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FOOD SECURITY AND INCOME DIVERSIFICATION NEXUS: USDA APPROACH

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Abstract

This study assesses the linkages between income diversification and household food security status using United State Department of Agriculture (USDA) 18 items questionnaire core module. Multistage sampling procedure was used to select 240 households, data were collected with the use of structured questionnaire and analyzed with descriptive statistics, Rasch model, Simpson Diversification Index (SDI) and ordered logit regression model. The result of the information function revealed that the scale is adaptable for this study. The SDI revealed that the households averagely diversify their income source. The USDA food security results revealed that majority of the households were in very low food security category. The ordered logit regression revealed that age ($p<0.05$), marital status ($p<0.05$) and dependency ratio ($p<0.05$) had negative effects on household food security status while income diversification ($p<0.05$) and access to health facilities ($p<0.1$) had positive effects. It was thereby concluded that income diversification increases household food security status while increase in number of dependent individuals reduces it. This study thereby recommended that regional government at all levels should set up skill acquisition and empowerment programs that will enable household's practices farming along with a wide range of income generating activities, this will go a long way in reducing number of dependent individuals and increasing households food security status.

Key words: *food security, income diversification, rasch model, ordered logit*

INTRODUCTION

Since its evolvement in development literature, non-agricultural economy had witnessed an increasing recognition across the rural communities at national and global settings. Farming, in spite of its central importance in rural livelihood, is becoming unable to provide a sufficient means of survival in rural areas, thereby requiring the need for diversification [15]. Livelihood diversification implies a process targeted at broadening of income and livelihood strategies away from purely crop and livestock production towards both off-farm and non-farm activities [28, 15]. Income diversification simply express 'is the presence of two or more income generating activities or sources'. According to [17] "rural livelihood diversification could be described as the process by which rural households construct portfolio of activities and assets in order to survive and improve their living standards". Evidences over the years showed that diversification is the norm [9] rather than the exception [35]. The activities combinations are of different risk profiles which are carefully chosen in other to secure a constant inflow of income. No single individual earn income from a single activity neither do they keep their wealth in form of a single investment. This is because of the uncertainty and risks associated with the outcomes in most business situations, which is more predominant in the agricultural sector given the external factors that interact with the efficiency of its enterprises operation. Farmers in an attempt to enhance their livelihood or mitigate possible farming risk, diversified into both agriculture and non-agriculture activities. Notable income sources are categorized into; agricultural wage income, self-employment in off-farm activities such as agro-processing and marketing, non-farm wage earning, assets earning and income transfer (remittances). Hence, diversification as implies measure the level of income earning sources associated with a households. Furthermore, the motive of diversification could vary from household to household or individual to individual, falling under a broad views of the pull and push factors. The “pull factors” has to do with the decision of an individual to tap into wealth making opportunities given the resources at his or her disposal, while livelihood and or welfare improvement is the major factor that push household into diversification. However, household’s food security status is a key element of a welfare assessment.

Food no doubt is a basic necessity of life, and its importance at the household level as basic means of sustenance is obvious. Adequate food intake in terms of quantity and quality is a key for healthy and productive life [18] and [32]. Food accounts for a substantial part of household’s budget, so does it rank topmost in the hierarchy of human needs given its essentiality for a healthy living. Various foods serve as important vehicles for taking nutrients into the body and bringing about a healthy state, hence the need for food to be taken in the right quality and quantity [25]. This therefore makes achieving food security to be of importance in any given country. [14] defined food Security as a situation in which people does not live in hunger or fear of starvation. Food security according to [17] and [29] is when all people at all times have access enough food for an active life, as against food insecurity which is the inability of a household or individuals to meet the required consumption levels in the face of fluctuating production, price and income. Many countries experience food insecurity with food supplies being inadequate to maintain their citizens’ per capita consumption. [20] Estimated that almost 1billion people are chronically malnourished and food insecure around the world, majority of these people are found in developing countries mostly in Asia and Africa. [2] Opined that approximately one-third of the people in sub-Saharan Africa are undernourished. However, food security achievement at the national, regional and local levels requires that food must be available, accessible and properly utilized. Food accessibility depends on availability of income to the households as well as distribution of income within the households and food price [14]. The sources of income and their reliability for a steady flow and reliable amounts are important to individuals and households in ensuring food security. The poor households given their inferiority in education, basic technical skills and employment and hence low income, are most vulnerable to food insecurity. The conventional view of the small farm households sustaining themselves solely on their crops is no longer in accords with reality. Peasants are also traders, craftsmen, entrepreneurs, migrant workers, animal raisers and wage laborers [35]. [38] and [10] opined that participation in rural non-farm activities exerts a pronounced impact on rural agriculture, household farm decisions [38] and [16], rural development [19], income and welfare [26] and household food security [37], [8], [19], [14] and [35]. [39] and [15] reported that diversification to non-farm work improves household food security. Diversification research interest in Nigeria revealed that despite the fact that many rural households are engaged in a diverse set of livelihood activities, food security is yet to be achieved. However, it becomes of great necessity to quantitatively link these economic variables (income diversification and food security) with a functionality view of generating more potent and environment specific measures whose adoption can settle the menace of food insecurity in the study area. Although there are considerable literatures linking income diversification and food security [14], [35], [39] and [5] the fact that food insecurity remains a challenge especially among the rural and low income households justify the need to probe further, if diversification of income as a livelihood improvement strategy truly merit any accolade in that regards or otherwise, and therefore propose possible alternative or complementary recommendations upon findings. Although there are growing literatures on linkages between income diversification and food security, this study differs from other studies as it employs USDA food security approach which measures the extent and intensity of food security. This study will however assess the linkage between income diversification and households food security status, specifically, this study will measures the level of income diversification among the households, assess the food security status of the households and estimate the effect of income diversification on household food security status.

MATERIALS AND METHODS

This study was carried out in Oyo state, Nigeria. The state is an inland state in south-western Nigeria, with its capital at Ibadan. It is bounded in the north by Kwara State, in the east by Osun State, in the south by Ogun State and in the west partly by Ogun State and partly by the Republic of Benin. Multistage sampling procedure was used to select respondents for this study, the first stage involved random selection of four Local Government Areas (LGAs) out of the thirty-three LGAs in the state using table of random numbers from the list of LGAs, the second stage entails random selection of four villages from the selected LGAs, the last stage entails purposive selection of fifteen households from the selected villages making a total sample size of 240 households. Purposive sampling technique was used at the last stage as there was no enough information on the total number of households in the villages. However, only 233 responses from the households were fit for analysis after data clean up. Primary data was collected from the households with the use of structured questionnaire; the data collected were analyzed with simple descriptive statistics, Simpson index of diversification, Rasch model and ordered logit regression model with the use of STATA 14.1 statistical package.

Food Security Analysis

The USDA 18 food security questionnaire core module was used to capture the households food security status, USDA categorizes households using a constructed food security scale that ranges between 0 and 10 for households without children and between 0 and 18 for households with children, the respondent indicated whether the statement was often true, sometimes true, or never true for a given household in the last one year. Appendix I give description of the eighteen questions that were used. Household's response to each of the questions was first coded as either affirmative or negative, sometimes true and often true were considered affirmative response because they indicated that the condition occurred at some time during the period covered by the study. However, households were classified into four food security status base on their number of affirmative responses on the scale. Following the recommended cut-points by USDA, households with non-affirmative response to the 18 questions or 0–2 are classified as High Food Secure (HFS), those with 3–7 as Marginal Food Secure (MFS); 8–12 as Low Food Secure (LFS) and those between 13–18 as Very Low Food Secure (VLFS). For adult-referenced items, households with 0–2 affirmatives are classified as HFS; those between 3 and 5 affirmatives as MFS; 6 and 8 affirmatives as LFS and between 9 and 10 affirmatives responses as VLFS.

Rasch Measurement Model

Rasch model was used to check for reliability and validity of the data collected. Rasch measurement model is a non-linear factor analysis with binary variable such as "yes" or "no" response to a survey item and it falls into the family of Item Response Theory models [24]. The model is a one-parameter model, meaning that it models the "one" parameter difference between person position and item difficulty. Following the specification of [5], [12], and [36]. Rasch model that the log odds of a household (j) responding to an item (q) correctly is a function of ability (θ_j) and the item's difficulty (β_q) was specified as:

$$\text{logit}\ (P_{q,j}) = \log\left(\frac{\Pr(Pq,j)}{1-\Pr(Pq,j)}\right) = \theta_j - \beta_{q}, \ldots \quad (1)$$

where:
j = number of households/respondents,
q = number of items, and

θ_j is normally distributed random variable with zero mean and variance.

Thus, the Rasch model was specified as:

$$P(X_{jq}=\frac{1}{\theta j}, \beta q) = \frac{\exp(\theta j - \beta q)}{1+\exp(\theta j - \beta q)}, \ldots\ldots\ldots (2)$$

Simpson Diversification Index (SDI)

Due to its wider applicability, computational simplicity and robustness, SDI was used to capture the income diversification of the households, following [1], the SDI was specified as:

$$SDI = 1 - \sum_{i=1}^{n} Z^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where:

SDI is a measure of income diversification and Z is income share of each activity, and Z is expressed mathematically as:

$$Z = \left(\frac{ki}{kt}\right)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where:

n is the number of income sources;

k_i is the income from each activity, and

k_t is the household's total income.

The value of SDI ranges between 0 and 1. When SDI is less than 0.01 there is no diversification; between 0.01–0.25 low diversification, between 0.26-0.50 average diversification and when greater than 0.51 there is high diversification [1].

Ordered Logit

The effect of income diversification on household food security status was estimated with ordered logit model, this was used because the food security status outcome was ordered or ranked. Following [23] the ordered logit model was specified as:

$$Y_i^{*} = \sum_{j=1}^{j} \delta j Xj + \varepsilon_j = Z_j \ldots\ldots\ldots\ldots\ldots (5)$$

where:

Y* continuous latent variable,

δ_j the vector of parameters or coefficients to be estimated by the model,

X_j represent vector of the explanatory or independent variables,

$Z_j = \sum_{j=1}^{j} \delta j Xj$, Z_j is the random disturbance term reflecting that relevant variables may be left out of the equation, or variables may not be perfectly measured.

Y* = Food security status of the household (0, 1, 2, 3)

Prob (Y_i= j) = J = food security status of households in the order set as:

j = 0, if High Food Secure (HFS),

j = 1, if Marginal Food Secure (MFS),

j = 2, if Low Food Secure (LFS), and

j = 3, if Very Low Food Secure (VLFS).

X_j = vector of explanatory variable conditioning the choice of the j^{th} alternative

δ_j = parameters to be estimated

ε_j= error term

δ_1= sex of household head (1=male, 0=otherwise)

δ_2= age of household head (years)

δ_3= marital status of household head (1=married, 0=otherwise)

δ_4= household size (Numbers of person)

δ_5= dependency ratio (number of non-working adults/number of working adults)

δ_6= level of education in (years)

δ_7= primary occupation (1=farming, 0=otherwise)

δ_8= access to credit (1=had access, 0=otherwise)

δ_9= income diversification (Simpson index value)

δ_{10}= household monthly expenditure (Naira)

δ_{11}= access to health facilities (1=had access, 0=otherwise)

However, marginal effects were generated to determine the predictive power of variables in the model, the probabilities of respondents being in any of the identified categories are determined using the natural log of the cumulative distribution. Following [13] and [31], the marginal effects of changes in the independent variables are computed as:

$$\frac{\delta\, prop(y=\frac{0}{x})}{\delta\chi} = -f\,(\mu_0 - x_\delta).\,\delta$$

$$\frac{\delta\, prop(y=\frac{1}{x})}{\delta\chi} = -f\,[(\mu_1 - x_\delta).\,\delta - f\,(\mu_0 - x_\delta)].\delta$$

$$\frac{\delta\, prop(y=\frac{2}{x})}{\delta\chi} = -f\,[(\mu_2 - x_\delta).\,\delta - f\,(\mu_1 - x_\delta)].\delta$$

$$\frac{\delta\, prop(y=\frac{3}{x})}{\delta\chi} = -f\,(\mu_2 - x_\delta).\delta \ldots\ldots\ldots\ldots (6)$$

where: 0, 1, 2, 3 are the various categories (HFS, MFS, LFS and VLFS), χ is the independent variable, μ_0, μ_1, μ_2 are the cut-off values for the ordered logit model and f is the cumulative probability function. The marginal effect for the dummy variable was calculated by taking the probabilities for each category at v = 0 and at v = 1, and take the difference [31].

RESULTS AND DISCUSSIONS

Validation and Reliability of Rasch Measurement Model

Table 1 revealed the difficulty and easiness parameter of the Rasch model; it was revealed that for the difficulty parameter 14 items were found to be significant while 11 items were found to be significant under the easiness parameter. Although some of the items were not significant, there is no enough evidence to remove them from the analysis.

The Item Characteristics Curves (ICC) in appendix 2 revealed that households could easily provide response to item 2, 3 and 18 while it is very difficult to provide answer to item 9, 14 and 15 in the food security assessment. The information function as displayed in appendix 3 is regular on the interval of the latent trait where the individuals are represented, and it can be concluded that the scale is adaptable for our population.

Table 1. Estimated Theta and Beta coefficient of Rasch Model

Items	Theta (difficulty parameter level)		Beta (easiness parameter level)	
	Estimate	Std Err.	Estimate	Std Err.
q1	0.240	0.310	-2.833*	1.496
q2	-0.215	0.328	-1.652*	0.895
q3	0.579*	0.301	-1.057	0.719
q4	0.579*	0.301	-0.632	0.63
q5	0.735**	0.299	-0.289	0.577
q6	0.579*	0.301	0.008	0.543
q7	1.448***	0.292	0.277	0.52
q8	1.919***	0.292	0.527	0.505
q9	1.718***	0.292	0.767	0.497
q10	1.550***	0.292	1.002**	0.494
q11	1.414***	0.292	1.235**	0.496
q12	1.172***	0.294	1.474***	0.504
q13	1.414***	0.292	1.721***	0.517
q14	1.345***	0.293	1.986***	0.539
q15	1.852***	0.292	2.279***	0.573
q16	1.242***	0.293	2.616***	0.625
q17	0.329	0.308	3.034***	0.713
q18*	-	-	3.623***	0.89

Source: Field Survey Data Analysis, 2020
***, ** and * significant at 1%, 5% and 10% respectively

Income Diversification Strategies

The result revealed that households were involved in diverse income generating sources (farm, off-farm and non-farm). The result showed that more than half (61.80%) were engaged in production of staple crops, lower proportion (1.72%) were engaged in staple and permanent crops, lower portion (6.87%) were engaged in staple, permanent crops and livestock production, smaller proportion (0.86%) were engaged in staple, permanent crops, livestock production and other agricultural production activities, lower proportion (8.58%) were engaged in staple crops and livestock production, lower proportion (11.16%) were engaged in permanent crops production, lower proportion (0.86%) combine permanent crops and livestock production, lower portion (4.72%) were engaged in livestock production while 3.43% were engaged in other agricultural production activities.

The result revealed that most (33.04%) of the households were engaged in processing of agricultural produce, more than a quarter (29.61%) were traders, lower portion (6.44%) were artisans, lower proportion (7.73%) were civil servants wile almost a quarter (23.18%) did not diversify their livelihood activities. This implies that majority were engaged in agricultural produce processing and this may be because farming was the primary occupation in the area, the result supports the findings of [22] that opined that rural people's livelihoods are derived from diverse sources and are not as overwhelmingly dependent on agriculture.

Table 2. Household's income diversification strategies

Variable	Frequency	Percentage
Farming Activities		
Staple crops	144	61.80
Staple and permanent crops	4	1.72
Staple, permanent crops and livestock	16	6.87
Staple, permanent crops, livestock and others	2	0.86
Staple crops and livestock	20	8.58
Permanent crops	26	11.16
Permanent crops and livestock	2	0.86
Livestock	11	4.72
Others	8	3.43
Total	233	100.00
Non-Farm and Off-farm Activities		
Agricultural produce processing	77	33.04
Trading	69	29.61
Craft/artisanal	15	6.44
Civil service	18	7.73
None	54	23.18
Total	233	100.00

Source: Field Survey Data Analysis, 2020.

Level of Income Diversification

The result revealed that more than half (52.79%) of the rural households typically diversify their income source, less than a quarter (23.18%) did not diversify their income source, none had low income diversification while almost a quarter (24.03%) highly diversify their income source. The mean income diversification among the households was 0.316 which implies that majority of the households averagely diversify their livelihood source. This result is in tandem with the findings of [4] and [1] that reported average level of livelihood diversification among rural households.

Table 3. Level of household's income diversification

Variable	Frequency	Percentage
Income diversification		
No diversification	54	23.18
Low diversification	0	0.00
Average diversification	123	52.79
High diversification	56	24.03
Total	**233**	**100.00**
Mean	**0.316**	
Minimum	**0.000**	
Maximum	**0.662**	

Source: Field Survey Data Analysis, 2020.

Food Security Categories

The result revealed that more than half (62.66%) of the rural households were in the very low food security category, lower proportion (4.29%) were highly food secure, lower proportion (4.29%) were marginally food secure while more than a quarter (28.76%) were low food secure. The implication of this result is that majority of the rural households were still food insecure despite the fact that the bulk of food produced comes from rural areas, this result is consistent with the findings of [31] and [7] that reported that the food insecurity among farming households in North-Central Nigeria and South-Western Nigeria were 84% and 65% respectively.

Table 4. distribution of households according to their food security status

Food Security Status	Frequency	Percentage
High Food Security	10	4.29
Marginal Food Security	10	4.29
Low Food Security	67	28.76
Very Low Food Security	146	62.66
Total	**233**	**100.00**

Source: Field Survey Data Analysis, 2020.

