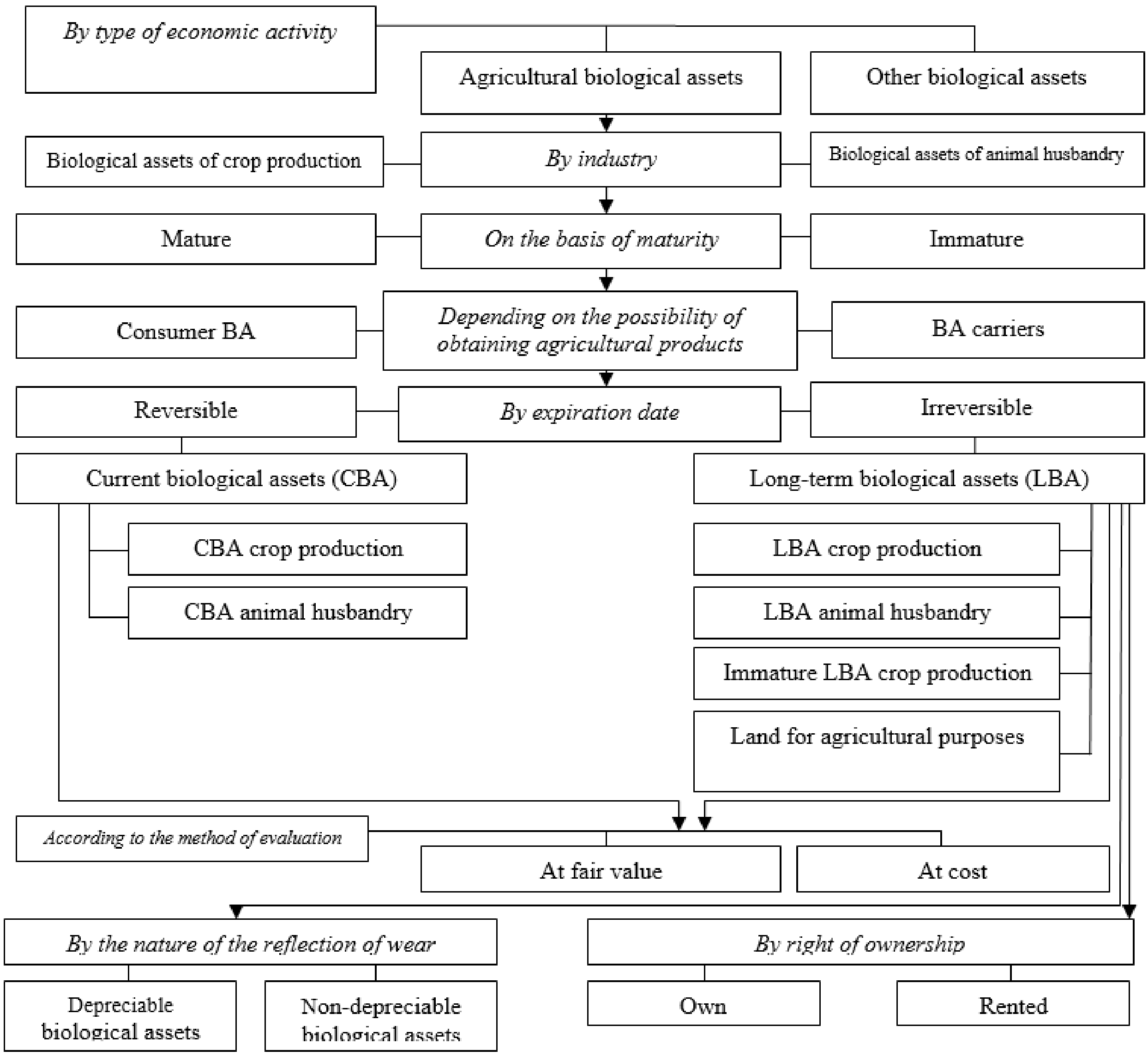

Fig. 2. Classification of biological assets
Source: generalized based on [4, 13, 14].

Examining the classification of biological assets, we found that in accounting, the most common is their grouping by expiration date. It is the division into current and long-term biological assets that are used in compiling the balance sheet. A special classification feature is an approach to the valuation of biological assets, which is due to the presence of two different options – at fair value and cost. A biological asset and/or agricultural product is recognized as an asset if it is probable that future economic benefits associated with the item will flow to the enterprise and the cost of the item can be measured reliably [8]. The basic approach to the measurement of biological assets is the application of fair value, at which all biological assets and agricultural products at initial recognition and the balance sheet date are measured at fair value with fewer costs to selling. However, the rules of ARS 30“Biological Assets” and the International Accounting Standard Accounting (IAS) 41 “Agriculture” on the valuation of biological assets and agricultural products are not without alternatives [1, 8]. Thus, long-term biological assets whose fair value cannot be measured reliably at the balance sheet date are recognized and recognized at cost, taking into account the amount of depreciation and impairment losses. The separation of the cost approach into a separate classification feature is primarily due to the disclosure requirements for biological assets, as the Notes to the Financial Statements should separately state biological assets not measured at fair value [8].

It is established that the basic approach to the valuation of biological assets is their fair (or market) value, which is expressed by the amount by which you can exchange this asset or repay the debt from the transaction between knowledgeable, interested and independent parties. In domestic practice, mainly use a market approach. There are three types of assessments of biological assets: on receipt; at initial recognition; on the balance sheet date.

The significance of approaches to the recognition and valuation of biological assets on the results of their use and property status of agricultural enterprises and their image and market position necessitated the need to consider the value of these assets. The identification of discrepancies in valuation allows us to state the need to use alternative valuation to address this issue through the formation of appropriate provisions of accounting policies [9]. The given classification of biological assets can be applied by agricultural enterprises, which will allow to properly organize synthetic and analytical accounting, will promote the full disclosure of information [17].

Table 1. Typical correspondence for accounting of receipts of long-term biological assets

Content of business transactions	**Correspondence of accounts**	
	debit	credit
Acquisition of long-term biological assets for a fee		
Received from suppliers - VAT payers at a value excluding VAT	155	631
The VAT tax credit for the supply transaction is reflected	641	631
The costs of LBA transportation are reflected	155	685
The tax credit for the number of transport services of a third-party organization is reflected	641	685
The acquired long-term biological asset is accounted for	162, 164, 166	155
Free receipt		
Accounts received free of charge received by the LBA	16	424
Costs of transportation of long-term biological assets received free of charge by own transport are reflected	155	234
Transportation costs are included in the initial cost of a biological asset received free of charge	16	155
Contribution from the participant of the enterprise		
Received from a participant of the enterprise as a contribution to the authorized capital of the LBA	16	46
Long-term biological assets that were not previously recorded on the balance sheet		
LBAs that were not previously recorded on the balance sheet are recorded at cost	162, 164, 166	746
LBAs that were not previously recorded on the balance sheet are recorded at fair value	161, 163, 165	719

Source: proposed by authors based on [1, 11, 12, 14].

Accounts 16 “Long-term biological assets” and 21 “Current biological assets” are assigned in the Chart of accounting and generalization of information on the availability and movement of biological assets.

Accounting of long-term biological assets depends on the sources of their income (Table 1). Commissioning of biological assets (perennial plantations) is carried out by a commission appointed by the head of the enterprise and formalized by an act of acceptance of long-term biological assets.

The correspondence of accounts for the disposal of long-term biological assets is given in Table 2.

Table 2. Typical correspondence of accounts for the disposal of long-term biological assets

Content of business transactions	Correspondence of accounts	
	debit	credit
Accounting for the sale of long-term biological assets valued at cost		
The amount of depreciation of the sold LBA, estimated at cost, is written off	134	162, 164
Transferred to assets for sale, LBA, valued at cost	286	162, 164
The residual value of the sold LBA, measured at cost, is written off	943	286
Proceeds from the sale of LBA, valued at cost	377	712
The amount of VAT liability is reflected	712	641
Accounting for the sale of long-term biological assets measured at fair value		
The value of the realized LBA, measured at fair value, is written off	901	161, 163, 165
Accounting for the elimination of long-term biological assets valued at cost		
The amount of depreciation of liquidated LBA, estimated at cost, is written off	134	162, 164
The residual value of the liquidated LBA, measured at cost, is written off	976	162, 164
Derecognised initial cost of liquidated immature LBA, valued at cost	976	166

Source: proposed by authors based on [1, 11, 12, 14].