Result of Ordered Logit Estimates

The pseudo R-square associated with ordered logit model were observed as inappropriate measure of the predictive power of ordered response models. Therefore, the chi-square value and the log-likelihood ratio criteria were used to evaluate the effectiveness of the model in line with [30]. The result revealed that the chi-square value of 46.2 shows that variables in the model are fit to explain the factors influencing the food security status of the rural households, also the value of probability of chi-square of 0.0000 shows the overall significance of the model at 1% probability level (p<0.01) with a lower log likelihood of -201.837. The estimated cut-off points (µ) satisfy the conditions that µ1< µ2< µ3 implies that these categories are ranked in an ordered way [27]. The result revealed that age (p<0.01), marital status (p<0.05) and dependency ratio (p<0.05) had negative effects on the food security status while income diversification (p<0.05) and access to health facilities (p<0.1) had positive effects. The coefficient of age of household heads showed that increase in age of the household heads decreases the probability of being food secure, the implication of this result is that increase in age of household heads reduces the food security status of the households; this result is in line with the findings of [33] who reported a negative relationship between age and household food security status in south-western Nigeria. The coefficient of marital status revealed that the food security status of married households is likely to reduce compared to their unmarried counterparts. This result is consistent with the finding of [31] who reported an inverse relationship between marital status and household food security status in North-central Nigeria but contrary to the findings of [40] that reported a direct relationship. The coefficient of dependency ratio revealed that increase in number of dependent individuals reduces the food security status of the households, this implies that the higher the number of dependent individuals the lower the household food security status. This result supports the findings of [11] and [40] that reported similar results. The coefficient of income diversification revealed that the higher the level of income diversification the higher the food security status of the households, this implies that highly diversified households are more likely to be food secure, this result conform with the findings of [15] who reported that income diversification improves household food security status.

Table 5. Effect of income diversification on household food security status

Variable	**Coefficient**	**Robust Standard Error**	**z-value**	**P-value**
Sex	-0.230	0.338	-0.68	0.497
Age	-0.029**	0.013	-2.23	0.026
Marital status	-0.961**	0.459	-2.09	0.036
Household size	0.015	0.049	0.30	0.763
Dependency ratio	-0.603**	0.280	-2.15	0.031
Level of education	-0.021	0.034	-0.61	0.539
Primary occupation	-0.144	0.344	-0.42	0.676
Access to credit	-0.175	0.297	-0.59	0.556
Income diversification	1.507**	0.696	2.17	0.030
Household monthly expenditure	-1.71e-07	1.89e-06	-0.09	0.928
Access to health facilities	0.585*	0.328	-1.79	0.074
/cut1	-5.809	1.035		
/cut2	-5.002	0.998		
/cut3	-2.948	1.013		
Diagnostic test				
Wald $chi^2(12)$	46.20***			
Prob > chi^2	0.000***			
Pseudo R^2	0.060			
Log pseudolikelihood	-201.837			

Source: Field Survey Data Analysis, 2020
***, ** and * significant at 1%, 5% and 10% respectively

The coefficient of access to health facilities revealed that households that have access to health care facilities are more likely to be food secure compared to their counterparts that did not have access to health facilities. This result supports the finding of [31] that reported positive relationship between household food security status and access to health care facilities.

Marginal effects of food security categories

The marginal effects of age revealed that the food security status of VLFS decreases by 0.007 if age of household heads increases by 1 year, this is so because as age increases productivity reduces thereby impacting negatively on the food security status. This result conforms with the findings of [34], [33], however, food security status of LFS, MFS and HFS increases by 0.005, 0.001 and 0.001 respectively if age of household heads increases by 1 year, this result agrees with the findings of [3] that reported a direct relationship between age and household food security status. The marginal effect of marital status revealed that the food security status of married household heads among VLFS category is likely to reduce by 0.197 compared to their unmarried counterparts, this is so because married households are more likely to have high number of dependent individuals thereby reducing per capita food consumption. This result supports the findings of [31], however, the food security status of married household heads among the LFS, MFS and HFS is likely to increase by 0.150, 0.025 and 0.0022 respectively, and this might be because married household members are more likely to pool their resources together thereby resulting to higher food security status. This result is consistent with the findings of [11] and [40]. The marginal effects of dependency ratio revealed that if the number of dependent individual increases by a unit the food security status of VLFS, LFS, MFS and HFS households will decrease by 0.140, 0.101, 0.020 and 0.019 respectively. This implies that household with more dependent individuals are more likely to be food insecure. This result is in tandem with the findings of [11], [33] and [40]. The marginal effects of income diversification revealed that if the income diversification increases by a unit the food security status of VLFS, LFS and MFS households will increase by 0.351, 0.253 and 0.047 respectively.

Table 6. Estimates of marginal effects

Variable	Very low food security		Low food security		Marginal food security		High food security	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Sex+	-0.0530	0.493	0.0385	0.497	0.0075	0.494	0.0070	0.4900
Age	-0.0068**	0.025	0.0049**	0.029	0.0010*	0.055	0.0009*	0.071
Marital status+	-0.1969**	0.014	0.1498**	0.016	0.0247*	0.042	0.0224**	0.049
Household size	0.0035	0.763	-0.0025	0.764	-0.0005	0.765	-0.0005	0.758
Dependency ratio	-0.1403**	0.032	-0.101**	0.039	-0.0202*	0.059	-0.0188*	0.065
Level of education	-0.0049	0.541	0.0036	0.531	0.0007	0.559	0.0007	0.581
Primary occupation+	-0.0337	0.678	0.0241	0.676	0.0049	0.688	0.0046	0.682
Access to credit +	-0.0155	0.695	0.0112	0.695	0.0022	0.703	0.0021	0.694
Income diversification	0.3505**	0.031	0.2531**	0.027	0.0504	0.105	0.0470*	0.089
Household monthly expenditure	-3.97e-08	0.928	2.87e-08	0.928	5.71e-09	0.928	5.33e-09	0.928
Access to health facilities+	0.1391*	0.077	0.09691*	0.072	0.02158	0.141	0.02065	0.146

Source: Field Survey Data Analysis, 2020
***, ** and * significant at 1%, 5% and 10% respectively
(+) dy/dx is for discrete change of dummy variable from 0 to 1

This implies that households that diversify into non-farm and off-farm livelihood sources are more likely to be food secure, this is so because diversification provides an alternative income source thereby enhancing food security. This result supports the findings of [15], [6] and [21].

The marginal effect of access to health facilities revealed that the food security status of households that have access to health facilities among VLFS and LFS category is likely to increase by 0.139 and 0.097 compared to their counterparts that did not have access to health facilities, this is so because access to and use of health facilities will increase the healthy time of the households thereby enhancing productivity and this will invariably improve their food security status.

CONCLUSIONS

This study was carried out to assess the effect of income diversification on household food security status using USDA 18 items questionnaire core module. Rasch model was used to check for reliability and validity of the scale, the result of the information function revealed that the scale is adaptable for the study. It was revealed that production of staple crops was the major farming strategy adopted by the households while processing of agricultural produce was the major off-farm strategy adopted. The result of Simpson Diversification Index revealed that more than half of the household's typically diversify their income sources, larger proportion of the households were food insecure as they measure very high on the food insecurity scale. The result of the determinants of food security revealed that households with older and married heads were less likely to be food secured. Similarly, increasing the number of dependent individuals reduces household food security status, however, increase in number of income sources as well as having access to health facilities increases household's food security status. It was thereby concluded that income diversification increases household food security status whereby increase in number of dependent individuals reduces household food security status. This study thereby recommended that regional government at all levels should set up skill acquisition and empowerment programs that will enable household's practices farming along with a wide range of income generating activities, this will go a long way in reducing number of dependent individuals and increasing households food security status.

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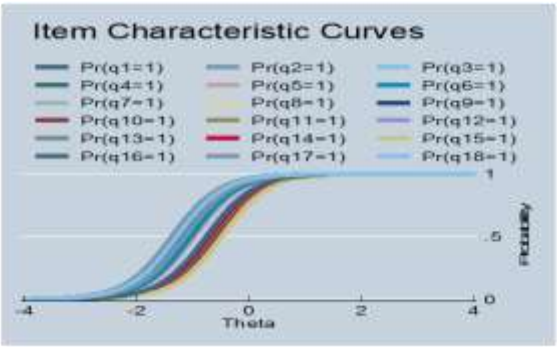
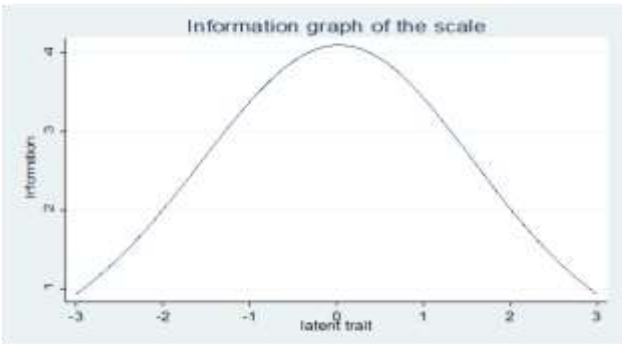
Appendix 1. Eighteen (18) Households' Food Security Items

S/No	Questions/Statements
1	We were worried our food would run out before we got money to buy more
2	The food we bought just didn't last and we didn't have money to get more
3	We couldn't afford to eat balanced diet
4+	We relied on only a few kinds of low cost food to feed the children
5+	We couldn't feed the children a balanced meal
6+	The children were not eating enough because we just couldn't afford enough food
7	Did some adults ever have to eat less than you felt you should eat because there wasn't enough money to buy food?
8	How often did this happen in the last 12 months?
9	Did some adults ever have to eat less than you felt you should eat because there wasn't enough money for food?
10	Were some members ever hungry but didn't eat because you couldn't afford enough food?
11	Did some members ever lost weight within the last 12 months because there wasn't enough food?
12	Were there ever a time within the last 12 months that some adults could not eat for a whole day because there wasn't enough money to buy food?
13	How often did this happen in the last 12 months?
14+	Did you ever have to cut the size of some of the children's meal within the last 12 months because there wasn't enough money to buy food?
15+	Did any of the children ever had to cut the size of some of the children's meals within the last 12 months because there wasn't enough money to buy food
16+	How often did this happen in the last 12 months?
17+	In the last 12 months, were the children ever hungry but you just couldn't afford more money?
18+	In the last 12 months, did any of the children ever not eat for a whole day because there wasn't enough money for food?

+Not applicable to households without children.
Source: [41]



Source: Field Survey Data Analysis, 2020.



Source: Field Survey Data Analysis, 2020.

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LOAN DIVERSION AND EFFECT ON THE GROWTH OF SMALL-SCALE POULTRY FARMS IN NIGERIA

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Abstract

Cases of loan diversion among small scale poultry farmer borrowers in Nigeria have occupied central position in both scientific and public debates in recent times. The study examines the evidence of loan diversion as it affects the productivity of poultry farms and the need for extension financial literacy advisory services in Nigeria. Two hundred and forty respondents were randomly selected using multiple stage method. Quantitative and qualitative data were primarily obtained using questionnaire. Parametric and non-parametric statistical tools were used to analyze data. The finding of the study revealed that the surveyed poultry farmers were male (70.42%) with an average age of 46 years, married and operated small scale farms. A good number of the surveyed farmers (86.67%) had obtained loan and diverted varying amounts of the loans. The test of hypothesis indicates that loan diversion exerts a negative and significant effect on poultry agribusiness growth (P< 0.05). Loan diversion is a significant determinant of loan default rate of poultry agribusiness (P< 0.05). The study recommends that poultry farmers should be made to access extension financial literacy advisory services. They should utilize loans for the intended purpose of enhancing poultry productivity and wealth creation in Nigeria.

Key words**:** *loan diversion, debt burden, extension financial literacy advisory services, poultry farms.*

INTRODUCTION

The poultry business is of significant economic importance with respect to food security, poverty alleviation, income generation and employment opportunities. Poultry agribusiness is one of the dominant sectors of Nigerian economy. Poultry contributes about 9-10% of agricultural GDP [4].

According to [12] the Nigerian’s livestock resources consist of 104,247,960 poultry.

Small and medium sized poultry agribusinesses are the backbone of all economies and a key source of economic growth, job creation and innovation in both developed and emerging market economies. Agribusiness plays critical role in the process of industrialization and economic growth contributing to employment, income generation and catalyzing development in urban and rural areas [5]; [13].

The small and medium sized poultry agribusinesses therefore deserve external financing through loan. Access to loan is an important strategic tool for small and medium sized poultry agribusinesses development. Loans are used as startup capital, the working capital and expansion capital to improve business productivity; thus establishing the centrality of credit utilization in poultry agribusiness development.

[14] classified loan into productive and unproductive loans. The former is a loan that is expected to create assets which will yield sufficient income repay the principal and interest on the loan. The diverted loan is a loan that is used for other purposes other than asset or wealth creation of agribusinesses. It does not increase the output of the firm, although may increase the general spending power of the borrower. Diverted loans may be channelled to disaster management and other uses (unproductive uses).

All loans are debt that must be repaid according to agreed terms [25]. Sources of loan include formal and informal financial institutions.

Poultry agribusiness needs capital to run their operations. Generating capital through credit systems has become a necessity for growth of small-scale agribusinesses so as to meet up the demand for food. [22] defines debt as amount of money owed to a person or organization to be repaid. Over the years, deliberate efforts have been made to improve small scale agro based firms by Nigerian governments and some foreign agencies but these efforts have not yielded expected results. Much of the failure can be attributed to different constraints such as financial constraints.

Debt enables business operators to finance the utilization of improved technologies that can raise productivity in terms of quality and quantity of output. Through debt, small businesses or infant industries can contribute substantially to national economic growth.

This has led various agencies to lend to the agricultural sector. The availability of these loans is an incentive for farms to shift sources of farm financing away from equity towards debt. The repayment may however not be smooth due to loan delinquency by poultry farmers [9].

The majority of commercial bank loans offered to poultry agribusinesses are often limited to periods far too short to warrant pay-off any fairly large investment [1]. Furthermore, banks in many developing countries prefer to lend to sectors other than poultry firms because the risk is lesser and higher returns are expected [18].

Additionally, servicing of debts exhausts up so much of the agribusiness revenue to the extent that the potential of returning to growth paths is eroded [15].

The negative effect of loan diversion on the growth of poultry agribusiness firms is often attributed to the crowding out effect. However, the degree and direction of causality loan diversion has not been empirically established. [7] argues that the causality runs from growth to debt.

Some studies have attempted to show the relevance of small-scale agribusiness in the growth and development processes of the developed economies, and emphasize that small scale agribusinesses are the relevant engines that drive the growth and development countries [8]; [3]; [16]; [20].

Similarly, the United Nations Conference on Trade and Development [17] notes that small and medium-sized enterprises (SMEs) are important agents of development throughout the world, and that promoting a country's SME sector through loan financing is vital for sustainable high employment rate and income generation and, as such, critical for achieving Sustainable Development Goal (SDG).

There is still a huge gap between supply of these loan and the financing needs of the small-scale poultry agribusiness. In Nigeria, the situation is even more widespread [10]. It is thus expected that poultry agribusinesses would need external credit facilities to augment domestic savings [23]; [19].

This research work is intended to study the effects of loan diversion on the productivity of poultry firms in Nigeria.

The broad objective of this study is to analyze the effect of loan diversion the productivity of poultry agribusiness firms in Nigeria.

The specific objectives were to:

(i)ascertain the volume of diverted loans in poultry farms;

(ii)assess the causal relationship between loan diversion and growth of poultry farms;

(iii)investigate the influence of loan diversion on credit default of poultry farmers; and

(iv)advocate for extension financial literacy advisory services for poultry farmer borrowers.

The following hypotheses were tested to guide the study:

H_{01}: Loan diversion has no significant causal relationship with growth of poultry farms.

H_{02}: Diverted loan has no significant effect on credit default of poultry farmers.

MATERIALS AND METHODS

This study was carried out in Delta State. Delta State was chosen for the study due to the presence of many poultry farms in it. Delta State consists of Twenty Five (25) Local Government Areas grouped into three agricultural zones which are: Delta South, Delta North and Delta Central. There are 9 Local Government Areas in Delta North: Aniocha North, Aniocha South, Ika Northeast, Ika South, Ndokwa East, Ndokwa West, Oshimili North, Oshimili South, Ukwuani.

Multistage sampling procedure was applied to select a total of 240 registered poultry farmers.

The study was based mainly on cross-sectional data. The instrument for data collection from the respondents was structured questionnaire. The instrument was subjected to the validity and reliability tests. The questionnaire was designed to capture information in the farm financial statements (balance sheet and income statement). Copies of the questionnaire was personally administered and retrieved from respondents by the researcher. The questionnaire was subdivided into the sections according to the specific objectives of the study. Information in the questionnaire was related to the socio-economic characteristics of the respondents, the financial status of the poultry agribusiness, the debt to income level of the poultry agribusiness, the debt status of the small-scale poultry agribusiness, the relationship between the debt status and the growth scale poultry agribusiness.

Amount of loan diversion as stated in objective i was achieved by employing descriptive statistics (mean, percentage, standard deviation and charts)

i. The credit default rate as stated in objective ii was analyzed by employing credit default rate formula as stated in equation 1.

$$\mathbf{CD} = [\frac{\mathbf{AB-AR}}{\boldsymbol{AB}}]\% \qquad [6] \qquad \text{(Equation 1)}$$

where:

CD = credit default rate;

AB = amount borrowed;

AR = amount repaid

Ordinary least square technique of multiple regression was used to analyze the relationship between loan diversion and poultry farm growth.

Relationship between loan diversion, debt status and farm growth parameters

This was measured using Pearson's Product Moment Correlation Coefficient. Pearson's *r* is a measure of the linear relationship between two variables, and can have a value between -1 and +1, where 1 is perfect positive linear correlation, 0 is no linear correlation and -1 is perfect negative linear correlation. It is a measure of the relationship between dependent (Y) and independent variables (X). It is stated equation 2 as:

$$r = \frac{n\,(\Sigma XY) - (\Sigma X)\,(\Sigma Y)\ 3.4}{\sqrt{([n(\Sigma X^2) - (\Sigma X)^2])\,[n(\Sigma Y^2) - (\Sigma Y)^2]}} \qquad \text{(Equation 2)}$$

Determinants of credit default were evaluated using ordinary least square technique of multiple regression as shown in equation 3 below.