Table 3. Correspondence of accounts for the receipt of current biological assets of animal product (CBA)

The content of the business transaction	Correspondence of accounts	
	debit	credit
Received CBA from the supplier	213	631
The amount of VAT tax credit is reflected	641	631
Accounting received free of charge CBA	212	718
CBA received as a contribution to the authorized capital was accounted for	212	46
Transferred to CBA in exchange for a similar facility	361	211
The amount of VAT liability is reflected	361	641
Received CBA in exchange for a similar object	213	631
The amount of VAT tax credit is reflected	641	631
Debts were offset	631	361
Domestic agricultural products were transferred in exchange for CBA	361	701
The amount of VAT liability is reflected	701	641
The cost of transferred agricultural products of own production is reflected	901	27
Received CBA in exchange for a different object	213	631
The amount of VAT tax credit is reflected	641	631
Debts were offset	631	361
The results of exchange transactions are determined		
- increase in the amount of cash based on the results of the exchange	311	361
- reduction of the amount of money as a result of the exchange	631	311
The offspring of animals are posted	212	232
The difference between the fair value of current biological assets of animal and the costs incurred for their biological transformation is recognized		
- income from initial recognition	231	710
- costs of initial recognition	940	231
Animals valued at fair value were culled from the main herd	212	163
Rejected from the main herd of animals valued at cost	213	164
The current biological asset of animal husbandry, which was identified during the inventory, was obtained	212	719

Source: proposed by authors based on [1, 11, 12, 14].

The main sources of income of current biological assets of animal product to the enterprise are purchase for a fee; free receipt; contribution to the authorized capital; exchange for similar and dissimilar assets; rearing in the enterprise – as a result of biological transformations, in particular, the offspring of young productive and working cattle, poultry incubation and others.

The procedure for reflecting the receipt of current biological assets of animal product in the accounts is shown in Table 3.

The main products obtained from raising young animals and fattening animals are:

a) increase in live weight of animals during the reporting period (the peculiarity of this product is that it can not be separated from living biological assets; therefore, the increase in live weight is added to the mass of biological assets, and its value increases the value of biological assets);

b) live weight of animals (this is the weight of animals sold, slaughtered in the enterprise, transferred to other groups and left at the end of the reporting period).

Correspondence on the disposal of current biological assets is shown in Table 4.

Table 4. Correspondence of accounts for the disposal of current biological assets of animal product

The content of the business transaction	Correspondence of accounts	
	debit	credit
Revenue from the sale of current biological assets of animal is reflected	361	701
Accrued VAT liability	701	641
The cost of sold CBAs, which are measured at fair value, is written off	901	212
CBA transferred free of charge	949	212
Accrued VAT liability for the free transfer of assets	949	641
Transferred CBA (at fair value) to the authorized capital of another enterprise	143	701
Accrued VAT liability	701	641
The cost of the transferred CBA is written off, which is equal to the fair value	901	212
Young animals were transferred to long-term biological assets at fair value	155	212
The animals in the main herd were posted	163	155
The fair value of CBAs removed from fattening for slaughter in the enterprise is reflected	233	212
The death of animals from the CBA (accounted for at fair value) is written off within the technological norms	232	212
The skins of dead animals were posted	27	232
The death of animals above technological norms has been written off	947	212
Revealed, as a result of inventory, shortages and losses of CBA	947	212

Source: proposed by authors based on [1, 11, 12, 14].

Agricultural products during its separation from biological assets include: in crop production – grain, fruits, berries, vegetables, seeds, green mass, potatoes, roots, hay; in animal husbandry – milk, wool, eggs, honey. Agricultural products are debited from account 27 “Agricultural products” at fair value.

The reflection of operations on the accounting of long-term and current biological assets using the proposed accounts will not only quickly and without additional selection to form financial statements, but also to obtain full information about them for operational control and analysis, organization of efficient agricultural enterprises.

CONCLUSIONS

The results of the study allow us to draw the following conclusions:

-Biological assets – one of the most important components of agricultural production, which determines its results and without which it can not exist. In this context, it is important to properly manage such assets, which cannot be done without a proper accounting system.

-Biological assets are classified according to the period of receipt (provision) of economic benefits or by term of use into long-term and current. In addition, it is appropriate to distinguish groups of such assets based on: their maturity; branch of agriculture (animal, crop production); the nature of the reflection of wear; by right of ownership; purposes of use; by type of agricultural market; type of assessment; structure. The classification of biological assets by structure is the basis of analytical and synthetic accounting and economic analysis.

-Recognition and valuation of biological assets have a significant impact on the results of their use and property status of agricultural enterprises, as well as their image and market position [18]. The basic approach to the valuation of biological assets is their fair (or market) value, which is expressed as the amount at which the asset can be exchanged or arrears between knowledgeable, interested parties and independent parties. In domestic practice, mostly use a market approach. There are three types of estimates of biological assets: on receipt; at initial recognition; on the balance sheet date.

In our opinion, the proposed system of accounting for long-term and current biological assets will allow us to obtain relevant information in full, strengthen the control function of accounting and promote the organization of effective financial and economic activities of agricultural enterprises.

The complex of theoretical, regulatory and practical issues related to biological assets and inquiries about ways to improve the management of their use requires the development of new types of accounting, able to provide the necessary information to all interested users.

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LEADING SECTOR ANALYSIS AND ECONOMIC SYSTEM LINKAGE OF CUSTOM VILLAGE IN BALI PROVINCE, INDONESIA (STUDY ON BALI ANYAR CUSTOM VILLAGE)

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Abstract

Traditional villages in Bali still exist and are in harmony with the village (administrative village), and play an important role in people's lives, including in the economic field. Based on the typology and the period of formation, custom village are divided into Bali Aga Village, Apanage Village, and Bali Anyar Village. The purpose of this study is to analyze the linkage system (both forward linkage and backward linkage) based on the potential analysis of the rural economy in Bali, with a study on custom villages which are included in the Bali Anyar Custom Village type. This research is an exploratory research where the research is focused on three traditional villages including Bali Anyar Village, namely Kutuh, Sesetan, and Karang Dalem Custom Villages. Data was collected through interview techniques, non-participant observation. The data collected were analyzed descriptively quantitatively and qualitatively, including the linkage system approach (backward and forward linkages). The results of the analysis show that the three leading economic sectors of Bali Anyar Village, namely: (1) the SMI, MSME, and cooperative sectors; (2) tourism sector; and (3) the creative and digital economy sector. These economic sectors have strong inter-sub-sector links with other sectors (backward and forward linkages) outside Bali, in Bali (locally), and foreign.

Key words*: *forward linkage, backward linkage, rural economics, custom village

INTRODUCTION

Local development is an integrated development that combines economic dimensions with other dimensions such as social, cultural, and institutional with an emphasis on local spatial contexts [5]. The development in question is a process that exists in the community, government, business actors, and other non-government sectors working together to create better conditions for economic growth and community welfare. The framework of the study of human survival is inexhaustible to discuss one phenomenon, namely development. Development as one of the phenomena inherent in one of the characteristics of human life often undergoes changes following various existing dimensions. The context of the study of a change is usually attached to the concept of development which is defined as a form of planned change, a change that has a better shape than the previous state and is expected by each person or certain group. Planning is needed to realize these expectations [11].

The development of the economic base in rural areas has long been carried out by the government through various programs. However, these efforts have not yielded satisfactory results as desired together. One of the most dominant factors is that government intervention is too large, as a result, it hampers the creativity and innovation of rural communities in managing and running the economic engine in rural areas. Economic institutional systems and mechanisms in rural areas do not work effectively and have implications for dependence on government assistance so that it kills the spirit of independence [20].

Ideally, the economic activities of rural communities are carried out in the form of institutions or business entities that are managed professionally [2], but still rely on the original potential of the village. This can make community businesses more productive and effective [4][16][21]. In particular, the purpose of developing village potential is to increase the active role of the community in making development decisions in an open, democratic and responsible manner; develop business capabilities and business opportunities to increase the income and welfare of poor households; and encourage the realization of integrated roles and partnerships between provincial and regency/city offices/agencies as well as other stakeholders as program actors and facilitators. Village potential is identified through physical characteristics (soil, water, climate, geographical conditions and human resources) and non-physical (spirit of mutual cooperation, Village institutions, educational institutions, health institutions, economic institutions, village apparatus and civil servants) which are currently owned by the village [1].

In addition to villages (administrative or service), in Bali there is also a Traditional Village, whose existence has also been legally recognized. Regional Regulation of the Province of Bali Number 4 of 2019 states that the Traditional Village is a unit of customary law community in Bali which has territory, position, original structure, traditional rights, own assets, traditions, manners of community life from generation to generation in the bond of sacred place (*Kahyangan Tiga* or *Kahyangan Desa*), duties and authorities as well as the right to regulate and manage their own household. So far, the dualism of villages in Bali can run in harmony and harmony in various aspects of Balinese life. Based on the typology and the period of formation, custom villages are divided into *Bali Aga* Village, *Apanage* Village, and *Bali Anyar* Village.

The purpose of this study is to analyze the linkage system (both forward linkage and backward linkage) based on the potential analysis of the rural economy in Bali, with a study on custom villages which are included in the *Bali Anyar* Custom Village type.

MATERIALS AND METHODS

Types of Custom Village in Bali

As previously mentioned, traditional villages in Bali are classified into *Bali Aga* Village, *Apanage* Village, and *Bali Anyar* Village [3][15].

(1)*Bali Aga* Village (Mountain Custom Village)

Custom villages that can be classified as *Bali Aga* Villages are mostly located in mountainous or inland areas with socio-cultural characteristics in little tradition. The tradition is dominated by pre-Hindu cultural characteristics. Even so, there is also a *Bali Aga* Village around the coast. Another characteristic is that in the *Bali Aga* Village there is no caste system, where the traditional village leadership generally adheres to a twin or collective pattern based on the basis of seniority known as *Ulu-Ampad*.

(2)*Apenage* Village (Custom Village in the Middle Bali era/The Influence of the Majapahit Kingdom)

When the Majapahit Kingdom (from Java Island) was able to conquer Bali, the Hindu religious aspects of Majapahit developed rapidly in Bali. The traditional villages which later came under the influence of Majapahit are known as the Bali Dataran or *Apanage* villages. *Apenage* village has the character of a rice field economy with an irrigation system, centralized power where the position of the king is a descendant of the gods (*devaraja* cults), the dominance of pedanda figures, religious concepts written in lontar, the existence of a color system to be casted, cremation ceremonies for the dead, the existence of Javanese Hindu calendar system, puppets performances, architecture, and art with Hindu and Buddhist motifs, as well as mask dances. The leadership in the villages of Bali Dataran is the sole leadership as the presentation of the king. Other characteristics such as differences in religion, social patterns, arts, and literature, and the arrangement of *palemahan*. In addition, the aspects of the social life of the Balinese people in the Dataran follow a social stratification which is dominated by elements of the Javanese Hindu tradition.

(3)*Bali Anyar* Village (modern Bali era)

So far, the custom village and the administrative village in Bali can run in harmony. However, in its development, in a traditional village there can be conflicts, especially related to land disputes, thus triggering the division or division of traditional villages. So that a new traditional village emerged in Bali in the era after Indonesia's independence until now. Or in an area that is not the territory of a traditional village, the people who live there agree to form a traditional village, this traditional village is called the *Bali Anyar* Village.

Concept of *"Kerthi Bali"* Economy

Departing from the aspiration to strengthen the structure and fundamentals of the Balinese economy, Governor of Bali (Wayan Koster) coined the concept of "*Kerthi Bali* Economy". The *Kerthi Bali* Economy is an economy to realize an Independent Bali in the economic field, built and developed based on the values of *Sad Kerthi*'s philosophy by applying 11 (eleven) principles, which are as follows [10].

(i)An economy that is built/developed from an attitude of gratitude/glorification for the wealth, uniqueness, and superiority of Bali's local natural resources and their contents as a gift from the God as Creator.

(ii)An economy that is built/developed according to the potential of Bali's local natural resources and their contents.

(iii)The economy built/developed by *Krama Bali* (member of custom village) is inclusive, creative, and innovative.

(iv)The economy that is built/developed is based on Balinese traditional values, arts, culture, and local wisdom.

(v)An economy that is built/developed by maintaining the natural and cultural ecosystem in a sustainable manner.

(vi)An economy that is built/developed to increase the capacity of the local Balinese economy, quality, added value, and competitiveness.

(vii)An economy that is built/developed by accommodating the application/development of science and technology as well as digital technology.

(viii)An economy that provides tangible benefits to improve the welfare and happiness of Krama Bali on a scale-by-scale basis.

(ix)An economy that is built/developed on the principle of *gotong royong* (communal work).

(x)An economy that is built/developed to increase resilience to the dynamics of the times locally, nationally, and globally.

(xi)An economy that fosters a spirit of embarrassment and love/proud as *Krama Bali*.

Based on the originality and superiority of Bali's local resources (Balinese Nature, Balinese *Krama*, and Balinese Culture), [11] further explained 6 (six) leading sectors as pillars of Bali's economy, namely:

-Agriculture sector (in a broad sense including livestock and plantations);

-Marine/fisheries sector;

-Industrial sector;

-Small and Medium Industry (SMI), Micro, Small and Medium Enterprises (MSME) and cooperative sector;

-Creative and digital economy sector;

-Tourism sector.

Rural Economic Development

Rural development must follow four major efforts, which are interrelated and constitute the main strategy of rural development. First, empowering the economy of rural communities [19][21]. In this effort, capital input and guidance on the use of technology and marketing are needed to enable and make village communities independent; Second, improving the quality of rural human resources so that they have an adequate basis to increase and strengthen productivity and competitiveness.

Third, infrastructure development in rural areas. For rural areas, transportation infrastructure is an absolute necessity, because transportation infrastructure will spur the backwardness of rural communities; and fourth, building rural institutions, both formal and non-formal. The institutions needed by the countryside are the creation of good services, especially to spur the rural economy such as financial institutions [2][18][19]. The administration of government in the field of development is basically the key to the success of developing local economic potential to strengthen regional competitiveness [7][16].

Research Methods

This research includes exploratory research which aims to explore objects according to the research objectives. Exploratory research is one type of social research whose purpose is to provide a little definition or explanation of the concepts or patterns used in research [8]. Although using a qualitative approach, this research is still supported by quantitative data and analysis.

The focus of the research is on Traditional Villages which are included in the category of *Bali Anyar* custom villages, with the consideration that in the future it is possible that new traditional villages will appear in Bali, which of course fall into the *Bali Anyar* category. Therefore, research on the linkage system of the *Bali Anyar* custom village will have useful futuristic implications.

There are three Balinese Anyar traditional villages that serve as the research locus, namely the Kutuh custom village and Karang Dalem custom village (in Badung Regency), and the Sesetan custom village (in Denpasar City). Data collection on the potential of traditional villages was carried out through a questionnaire instrument originating from the Census program of *Sad Kerthi Semesta Bali* Based on Custom Village. The census of *Sad Kerthi Semesta Bali* Based on Custom Villages aims to record how much cultural wealth and local wisdom exists in each traditional village in Bali in an effort to develop and empower traditional villages in Bali that are closely related to cultural values.

In addition, data collection was also carried out through in-depth interviews with local traditional leaders, especially *Bandesa* from the three traditional villages that became the research locus. *Bandesa* is the name for the traditional village head. Non-participant observations were also conducted to obtain a direct picture of the rural economy of the traditional village of *Bali Anyar* at the research locus. Non-participant observation is an observation method in which the observer does not take part in the observer's life [6].

The collected data is then analyzed to obtain an overview of the potential profile of traditional villages and village economic analysis using a linkage system approach. As previously explained, the linkage system consists of backward linkage and forward linkage.

Mapping of local potential is an activity carried out to find and recognize the socio-economic and cultural potential of local communities or also known as social orientation activities [13][9]. This activity is part of the initial socialization process, carried out after and or simultaneously with non-participant observation activities to strategic groups at the customary village level.

Socio-cultural and socio-economic conditions that need to be identified include the following conditions: what values are dominantly embraced by the community that are able to move the community; what social forces are capable of bringing about changes so that people can change from within themselves; what is the character and characteristics of the community, especially in responding to social interventions; such as what is the pattern of communication information that occurs in the community, both in the dissemination of information and in the learning framework; What media and learning resources are used and believed by the community as a means of information and learning; Dominant social forces within the framework of social change; What environmental factors influence people's attitudes and behavior [13].

In determining the leading sector, there are several criteria that can be used as described in Table 1.

Each criterion is then given a value by the informant based on a Likert scale from a value of 1-5 according to perceptions about the level/condition of the economic sector. The higher the value, the better the condition. Furthermore, the scores obtained by each of the leading sectors of the *Kerthi Bali* Economy on each criterion are averaged, so that a composite or combined value is obtained.

Table 1. Criteria for Determining Leading Sector

No	Criteria	Code
1	The sector has a high contribution and growth rate so that it can improve the regional economy.	C1
2	The sector's ability to meet market needs.	C2
3	The sector has a large competitive ability to the wider economic system and a large growth of economic activity in the local and wider area.	C3
4	The sector has a multiplier or a large impact on other economic activities and the development of the surrounding area.	C4
5	The sector has strong links between sub-sectors and other sectors (forward linkages and backward linkages).	C5

Source: [14].

Analysis of linkages between sectors (linkage system) is divided into backward linkage and forward linkage. Both linkages are analytical tools used to determine the level of linkage of a sector to other sectors in the economy [17]. Backward linkages are the linkages of a sector to other sectors that contribute inputs to it. Forward linkages are linkages of a sector that produce output to be used as input for other sectors [12].