Model Specification

Loan diversion as a determinant of credit default

The determinants of credit default were put in a model which was implicitly specified as:

$$\mathbf{CD} = \beta_0 + \beta_1 \mathbf{LS} + \beta_2 \mathbf{INT} + \beta_3 \mathbf{LCD} + \beta_4 \mathbf{LDU} + \beta_5 \mathbf{FMSZ} + \beta_6 \mathbf{FAGE} + \beta_7 \mathbf{LNFRQ} + \beta_8 \mathbf{CRWT} + \beta_9 \mathbf{EQT} + \mu \qquad \text{(Equation 3)}$$

where:

CD = credit default in percent %

LS =Loan sources (1 if formal, 0 if otherwise)

INT = interest rate in %

LCD = loan condition (collateral security = 1, 0 = otherwise)

LDU = loan duration in months

FMSZ = farm size (stock size or number of bird stocked overtime)

FAGE = farm age in years

LNFRQ = loan frequency (number)

CRWT = credit worthiness (1 if credit worthy, 0 if otherwise)

EQT = owner's equity in ₦

RESULTS AND DISCUSSIONS

Demographic Characteristics of Poultry Farmers

The demographic attributes of the respondents include gender, age, level of education, marital status, farm size (stock size), farm experience, household size and type of labour.

Age of respondents

The distribution of age of respondents is shown in Table 1. The finding revealed that the farmers were within the age bracket of 41 – 50 years. This implies that the farmers are mainly young people.

Table 1. Socio-Economic Characteristics of Poultry Farmers (n=240)

Variable	Frequency (Percentage)	Mean/ mode
Gender		
Male	169 (70.42)	Male
Female	71 (29.58)	
Age (years)		
< 30	53 (22.08)	46 years
31 – 40	78 (32.5)	
41 – 50	82 (34.17)	
51 – 60	15 (6.25)	
60 and above	12 (5)	
Level of Education		
No formal education	3 (1.25)	Secondary education
Below FSLC	5 (2.08)	
Primary education	16 (6.67)	
Below WASSC	22 (9.17)	
Secondary education	93 (38.75)	
OND/NCE	75 (31.25)	
BSc/HND	20 (8.33)	
Postgraduate	6 (2.5)	
Marital status		
Single	77 (32.08)	Married
Married	147 (61.25)	
Widow/widower	12 (5)	
Divorced	4 (1.67)	
Farm Size (stocksize)		
1 – 300	75 (31.25)	401 birds (small scale)
301 – 500	108 (45)	
501 – 800	36 (15)	
801 – 1,200	7 (2.92)	
1,201 – 1,500	2 (0.833)	
1,501 – 1,800	2 (0.833)	
1,801 – 2,100	2 (0.833)	
2,101 and above	8 (3.331)	
Farming Experience (years)		
1 – 5	145 (60.42)	1 – 5 years (modal)
6 – 10	76 (31.67)	
11 – 15	19 (7.91)	
Household size		
1 – 3	81 (33.75)	5 persons
4 – 6	133 (55.42)	
7 – 10	26 (10.83)	
Type of labour		
Hired	122 (50.83)	Hired labour
Family	118 (49.17)	

Note: The figures in parenthesis are the corresponding percentage values. (n=240)
Source: Field survey Data, 2018.

This concurs with [2] that concluded that farmers between 35 and 44 are more productive. They form over 66% of the sampled farmers. This implies that young people below 30 were not so much involved in poultry farming, probably due to schooling or due to inadequate financial standing to start a poultry farm. The farmers between the ages of 31 – 50 have the experience over the years. Table 1 shows that the older the farmers get, the less involved they are with poultry.

Educational Level

The educational level of poultry farmers is shown in Table 1. About 1.25% of the poultry farmers had no formal education, 2.08% had an education below FSLC, 6.67% of the poultry farmers had primary education, 9.17% had an education below WASSC, 38.75% had a secondary education, 31.25% had an OND/NCE education, 8.33% of the farmers had a tertiary education and 2.5% of the farmers had a postgraduate education. From the table, we can see that the highest number of poultry farmers had obtained their WASSC. Following closely are the respondents who had OND/NCE. It means that a reasonable level of education is required to operate a poultry. This is in line with [21], he said that the more the years spent in gaining formal education, the higher the productivity of the farmers.

Gender Distribution

The gender distribution of the poultry farmers is shown in Table 4.1. The result shows that majority of the poultry farmers were male 169 (about 70.42%) and about 71 (29.58%) were females. We can deduce from Table 4.1 that more males were involved in the farming than the females. This is in line with the study of [11] who reported that men were more involved in certain activities than women especially energy sapping farm activities such as poultry.

Marital Status of farmers

Marital status of respondents is displayed in Table 1. The result revealed that 61.25% were married. This also shows that the others (widow/widower, divorced) were less involved in poultry. It is then safe to say that married respondents are involved to provide for their families and to earn more money. They might also be more financially stable to obtain loans, improve their poultry and payback.

Distribution of Stock size

The stock size (farm size) distribution of the respondents is presented in Table 1. The result shows that most farmers had a stock size of between 301 and 500 birds. It means that majority of the poultry farmers are operating on a small scale. Therefore, they will need to obtain loans several times to grow their business and expand. Also loan friendly policies should be put in place to help these growing small-scale poultry farmers to enable them obtain loan and payback with less interest.

Distribution of Farm Experience

The distribution of the farmer's farm experience is shown in Table 1. The result shows that a good number of the farmers (60.42%) had a farm experience between 1 – 5 years while 31.67% of the farmers had a farm experience between 6 – 10 years. A few of the farmers 7.91% had a farm experience between 11 – 15 years. It can be observed that most of the poultry farmers had been operating between 1 – 5 years, some of them are struggling to survive and need funds in form of loans to keep afloat. Emerging poultry farms also need help through capitals to find their ground in the competitive poultry market.

Household Size Distribution

The distribution of household size of the surveyed poultry farmers is depicted in Table 1. The finding revealed that they maintain an average household size of 4 – 6 people. This result implies that the poultry farmers had an average family size of five (5) persons. This means that they did not have a large family. They will also need to hire labour because family labour might not be an option.

Type of labor Distribution

The labor distribution of respondents is presented in Table 1. The result reveals that a high percentage of the poultry farmers (50.83%) engaged hired labor while 49.17% of the respondents made use of family labor to operate their poultry farms. From Table 1, we can observe that a number of the poultry farmers (50.83%) used hired labour on their farms. It means that the farmers will have to pay them wages or salaries and that will add to their operating cost.

Table 2 presents the result on the distribution of loan borrowed by poultry farmers in the study area. It shows that a large number of farmers 97.5% borrowed loans less than ₦ 500,000 while very few farmers 1.3% borrowed loans between ₦500,100 to ₦10,000,000. Also some farmers 1.3% borrowed loans between 15,000,100 to 20,000,000. This implies that most of the farmers did not borrow so much loans because they were small scale farmers.

Distribution of volume of loan diversion

The distribution of loan diversion by respondents is presented in Table 3. The finding reveals that 225 respondents (93.8%) had diverted less than ₦500, 000. Seven of the poultry farmers 2.9% had diverted between ₦ 500,100 -- ₦1,000,000. Two of the poultry farmers 0.8% had diverted between ₦1,000,100 -- ₦1,500,000, five of the poultry farmers 2.1% diverted between ₦1,500,100-₦2,000,000. Only one farmer 0.4% diverted more than ₦2,000,000.

The result also shows that most of the poultry farmers (86.67%) diverted varying amounts of loan. They diverted an average of ha less t₦500, 000. It can be inferred that most poultry farmers had to obtain loan to fund the farm and acquire equipment. This agrees with literature that says that most farmers need start-up capital.

Table 2. Distribution of diverted loan among poultry farmers

Class of diverted loan (₦)	Number of farmers	Percent	Mean
<500,000	225	93.8	<500,000
500,100-1,000,000	7	2.9	
1,000,100-1,500,000	2	0.8	
1,500,100-2,000,000	5	2.1	
2,000,100-2,500,000	1	0.4	
Total	240	100	

Source: Field survey Data, 2018.

Distribution of loan default rate of poultry farmers

The statistical distribution of the default rate of respondents is presented in Table 3. The finding reveals that all the surveyed poultry operators had various degrees of loan default rates ranging from 0-70%. Further analysis of Table 3 reveals that the default rate of most of the poultry farmers was between 1% and 10%. This implies that the debt status of most poultry farmers is in a tolerable level. From literature, default rate of above 50% is in the debt overhang region. However, default rate of 1 – 40 (89.59%) of farmers are in the declining debt level, default rate of 41 – 50 (7.08%) of the farmers are in the sustainable debt level while 51 – 100 (3.33%) of the farmers are in the distressed debt level.

Table 3. Distribution of loan default rate of poultry farmers

Default rate {%}	Number of farmers	Percentage Distribution	Cumulative frequency
1 – 10	87	36.25	36.25
11 – 20	73	30.42	66.67
21 – 30	27	11.25	77.92
31 – 40	28	11.67	89.59
41 – 50	17	7.08	96.67
51 – 60	4	1.67	98.34
61 – 70	2	0.83	99.17
71 – 80	0	0	99.17
81 – 90	2	0.83	100
91 – 100	0	0	100
Total	240	100	100

* Default rate of 50% is the debt threshold of poultry farms.
Source: Field survey Data, 2018.

This implies that farmers in the tolerable level can still borrow loans in relation to their equity. At the tolerable level more, loans will help the growth of the farm. Farmers that are at the distressed debt level are advised to stop borrowing, the high default rate is a warning sign that farmers should pay off their loan and increase their equity base.

Relationship between Loan Diversion and poultry growth parameters

Table 2 and Table 3 present the result on the relationship between loan diversion and poultry farm growth parameters. The finding reveals that there is significant and negative relationship ($p<0.05$) with all the poultry growth parameters that were captured in the study. This result implies that an increase in the amount of diverted loan will lead to a decrease in all the poultry growth parameters (revenue, equity and stock size). This finding could be attributed to the fact that diverted loans are spent on unintended purposes other than poultry farms. Diverted loans are unproductive in nature because they do not create additional asset or wealth in the farm. Yet the farm is required to pay such loans from its revenue. This will also reduce owners' equity and stock size. This result agrees with the earlier finding of [11], who reported that loan diversion tend to increase the level of loan default and negative consequences on firm performance.

Table 4. Relationship between diverted loan, debt status and poultry farm growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	332567.2	79865.40	4.164096	0.0000
Debt Status	1592.861	2752.471	-0.578702	0.5633
Loan Diversion	-0.513524	0.093561	5.488628	0.0000**
R-squared	0.113847		F-statistic	15.09568
Adjusted R-squared	0.106306		Prob(F-statistic)	0.000001
Durbin-Watson stat	2.072488			

Dependent Variable: Poultry farm growth **significant at 1%
Source: Field survey Data, 2018.

Relationship between loan diversion and productivity of poultry agribusiness firm

Table 4 shows the relationship between loan diversion and poultry farm growth. The result revealed that the association between poultry farm growth and loan diversion is negative and statistically insignificant as indicated by the p-value of 0.88 which is greater than 0.05($p>0.05$).This means that an increase in loan diversion would also mean a decrease in poultry farm growth, in the same vein, a decrease in loan diversion would lead to an increase in poultry farm growth as both variables move in opposite directions.

Loan Diversion of Poultry Farms

Table 4 shows that it the farm manager needs to be rational in borrowing of loan for the farm. Before more loan is borrowed, the return on investment needs to be monitored. Previous financial records need to be consulted before the decision to obtain more loan. Poultry farmers who do not consider their equity base before borrowing run the risk of borrowing more than what they can pay for thereby impeding the growth of the farm firm in the long run. Farm managers need to be vast in loan management and how to sustain loan below the threshold level.

Table 4 shows that the R^2 of the regression is 0.209269 or 20.92% this means that the variables used in the equation only explain 20.92% of the explained variable (dependent) while 79.08% of the dependent variable are explained by variables not captured in the study. However the P-value of the F-statistic is significant (0.00) this means that the model is fit and the result can be relied upon to make inference with regards to the dependent variable. Loan diversion has a positive and statically significant relationship with debt status this means that an increase in diverted loan increases debt status by 9.03%.

Table 5. Loan diversion as a determinant of default rate in poultry agribusiness

Variable	Coefficient	Std. Error
Constant	23.47664	5.768529
Creditworthiness	3.307279	3.924287
Equity	9.49E-06	2.38E-06
Farm age	-4.724139	1.726501
Farm size	-0.063282	0.015864
Interest	0.116474	0.498639
Loan condition	6.293070	2.879024
Loan duration	0.563955	0.152177
Loan frequency	0.299530	0.160203
Loan sources	-7.042216	2.758092
Loan Diversion	9.03E-06	2.24E-06
R-squared	0.209269	F-statistic
Adjusted R-squared	0.170782	Prob(F-statistic)
Durbin-Watson stat	1.709228	

Dependent variable: Default rate
**significant at 1%
*significant at 5%
Source: Field survey Data, 2018.

Implications for Extension Education on Financial Literacy

Financial literacy is the possession of the required skills and knowledge that enables an individual to make effective decisions with respect to the use of financial resources. Understanding basic financial concepts enhances people to operate effectively in the financial system. People without appropriate financial literacy training will lack the ability to manage credit effectively and are easily exposed to financial trouble. Many poultry farmer borrowers have had little or no understanding of financial literacy, how credit works and the potential impact on their poultry farms. The dearth of financial understanding is a warning signal poultry business failure. Financial literacy is the pivot of financial, credit and debt management and the knowledge that is required for financially responsible decisions and actions. The level of financial literacy varies according to education and income levels, but evidence shows that highly educated consumers with high incomes can be just as ignorant about financial issues as less-educated, lower-income consumers (though in general, the later do tend to be less financially literate. Financial illiteracy contributes to people making poor financial decisions and becoming victims of abusive financial practices. Financial literacy is an indicator of human capital that can be factored as a model input to predict the variation in the savings, investing and debt behaviour [24] of poultry farmer borrowers.

CONCLUSIONS

The study investigated the evidence of loan diversion and effect on the productivity of poultry farms over time. The study provided evidence that a proportion of borrowed loan for poultry business was diverted to other uses. Diverted loan caused negative effect on the growth of poultry farms. Increase in amount of loan diversion (loan leakages) would certainly lead to a decrease in poultry farm growth.

Based on the findings of the study the following recommendations are made:

(i)Loans borrowed for the operations of small scale agribusiness firms should not be diverted to alternative uses.

(ii)Credit agencies/institutions should supervise and monitor credit utilization among operators for small scale poultry agribusinesses.

(iii)Creditors should ensure that previous loans are well utilized before granting more credit to small scale poultry agribusiness operators.

(iv)Extension agent should sensitize poultry famer borrowers on financial literacy.

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ANALYSIS OF IMPROVED CASSAVA VARIETIES' CULTIVATION AND DOWNSIDE RISK EXPOSURE AMONG FARMERS IN ONDO STATE, NIGERIA

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Abstract

This study examined the impact of improved cassava varieties' cultivation and downside risk exposure among farmers in Ondo State, Nigeria. The multistage sampling procedure was employed to select 154 respondents for the study. The analytical tools employed are descriptive statistics and Endogenous Switching Regression (ESR) model. The empirical findings revealed that the respondents who were adopters and non-adopters were in their active ages, married, with some level of formal education and mainly male. The results of the Endogenous Switching Regression model revealed that years of formal education, extension agent visit, the quantity of herbicide used, quantity of hired labour, the quantity of fertilizer used and awareness of the importance of improved cassava varieties were positive and significant in determining the adoption of improved cassava varieties. Adoption of improved cassava varieties reduced the downside risk exposure (probability of crop failure) among farmers. Adoption of improved cassava varieties can reduce the downside risk exposure (likelihood of crop failure) among farmers. Therefore, the study recommended that extension agents should be supported by both government and non-governmental organizations to visit the farmers regularly and orientate them about inputs combination that can therefore, increase the farm output and reduce the probability of crop failure.

Key words: *improved cassava varieties, downside risk, crop failure, endogenous switching regression*

INTRODUCTION

Economic growth and development in sub-Saharan Africa cannot be appraised without reference to Agriculture as it plays an important role. It has engaged most of the labour force, provide the industries with raw materials and food commodities to the populace [10]. According to [1], Cassava (*Manihot esculenta*) serves as crucial food source for the population of sub- Saharan Africa and it is very vital in the welfare of farmer due to its ability to produce in average soil and survive drought. Farming system of Nigeria supports the cultivation of cassava as a food crop and Nigeria is the largest cassava producer in the world. Three times cassava output produced in Brazil, Ghana and Democratic Republic of Congo can be attributed to Nigeria making her to produce nineteen percent of the world cassava output [11].

[5] revealed that farm productivity can be raised and household poverty can be reduced through the adoption of agricultural technologies in developing economies. [19] identified with increase households' income and reduce poverty, increase households' food security, increase production and reduce various agricultural risks as part of the numerous reasons why improved cassava varieties (ICV) were developed. ICV, a product of improved technology plays a critical role in increasing agricultural productivity [24]. The rate at which this ICV is adopted is on the increase as identified by [5], translating to increase in annual income and annual consumption expenditure of farmers thus increasing welfare in Nigeria. Despite this adoption and production level, [20] posited that low yields characterize cassava production in Nigeria unlike other regions of the world where this crop is cultivated. Also, agriculture is known to be

very risky all over the world because of numerous reason which could be classified as controllable and uncontrollable factors. Production risk can be among the highly uncertain and potentially devastating resulting to uncertainty in consumption and profit of farmers [26].

Agricultural risks are common all over the world and they are strenuous to small scale farmers in developing countries [9]. According to [21], outcome of risks in agricultural production are strong in Africa where there is inconsistent rainfall, prevalence of pests and diseases outbreaks resulting into wide variations in crop and livestock yields.

There are various studies on impact of improved technologies on farming households' welfare (such as [5]. Also, there are well known literatures on farmers' attitude towards risk and few studies on the risks that the farmers might face in the adoption of such technology. With these in the literature, there is little or no information about downside risk exposure of farmers because of the agricultural technology especially among cassava farmers being one of the most exploited crop in this part of the world. Policy makers and donors agencies need information on these impacts to allocate resources to fruitful lines of research and to strengthen the role of agricultural research in fighting poverty, hunger, and malnutrition. International organizations and governments expect improved varieties to alleviate malnutrition and hunger, but to date; impact assessment studies have mainly been directed towards productivity and aggregate welfare measures. Hence, this study examined the improved cassava varieties cultivation and the downside risk exposures among farmers in Ondo State, Nigeria.

This paper contributes to the body of knowledge in these ways. This study has analysed the contribution of improved cassava varieties cultivation to welfare i.e. lower downside risk exposure (probability of crop failure) since it has not been exploited studies. It simultaneously estimate the determinants of adoption and impact of improved cassava varieties adoption on the downside risk exposure of the farmers as it account for both observable and unobservable factors efficiently, endogenous switching regression model approach [15] was used for downside risk exposure being a continuous outcome.