RESULTS AND DISCUSSIONS

Overview and Potential of *Bali Anyar* Custom Village (Research Locus)

As previously explained, there are three *Bali Anyar* Custom Villages that will be used as the research locus, namely the Kutuh Custom Village, Karang Dalem Custom Village, and Sesetan Custom Village (Fig. 1).

Kutuh Custom Village

Kutuh Custom Village is a coastal area located in the South Kuta District, Badung Regency, Bali Province. Kutuh Custom Village consists of 10 *Banjar Adat*, with a population of about 1,193 families. The economic potential of the Kutuh Custom Village is in the form of tourism, services, and retail SMEs. In 1998, the Kutuh Custom Village was initiated by the local government of Bali to establish an LPD (Custom Village Credit Institution) with an initial capital of 13 million Rupiah, and in 2021 the assets of the LPD have reached 125 billion Rupiah.

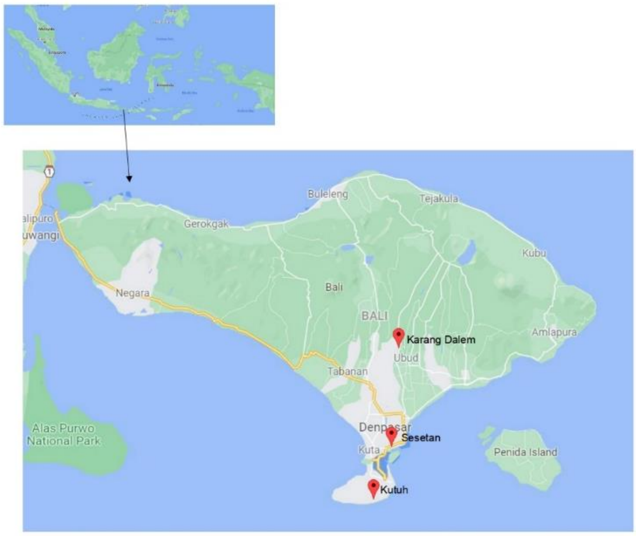

Fig. 1. Map of Research Locations for Traditional Villages in Bali (Inset Map of Indonesia)
Source: Google Maps (Processed).

Kutuh Custom Village established custom village-owned enterprises a.k.a. BUMDA *(Baga Utsaha Manunggal Desa Adat)* in 2014 to drive the economy in the real sector of the community. BUMDA has nine business units and three service units. The nine business units in question include LPD, Pandawa Beach Tourism, Gunung Payung Cultural Park, Timbis Paragliding Special Tourist Attractions, Special Arts and Culture Tourist Attractions, Goods and Services Unit, *Piranti Yadnya* (offering things) Unit, Transportation and Construction Services *(Undagi)*. Meanwhile, educational and partnership tourism services, regional security and order services, and insurance and health insurance services are three integrated service units to support village tourism. Kutuh Custom Village also has a special art and culture tourist attraction, i.e. Kecak Dance performance at Pandawa Beach.

Sesetan Custom Village

Sesetan Custom Village located in Denpasar City, Bali Province with an area of 7.39 km² (739Ha) and geographically located at an altitude of less than 500 meters above sea level stretching to the north. Sesetan Custom Village consists of nine *Banjar Adat*. The economic potential possessed by the Sesetan

Custom Village is in the form of culinary SMEs, the creative economy also trade and services. Sesetan Custom Village also has financial institutions in the form of LPD which has developed quite rapidly, and BUMDA with business units in the field of services in the form of markets, garage rentals, boarding houses. In addition, the Sesetan Custom Village also has a unique art and culture, namely the *Bungbang gamelan* and the *omed-omedan* tradition. *Gemelan Bungbang* is a *barungan* (a set) of bamboo orchestra classified in Balinese *karawitan* (traditional music) art as new *gamelan* (the art of new percussion). *Omed-omedan* tradition is an empty-handed tug-of-war between young men and women aged 17 to 30 who are not married yet and is held once a year after *Nyepi* day. Sesetan custom village also has several well-known art studios, one of which is *Gases* who is active in the preservation of cultural arts, and involves the local community in their artistic activities.

Karang Dalem Custom Village

Karang Dalem Custom Village is located in Abiansemal District, Badung Regency, and not a coastal area. Karang Dalem Custom Village has the natural potential of rural scenery, the meandering flow of the Ayung River stretching from upstream to downstream, agricultural landscapes starting from rice fields. When viewed from the socio-cultural aspect, religious ritual activities in the rice fields, *Bedugul*, *Subak* Temple, or *Kahyangan Tiga* Temple. The unique thing in the Karang Dalem Custom Village is the *Batu Megong* at the Subak Temple which can be used as a cultural symbol, in addition to Balinese architecture in the traditional houses of the local community. The economic potential of the Karang Dalem Custom Village is agriculture, animal husbandry, and plantations as well as MSME handicrafts and tourism. The daily activities of the community are farmers working in the fields, making handicrafts, as well as local traditional cuisine as socio-cultural attractions. Artificial attractions for recreation can be found at Bali Swing, Pinball and ATV attractions as well as silver craft centers

Analysis of the Leading Sector of the New Bali Traditional Villages

Based on the description of the overview and identification of potentials, it is known that of the six leading sectors of the Traditional Village economy as in the *Kerthi Bali* Economic concept, the sectors that are superior in the *Bali Anyar* Custom Village are analyzed according to the criteria and the results are presented in Table 2 below.

Table 2. Analysis of Leading Sector of *Bali Anyar* Custom Villages

No	Leading Sector of Custom Village	Code of Criteria					Average
		C1	C2	C3	C4	C5	
1.	Agriculture sector	2.33	2.33	2.33	2.33	2.33	2.33
2.	Marine/fishery sector	2.33	2.33	2.33	2.00	2.00	2.20
3.	Industrial sector	2.00	2.00	2.33	2.00	2.00	2.07
4.	SMIs, MSMEs, and cooperatives sector	3.67	4.00	4.00	3.67	3.67	3.80
5.	Creative and digital economy sector	3.00	3.00	3.00	3.33	3.33	3.13
6.	Tourism sector	3.67	3.67	3.67	3.67	3.67	3.67
	Average	2.83	2.89	2.94	2.83	2.83	

Source: Results of data analysis (2021).

Based on Table 2, it is known that there are three leading economic sectors of *Bali Anyar* Village, namely: (1) the SMI, MSME, and cooperatives sectors; (2) tourism sector; and (3) the creative and digital economy sector.

More specifically, Figure 2 presents a comparison chart of the leading sectors in each Indigenous Village at the research locus and on average in the *Bali Anyar* Village. Figure 2 shows that the tourism sector is the leading sector of the Kutuh Custom Village. While the SMI, MSME, and cooperative sectors are the flagship of the Sesetan Custom Village. Furthermore, Karang Dalem Custom Village with leading sectors in agriculture and tourism.

In addition, it is also necessary to review the position of the *Bali Anyar* Village on each of the criteria.

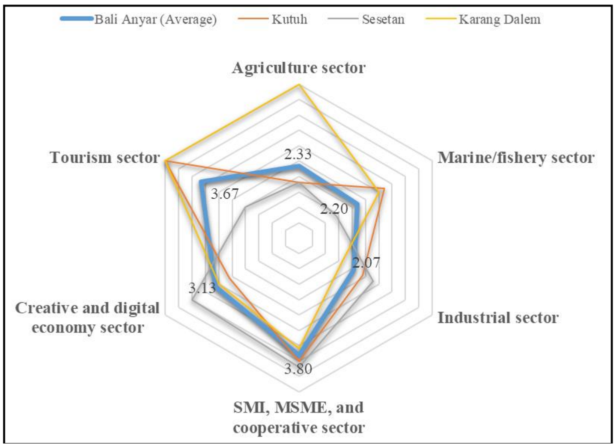

Fig. 2. Leading Sector Map of *Bali Anyar* Custom Village
Source: Results of data analysis (2021).

Figure 3 shows that on average or partially, *Bali Anyar* Village excels in criteria C5, which shows that economic sectors have strong sub-sector links with other sectors (forward linkages and backward linkages). Therefore, it is necessary to continue with the analysis of the linkage system.

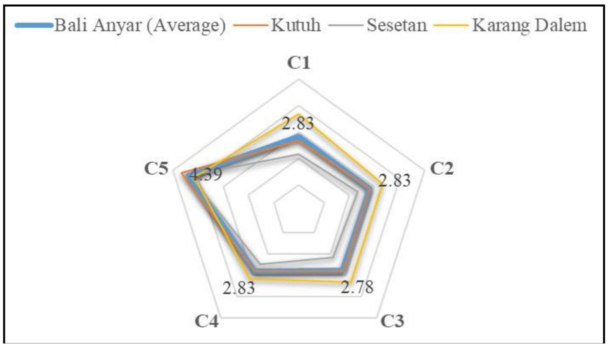

Fig. 3. Value Map of Traditional Village Economic Sector in accordance with Leading Sector Criteria
Where: C1=The sector has a high contribution and growth rate so that it can improve the regional economy; C2=The sector's ability to meet market needs; C3=The sector has a large competitive ability to the wider economic system and a large growth of economic activity in the local and wider area; C4=The sector has a multiplier or a large impact on other economic activities and the development of the surrounding area; C5=The sector has strong links between sub-sectors and other sectors (forward linkages and backward linkages).
Source: Results of data analysis (2021)

Linkage System of *Bali Anyar* Custom Village Economy

Based on the results of the analysis and field observations, partnerships in the form of a linkage system in *Bali Anyar* Custom Village can be arranged, especially in the leading sectors, namely the SMI, MSME, and cooperative sectors, the tourism sector, as well as the creative and digital economy sectors.

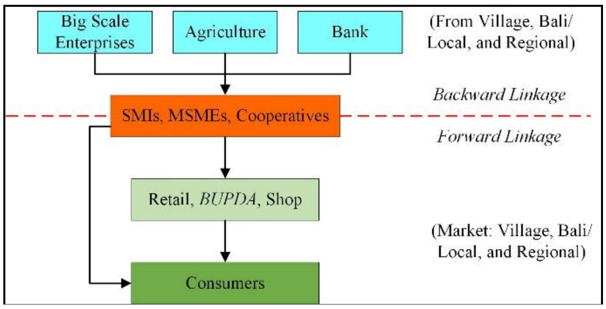

Fig. 4. Linkage System of SMI, MSME, and cooperative sector
Where: BUPDA *(Baga Utsaha Padruwen Desa)* = Custom Village Owned Enterprises
Source: Results of interpretation (2021).

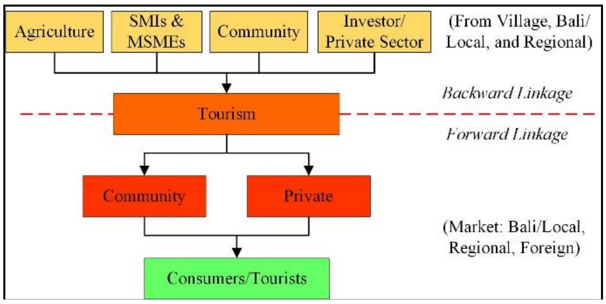

Fig. 5. Linkage System of Tourism Sector
Source: Results of interpretation (2021).

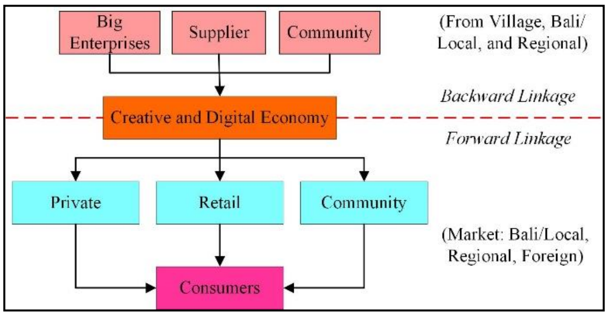

Fig. 6. Linkage System of Creative and Digital Economy Sector
Source: Results of interpretation (2021).

Figures 4 to 6 show the linkage system in the three leading sectors of *Bali Anyar* Village. Backward linkage shows that the leading sector is related to other sectors originating from the local (local) and domestic area. Meanwhile, forward linkage shows that the sector has a fairly good market share, including the creative economy sector that is able to penetrate the international market. In addition, many tourists who enjoy the tourism sector come from international tourists.

CONCLUSIONS

Based on the results of the analysis, it is known that there are three leading economic sectors in *Bali Anyar* Custom Village, namely: (1) the SMI, MSME, and cooperative sectors; (2) tourism sector; and (3) the creative and digital economy sector. The economic sectors of *Bali Anyar* Custom Village have advantages which indicate that these economic sectors have strong sub-sector links with other sectors (forward linkages and backward linkages) both outside Bali, in Bali (local), and foreign.

As a follow-up, it is recommended that the local government can review so that backward linkage is made closer, such as connecting with suppliers of raw materials from Bali. In addition, the expansion of market share is also very important. So far, the output of SMI and MSME products is only for local market share, except for the creative economy sector which has begun to penetrate national and international markets. The tourism sector is also in demand by international tourists, in addition to domestic and local tourists.

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ECOLOGICAL AGRICULTURE DEVELOPMENT IN THE REPUBLIC OF MOLDOVA: EVOLUTION AND BENEFITS

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Abstract

In recent years, organic products have been in an increasing demand with consumers. For those who decide to make the transition from conventional to organic or to start a business with organic products, organic agriculture offers many benefits. Organic agriculture is growing in the Republic of Moldova and contributes to global agricultural exports. However, subsidies for organic agriculture are limited. In this context, the study aims to analyse the development prospects in competition with less quality but cheaper traditional products. During the research of this subject, the following methods were used: deduction and induction, analysis, comparison, tabular method and graphical method. In the Republic of Moldova, organic agriculture began to grow only in the years 2002-2004 when the dialogue with the European Union on the share of vegetables, fruits, grapes, berries produced in Moldova and exported to the EU countries began. The structure of crops grown within organic agriculture practices in the Republic of Moldova includes primarily traditional crops (wheat, corn, barley, sunflower, sugar beet, soybeans, peas, etc.), medicinal plants, orchards and vineyards. However, the implementation of organic agricultural systems in the Republic of Moldova is characterized by modest indicators compared to other European countries. Impediments to its promotion are related to the low level of investment, limited access to financial resources, low level of entrepreneurial and professional qualities of most farmers, limited size of the internal market and tough demands of foreign markets, poor harmonization of national standards with the European ones.

Key words: *organic agriculture, conventional agriculture, sustainable development, trade, subsidies.*

INTRODUCTION

The traditional farming system, with its accompanying shortcomings, tends to be replaced by organic farming (sustainable agriculture). It has also begun to take on a clearer profile in the Republic of Moldova.
Organic agriculture is based on the use of those means and methods offered by scientific and technical innovations that ensure high quality production, promoting land cultivation by those means that ensure a balance between agroecosystems and the environment. Organic agricultural systems avoid or completely exclude the use of synthetic fertilizers, pesticides, growth regulators and feed additives. They are based on crop rotation, the use of residues obtained in plant cultivation and animal husbandry [14].
The foundations of organic agriculture were laid between 1920 and 1960, immediately after the beginning of the process of industrialization of agriculture and at the start of the "green revolution" by Rudolf Steiner in Germany, the founder of the concept of "biodynamic agriculture", Sir Albert Howard in England, whose ideas founded the school of "organic farming", H. Müller in Switzerland, author of the concept of "organic-biologic" agriculture, and the founders of the school of "organic farming" C. Lemaire and J. Boucher in France [16].
Initially, the agricultural activity was oriented towards obtaining a higher productivity, in order to satisfy the basic food needs and to increase the self-sufficiency rate. Since the period 1970-1975, organic agriculture has gained in importance, being aware of the issue of conservation of the natural environment.
In 1991, the EU Regulation on organic agriculture appeared, marking the beginnings of the official interest in this type of agriculture at European level. Since 1999, the FAO's Global Codex Alimentarius has also included information on organic agriculture. Codex information is intended to guide and

promote organic agriculture, labeling requirements for organic products, contribute to their standardization and thereby protect consumers and facilitate international trade.

Organic agriculture involves the use of environmentally sustainable practices and respect for natural resources, by updating traditional methods verified for centuries and combining them with modern methods, in order to maintain and increase soil productivity [20].

The global concept of organic agriculture starts from two major social implications [12]:

1. Organic agriculture is a method of producing food that is usually more expensive than traditional food. Thus, organic agriculture is supported by consumers who benefit from organic products. In this context, organic farming is subject to market rules.
2. Organic agriculture provides public goods, which are financed from the state's financial resources. From this point of view, the development of organic agriculture is a direction of public policies, especially in the field of environmental protection.

However, organic agriculture is considered a mode of production that is characterized by the use of techniques of plant cultivation and animal husbandry that respect the natural balance, aims to harmonize the dynamic interactions between nature and man. Being a type of sustainable agriculture, the purpose of organic agriculture can be expressed by optimizing production in line with existing natural resources and minimizing the negative externalities of agricultural activities [18].

Organic agriculture pursues two fundamental objectives [17]:

1) Reduction of pollution by excluding use soluble pesticides and fertilizers;
2) Conservation of fertility heritage and even enriching the soil with organic matter.