Agricultural Risk and Technology Adoption

The use of new technologies do comes with risk and uncertainty which could be seen in the distribution farmers' profits [13]. [17] argued that farmers are likely to come to any new technology with doubt, uncertainty, prejudices and preconceptions. Unless they are greenhorn farmers, they would have tested some new invention in the previous years and conclude it may not be true as claimed by the developers. Farmers are likely to be skeptical about methods which differs from what they are familiar and comfortable with. This could result to them holding an attitude that the people inventing new technology of system don't understand the realities of farming or at least of their farm.

MATERIALS AND METHODS

Study area

This study was carried out in Ondo State, southwest, Nigeria. There are three distinct ecological zones within the State; the mangrove forest to the south, the rain forest in the middle part and the derived savanna to the north. The State has 18 Local Government Areas (LGAs). The State lies within latitudes 50 45' and 80 15' N and longitudes 40 45' and 60 5' E. The land area is about 14,793,186 square kilometer with varying features like hills, lowland, rivers, creeks and lagoons [18]. The State has a fairly large population of about 3.4 million people suggesting a potential for high output. From the population records, 60.92 percent of the population lives in rural areas while the remaining 39.6 percent live in the urban areas [18]. The State enjoys luxuriant vegetation with vast rain forests in the southern part while the northern fringe in the mostly sub-savanna forest.

Data Source

Data for the study were obtained from the primary source. Primary data were collected with a structured questionnaire from cassava farmers in Ondo State. Some of the data collected include valuable information on households' composition and characteristics, area planted, output and yield.

Classification of Respondents as Adopters and Non-Adopters of Improved Cassava Varieties

In this study, farmers were classified as adopters if they have grown at least one of the prominent improved cassava varieties introduced for at least one season before year 2018 (the year the data for the study were collected) or still growing anyone in the study area and non-adopters otherwise.

Sampling and Sample Size

The multi-stage sampling procedure was used for the study. The first stage involved a purposive selection of four blocks which include Okitipupa, Ondo West, Akure North, and Akoko South-West of the four Agricultural Development Programme (ADP) zones based on the intensity of cassava farmers. The second stage was a random selection of two communities in each of the selected blocks. The last stage was a random selection of ten cassava producing households that adopted the selected improved cassava varieties and ten cassava producing households that planted none of the selected improved cassava varieties from each of the selected communities in Ondo State. 154 completed copies of the questionnaire comprising seventy-nine adopters and seventy-five non-adopters were analysed. Out of all the cassava farmers sampled, data from 154 cassava farmers were used for the analysis while 6 were discarded due to incomplete information supplied by the farmers.

Conceptual Framework

Improved Cassava Varieties Adoption Decision

The choice of farmers is assumed to be two possible outcomes of either to adopt ICV or otherwise, the adoption decision-making process and effect of the improved cassava varieties on downside risk exposure can be modeled in an optimization framework denoted by U_{iA} and U_{iN}, respectively. The net welfare of farmer i which is unobserved is represented by $P_i^* = U_{iC} - U_{iN}$. This is possible only when the decision status is known to the researcher, but the households' preferences like net are known to only the farmer. The net welfare from improved cassava varieties adoption can be expressed regarding a vector of household explanatory variables in a latent variable framework as:

$$P_i^* = X_i'\alpha + \varepsilon_i, \quad P_i = [P_i^* > 0] \qquad (1)$$

where:

P_i^* is a binary variable, with 1 for farmers who adopted the improved cassava varieties and 0 otherwise;

X includes all observable factors that influence improved cassava varieties adoption decision, such as household and farm level characteristics; $\propto$ is a vector of parameters to be estimated; $\mathcal{E}$ is the error term with mean zero, and variance σ_ε^2 capturing measurement errors and unobserved factors.

Farming Households' Impact Evaluation

This study investigates the impact of improved cassava varieties adoption on farming households' downside risk exposure. Given this vector of outcomes is a linear function of a vector of farm and household characteristics, the outcome variables can be expressed as

$$Y_h = Z_h'\beta + C_h\gamma + \mu_{h,} \qquad (2)$$

where:

Y_h represents a vector of outcome variables; Z_h is a vector of farm and households' characteristics (e.g., extension visit, age, education);

C_h as described is an indicator of household improved cassava varieties adoption status; μ_h is a random error term, and

β and γ are the vector of parameters to be estimated.

In impact evaluation, only observed attributes declared by the farmer in the survey are known to the researcher, but unobservable factors like innate technical, social networking, risk, and managerial abilities are known to only the farmer. Potential selection bias arises where the undeclared factors in the outcome influencing the selection. This implies the correlation coefficient of the error terms $\rho = corr\ (\varepsilon\ ,\ \mu\ ) = 0$, hence ordinary least squares (OLS) yield bias estimates. In a randomized control trial setting, this selection bias problem is addressed by randomly assigning individuals into treatment (adopters) and control (non-adopters) groups, so the only differentiating factor among adopters and non-adopters in the technology [7].

However, in a non-randomized experimental situation like the adoption of improved cassava varieties, adoption is not random and selection bias may occur. The PSM approach is commonly used in impact evaluation of technology on household welfare, in particular when self-selection occurs (e.g., [14]. According to [2] a major drawback of the PSM approach is that it only accounts for observable factors. To simultaneously estimate the determinants and impact of adoption, while accounting for both observable and unobservable factors efficiently, an Endogenous Switching Regression Model approach developed by [15] is employed. Therefore, the Endogenous Switching Regression is suitable for continuously expected welfare indices like downside risk exposure.

Analytical techniques

The objectives of this study were achieved with using several analytical methods. These include descriptive statistics, Endogenous switching regression model.

Endogenous switching regression model

Endogenous Switching Regression Model was used to examine the impact of improved cassava varieties adoption on downside risk exposure. In the ESR model framework, a two-stage estimation procedure is estimated simultaneously. The first stage involves estimating the adoption decision to determine the factors influencing adoption in equation (1). In the second stage, the impact of adoption on the outcome variables is specified for two regimes of adopters and non-adopters of the improved cassava varieties as:

Regime 1 (adopters):

$$Y_{hA} = Z'_{hA}\,\beta + \mu_{hA} \text{ If } P_h = 1, \qquad \text{(3a)}$$

Regime 0 (non-adopters):

$$Y_{hN} = Z'_{hN}\,\beta + \mu_{hN} \text{ If } P_h = 0, \qquad \text{(3b)}$$

where: Y_{hA} and Y_{hN} are outcome variables for adopters and non-adopters respectively; Z is a vector of households' endowments and farm-level characteristics; β is a vector of parameters to be estimated; μ is the error term. The structure of the ESR model allows for an overlap of X in Eq. (2) and Z of Eqns. (3a) and (3b). But for identification, at least one variable in X should not appear in Z, hence the selection equation is estimated using the same variables in the outcome equation besides at least an identifying instrument. A valid instrument is expected to influence adoption and not the outcome. To account for selection bias, the variables in Z in Eqs. (3a) and (3b) account for only observable factors. However, the ESR model can address selection bias due to unobservable factors within a framework of the omitted variable problem. Specifically, Heckman 1979 indicates that the inverse mills ratios or selectivity terms from the selection equation represented by λ_A for adopters and λ_N for non-adopters, and the covariance terms $\sigma_{A\varepsilon}, \sigma_{N\varepsilon}$ are plugged into (3a) and (3b) to obtain (4a) and (4b) and specified as:

$$Y_{hA} = Z'_{hA}\,\beta + \sigma_{A\varepsilon}\,\lambda_A + \vartheta_{hA} \text{ If } P_h = 1, \qquad \text{(4a)}$$
$$Y_{hN} = Z'_{hN}\,\beta + \sigma_{N\varepsilon}\,\lambda_N + \vartheta_{hN} \text{ If } P_h = 0, \qquad \text{(4b)}$$

where: the selectivity terms λ_A and λ_N correct for selection bias from unobservable factors and ϑ_A and ϑ_N are the error terms with conditional zero means.

[15] argued that a disadvantage of the two-stage approach is that it generates residuals that are heteroskedastic and cannot be used to obtain consistent standard errors without cumbersome adjustments. They then proposed a full information maximum likelihood approach, used in this study, as an efficient methodology to simultaneously estimate the outcome and selection equations. Therefore, the Endogenous Switching Regression model was used to examine the impact of adopting improved cassava varieties on downside risk exposure.

It is used where both observable and unobservable characteristics are accounted for, thus controlling for a 'hidden bias' which could arise when unobservable variables are not taken into account. Ignoring the endogeneity of the adoption of improved cassava varieties would cause biased estimated parameters. To address the endogeneity problem, this study used the Endogenous Switching Regression model, which accounts for the correlation in the unobserved characteristics in the decision to adopt the improved cassava varieties and continuous expected outcome i.e. downside risk exposure.

A valid instrument is expected to influence adoption and not the outcomes. In this study, a variable on farmer's awareness of the usefulness of improved cassava varieties is hypothesized to affect adoption decisions but not the outcome. This is considered valid and relevant instrument.

The impact of adopting the improved cassava varieties on downside risk exposure was examined by comparing the expected outcome of downside risk exposure of farmers who adopt with expected outcomes of the counterfactual hypothetical cases that did not adopt. The expected values of the outcome Y on adoption and non-adoption can be expressed as in Equations. (9a) and (9b):

Regime 1 (adopters):

$$E(Y_{hA}|P = 1) = Z'X_{hA} - \sigma_{A\varepsilon}\lambda_A \quad (5a)$$

Regime 0 (non-adopters):

$$E(Y_{hN}|P = 1) = Z'X_{hN} - \sigma_{N\varepsilon}\lambda_N \quad (5b)$$

A change in the outcome due to adoption termed the average treatment effect on the treated (ATT), is expressed in Eq. (10) as the difference in the expected outcomes from Eqs. (5a) and (5b) [20]:

$$ATT = E(Y_{hA}|P = 1) - E(Y_{hN}|P = 1)$$

$$\text{ATT} = Z(\beta_{hA} - \beta_{hN}) + \lambda_A(\sigma_{A\varepsilon} - \sigma_{N\varepsilon}) \quad (6)$$

where: E (Y_{hA} and Y_{hN}) are expected outcome variables for adopters and non-adopters respectively;

X_i is a vector of households' endowments and farm-level characteristics; Z is a vector of parameters to be estimated; λ is the inverse mills ratios; σ is the covariance of the error terms.

Thus, the independent (explanatory) variables used are as specified below:

X_1 = Age (years),
X_2 = Sex (1 if male 0 otherwise),
X_3 = Household Size (Number),
X_4 = Farming experience (years),
X_5 = Marital status (1 if married and 0 otherwise),
X_6 = Membership of association (1 if a member of farmers' association and 0 otherwise),
X_7 = Contact with Extension Agent (1 if yes),
X_8 = Years of formal education (years),
X_9 = Quantity of hired labour (man days)
X_{10} = Quantity of fertilizer used (kilograms)
X_{11} = Quantity of herbicide used (litres)
X_{12} = Awareness of the importance of ICV (1 if aware and 0 otherwise),
X_{13} = Farm Size (Number).

Estimation of downside risk exposure

For this study, the specification of the downside risk exposure follows, [6] flexible moment-based approach. The flexible moment-based approach used the first moment (mean), second moment (variance) and the third moment (skewness) of the production function to measure the impact of various inputs on yield and downside risk. The flexible moment-based approach considered skewness of output as a measurement of downside risk exposure.

The production is represented by the production function $y = g(x, v)$, where v is a vector of random variables reflecting uncontrollable factors affecting output (e.g., rainfall).

Consider the following econometric specification for $g(x, v)$:

$$g(x, v) = f_1(x, \beta_1) + u \quad (7)$$

where:

$f_1(x, \beta_1) \equiv E[g(x, v)]$ is the mean of $g(x, v)$, and $u \equiv g(x, v) - f_1(x, \beta_1)$ is a random variable with mean 0.

$$y = \beta_0 + X_i\,\beta_i + e \quad (8)$$

y = Cassava Yield

X_1 = Age (years),
X_2 = Years of formal education (years),
X_3 = Access to improved cassava cutting,
X_4 = Quantity of fertilizer used (kilogrammes),
X_5 = Household Size (Number),
X_6 = Total labour used (man days),
X_7 = Quantity of pesticide used (litres),
X_8 = Quantity of insecticide used (litres),
X_9 = Contact with Extension Agent (1 if yes),
u = error term

The higher moment of $g(x, v)$ are given by

$$E\{[g(x,v) - f_1(x,\beta_1)]^k \mid x\} = f_k(x,\beta_k) \qquad (9)$$

For k = 2, 3,….. Equations (11) and (12) give the central moments of distributing $g(x, v)$, including the first moment (the mean) $f_1(x,\beta_1)$, the second central moment (the variance) $f_2(x,\beta_2) > 0$, and the third central moment (measuring skewness) $f_3(x,\beta_3)$. This flexibly represents the impacts of inputs x on distributing output under production uncertainty.

This study involves the estimation of the production function for cassava output. It relies on equations (11) and (12), where the dependent variable y is the cassava yield, with the mean $f_1(x,\beta_1)$, variance $f_2(x,\beta_2)$and skewness $f_3(x,\beta_3)$.

RESULTS AND DISCUSSIONS

This section presents the discussion and interpretation of results obtained from the analysis of data collected for this study.

Socio-economic Characteristics of Respondents

As shown in Table 1, the mean age of the respondents was 42.96 years and 43.70 years old respectively for adopters and non adopters. This is an indication that majority of the respondents were still within the economically active age. It also implied that the respondents were agile and active to withstand the rigours of farming. The results is in agreement with [22] who opined that for farmers to be productive in farm chores, they must be young and active in order to contribute meaningful labour input into all the stages of production for efficient output realization which in turn results in consumptive and income opportunities with proportional household welfare. Male farmers had the larger percentage of the sampled adopters and non adopters and this could be due to laborious nature of cassava production.

The educational status of the respondents revealed that majority (93.7% and 88.0%) of the respondents who were adopters and non-adopters respectively had at least primary school education. It indicated that only 6.3% of the adopters and 12.0% of non-adopters had no formal education. Therefore, it can be concluded that most of the sampled respondents in the study area were educated. This is in line with the findings of [20] who reported there was no significant difference in the educational status of adopters and non-adopters of improved cassava production technology because most farmers were educated. The results showed that 62% and 54.7% of the adopters and non-adopters in the study area respectively had between one to five people per household. Mean household size for the study area was 5. This is corroborated by the work of [20] who found no significant difference in the household size of adopters and non-adopters. The result also revealed that majority of the respondents were married in the study area.

The study also showed that the mean farming experience of the farmers was 16.4 years and 18.4 years for adopters and non adopters respectively. The higher in the years of farming experience for non-adopters could be part of the reasons for not adopting improved cassava varieties in the study area. This study affirmed the findings of [5] on cassava production that a good proportion of the respondents have farming experience of about 20 years or less. It is expected that farmers in the study area should be knowledgeable in up-taking production risks. This suggests that the farmers had enough experience in cassava production to make the best decisions that will help boost their productive capacity. The average land area cultivated by the farmers was 1.99 and 1.28 hectares respectively. This implies that majority of the respondents in the study area are small scale farmers. This result

is in conformity with [4] that over 90 per cent of Nigerian farmers are small-scale farmers who cultivate less than 5
hectares. According to [16], the probable reason for the small-scale farm size was because of the low level of mechanization of traditional agriculture or owing to land tenure problems.
The findings also revealed that majority of the respondents had no access to credit. This might have affected the cassava farmers by hindering them from performing at optimal level. This is in line with the findings of [8] who posited that there are credit market imperfections in Nigeria and this could limit the investment and operation of the farms. The result also shows that 72% and 16% of adopters and non-adopters respectively had access to extension agents while 28% and 84% of adopters and non-adopters respectively had no access to extension agents in the study area. This implies that most of the farmers that adopted improved cassava varieties in the study area were privileged to benefit from extension education and training which would have impacted the farmers positively in terms of information and innovative technologies to take good decisions that will increase their production level. Most of the non-adopters however, were not able to access the extension agent which may be the reason for their dis-adoption in the study area. This result is in line with the findings of [20] who affirms access to extension agent as a strong determinant of adoption of improved cassava production. About 39.2% and 37.3% show the percentage of adopters and non-adopters that respectively owned their land personally. There will be minimal level of land fragmentation in the study area because both adopters and non-adopters have low percentages for land acquisition through inheritance. However, purchased land maybe used as collateral to access credit facility in production process.

Table 1. Respondents' Distribution by Socioeconomic Characteristics

Variable	Adopter		Non-Adopters	
	Mean	Dominant Indicator	Mean	Dominant indicator
Age	42.96	67.1% falls below or equals 44 years (active)	43.70	61.4% falls below or equals 44 years (active)
Sex		79%		65%
Education Level		93.7% had formal education		88.0% had formal education
Household Size (Number)	5.4	62% between 1and 5 persons	5.4	59% between 1 and 5 persons
Marital Status		73.4% married		80% married
Farming Experience (Years)	16.4	45.6% between 1and 10 years	18.4	42.8% between 1and 10 years
Farm Size (hectare)	1.99	67.1% had less than or equal to 2 ha	1.28	85.3% had less than or equal to 2 ha
Access to Credit		75.9% had no access		76.3% had no access
Access to Extension Agents		72% had access		16% had access
Method of Land Acquisition		39.2% through purchase		37.3% through purchase

Source: own processing.

Estimation of Adoption and Impact of Adoption on Downside Risk Exposure

The full information maximum likelihood approach is employed to jointly estimate the selection and outcome equation in the specification. Table 2 presents the estimates for downside risk exposure. The coefficients of the ESR estimates reported in the second column of Tables 2 is the selection equation estimates, while the fourth and sixth columns report the impact of adoption on adopters and non-adopters. As stated in the empirical specification, identification of the model requires that at least one variable in the selection equation should not appear in the outcome equations. In ESR specification, the variable awareness of the importance of improved cassava varieties is used as an identifying instrument. It is expected that farmers' level of awareness about ICV will influence adoption decisions but not directly on downside risk exposure [25].

This analysis relied on a moment-based specification of the stochastic production function for the estimation of downside risk exposure [6]. The approach captures the effects of ICV and other characteristics on the mean, variance, and skewness of cassava production. However, the variance does not distinguish between unexpected bad events and unexpected good ones. On that basis, it seems important to consider skewness in risk analysis. An increase in the skewness of yield means a reduction in downside risk exposure (e.g., a decrease in the probability of crop failure) [23].

The likelihood ratio test for joint independence of the equation in the ESR specification shows that the equation is dependent. The correlation coefficient ρ_1 and ρ_2 in the specification are both statistically significant, indicating that the selection bias due to unobservable factors occurred in adoption. Therefore, using ESR model, which accounts for both observable and unobservable factors, is appropriate in this study [15]. Since ρ_1 is negative and ρ_2 is positive, it implies that adopters with higher skewness have a lower probability of crop failure after adopting the improved cassava varieties than the non-adopters. However, non-adopters of ICV with lower skewness have a higher probability of crop failure than the adopters.

Given that the empirical result in the selection equation can be interpreted as normal probit coefficients, the result for variables in Table 2 represents the probability of adopting improved cassava varieties and effects of adoption.

Table 2. Full Information Maximum Likelihood Estimates of Endogenous Switching Regression Model for Adoption and Impact of Adoption on Downside Risk Exposure

	Selection		**Adopters**		**Non-adopter**	
	Coefficient	**t-value**	**Coefficient**	**t-value**	**Coefficient**	**t-value**
Constant	-1.316	-4.42	0.298	0.23	0.951	2.11
Age	- 0.023	-0.31	0.003**	2.01	0.006**	2.22
Sex	- 0.269	-0.87	-0.185	-1.32	-0.255	-0.69
Farm Size	- 0.241*	-1.91	0.008	1.45	0.207*	1.79
Household Size	0.012	1.47	0.003**	1.98	0.042	0.78
Years of Formal Education	0.017*	1.93	0.003*	1.89	-0.047	-1.22
Farming Experience	0.014	0.21	-0.009	-1.64	0.009**	1.98
Membership of Association	0.077	0.45	0.116*	2.10	0.236	0.94
Extension Agent Visit	1.390***	6.56	-0.138	-0.98	-0.923	-1.65
Quantity of Herbicide	0.048***	4.07	0.006**	2.21	0.170***	6.92
Quantity of Cassava Stem	- 0.008	-1.42	0.003***	5.34	-0.005	-0.32
Quantity of Hired Labour	0.026**	2.00	0.002	1.44	0.020	1.32
Quantity of Fertilizer	0.007***	6.30	0.004*	1.90	0.005***	7.32
Awareness of import. of ICV	1.186***	5.67				
$\ln\sigma_1$			0.879***	4.01		
ρ_1			-0.184**	2.32		
$\ln\sigma_2$					0.209***	7.21
ρ_2					0.473***	3.14
Log likelihood	-190.16					
Likelihood ratio of independence: $\chi^2(1)$			31.78**			

Source: own processing.
* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level

The coefficient of the variable farm size is negative and different from zero in the specification, indicating that as the farm size increases, it also increases the probability of being non-adopter of improved cassava varieties.

This could be due to large farm size increasing the cost of purchasing improved varieties. The estimate of the variable education, which is positive and statistically significant suggesting that more years of education increase the probability of being an adopter of improved cassava varieties. The result of years of education is in line with other findings like [2], which reveals that years of education are a strong determinant of technology adoption.

The access to extension agents is positive and statistically significant, indicating that farmers with more contacts with extension agents are more likely to adopt improved cassava varieties. The result reveals that the increase in the extension contact increases the probability of being an adopter of improved technology. The result on extension contact is in line with other findings like [12], which showed that extension is a strong determinant of technology adoption.

Also interesting is the effects of the quantity of herbicide used variable, which differs significantly from zero and positive in the selection specification. It reveals that as the quantity of herbicide used increases, there is an increase the probability of adopting ICV.

The quantity of hired labour is positive and different from zero, suggesting that an increase in the quantity of hired labour increases the probability of adopting ICV by the farmers. The result may imply that farmers can hire additional labour in the cultivation of ICV after adoption. In the same vein, the positive and statistical significance of the quantity of fertilizer used is an indication that increasing the use of fertilizer will likely increase the probability of adopting ICV. Also, interesting is the estimate of the variable awareness of the importance of improved cassava varieties, which is positive and statistically significant in the specification. It reveals that as the level of awareness of the farmers increases there is an increase in the probability of adopting ICV. The increase in awareness may be because of information from the extension agents or education.

The estimates in the outcome equations in the columns for adopters and non-adopters in Tables 2 show the impact of farm and household characteristics on downside risk exposure for adopters and non-adopters. The impact estimates suggest that age influences the level of downside risk exposure among adopters of improved cassava varieties. The positive and statistically significant coefficient indicates that as the age of the farmer increases, it reduces the probability of crop failure which may be because of the experience they acquire in the production of cassava. The positive and statistically significant estimate of the household size for adopters indicate that higher household is more likely to reduce the probability of crop failure, which may imply that increasing household size will be available for farm operations in place of hired labourers who do not care about crop survival. The positive coefficient of years of formal education in the outcome equation for the downside risk exposure specification indicates that as the years of formal education increases, the probability of crop failure for adopters reduces. The result implies that as the years of formal education of farmers increase it also increases the probability of adopting improved cassava varieties which in turn reduces the probability of crop failure. The positive coefficients of membership of the association in the downside risk exposure-outcome specification indicate that membership of the association is significant as it reduces the downside risk exposure (probability of crop failure) for the adopters. The result implies that belonging to one form of association or the other makes bulk purchases of inputs easy reducing downside risk exposure.

The estimate for the quantity of herbicide used is positive and statistically significant for adopters and non-adopters' downside risk exposure specification indicating the positive impact of quantity herbicide on skewness (probability of crop failure). The farmers use more herbicide to reduce the effect of weed on the crop thus, reducing the possibility of crop failure for the adopters and non-adopters.

The estimate for the quantity of cassava stem variable is positive and statistically different from zero for adopters in the downside risk exposure. The result indicates that as the quantity of cassava stem used increases it lowers the probability of crop failure. For the adopters of improved cassava varieties, an increase in the quantity of stem planted translates to higher output, hence increase household welfare. The variable quantity of fertilizer used has positive and significant impacts on downside risk exposure for adopters and non-adopters of improved varieties in the specification. This finding suggests that as the quantity of fertilizer used increases for adopter and non-adopters of improved cassava varieties, the probability of crop failure is reduced. However, the increase in quantity of fertilizer used by non-adopters may not translate to an increase in welfare for them. The variable farm size has a positive and significant impact on downside risk exposure for non-adopter in the specification. This finding suggests that as the farm size increases, farmers may not acquire enough improved varieties that will cover the farm reducing the skewness of production in the study area. The estimate for the farming experience is positive and statistically different from zero for non-adopters in the downside risk exposure specifications for non-adopters. The result indicates that as farming experience increase, skewness also increases for non-adopters as farmers use experience gathered in production years for management of cassava, hence increase in household welfare.

Impact of ICV cultivation on the households' downside risk exposure

The impact of adoption on households' downside risk exposure was examined by the average treatment effects (ATT) on the expected outcomes estimated. Table 3 presents the ATT estimates of the Endogenous Switching Regression specification for downside risk exposure. These ATT estimates account for other confounding factors including selection bias arising from potential systematic differences between adopters and non-adopters. The results reveal that adoption reduces downside risk exposure. Specifically, the adoption of improved cassava varieties contributes to higher skewness (lower probability of crop failure) at 1.342 and that of non-adopters at lower skewness (higher probability of crop failure) at 0.543. The higher skewness implies a lower probability of crop failure from adopters of ICV. These findings follow other studies, which report that the adoption of new agricultural technologies can reduce the probability of crop failure. (e.g., [3]).

Table 3. Impact of Improved Cassava Varieties Cultivation on Farmers Downside Risk Exposure

Variable	**Adopters**	**Non-Adopters**	**ATT**
Downside risk exposure (Skewness)	1.342	0.543	0.799***

Source: own processing
* 10% level; ** 5% level; *** 1% level

CONCLUSIONS

This study assessed the impact of the adoption of improved cassava varieties on the downside risk exposure of farming households' in Ondo State, Nigeria. About 87.3% of the farmers adopted TME 419 which is the most widely adopted variety among the introduced improved cassava varieties in the state. The results also showed that the cultivation of improved cassava varieties in the study area reduced the downside risk exposure (probability of crop failure) of cassava farming households thus increasing their welfare. The results also demonstrated that, if the impact of ICV on these outcomes was estimated without accounting for observable and unobservable factors in the adoption decision process, sample selection bias could have occurred. Therefore the following recommendations were proffered based on the findings of this study:

- Government policy should be geared towards making education affordable and accessible at all levels. Adult and non-formal education will be of great assistance to the aged farming households.
- Extension agents should be supported by both government and non-governmental organizations to visit the farmers regularly and orientate farmers about input combinations that can, therefore, increase the farm output.

- There is a need to facilitate the development of infrastructures by the government among communities in the study area.

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UTILIZATION OF ICTS IN ACCESSING COCOA BEANS MARKET INFORMATION BY CROSS RIVER STATE FARMERS

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Abstract

The research work investigated farmers' level of use of Information and Communication Technologies (ICTs) in accessing cocoa beans market information in Cross River State, Nigeria. Sixty farmers were selected using random systematic sampling technique. Pertinent information was collected with structured questionnaire. Data were analysed with descriptive statistics and Pearson Product Moment Correlation (PPMC). Results reveal that 90% of the respondents used mobile phone while 85% used radio to access cocoa beans market information. Frequency of use for mobile phone (75%) and radio (35%) were on weekly basis. The major market information used for ICTs were cocoa beans sales price (88.3%), quality (85%), value addition (78.3%) and certification (75%). Cocoa beans sales price was accessed regularly, while certification of cocoa beans was occasional. Major constraints to the utilization of ICTs were poor electricity supply and internet services. Income (r=0.279, p=0.021), cocoa farm size (r=0.300, p=0.020) and age (r= -0.301, p=0.019) correlated significantly with extent of using ICTs in accessing cocoa market information by farmers. Efforts should be made by internet providers to ensure optimum internet connection for improved ICTs used by farmers in sourcing cocoa market information.

Key words: *ICT use, cocoa farmers, market information, farmers' income*

INTRODUCTION

Information and Communication Technologies (ICTs) represent medium like radio, television, fixed and mobile telephones, computer and internet. Messages communicated through these means gets to the recipients faster and quick [2]. Nigeria's teledensity (a measure of the penetration of telephone lines within a territory), which is an indicator of a country's ICT potentials, grew from near zero at the turn of the millennium to 107% by 2015. The country has been ranked as the largest and fastest growing in terms of telecom in Africa; and among the 10 fastest growing telecom markets in the world [13]. Globally, the revolution of ICTs has opened greater opportunity for efficient information sharing in the agricultural sector. The application of ICTs by farmers for agricultural activities is gaining popularity in every sphere of human endeavor. The emergence of e-agriculture has inherent potentials to overcome the limitations of rural-urban dichotomy and consequently improve farming households' food and nutrition security, farm income and poverty reduction.

There have been improvements in agricultural practices over the years in Nigeria. This could be attributed to access to information, improved farming techniques and other needed resources. The use of ICT has potential in bridging the information gap among farmers especially, cocoa farmers. This will elicit assess to cocoa beans market information, farm inputs and government policies directly required for optimum productivity.

Farmers need information to organize their production activities, make decision and identify market outlets for their farm produce. Cocoa is a major agricultural export crop and a top foreign exchange earner for Nigeria [3]. It provides stable income and creates jobs for farmers, processors, marketers, researchers and other stakeholders in the value chain. Irrespective of the economic importance, access to credible market information remains a crucial issue in sustaining cocoa business among farmers. In Cross River State, cocoa production is a major activity that provides livelihood for farmers and other actors in agricultural sector. Therefore, the desire to promote better access to information in improving the socio-economic condition of farmers is a top priority of agricultural extension and rural advisory service providers. Agricultural extension professionals are well positioned to organize information to advance the socio-economic landscape of stakeholders in agriculture value chains to exit poverty [9]. The sustainability of food security can be enhanced through mobile-based phone technology. This has been exploited and leveraged to provide farmers with relevant, accurate, timely and consumable agricultural information ranging from farm preparation to pre-harvest and post-harvest crop and farm produce management [5]. They include information on precision farming, pest and disease control, irrigation, market availability and produce pricing, access to credit facilities and extension services.

Agricultural marketing is germane to cocoa production. It is the performance of all the business activities involved in the flow of goods and services from the point of initial agricultural production to the ultimate consumers [6]. This involves all the stages of operation and movement of commodities from the farmers to the consumers. These include assemblage of goods, storage, transportation, processing, grading, and financing. Cocoa farmers along the cocoa value chain are faced with the challenges of middlemen who buy cocoa beans usually less than the official international market price. The market price before sales is usually not known to the rural farmers. Farmers feel cheated and dissatisfied when they do not have prior knowledge of market prices for their cocoa.

The middlemen ceased this opportunity and take undue advantage of buying the farm produce at cheaper prices directly at the farm gate and later sell to the final consumers at an exorbitant price. Unfortunately, the Cocoa Marketing Board which supposed to regulate their production activities was dissolved by the Nigerian government in 1986. The cocoa sub sector was liberalized and since then, farmers find it difficult to access coordinated information on market structure, improved seedlings, credit, recommended pesticides and standard quality requirements. The limitation in obtaining information about cocoa marketing has been identified as a constraint to farmers' productivity and enlargement across the world. It was observed that in Nigeria, there is an inefficient market information system; leading to a wide gap between farmers and end-users [15]. Therefore, the application of ICTs by cocoa farmers is playing a vital role in accessing relevant information that will enhance productivity and increase livelihood.

It is against this backdrop that farmers' level of use of Information and Communication Technologies (ICTs) to access cocoa beans market information was investigated in Cross River State. The specific objectives are to:

- Determine some farmers' socio-economic characteristics.
- Identify the type of ICTs farmers utilise to access cocoa beans market information.
- Assess how ICTs are frequency used by farmers to access cocoa beans market information.
- Examine the use of ICTs to obtain cocoa market information from farmers.
- Determine the constraints to utilization of ICTs in accessing cocoa market information by farmers.

It was hypothesized that there is no significant relationship between some socio-economic characteristics of farmers and the level of using ICTs in accessing cocoa beans market information.

MATERIALS AND METHODS

The study was carried out in Cross River State, Nigeria. It is the second largest cocoa producing State which has boundaries with Benue State in the northern part. In the West, the state maintains boundaries with Enugu

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and Abia. In the eastern end, Cross River shares border with Cameroon. Akwa-Ibom and the Atlantic Ocean also have their boundaries with the State at the southern part. The State has a mean annual temperature of 30°C and annual rainfall of 1,300-3,000mm [12]. The main crops grown are cassava, yam, rice, plantain and banana. Others include cocoyam, maize, cocoa, rubber; groundnut and palm produce [12].

The sample for the study was purposively selected across four communities in Boki and Etung Local Government Areas due to prominence of cocoa production. The communities include Biakwan and Orimekpang in Boki, Ajassor and Effraya in Etung. A systematic random sampling was used to select 60 farmers based on list of cocoa farmers obtained from Cocoa Association of Nigeria. Thirty farmers each were chosen from the selected communities to ensure equal representation. Information was collected from the farmers using structure questionnaire. Data were subjected to descriptive and inferential statistics. Data were analysed with Statistical Package for Social Sciences (SPSS) software to obtain the Pearson Product Moment Correlation PPMC (r). The r and p-values at ($P< 0.05$) were used to understand which variables were significant and not significant in terms of tested hypothesis of the study.

RESULTS AND DISCUSSIONS

Cocoa farmers' socio-economic characteristics

Majority of the cocoa farmers constitutes 80% male, while 20% were female (Table 1).

Table 1. Cocoa farmers' socio-economic characteristics *N=60*

Variables	Frequency	Percentage	Mean
Sex			
Male	48	80	
Female	12	20	
Age (years)			
≤ 34	7	11.7	
35-40	29	48.3	
41-45	16	26.7	40.35
46 and above	8	13.3	
Educational Status			
Primary	10	16.7	
Secondary	43	71.6	
Tertiary	7	11.7	
Number of years spent schooling			
3-9	6	10.0	
10-16	49	81.7	
17-23	2	3.3	
24-30	1	1.7	12.93
31-37	1	1.7	
38 and above	1	1.7	
Cocoa farm size (Hectares)			
1-2	30	50.0	
3-4	23	38.3	
5-6	2	3.3	3.11
7-8	1	1.7	
9 and above	4	6.7	
Estimated annual income (₦)			
Less or equal to 500,000	7	11.7	₦1,139,000.00M
501,000,000-1,000,000	30	50.0	($3,163.89)
1,000,001-1,500,000	15	25.0	
1,501,000-2,000,000	6	10.0	
Above 2,000,000	2	3.3	

Source: Field survey, 2018.

It means that more men dominated cocoa production in the study area. Average age of farmers was 40 years implying that they were more of youths engaged in cocoa farming. Majority (71.6%) had secondary education which could influence their use of ICT in obtaining market information. It implies that most of them had a moderate level of education. This is in tandem with [14]. They pointed out that educational status was related

to the use of ITCs by farmers in Edo State. The average farm size of farmers was about 3 ha which suggests small holdings with an estimated annual mean income of One Million One Hundred and Thirty-Nine Thousand Naira only (₦1,139,000). This is equivalent to Three Thousand, One Hundred and Sixty-Three Dollars Eighty-Nine Cents ($3,163.89).
The income realized could facilitate sourcing cocoa market information using ICTs in order to improve the socio-economic lives of the farmers. Such information has proved to increase farmers' revenues, potentially enabling their move from subsistence to revenue generating farming [7].

Type of ICTs used to access cocoa beans market information by farmers

Cocoa farmers in the study area used Mobile phone (90.0%), Radio (85.0%), Internet (21.7%) and other ICT platforms in sourcing for cocoa market information (Fig. 1).