Therefore organic agriculture is an alternative to traditional agriculture as a result of improper operation thereof and the causes which led to decreased resistance of plants, animal health and soil quality and thus human health. Organic agriculture is based in principle on increasing soil organic matter content by using natural fertilizers [2].

Sustainable agri-food production aims to retain the environmental balance and not to adopt practices that negatively affect ecosystems. A sustainable agri-food supply chain system also benefits the society through the creation of synergies among stakeholders with different objectives and through fostering the wellbeing of the society [9].

Agricultural organic sector is differed by its own characteristics, arising from the natural, economic, social and other conditions of production. Organic agricultural production refers to the intensive agricultural [1].

The need to address this research topic originates from current trends in promoting the consumption of organic products. The research in this field has a multilateral character: social, economic, political, etc. In accordance with the aspects mentioned above, the paper aims to analyze the development trends of organic agriculture in the Republic of Moldova, the marketing of organic production, and the subsidization of organic agriculture.

MATERIALS AND METHODS

The theoretical and methodological basis of this article is the scientific work of researchers in the field, as well as the institutional and regulatory framework for organic agriculture. The data required for the analysis were selected from the statistical databases of Eurostat and the National Bureau of Statistics. During the research of this subject, the following methods were used: deduction and induction, analysis, comparison, tabular method and graphical method.

RESULTS AND DISCUSSIONS

The results of the study are reflected in four compartments: fundamental notions regarding organic agriculture, the evolution of organic agriculture in the Republic of Moldova, marketing of organic agri-food products, subsidizing organic agriculture.

Fundamentals of organic agriculture. The process of obtaining organic products is governed by strict rules and principles, which aim to maintain soil quality and obtain organic products. The role of the organic agricultural system is to produce much more natural food, but in full correlation with the environmental protection. In plant cultivation, organic agriculture tends to sustainably preserve the natural basis of agricultural products, genetically modified organisms and their derivatives being banned. Animal welfare aims at the well-being and high performance of animal life.

The principles and practices underlying organic agriculture have been described in the International Federation of Organic Agriculture Movement (IFOAM) standards document. These principles refer directly to organic agricultural techniques, such as: the use of large rotations; avoidance of soluble fertilizers; prohibition of intensive animal husbandry; avoidance of antibiotics and hormonal stimulants; emphasizing the processing of products on the farm and the direct sale to the consumer; the use of additional work when strictly necessary (Figure 1).

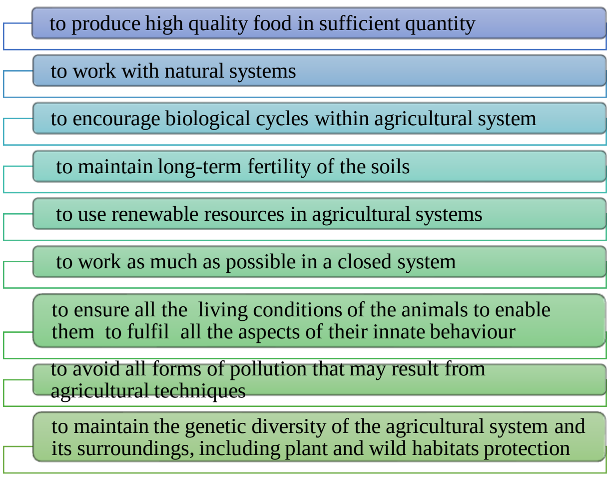

Fig. 1. Principles of practicing organic agriculture according to IFOAM standards
Source: Developed by the author based on [14].

The conditions for compliance with the principles of organic agriculture are governed by the national law. The control of the technological process of obtaining ecological products is carried out by the bodies specialized in inspection and certification.

IFOAM defines organic agriculture as a production system that supports the health of soils, ecosystems and people. It is based on ecological systems and life cycles adapted to local conditions, instead of using resources with adverse effects. Organic agriculture combines innovation and science for the benefit of the environment, promotes fair relations and a good quality of life. Thus, organic agriculture differs fundamentally from conventional agriculture (Figure 2).

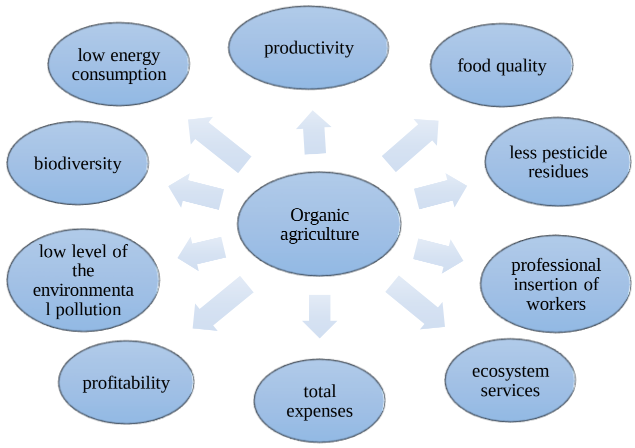

Fig. 2. Peculiarities of organic agriculture compared to conventional agriculture
Source: Developed by the author based on [6].

Comparing organic agriculture and conventional agriculture, from an economic point of view, we can mention that it brings slightly higher incomes, in some cases, such as the initial costs for pesticides, fertilizers or fuel. However, the mechanization of agricultural works favors the occurrence of environmental risks, so organic agriculture doesn’t differ from conventional one. There are small differences between the two agricultural systems when it comes to invested capital, as the practice of organic production requires additional investment, which aims to obtain certifications and investment in special equipment. Large differences occur in the case of social and environmental benefits offered by organic agriculture aimed at food safety, reducing environmental risks by replacing chemical resources with renewable ones, crop resistance in situations of heavy rain or drought, etc. Due to the abandonment of synthetic pesticides, organic agri-food products contain less residues and pesticides than conventional products.

Also, organic agriculture increases natural biodiversity, does not pollute the aquatic environment, protects the climate, it is energy efficient, etc. Organic agriculture stimulates the development of advanced science and technology through the application of various modern devices and programs.

Practicing organic agriculture has a number of beneficial effects for both the farmer and the environment and society [13]. Thus, the beneficial effects at farm level are:

• restoring natural balances by using classical technological measures (fertilization, soil works, etc.), as well as by using ecological measures (rotation, associated and catch crops, agroforestry curtains, hedges, grass strips, etc.), improvement measures of soils (green fertilizers, mulching, conservative works, etc.) and plant protection (preventive, biological, biotechnical methods, etc.);

• sustainable increase of soil fertility by stimulating the activity of soil microorganisms and the use of compost, green manures and long rotations with perennial and annual plants with rich and deep root system;

• decrease of soil erosion as a result of the improvement of its quality (increase of the organic matter content and improvement of the structure) and of its better coverage (mulching, protection crops, etc.);

• water retention and conservation in the soil. The high content of soil organic matter leads to better retention and conservation of water in the soil, as a result the irrigation needs are reduced and the soil structure is maintained;

• compliance with the basic needs of animals regarding food, shelter, movement; ensuring the best living conditions for each species and category of animals, this objective being a primary one in organic agriculture.

The beneficial effects on the environment are manifested by:

• reducing global environmental problems. Organic agriculture contributes to the reduction of global environmental problems, such as: acid rain, global warming, biodiversity reduction and desertification;

• protection of soil, water and air. By not using synthetic chemical fertilizers, pesticides, etc., by rational and balanced use of resources, especially renewable ones, by caring for nature and by specific methods and techniques, organic agriculture ensures good protection of soil, water and air;

• increasing and conserving biodiversity. The basic principle of organic agriculture is the growth and maintenance of biodiversity. This fact contributes to ensuring the sustainability of the agro ecosystem;

• restoration and protection of the natural landscape. The organic agricultural system is an environmentally friendly system, it promotes the sustainable use of natural resources, helping to restore and protect the natural landscape.

The beneficial effects of organic agriculture on the society are less visible, but by no means less important. Among them we can highlight:

• production of food and other agricultural goods of high quality and in sufficient quantity. Organic agriculture contributes to ensuring food security and safety;

• diversification of agricultural production. The structure of agricultural production is largely influenced by consumer requirements. Organic agriculture contributes to the diversification of agricultural production, in particular through quality and healthy products, which meet the consumer’s requirements;

• reducing the consumption of non-renewable resources, promoting the use of renewable sources and actively contributing to the reduction of non-renewable energy consumption;

• improving the quality of farmers’ life. Organic agriculture offers business opportunities and rural development, which leads to improved quality of life for farmers and rural residents.

In addition to the mentioned benefits, however, organic agriculture has some disadvantages [8]:

• low level of yields;
• higher prices than conventional products;
• the need to support organic agriculture;
• the presence of counterfeit organic products on the market;
• difficult certification process;

• research and limited extension of ecological agricultural practice.