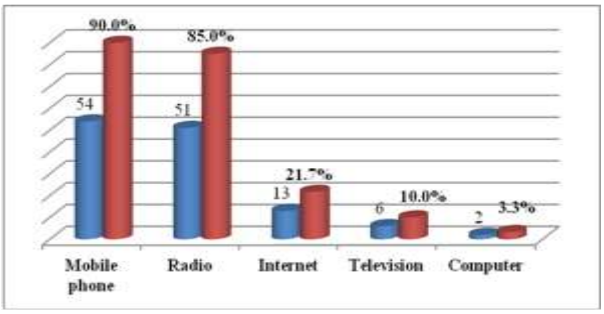

Fig. 1. ICTs used to access cocoa beans market information by farmers *N=60*
Figures without percentages are frequencies
Source: Field survey, 2018.

Mobile phone and Radio were the popular ICTs used. This finding agrees with [11] who reported that mobile phones when combined with other ICTs have high impact on agriculture. Furthermore, [8] pointed out that Radio provides adequate information on how to get and sell their agricultural commodities.

Level of use of ICTs to access cocoa beans market information

Results in Table 2 revealed that 75% and 35% of cocoa farmers used mobile phone and Radio respectively on a weekly basis. Majority of the farmers did not use computer (93.3%), Television (83.3%) and internet (78.3%) regularly.
It suggests that Mobile phone and Radio were the ICT platforms frequently utilized to access cocoa beans market information by respondents.
This is in line with the study of [10]. They reported that Mobil phone and Radio were highly used to access cocoa information.

Table 2. Distribution of farmers' level of use of ICTs to access cocoa beans market information

Level of use of ICTs	Frequency	Percentage
Mobile phone		
None	6	10.0
Daily	6	10.0
Weekly	45	75.0
Monthly	3	5.0
Radio		
None	9	15.0
Daily	3	5.0
Weekly	21	35.0
Monthly	27	45.0
Internet		
None	47	78.3
Daily	1	1.7
Weekly	7	11.7
Monthly	5	8.3
Television		
None	53	88.3
Daily	2	3.3
Weekly	4	6.7
Monthly	1	1.7
Computer		
None	56	93.3
Daily	1	1.7
Weekly	1	1.7
Monthly	2	3.3

Source: Field survey, 2018. Note: *N=60.*

Cocoa market information obtained with ICTs and frequency of sourcing

In Table 3, the major market information obtained using ICT platforms were to know local sales price of cocoa beans (88.3%), cocoa value addition (78.3%), cocoa certification (75%) and bagging dried cocoa beans with standard jute bags. Accessing local sales price was obtained always, while others were sourced occasionally. The implication is that price was a major determinant in using ICTs to obtain necessary information for producing cocoa by farmers. Utilization of ICT for agricultural activities has played a greater role in inspiring and attracting rural youths into agribusiness activities as it makes market information accessible [16].

Table 3. Cocoa market information obtained with ICTs and frequency of sourcing *N=60*

Market information & frequency of sourcing	Yes	F	%
Know current international price of cocoa	16(26.7)	-	-
None		44	73.3
Occasionally		13	21.7
Always		3	5.0
How to know current market demand for cocoa	15(25.0)	-	-
None		45	75.0
Occasionally		12	20.0
Always		3	5.0
Know local sales price of cocoa beans	53(88.3)	-	-
None		5	8.3
Occasionally		26	43.3
Always		29	48.3
Cocoa beans quality	51(85.0)	-	-
None		8	13.3
Occasionally		32	53.3
Always		20	33.3
Certification of cocoa beans	45(75.0)	-	-
None		14	23.3
Occasionally		40	66.7
Always		6	10.0
Cocoa value addition	47(78.3)	-	-
None		15	25.0
Occasionally		38	63.3
Always		7	11.7
Bagging cocoa beans with standard jute bags	47(78.3)		
None		20	33.3
Occasionally		31	51.7
Always		9	15.0

Source: Field survey, 2018.
Note: Figures in parentheses are percentages F Frequencies % Percentages

Constraints faced by farmers in using ICTs to access cocoa market information

Poor electricity supply (96.7%) and internet connectivity (56.7%) were the major constraints encountered by farmers in using ICTs to access market information of cocoa. The high cost of internet services (55%), poor extension services (50%) and high cost of buying ICT were minor constraints (Table 3).

Table 4. Constraints to utilization of ICTs in accessing cocoa market information

Constraints	Major	Minor	Not a constraint
Poor electricity supply	58(96.7)	1(1.7)	1(1.7)
High cost of internet services	15(25.0)	33(55.0)	12(20.0)
Low knowledge of ICT use	5(8.3)	18(30.0)	37(61.7)
High cost of buying ICT	20(33.3)	30(50.0)	10(16.7)
Poor internet connectivity	34(56.7)	20(33.3)	6(10.0)
Poor extension services	4(6.7)	30(50.0)	26(43.3)

Source: Field survey, 2018 Note: Figures in parentheses are percentages and others are frequencies.

However, 61.7% of the farmers claimed that low knowledge of ICT use was not a constraint. By implication, poor electricity supply and internet services posed serious limitations to farmers in using ICT to access cocoa market information. This result is supported by [1].

Hypothesis Testing: Relationship between some farmers' socio-economic characteristics and the level of using ICTs in accessing cocoa beans market information. The results in Table 5 reveal that estimated annual income (r=0.279, p=0.021), cocoa farm size (r=0.300, p=0.020) and age (r= -0.301, p=0.019) correlated significantly with extent of using ICTs in accessing cocoa market information by farmers. The implication is that the higher the income realised from the sale of cocoa beans, the more farmers will use ICT to source for information at improving cocoa marketing and production. Income is an important variable motivating farmers in accessing and using ICT platforms for cocoa production. The study of [4] corroborated this finding. They found that there was positive association between ICTs usage and farmers' income. Consequently, a higher farm size would translate to more utilisation of ICTs for information access on cocoa market. This situation enhances regular ICT application in agricultural production. The inverse and significant relationship between age and level of ICT usage implies that as the age of respondents' increases, the use of ICTs decreases. Therefore, access to cocoa market information through ICT was determined by age. However, there was no significant relationship between numbers of years spent schooling and level of using ICTs in accessing cocoa market information by farmers. The youths used Mobile phone and Radio more than the elderly farmers. [16], shows that young farmers use ICT more often than adult farmers in Nigeria.

Table 5. Relationship between some farmers' socio-economic characteristics and level of using ICTs to access cocoa beans market information

Variables	r-value	p-value	Decision
Estimated annual income	0.279	0.021**	S
Cocoa farm size	0.300	0.020**	S
Age of farmers	-0.301	0.019**	S
Number of years spent schooling	-0.025	0.849	NS

Source: Field survey, 2018.
Note: S=Significant NS=Not significant **Significant at P< 0.05

CONCLUSIONS

The application of ICTs to access cocoa beans market information by farmers revealed that Mobile phone and Radio were commonly used. Major information sourced include: knowing current cocoa beans price, beans quality, certification, value addition and bagging dried cocoa beans with standard jute bags. Income was an important variable motivating farmers in using ICT platforms for cocoa production. Poor electricity supply and internet connectivity were serious constraints to ICT usage by Cross River State farmers. Efforts should be made by internet providers to ensure optimum internet connection for improved ICTs used by cocoa farmers in sourcing cocoa market information.

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DEVELOPMENT AND EVALUATION OF EFFICIENCY OF LEASING ACTIVITIES IN AGRICULTURAL SECTOR OF UKRAINE

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Abstract

It is noted that leasing is a special form of reproduction of fixed assets, which is a kind of entrepreneurial activity. This is one of the most attractive and promising forms of investment that can significantly revive the process of updating the material and technical base of agricultural producers and the entry of the Ukrainian economy into the structure of the world market. The basis of the lease is long-term lease of the property, namely its transfer for temporary use on terms of payment, urgency or redemption. It is proved that in recent years, there has been an increase in the financial leasing market in Ukraine. The decisive contribution to the positive trend is made by companies, members of the professional association of lessors, because today they show the highest dynamics of development. It is proved that leasing is characterized by certain advantages over bank lending, namely: the possibility of quick acquisition of the property and the beginning of its operation without significant one-time investments; release of considerable funds for the solution of priority tasks; after the expiration of the contract there is an opportunity to purchase the property for the residual book value or contract price or to continue leasing for a new term. In our article it is substantiated that the number of leasing operations in Ukraine remains several times lower than the similar indicators of the western countries. For more active development of the leasing services market and, as a result, successful leasing development in Ukraine, it is advisable to carry out a set of measures proposed in the presented study, the main of which, in our opinion, is the support of agricultural producers by the state, which should be based on the development of a better budgetary allocation mechanism. subject to the adoption by the Verkhovna Rada of Ukraine of bills initiated by the Association of Lessors of Ukraine, which will help to increase the demand of agricultural commodities Aviation producers to leasing companies, filling the market of agro-leasing services with private capital, and thus improving the investment environment in the agricultural sector.

Key words: *agricultural sector of the economy, leasing services market, leasing payments, financial leasing*

INTRODUCTION

The production of agricultural products requires considerable costs of logistical and energy resources. In order to ensure efficient management, the material and technical base of agricultural enterprises must meet the requirements of agricultural technology to the quality and timeliness of the work.

However, the machinery and tractor fleet available in agricultural enterprises does not fully meet the requirements of the latest technologies, especially in small and medium-sized farms. This is due to the low level of their solvency, the high cost of new equipment and the inaccessibility of loans due to high-interest rates. The purchasing power of Ukrainian enterprises to acquire machinery annually is only 5 – 7 billion UAH with an annual market capacity of 22 – 28 billion UAH. That is, the technological need is only covered by 15 – 20 %.

In addressing the problem of providing agricultural producers with technical means as soon as possible the important role played leasing activity. World experience shows that agribusiness leasing gave quite a significant role. It is because of leasing developed market countries in times of crisis in the agricultural sector leasing relationships are widely used (and continue this progressive practice) to provide the necessary technical capacity for high production.

The study of the leasing activities for the maintenance involved in the agricultural sector such scholars as Barabash A. [2], Boiar A. [3], Burkovska A. [4], Demyanenko M. [5], Dziamulych, M. [6, 7], Gudz A. [10], Kostecki Ya. [11], Nepochatenko A. [12], Popescu A. [13, 14, 15], Sabluk P. [16], Sodoma R. [1, 19], Stativka A. [20], Gorislavska I. [8], Shmatkovska T. [18], Tofan I. and Ahres O. [21], Vnukova N. [24], Yakubiv V. [25, 26, 27], Zagorodny A. [28] and others. However, the question of the role and updating of logistics in agricultural enterprises through leasing in agriculture requires a further study.

MATERIALS AND METHODS

The purpose of the article is to study the functioning and development of the leasing market in the agricultural sector of Ukraine, outlining the prospects of its application in the domestic sphere of the economy.

The choice of research methods is determined by the nature of the actual material, the conditions and the purpose of the study. Since scientific methods are an orderly system in which they are determined according to a certain stage of research, use of the system of techniques and operations with theoretical and factual material in a given sequence, we, in the process of research of financial leasing in agriculture, used a set of methods, in particular: the method of analysis (analyzed the deep processes, characteristics and features in certain links and branches of production, analyzed the performance of economic sectors, with separate agricultural production during the study period), the method of comparison (comparisons of homogeneous objects were performed to identify similarities or differences between them). The comparison revealed the general and special in the analyzed economic phenomena, determined the changes in the level of the objects studied in the publication, worked out trends and patterns of their development. In the course of the study, general methods of scientific knowledge were also used, namely, methods of empirical research (observation and comparison).

RESULTS AND DISCUSSIONS

Leasing is a relationship whereby one party (the lessor) transfers or undertakes to transfer to the other party (the lessee) the use of property owned by the lessor under the ownership rights and acquired without the prior agreement with the lessee (direct leasing), or property acquired by the lessor from the seller (supplier) in accordance with the lessee's specifications and conditions (indirect lease) for a fixed term and for a fixed fee (lease payments).

There are two main types of leasing: operating and financial leasing. Financial leasing is an agreement whereby the full cost of the equipment is paid for the entire term of the lease (which is legally defined for at least one year). Thus, financial leasing usually means the acquisition of equipment at the end of its useful life.

When operating leases, the lease term is much less than the useful life of the leased asset. At the end of the contract, the leased asset is either returned to the lessor and may be re-leased or redeemed by the lessee for a residual value [17].

The main difference between Ukrainian leasing for peasants and leasing in developed countries is that the main investor is the state, providing the National Joint Stock Company «Ukragrolizing» budget funds for a certain period. The company, by transferring agricultural machinery into financial leasing, returns the funds to the budget, regularly collecting leasing payments from lessees. Agricultural machinery and equipment are transmitted for a period of five to seven years. In this case, the payment for the use of funds is equal to 7 percent of the undamaged amount of the original cost. There are no cheaper funds for lessees. In addition, 2.8 % per annum is significantly less than the annual inflation rate financed in recent years, and thus the interest payments to lessees are offset by a surplus.

Leasing is characterized by certain advantages over bank lending, namely:

- the possibility of rapid acquisition of the property and the beginning of its operation without significant one-time investments;
- release of considerable funds for the solution of priority tasks;
- after the expiration of the contract, it is possible to purchase the property for the residual book value or contract price or to continue leasing for a new term;
- the leasing property does not carry out depreciation, then the funds of investment funds of the enterprise can be used for other purposes, for example, for the implementation of scientific and technical works [11].

Bank leasing is carried out on the basis of a license of the National Bank of Ukraine. Until 2017, there were no licensing requirements for non-banking institutions providing financial leasing services in Ukraine. On December 6, 2016, the Cabinet of Ministers of Ukraine approved new licensing requirements under which lessors are required to obtain a license to provide financial leasing services. It should be noted that operating leasing is not subject to licensing. However, financial leasing services may be provided by banks and other non-banking institutions entered in the relevant register maintained by the Natcomfinance Services.

In recent years, there has been an increase in the financial leasing market in Ukraine. The decisive contribution to the positive trend is made by companies, members of the professional association of lessors. They show the highest dynamics of development: +41.9% *under existing contracts (against +3.3 % **of all-Ukrainian growth rates), and +37.2 % under newly concluded contracts against +12.2 % respectively (compared to I half of 2018). The main leasing sectors remain representatives of the transport and agriculture sectors.

Figures 1 and 2 illustrate the dynamics of concluded and operating leasing agreements both in general and by members of the Ukrainian Association of Lessors (UAL).

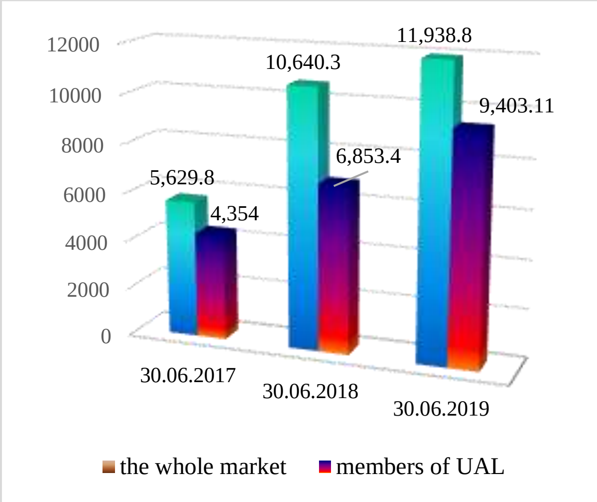

Fig. 1. Dynamics of contracts concluded during 1-st half of 2017 – 2019 (mln. UAH)
Source: National Financial Services Commission and the Association of Lessors.

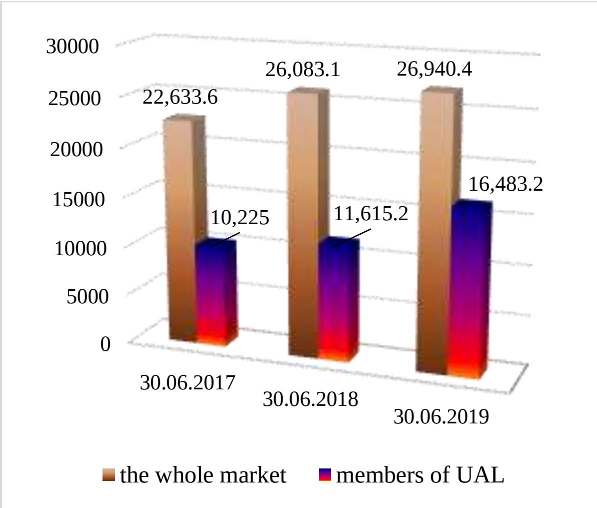

Fig. 2. Dynamics of existing contracts for 1-st half of 2017 – 2019 (mln. UAH)
Source: National Financial Services Commission and the Association of Lessors.

After analyzing the leasing contracts, we observe their dynamic growth from year to year (throughout the market – by UAH 6,309.0 million, and at the expense of UAL members – by 5,049.11 million UAH).

It should be noted that the dynamics of changes in the concluded contracts in the first half of 2019 in relation to the first half of 2018 indicates that the main industries with a positive value are agriculture (+ 25.3%) and transport (+ 4.3%). In total, they make up about 53% of the total cost. The industries with the highest growth dynamics include: processing (+ 108.5%), food (+ 83.1%), computer and telecommunications industries (+ 74.7%). However, industries such as light industry (-97.1%), metallurgy (-75.5%), and health care (-75%) are negative. The dynamics of growth in the value of contracts decreased from 89.0% to 12.2%, and the dynamics of their number decreased from 19.4% to 12.4%.

It should be summarized that 97.0% of the total value of concluded contracts and 70.5% of their total number are retained by legal entities - lessors. The extended term of such agreements is considered to be from 2 to 5 years in the amount of UAH 8.5 billion, which is almost 69% of all concluded contracts [22].

Assessing the dynamics of existing contracts in the first half of 2019 and the first half of 2018, we can conclude that the main industries are transport (-2%) and agriculture (+ 1.3%). Together, they make up about 47% of the total cost. The industries with the highest growth dynamics include computer and telecommunications (+188.8%), processing industry (+170.6%), and metallurgy (+ 24.9%).

Industries such as light industry (-98.9%), chemical industry (-25.1%), food industry (-20.9%) are the ones with the largest understatement. The dynamics of growth in the value of contracts slowed down from 15.2% to 3.3%, and the dynamics of their number accelerated from -2.2% to 7.0%.

In comparison with the concluded contracts, legal entities - lessors keep 98.6% of the total value of existing agreements and 96.4% of their total number, and the most common term of the agreements is the term from 2 to 5 years in the amount of UAH 18.9 billion. which is also 69% of all existing agreements [22].