Organic agriculture can be analyzed in three dimensions, comprising ecological, economic and social elements, these being in a balanced ratio.

The ecological dimension includes climatic, biological, plant and animal potential. The ecological agricultural system is long-lasting, it's a peculiarity determined by its high level of integration in nature. The processing of organic agricultural products is carried out while maintaining the quality and, as far as possible, the structural integrity of agricultural products, in impeccable hygiene conditions.

The economic dimension includes material and financial values in operation or conservation. The lands, goods and services of agro-ecological enterprises are private property, and the money sources are provided, for the most part, from own resources. In developed countries, a significant part of the financial resources for the development of organic agriculture is provided by the state through subsidies.

The social dimension includes labor, physical skills and knowledge of agriculture and related economic activities, as well as interpersonal relationships. Practicing organic agriculture involves the use of a larger number of labor than in conventional agriculture, which, from a practical point of view, means not only new jobs, but also additional expenses.

In general, we can mention that organic technologies and foods are, with the exception of costs and the level of production, superior to traditional technologies and products. Organic agriculture is agriculture of the future.

The evolution of organic agriculture in the Republic of Moldova

Organic agriculture is becoming more and more important and is constantly expanding worldwide. This development is supported by the growing consumer demand for organic agricultural products, which are becoming more aware and interested in health insurance through the consumption of products, to which are added the company's requirements for sustainable agricultural development, as well as the multitude of favorable effects at the level of agricultural enterprise and the environment.

In the Republic of Moldova, organic agriculture began to grow only in the years 2002-2004 when the dialogue with the European Union on the share of vegetables, fruits, grapes, berries produced in Moldova and exported to the EU countries began. Taking into account the fact that in the Republic of Moldova agriculture is the basic branch of the national economy, the problem of major importance such as organic agriculture has emerged. Our country has the full human and production potential, favorable climatic conditions, fertile soil and so there are all the prerequisites to partially move from traditional agriculture to organic agriculture.

In support of organic agriculture, since 2005 the Ministry of Agriculture and Food Industry has adopted the basic legislative framework harmonized with the EU regulations in this field, necessary for the development of organic agriculture. In order to implement them, within the Republican Center of Applied Pedology there were elaborated and there are applied in practice "Land assessment procedure in the ecological agricultural circuit", the guide "Risk management within ecological agricultural practices", and during the years 2007-2008 the National Body for Inspection and Certification of Ecological Agri-Food Products included 46 economic agents with about 9 thousand ha of agricultural land in the ecological agricultural circuit.

An important step towards achieving this goal was the elaboration of the National Strategy for agricultural and rural development for the years 2014-2020 which provides for 3 general objectives and 8 specific objectives. One of the specific objectives is "Supporting environmentally friendly production technologies, environmentally friendly products, including biodiversity" [10]. The achievements of this objective include "Development of minimal tillage technologies, including the organization of seminars on the advantages of the No-till / Mini-till tillage system". Thus, only in the first year of implementation, the area of agricultural land cultivated under No-till/Minitill technology is about 84 thousand ha, increasing by 20 thousand ha compared to 2014. This increase is largely due to the subsidy allocated to procured agricultural equipment and implementation of programs through IFAD and 2KR projects.

Another achievement is "Development and promotion of the organic agricultural system". By the MAFI Order no. 49 of 27.03.2015, there was approved the Regulation on the organization and functioning of the Profile Commission on the examination of applications for the use of the national trademark "Organic Agriculture - Republic of Moldova". That Commission examines national trademark application and use confirming that the goods in question are environmentally friendly [19].

At the same time, in order to ensure the promotion and implementation of the objectives specified for organic agriculture, by Order no. 107 of May 26, 2008 of the Ministry of Agriculture and Food Industry, the Republican Center for Applied Pedology is empowered with the function of coordinator of the activities related to organic production, but also responsible for assessing soil quality and fertility and developing projects and plans for ecological management of agricultural enterprises.

In recent years, the spectrum of crops grown within organic agriculture practices has diversified considerably. In the northern part of the Republic of Moldova, the structure of crops includes primarily traditional crops (wheat, corn, barley, sunflower, sugar beet, soybeans, peas, etc.). In the Central area, in addition to traditional crops, the structure of the crops also includes medicinal plants, and the products obtained from the processing of the latter are exported to Bulgaria and France. Organic orchards and vineyards have been set up in the South and South-East.

The main danger, which threatens and may compromise organic agriculture in the Republic of Moldova, is the wrong approach and misperception of this field. Thus, the implemented ecological agricultural practices are reduced when they refuse synthetic mineral fertilizers and phytosanitary substances.

Organic agriculture has the chance to assert itself in the Republic of Moldova only if we realize that organic agricultural systems are a new generation of agricultural systems, which involves two basic components: greening and biologicalization of agrosystems. The first involves the practice of agricultural systems adapted to the functioning mechanisms of the soil ecosystem. The second component involves restoring the energy resources of pedogenesis by increasing the amount of organic matter.

According to official statistics, organic agriculture grew at a steady pace during 2009-2012. Organic agricultural areas (both certified and in conversion) have expanded from 16.6 thousand ha to 61.6 thousand ha. Subsequently, by 2015, the area of organic agriculture is declining, and then it rises again (Figure 3).

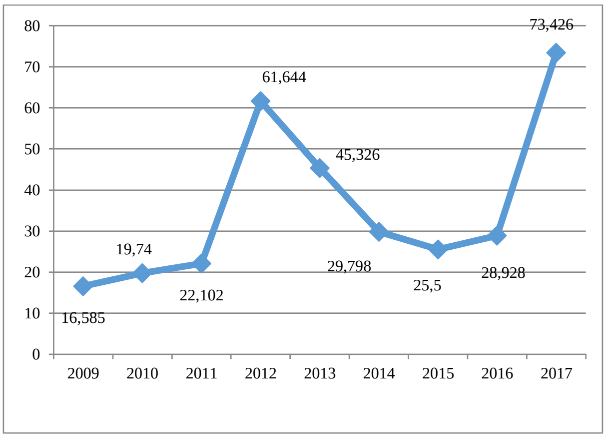

Fig. 3. Area registered in organic agriculture in the period 2009-2017 (ha) in the Republic of Moldova
Source: Elaborated by the author based on [11].

At the same time, the number of economic agents who practiced organic agriculture expanded during the period 2003-2009, reaching a number of 185. Starting with 2011 the number of economic agents who practice organic agriculture is in permanent decline, reaching 40 until 2015, and then there is again an increase to 127 producers in 2018 (Figure 4).

One of the main reasons for the increase in the registered dynamics was the favorable policies supported by the Government of the

Republic of Moldova, being granted subsidies from 2007 for the reimbursement of the expenses incurred during the conversion period. Since 2012, the granting of subsidies has been directed towards the establishment of multi-annual plantations, which has had a negative impact on organic agriculture.

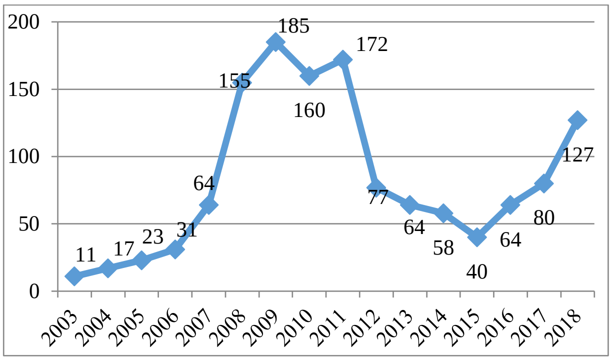

Fig. 4. Number of economic agents registered in organic agriculture within the period 2003-2018 in the Republic of Moldova
Source: Elaborated by the author based on [11].

Another factor that influenced the growth of organic agriculture during that period was the European Union's policies regarding the import regime of organic products from third countries, which allowed the export of "organic" products to the European Union market. The export of organic products was carried out on the basis of import authorizations, which were granted by Member State authorities and national inspection and certification bodies. This option, however, was transitory.

From June 2014, the transition period ended, with the system of import authorizations being replaced by the system of equivalent control bodies.

However, despite the efforts to increase the number of economic operators applying organic production methods, the organic area is found to be considerably small compared to other European countries (Figure 5).

The small areas registered in the national organic agriculture are marked by a series of factors, such as:

• lack of information on the record of areas, types of crops grown in organic agriculture;

• lack of an effective legal framework for granting exceptions for organic agri-food production;

• lack of a system of state supervision and control regarding the traceability of organic agri-food products.