The high demand for financial leasing transactions is usually caused by the growth of financing of such operations through bank loans, financial resources of international financial organizations, as well as the issuance of debt securities by the main leasing entities. For example, the amount of loans attracted at the end of 2019 totalled UAH 5.8 billion, which is 20% or UAH 962 million more than in the previous year. The issue of corporate bonds amounted to UAH 254 million, that is by 70.9% or UAH 105 million more. Cash of international financial organizations that can be invested in the leasing market amounted to UAH 496 million. Another aspect of increasing the size of financial leasing is deregulation in the represented market, which served the inflow of foreign capital [23].

Therefore, according to the decision of National Commission for State Regulation of Financial Services Markets , financial leasing can be carried out not only by financial institutions, but also by other legal entities that have the appropriate license.

At the end of 2019, there were 439 financial institutions with the right to provide financial leasing services in Ukraine, accounting for 6.1 % of the volume of this market, the remaining 93.9 % being 113 legal entities that are not financial institutions but have been licensed to provide financial services. At the same time, 93.4 % of leasing services are for the 20 largest legal entities-lessors. The largest growth in the provision of financial leasing services to legal entities-lessors in 2019 was in the following categories: natural persons – 149.7 %, natural persons - entrepreneurs – 61.4 %, legal entities – 16 %.

In the structure of financial leasing industries, contracts concluded in 2019 are dominated by agriculture (UAH 6,759 million), transport (UAH 5,262 million), services (UAH 1,723 million), food industry (UAH 1,557 million), construction (UAH 1,133 billion), metallurgy (UAH 455 million), computer and telecommunications (UAH 353 million), mining (UAH 279 million), manufacturing (UAH 199 million) and medical equipment (UAH 81 million) [23].

As mentioned above, during 2019, the largest share of financial leasing contacts was concluded for a period of two to five years. This is where the trend of increasing the share of long-term financial leasing agreements was observed. For example, the value of financial leasing contracts for a period of two to five years increased by 35.2%, or UAH 5.1 billion.

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As can be seen from Fig. 3 in the structure of the financial lease portfolio, agriculture has an advantage.

A change in the taxation system of agricultural producers has a positive impact on this segment of this industry. Agricultural enterprises have switched to full payment of value added tax on a general basis since 2017. In order not to overpay to the budget, in order to optimize taxation in accordance with the law, agricultural producers apply for a tax credit, which they receive on the cost of machinery during the same month in which they sold their products. Thus, financial leasing will be more effective than a bank loan, because the decision on it is made much faster.

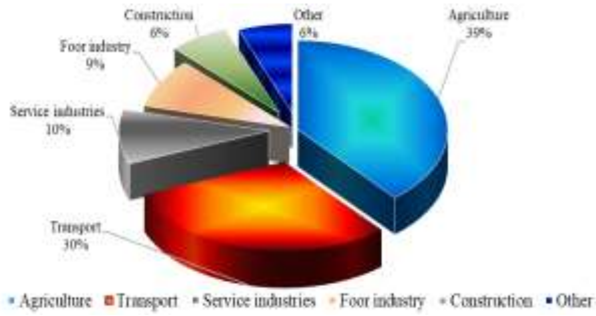

Fig. 3. Structure of Ukraine financial leasing portfolio in terms of industries, 2019
Source: Own design based on the source [23].

There are a number of commercial leasing companies operating in Ukraine. Among them: «Privat Leasing», «Raiffeisen Leasing Aval», «Advance-Leasing LLC», «VAB Leasing LLC», «OTP Leasing LLC», «UniCredit Leasing LLC», «TEKOM-Leasing» and others implementing new agricultural machinery and used machinery.

It should be noted that the Association of Ukrainian Lessors Association is quite active today, members of which are companies that offer leasing services in Ukraine. So, in total, 669 agricultural objects were leased to the members of the UAL during January – June 2019.

Of the 297 new tractors leased, Belarus, New Holland and Case were in high demand. Among the combines, the top three look like New Holland, John Deere, and Claas. Agrarians were in demand last year for both expensive tractors (Case, New Holland, Fendt, John Deere trademarks) and cheaper tractors (Belarus, Minsk Tractor Works).

Table 1. Lessors and farm equipment provided by them on lease, Ukraine

Leasing company	Key Partners agricultural machinery
Ukragroleasing	Kharkov Tractor Plant, Belarus, Svarog, Horsch-Agrosoyuz
Raffayzen Leasing Aval	Vaderstad, Fendt, Challenger
UNICREDIT	Horsch, Krone, YTO, Challenger
OTP Leasing	Fendt, Challenger, ASTRA
Euro Leasing	Minsk Tractor Works, CLAAS, MASSEY FERGUSON, John Deer
VAB Leasing	Challenger, Minsk Tractor Works, Photon
SG Leasing Ukraine Ekvilment	New Holland, Quivogne, Lemken, Gherardi
Credit Europe Leasing	AMAKO
Ukrainian Leasing Company	MASSEY FERGUSON
Lend-Lease	Minsk Tractor Works, YTO, HORSCH, Agroresurs, DON-LAN, Inter-HROTEH
Truck Finance	Arnazone, CASE, Fendt, Geringhoff, LEMKEN, Massey Ferguson, Gregoire Besson, Gherardi, NEW HOLLAND, JOHN DEERE, Kuhn
Ukrahropostach	Gomselmash, Bobruysksilmash, Lidahromash
Alpha Bank	AMAKO

Source: own research.

The growth of the agricultural machinery fleet in the leasing companies, which are part of the Ukrainian Association of Lessors (UAL), was observed last year. As of early 2018, they have cumulatively increased their fleet of machinery to 3,415 units. At the same time, the number of leased units has increased in most of the Association's leasing companies that actually work with representatives of the agricultural sector. In 2017, according to the Ukrainian Association of Lessors, the growth of agricultural machinery in such leasing companies reached 11–16 % [9].

They provide leasing services to agricultural producers and banks directly, without the mediation of affiliated leasing companies. But the number of such banks is still small and the volume of leasing services is negligible. However, there are exceptions. For example, «PrivatBank» concluded 32 leasing agreements with agricultural enterprises in 2017 for a total amount of UAH 68 million. And as of 01.01.2018, the Bank had 294 transactions worth UAH 306.4 million.

Table 2. Conditions of leasing in «PrivatBank» for agricultural machinery of domestic and imported production, Ukraine*

The lease term	**From 12 to 60 months. agricultural machinery of domestic and imported production**
The amount of funding	- for SME customers from UAH 200,000; - for corporate customers by USD 1 million.
The rate of UAH**	**3 % to 15 % (depending on the affiliate program)
One-time fee	1 % of the cost of the leased item (not charged at the standard rate of 15 %)
Advance	From 20 % of the leased asset
payment Schedule	Seasonal, at least 2 times a year, paying % - monthly
Insurance	Each year, according to the tariffs accredited bank insurance company
Software	1) equipment that is leased on the basis of a lease agreement; 2) bail.
Customers	Lessee – a business entity (entity / individual – entrepreneur)

*Subject to agricultural discount from the supplier.
**For corporate clients rate can be reduced by using an integrated food bank (salary project, foreign economic activity, foreign exchange transactions, collection, acquiring, receiving payments and other banking products).

«PrivatBank» has some advantages of providing financial leasing, in particular:
•Rate – 15 %.
•Leasing term – up to 5 years.
•Adjusted repayment schedule taking into account the seasonality of the business.
•No need to withdraw all 100 % of the purchase price. You can pay for the equipment in parts at the expense of the profits from its use.
•Savings on tax payments due to depreciation, VAT credit, and increased interest and commission expenses.
•Privatization is guaranteed by «PrivatBank».
•The Bank protects your property.
•Leasing cannot be seized or levied.
•No additional collateral is required to raise funding.

It should be noted that «PrivatBank» provides the possibility of simplified leasing in case of transaction amount up to UAH 5 million.

It should be noted that the opportunity «PrivatBank» simplified lease in the event the transaction amount to 5 million.

Therefore, both the management of the bank and representatives of leasing companies argue that the agricultural sector is now among the top priority sectors for service.

Experts from the USAID Financial Sector Transformation Project and the Ukrainian Union of Lessors emphasize that the high demand for leasing services in Ukraine, as well as the size of leasing contracts, will increase rapidly in the future, and the amount of financing for Ukrainian business activities under lease contracts will be able to increase twice as much by 2021. However, limited financing of the industry, imperfection of legislative processes and lack of proper tax incentives, incompetence of entrepreneurs in modern business financing instruments are considered the biggest obstacles to the effective growth of leasing processes in Ukraine.

To improve the development of leasing relations in the agricultural sector of the economy, it is necessary to pay attention to the support of agricultural producers by the state. It should be based on the development of a better mechanism for allocating budget funds subject to the adoption by the Verkhovna Rada of bills initiated by the Ukrainian Union of Lessors – Law №1111 «On Financial Leasing» and Law №1218 «On Amendments to the Tax Code». The full-fledged development of leasing in the agricultural sector should operate on the basis of market competition with the participation of both state and commercial leasing companies.

In order to cooperate with agricultural enterprises and the state, private leasing companies should be encouraged through a certain compensation of the leasing interest rate at the level of the National Bank of Ukraine discount rate; by partial refund of the value of the leased asset after the advance payment by the lessee at a rate equivalent to the advance payment, but not more than 30% [4]. Also, for the effectiveness of the introduction of state support for technical equipment of the agricultural sector, it is enough to offer future buyers of agricultural machinery to invest their own funds. Thus, the volume of the equipment market will increase not at the expense of the budget, as it was before, but at the expense of private capital.

CONCLUSIONS

The market of leasing services needs special attention, as it is not only a means of stimulating the introduction of new technologies, accelerating the updating of the material and technical base, but also intensifying the development of the national economy as a whole, improving its quality level.

Therefore, in order to improve the development of the leasing market in the agricultural sector, it would be necessary to regulate the legal framework in terms of leasing transactions, namely in the context of the introduction of international leasing, the introduction of acceptable conditions of taxation, lending, depreciation; create conditions for the effective functioning of public and private leasing operators at the same time, and this, in turn, will contribute to a smooth process of renewal of fixed assets in enterprises with different profits; find ways to increase funding for programs of partial compensation for the cost of agricultural machinery and further cooperation on financial leasing of domestic agricultural machinery.

In general, it should be noted that our proposed measures will increase the demand of agricultural producers for the services of leasing companies, fill the market of agro-leasing services with private capital, and thus improve the investment environment in the agricultural sector.

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COMMUNICATION PATTERN USED BY COMMUNITY DEVELOPMENT ASSOCIATIONS: EMPIRICAL EVIDENCE FROM ILERO, OKE-OGUN, OYO STATE, NIGERIA

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Abstract

The study assessed the pattern of communication applicable for information sharing in community development associations (CDAs). Specifically, the study identified the development projects undertaken, determined the level of use of communication channels within and between CDAs and the sequence of information flow within the CDAs. A total of 120 CDA members chosen from the 6 most prominent CDAs in Ilero. These were interviewed with the aid of well-structured interview schedule for data collection. Data analysis was conducted with the use of frequency counts, percentages, mean and standard deviation as well as Pearson Product Moment Correlation analysis for hypothesis test. Results revealed that the CDAs had completed infrastructural projects like water bore-hole, interpersonal communication channels were noted as the main media through which information were relayed among CDA members. Also, the sequence of information transmission was found to involve group executives as foremost followed by committees and then general members with proceeds of the general/open discussions to be transmitted to the patrons and advisers. The size of CDA (r=0.375), number of active committees (r=0.33) and average number of people per committee (r=0.391) were indicated to be significantly related to the use of communication channels at 0.01 level of confidence. Therefore, it concluded that the level of use of the communication channels is influenced by the composition and functioning of CDAs.

Key words: *communication, communication patterns, community development, association*

INTRODUCTION

Social interactions among collection of people had long underpinned joint action for enhancing their collective well-being and ease of day to day activities. The recognition of pending needs bearing on general strive for normal living and progress has being the precursor for the evolution of community driven development. In view of this, Akinsorotan and Olujide (2007) [1] opined that community development is an age long social activity in our societies. This gives a long history communal initiatives tailored towards improving the basic elements which defines their life. This is identified as particularly strategic in rural societies to bring about much needed socio-economic changes (Mequanent, 1998) [8]. This relies on the premise that rural socio-economic activities occur mostly at the community level (Li, 1995) [6]. In essence, conscious efforts are undertaken by groups of people especially at the grassroots level to service common needs related to generating improvements of their socio-economic and cultural well-being. The progression of this initiatives have only become more relevant and instrumental for re-adjusting to the dynamic society we live in. The discharge of these efforts have gradually become even more germane with greater recognition of the imperatives of their organization and functioning. This led to the birth of wide range of Community Development Associations (CDAs) as recognised entities through which communal issues and needs are voiced, grouped and addressed.

These CDAs are characteristically different in terms of composition, sizes, fund sourcing approach and mode of operations among others (Omofonmwan and Odia, 2017; Akinsortan and Olujide, 2006) [10, 1]. Unarguably, their functioning is centred on interactive synthesis of ideas for collective course of action. This is fostered with cooperative sharing of information on needs and exchanges for decision making through relevant channels or methods for course of action. Accordingly, communication which encapsulates the exchange of ideas or meaning among entities, activates interaction among people who have come together to engender impactful improvements in the community, thereby actualising the basis of their collection. In fact, the coming together of people as a CDA presupposes that there is communication of common needs or interests to be fostered. The potency of this is reflected in the importance of communication in the creation, facilitation and maintenance of all forms of social relationships on which the operations of the CDAs are dependent. This is entrenched by the positions that communication is the livewire of societies as it is both interactive and purposeful; also it is the bedrock of meaningful co-existence and relations at all levels in the global community (Aruma, 2018; Mehta, 1987) [2, 7]. To emphasise, planned use of communication techniques, activities and media prepares and empower people for targeted change (Fraser and Ville, 1994) [5].

United Nations International Children Fund, UNICEF (2008) [12] identified three basic components of communication in development efforts, which were advocacy, social mobilization and behaviour change. It is obvious that there is no one-fit all method or pattern for communication in CDAs. Necessarily, the choice of channels involved in the conveyance of meaning in different CDAs cannot be specifically nailed. Relatedly, Soola (1995) [11] had long argued that people's participation in community development such as that fostered by CDAs requires alternative communication types, channels and strategies in the pursuit, actualisation and sustainability of development objectives. As such typical CDA characteristics, location and operations' uniqueness portend array of peculiarities in their communication experience. Invariably, it is valuable to investigate the modalities of communication among members of CDAs as well as for inter-CDAs interactions for factual understanding of the groups functioning measures. The recognition of this need is the impetus for the conduct of this study.

Objectives of the study

The study was poised to assess intra and inter-CDAs communication. The specific objectives were to:

(i) identify the CDAs project and the present level of implementation

(ii) identify the channels used for information transmission within and between CDAs and their level of use; and

(iii) ascertain the sequence of information flow within the CDAs

Hypothesis testing

There is no significant relationship between use of communication channel and CDAs' characteristics

MATERIALS AND METHODS

This study was conducted in Ilero town of Kajola Local Government Area in Oke-Ogun region of Oyo State. The area lies on coordinate 8.03^o N 3.35^o E. It is an agrarian Yoruba community, with a land area of 609m^2 and a population of 200,997 people (National Population Census, NPC, 2006) [9]. This study focussed on the six well known CDAs in the town namely Irepodun (67), Isegii (50), Gbelekale (60), Opara Ojete (73), Ifepeju (83) and Igbaye (67) CDAs. Thirty percent (30%) of members were proportionately selected per CDA.

This culminated in a total of 120 respondents sampled for this study. Structured interview schedule was used for eliciting required information from the respondents.

Data collected were analysed using simple descriptive statistics such as frequency counts, percentage, mean and standard deviation for descriptions and summary.

On the other hand, Pearson Product Moment Correlation (PPMC) analysis was used to test relationship of the CDA characteristics and their use of communication channels for information transmissions.

Information were elicited on the respondents personal characteristics and their CDAs', the CDA projects, the type and level of use of communication channels within and between CDAs and the order of reception of necessary CDA information.

The dependent variable for this study was the use of communication channels and was measured on a four-point Likert-type scale involving never used scored 1, rarely 2, seldom 3 and always 4.

For the sequence of information flow, respondents indicated their views of the first, second, third and fourth categories of CDA members informed of community issues to be tackled by their projects.

RESULTS AND DISCUSSIONS

Socio-economic characteristics of CDA members

Results in Table 1 showed that majority of the CDAs members were married (82%) people who were slightly above the middle age as reflected by their mean age of 53.16 years ±13.88 and predominantly males (85.5%).

This corroborates the findings of Akinsorotan and Olujide (2007) [1] who equally found that most CDAs compose of married people within the ages of 30-59 and largely male dominated.

Also, the respondents were noted with slightly high household sizes of about 7 persons per household (mean=6.7±2.22) as about one-third (34.2%) of them were identified as farmers while a quarter (25.8%) were civil servants.

The mean of the respondents' monthly household income was found to be ₦40,342.24 ±18,425.

This reflects that the CDAs were populated by people above the national minimum wage. As such, it can be implied that CDAs were composed of people earning enough to live beyond the regulated minimum income expectation.

Table 1. Distribution of respondents based on their socio-economic characteristics

Variable	Freq.	%	Mean & St. Dev.
Age			
<25	1	0.8	
26-40	23	19.1	
41-55	48	40	
56-70	33	27.6	
>70	15	12.5	
Sex			
Male	103	85.8	
Female	17	14.2	
Marital status			
Single	4	3.3	
Married	98	81.7	
Separated	6	5.0	
Widowed	12	10.0	
Household size			
≤6	62	51.7	
7-12	58	48.3	6.70±2.22
Religion			
Christianity	65	54.1	
Islam	53	44.2	
Traditional	2	1.7	
***Main occupation**			
Farming	41	34.2	
Civil service	31	25.8	
Trading	28	23.3	
Artisanship	20	16.7	
Monthly income			
≤25,000	23	17.6	
26,000-50,000	79	64.9	40,342± 18,425
51,000-75,000	17	14.0	
>75,000			

Source: Field survey, 2017.
*Multiple choices

CDAs projects

Evidence presented in Table 2 reveals that nearly all the respondents indicated that their respective CDAs had completed water projects through the sinking of borehole/ water well in different parts of the communities. In the same vein, half of the respondents noted that their groups had completed road rehabilitation projects just as one third noted that their CDAs had on-going road projects and 16.7 percent indicated they were about to start road rehabilitation in identified areas of the community. In the case of rural electrification, two third of the respondents indicated that their CDAs had completed intervention efforts in the regard while the remaining 33.3 percent noted consideration of such effort. Building of bridges and culverts was also noted as completed project by one-third of the respondents just as they were about to be started as noted by another one third of the CDAs members. Few (17.5% and 16.7%) identified completion of classroom buildings for schools and construction of public toilets, respectively by their respective CDAs.