In this context, we can mention that organic agriculture represents for the Republic of Moldova a solution for the revitalization of agricultural lands with the help of sustainable practices, but also an opportunity, taking into account the relatively small areas with which we can assert ourselves on the foreign market.

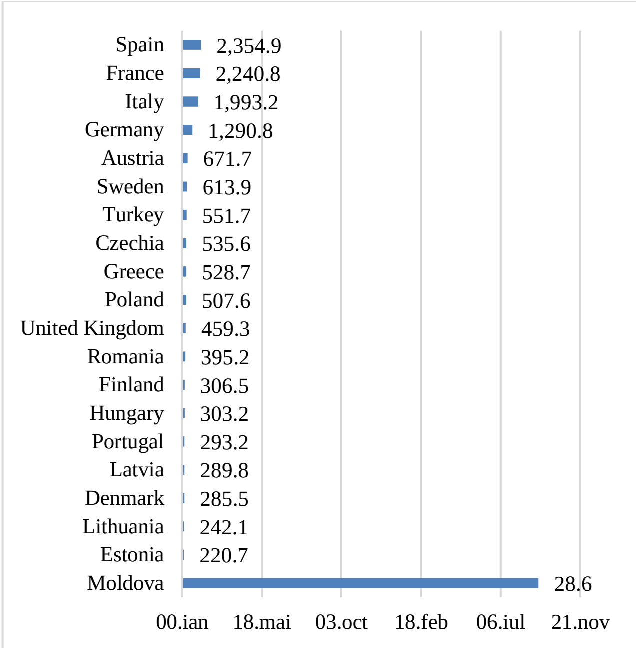

Fig. 5. The total area registered in organic agriculture – 2019, thousand ha
Source: Elaborated by the author based on [4, 7].

Marketing of organic agri-food products

Regarding the formation of a national market of organic agri-food products, we can say that in the Republic of Moldova there are no shops or sections specializing in the sale of organic products, although some organic products can be seen occasionally in large supermarkets.

Organic agriculture and organic products are not sufficiently promoted, the perception of this field is quite low and consumers confuse organic products with conventional ones. Contrary to the legislation of the Republic of Moldova, words such as "biological", "ecological", "organic" are frequently used on the packaging of products that, in fact, are not ecologically certified. Thus, because there is no clear line of differentiation for consumers, on the local market organic products compete in the same segment as products from conventional agriculture. As a result, organic farmers tend to export their products.

In the Republic of Moldova, the market for organic products is very small, but there are accessible distribution channels for organic products. To facilitate the connection between consumers and farmers, who practice organic agriculture, web portals have been created in the Republic of Moldova. The primary objectives that web portals assume are the following:

1. Strengthen cooperation between eco-farmers and consumers;
2. Systematization of ecologically certified products from the Republic of Moldova in a catalog;
3. Development of farmers' skills in the field of organic agriculture, by describing different environmentally friendly agricultural practices;
4. Increasing the level of information on local organic products.

Following a liberal trade regime, the Republic of Moldova became a full member of the World Trade Organization in 2001. This step has led to a gradual advancement of foreign trade and increased efforts to adopt international standards in production processes. Moldova has signed free trade agreements with 43 countries so far. The one that most influences the trade of the Republic of Moldova is the Deep and Comprehensive Free Trade Agreement (DCFTA) with the member states of the European Union. There are also Free Trade Agreements with the Member States of the Commonwealth of Independent States (CIS), the Balkan countries (Albania, Bosnia and Herzegovina, Kosovo, the former Yugoslav Republic of Macedonia, Montenegro and Serbia) and Turkey. In addition, Moldova has signed preferential trade agreements with Canada, Japan, Norway, Switzerland and the United States (MIEPO, 2017).

At the same time, the lack of homogeneous, compatible, packaged and certified domestic products that would be accepted by importers from the European Union substantially reduces the capacity of Moldovan organic products to cover the quotas and tariff concessions set by DCFTA. The non-tariff measures set by DCFTA – sanitary, phytosanitary, quality standards, product certification and compliance – are currently the worst barriers to increasing the export of Moldovan organic products to the EU [15].

However, organic agriculture is gaining more and more ground in our country and contributes significantly to the export of agricultural products of the Republic of Moldova (Table 1).

Table 1. Export of certified organic products to the EU, 2019

No	Products	Quantity, t
1	Prunes	298
2	Peas	1,010
3	Soya	1,221
4	Peeled nuts	3,665
5	Wheat	8,883
6	Corn	9,191
7	Sunflower seeds	15,593
	Total	**39.861**

Source: Elaborated by the author on the base [5].

Moldova's exports to the EU have declined in recent years. Thus, in 2019, Moldovan exports decreased by 27.7% compared to 2018. One of the causes could be the ecological fraud manifested by the repeated detection of pesticide residues. Moldova has joined Ukraine, Kazakhstan and Russia, countries from which additional residue analyzes are required on each batch before shipment.

Another reason would be Moldova's position in competition with the three mentioned countries: Ukraine, Kazakhstan and Russia, which have much larger production units. In this case, the solution for Moldovan farmers is to carry out the primary processing of organic products in the country, exporting value-added products.

Subsidizing organic agriculture

The promotion and development of organic agriculture, the extension of greening measures of conventional agriculture can stimulate the possibilities of the Republic of Moldova to respond to global environmental challenges, in order to ensure the sustainable social, economic and ecological development of the country.

In order to support organic agriculture, the state provides subsidies. In the Republic of Moldova, support is granted to producers who are registered in the organic agricultural system in the form of compensation for loss of income and additional costs incurred by agricultural producers and who undertake to remain in the organic agricultural system for a period of 5 years. If the agricultural producers do not stay in the organic agricultural system for 5 years they will return the collected amounts. Agricultural producers who repeat the conversion period for one and the same area may not benefit from subsidies.

Subsidizing organic production is much lower than current needs (Table 2). The main problems, that manufacturers face, are the lack of infrastructure to prepare products for sale, lack of access to certain technologies and finance, lack of tools in export promotion, imperfect information and limited knowledge of the opportunities offered by the external market.

Table 2. Distribution of the means of the subsidy fund for agricultural producers, 2019

Areas and forms of support		Nr. of applicants	Amount requested, thousand USD	Nr. of beneficiaries	Authorized amount, thousand USD
Priority: Ensuring sustainable management of natural resources	Consolidation of agricultural land	3	5.19	2	2.88
	Purchase of irrigation equipment	230	2, 464.25	111	1,478.09
	Compensation for irrigation costs	32	262.40	0	0
	Purchase of No-Till and Mini-Till equipment	192	1, 959.63	107	1,163.21
	Promotion and development of organic agriculture	76	497.12	22	75.55
Total subsidies requested		**7,505**	68,212.23	**2,331**	**33,737.60**

Source: Elaborated by the author on the base [3, 21].

We can state that the largest share of grant applications in 2019, aimed at ensuring the sustainable management of natural resources, are aimed at subsidizing investments in the purchase of irrigation equipment. During that period, 230 applications for financial support were received in the amount of the requested subsidy of USD 2,464.25 thousand, which is 3.61% of the amount of the requested subsidies.

The subsidy for organic agriculture is much more modest, during the analyzed period being received only 76 applications for financial support in the amount of the requested subsidy of USD 497.12 thousand, which is 0.73% of the amount of the requested subsidies.

Based on the analysis, we can mention that for the promotion and development of organic agriculture, for the stabilization of the market of organic agri-food products, ensuring fair incomes for farmers practicing organic agriculture it is appropriate and rational to grant direct payments, depending on the crop, animal species and birds, as well as depending on the actual land area or the number of animals in possession.

CONCLUSIONS

In the Republic of Moldova, climatic and pedological conditions are favorable for the practice and development of organic agriculture, organic agri-food production, they create opportunities for competitive organic production on markets abroad.

The implementation of organic agricultural systems in the Republic of Moldova is characterized by modest indicators. Impediments to its promotion are related to the low level of investment, limited access to financial resources, low level of entrepreneurial and professional qualities of most farmers, limited size of the internal market and tough demands of foreign markets, poor harmonization of national standards with the European ones. The problems related to the reduction of the technical-material and financial base of the research and higher education institutions in the field, the vulnerability of the agricultural sector to natural disasters and the deterioration of the production infrastructure remain unsolved.

The development of organic agriculture is supported by financial aid or other incentives, which promote conversion to organic agriculture and stimulate the development of the agricultural sector as a whole. In the Republic of Moldova, the stimulation of the promotion and development of organic agriculture is carried out by granting subsidies from the National Fund for the Development of Agriculture and Rural Environment, and the size of subsidies and their allocation are established by the Government.

The development of a market of ecological products can be achieved by creating commercial policies adapted to the specifics of each region, taking into account the degree of urbanization, the existing professional categories, the degree of environmental damage.

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