These results show that CDAs have functioned principally in the areas of infrastructural development of their community. For this, the provision of portable water is revealed as being of the highest priority among the CDA projects followed closely by road rehabilitation works and then rural electricity as well as the construction of bridges/culverts. In contrast, the least considered and implemented projects by the CDAs include the construction of public library, public toilets and building of town hall. These affirm that CDAs play immense roles in infrastructural provisions for communal benefits (Omofomwan and Odia, 2017; Akinsorotan and Olujide, 2007) [10, 1]. However, the revelation of the intervention of CDAs in the provision of these essential community facilities expose the poor infrastructural development status of the study area as obtainable in a typical rural community of Nigeria. As such, the importance of CDAs initiatives in bridging developmental gaps and providing basic life conveniences is accentuated.

Table 2. Distribution of respondents based on indication of CDAs projects

Variables	**Considered (%)**	**About to start (%)**	**On-going (%)**	**Completed (%)**	**Rank**
Building of school classrooms	32.5	0.0	0.0	17.5	**5th**
Rural electricity	33.3	0.0	0.0	66.7	**3rd**
Town hall project	0.8	0.0	17.5	0.0	**6th**
Bridge /culvert	16.7	34.2	16.7	32.5	**4th**
Grading/rehabilitation of road	0.0	16.7	33.3	50	**2nd**
Borehole/well	0.0	0.8	0.8	98.3	**1st**
Construction of public library	0.8	0.0	0.0	0.0	**7th**
Construction of public toilets	0.8	0.0	0.0	16.7	**6th**

Source: Field survey, 2017.

Intra CDA communication channels and level of use.

The Result presented in Table 3 shows that general meeting ($\bar{x}$=4) was the paramount forum through which information exchanges occur among members of CDAs. It was revealed that majority of the CDAs members always share information amongst themselves through letters ($\bar{x}$=3.83±0.38), phone calls ($\bar{x}$=3.33±1.11), interactions in committee meetings ($\bar{x}$=3.33±0.47) as well as executive meetings ($\bar{x}$=32±0.47) and meeting circulars ($\bar{x}$=3.3±0.67), while text message ($\bar{x}$=2.9±0.81) was noted to be used seldomly. The communication channels identified to be rarely employed by majority of members are leaflets ($\bar{x}$=2.28±0.7), home visits chats/dialogues ($\bar{x}$=2±0.2) poster/banners (1.95±0.95) among others. Social media chat forums, and town criers were indicated to be largely unused for members' communication.

These results point out that the conduct of general meetings in which all categories of members participate, is the main outlet through which members share ideas and decide on community issues to be addressed. In addition, high use of interactive forums such as sub-group meetings, telephone calls and messaging as well as some level of use of print media bulletin and leaflets were found. As such, it could be implied that communication within CDAs is mostly mediated with use of varieties of interpersonal communication channels. In contrast, mass media channels namely newspapers, radio and television were more or less unused. The rural nature of the community in which these CDAs were domiciled could be responsible for their reliance on interpersonal channels of communication as the mass media channels might be unnecessary for serving their communication needs. This could be explained with the position of FAO (1999) [4] which noted that rural population relied greatly on the spoken word and traditional forms of communication for sharing knowledge and information.

Regarding communication between CDAs, it was shown that correspondence/letter ($\bar{x}$=3.42±0.57) was the most widely employed channel. More so, majority of the respondents affirmed occasional communication of their CDA with other CDA through executive ($\bar{x}$=3.33±0.47) or committee ($\bar{x}$=3±0.83) meetings, exchange of circular ($\bar{x}$=3.2±0.98), telephone calls ($\bar{x}$=3.02±0.75) as well as text messages ($\bar{x}$=2.65±0.5). Communication between CDAs via home visits chats/dialogues ($\bar{x}$=2.17±0.37), leaflets ($\bar{x}$=2±0.59), posters/banners ($\bar{x}$=2±0.09) were indicated by majority of the members to occur occasionally. These results highlight higher utilization of letter writing, circular exchanges and meetings by CDAs for reaching out or connecting with other CDAs in their locality. This also affirm that the CDAs do not work in isolation but rather communicate with each for ideas related to the progress and development of their community.

Table 3. Use of communication channels within and between CDAs

Communication channels	Intra-CDA s			Inter-CDAs		
	$\bar{x}$	Δ	Rank	$\bar{x}$	Δ	Rank
General meetings	4	0	1st	3	1.12	5th
Correspondent/Letter	3.83	0.38	2nd	3.42	0.57	1st
Telephone call	3.33	1.11	3rd	3.02	0.75	4th
Committee meetings	3.33	0.47	3rd	3	0.83	5th
Executive meetings	3.32	0.47	4th	3.33	0.47	2nd
Circular	3.3	0.67	5th	3.2	0.98	3rd
Text messages	2.9	0.81	6th	2.65	0.5	6th
Leaflets	2.28	0.7	7th	2	0.59	8th
Home visit/dialogue	2	0.2	8th	2.17	0.37	7th
Bulletin	2	0	8th	1.88	0.68	9th
Poster/banners	1.95	0.95	9th	2	0.09	8th
Office calls	1.67	0.37	10th	1.3	0.46	13th
Newspapers	1.5	0.5	11th	1.33	1.47	12th
Television	1.5	0.5	11th	1.17	1	14th
Emails	1.4	1.02	12th	1.02	0.18	15th
Town crier	1.17	0.37	13th	1	0	
Radio	1	0		1.17	0.38	14th
Social media chat	1	0		1	0	

Source: Field survey, 2018.

Sequence of information flow within Community Development Associations

The result presented in Figure 1 show the evidence of the ordered sequence through which information on group activities are relayed to or received by the different categories of CDAs members. It was indicated by majority (66.1%) of the respondents that the CDAs executives were usually the first to learn about the various CDA information, while only (3%) indicated the CDA general members as the first and about one fifth noted Advisers and Patrons as the first to informed about CDA issues.

As for the second level in the sequence of CDA information reception, few proportions (8.4%, 7.3% and 2.2%) indicated the executive, general members and patrons/advisers, respectively. However, 45 percent opined that the committee members were the second to learn about any necessary information. It is revealed from this that the committee members were indicated by the CDA members to be at the second level in the chain of information flow on community development issues. Correspondingly, about half (49%) affirmed that the general members get informed of relevant issues at the third level while patrons/ advisers were indicated by 45% as the last to be updated with information on the CDA issues of interest.

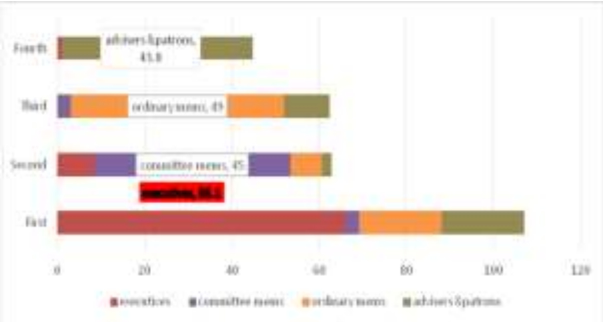

Fig. 1. Levels of information flow sequence within CDAs from the first to fourth
Soirce:Field survey, 2018.

In view of the above results, it could be juxtaposed that the relay of information within each CDAs is hierarchical with the order involving the CDAs executives occupying the highest echelon in the process. As such, executives were usually foremost in knowing about pending issues followed by relevant committee members ahead of general discussion among all members and final notification of the patrons and advisers. This pattern of communication could be adjudged to reflect the rural culture of social system stratification. Given this, the view of Elegbe and Nwachukwu (2017) [3] that culture has a significant influence on communication patterns in a social system is affirmed from these findings. A schematic presentation of this ordered sequence is presented in Fig. 2.

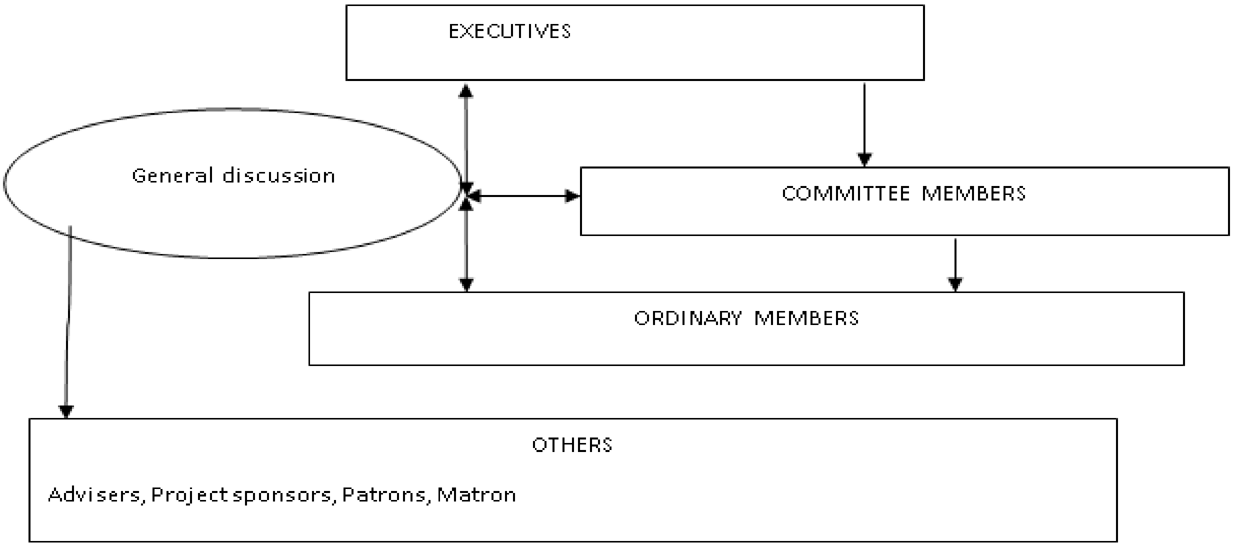

Fig.2. Schematic illustration of sequence of information flow within CDAs
Source: Field Survey, 2017.

Test of Hypothesis

The result of the correlation analysis presented in Table 4 revealed that out of the CDA characteristics tested, only 3 variables showed significant and positive relationship with their use of communication channels. The significant variables were size of CDA (r=0.375), number of CDA committees (r=0.33) and average composition of committees (r=0.391) at 0.01 level of significance. This implies that the greater the association size, the higher the use of communication channels. This can be explained by the fact that an association that has large number will need to explore different channels to transmit information among members. This might influence members' degree of interactions and resultant increased participation as well as active contribution in CDA activities. From this it could be hypothesised that larger CDA sizes associated with higher use of communication channels, portend greater dynamism on discussion of community issues for potential actions.

Table 4. Result of correlation analysis showing relationship between CDAs' characteristics and use of communication channels

Variables	Correlation coefficient (r)	Co-efficient of determination (r^2)	P-Value
Year of existence	-0.170	0.000	0.064
Association size	0.375**	-0.118	0.000
Number of committee	0.334**	0.112	0.000
Number of each committee	0.391**	0.153	0.000

**Significant at ≤ p 0.01
Source: Field Survey, 2017.

CONCLUSIONS

Based on the findings of the study, it was concluded that rural CDAs are functioning to bridge developmental gaps through the provision of basic infrastructural facilities essential for normal living. The sharing of ideas on these communal issues for group decision and action are fostered through interpersonal interactions opportune by the conduct of meetings, correspondent/letters and exchange of circulars among others. Via these networks, the sequence of information transmission involves intimating executives with relevant issues and from whom committees to be tasked get informed ahead of general discussion with all members and finally informing patrons and advisers with discussion outcomes. The depth of use of the channels for communication at the various hierarchical levels are related to the composition of the CDAs and parameters of their organized functioning. Essentially, communication within and between the CDAs are reflective of the traditional rural caste system. It was recommended that CDAs should strategically explored ICT media for scaling up communication among members and with other CDAs, also government should support CDAs by establish working linkages with respective CDAs

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AN APPRAISAL OF TRADITIONAL INCUBATION AND HATCHING METHODS OF INDIGENOUS POULTRY EGGS IN KWARA STATE, NIGERIA

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Abstract

This study was conducted to assess traditional incubation and hatching methods of indigenous poultry eggs, and the level of knowledge of poultry farmers in Kwara State of Nigeria. A multi-stage sampling procedure was used to select 80 household poultry keepers who were interviewed using structured questionnaires for data collection. Four Local Government Areas (LGAs) were randomly selected while a non-probability snow-ball technique was used to select five households who are known for rearing indigenous chickens. The results showed the mean age of poultry keepers in the study area was 51±8 and the mean flock size in the study was 21±5.chickens About 11.2% of the respondents keep poultry as a source of income and 7.5 % raise chickens solely for consumption while 87.5% keep chickens for both consumption and income purposes. 71.2% of respondents keep chicken eggs for incubation and hatching for replacement purposes. The mean income from sales of poultry products was 2,800±149 NGN (US$7.7). The result further showed that 52.8% of the farmers had a low level of knowledge while 32.4% had a moderate level of knowledge and only 14.8% of them had a high level of knowledge about the process of traditional incubation and hatching methods. The ordered logistic regression model results showed that, age 0.128 (p=0.00611), annual income 0.000212 (p=0.0193) and years of formal education 0.5318 (p=0.0121) influenced the likelihood of higher level of knowledge about the processes of incubation and hatching of eggs of indigenous chicken of the respondents. Predator, inadequate funds, and theft are the major constraints faced by the poultry keepers in the study area. There is a need for more empirical studies by animal breeders and extension service providers to give proper orientation to the poultry keepers on the process of incubation and hatching of eggs for rapid multiplication of indigenous poultry birds to improve food and nutritional security for a sustainable development.

Key words: *poultry farming, hatching strategies, Indigenous knowledge*

INTRODUCTION

Indigenous poultry production is a common family poultry management in Africa and more than 80% of the total population of birds is raised in the rural areas [11]. The poultry may range freely in the household environment for feed and may get supplementary feeds from the keepers [18].
Rearing of indigenous poultry is common in rural communities because of the easy of establishment for low-income families and its maintenance where they scavenge for feed and from kitchen wastes [16]. Its importance in rural household nutritional security and poverty alleviation has given it the attention in the last decade in most African Development Programmes [12]. They play a significant role in the livelihoods of most rural families in Africa. Many studies had proved the importance of indigenous poultry production in terms of contribution to income, improved nutritional status and improvement in food security for rural households of various African countries [13]; [9]; [2]; [15]; [4].
[14] noted that natural incubation is the most commonly used method for replacing and increasing the size of flocks by the use of broody hens. These broody hens must be provided with a dark and quiet place for

laying and incubation and keepers must prepare appropriate environments for brooding. The increase and multiplication of these chickens is then essential. [2] listed the following factors that are important for successful natural incubation. These include; availability of feed and water for the hen, absence of external parasites on the broody hen, eggs must be stored under a controlled environment (Temperature between 12 and 14 ^{0}C, the humidity of between 75 to 85 %and storage period should not be longer than seven days); extra fertile eggs introduced under the hen from elsewhere should be introduced at dusk and finally, the eggs must be tested for fertility after one week by holding them up to a bright light. A completely clear egg is infertile. The authors further indicated that hatchability of 80 % of egg set is normal but a range of between 75 and 80 % is considered satisfactory.

There is a paucity of information on traditional incubation and hatching methods of indigenous poultry eggs since its rearing has been considered as a side-line agricultural activity. Therefore, the objectives of this study were: to assess the socio-economic characteristics of indigenous poultry keepers in the study area; determine the knowledge of farmers about testing techniques of fertility of indigenous poultry eggs as a traditional incubation and hatching method and determine the level of indigenous knowledge of the poultry keepers about processes involved in incubation. Sound knowledge of such indigenous practices will guide the design of intervention programmes to increase the yield and outputs of indigenous poultry production systems.

MATERIALS AND METHODS

This survey was carried out in Kwara State of Nigeria. The study area is known for its agriculture and cultural activities. There are 16 Local Government Areas (LGAs) in the State. A multi-stage sampling procedure was used. At the first stage, 25% of the total LGA was proportionately selected (Isin; Edu; Oyun; and Moro) LGA. In the second stage, four villages were randomly selected from each LGA and at the last stage, the non-probability snowball technique was used to select five respondents to represent their household in each village. In the end, 80 respondents who were keepers of indigenous chicken were interviewed. Data were collected using well-structured open-ended questionnaires

Data management and statistical analysis

Data collected were summarised using SPSS Version 21.0 Package to interpret the socio-economic status of the respondents using frequency count, percentages and charts. Inferential statistics which included ordered logistic regression and correlation analysis were used in the study. The hypothesis tested was that there is no significant influence of selected socio-economic characteristics and farmers' knowledge of incubation and hatching processes.

The knowledge score was determined with the use of maximum and the minimum score to determine the range. The least score was 12 points while the maximum was 30. The range was 18 (i.e. 30-12= 18). The range was divided into three since knowledge was grouped into high, moderate and low. The result, 6 was obtained. This was added to 12 to make 18, also added to 18 to make 24 and to 24 to make 30. Then, knowledge scores were grouped into 12-18 (low), 18-24 (moderate) and 24-30 (high). The respondents whose scores fell within these intervals were described as exhibiting the corresponding level of knowledge.

RESULTS AND DISCUSSIONS

Respondents' profile and socio-economic characteristics

Results in Table 1 show that many (78.80%) of the respondents' for the study were females and others (21.20%) were males. This is comparable with the report of [17] that reported that 78% of men and 22 % of women keep village chicken in Nigeria. [5] also noted that village fowls kept in Nigeria are largely owned by women (86%) compared with 14 % male keepers. These results indicated that, poultry keeping is traditionally the role of women in many developing countries. This

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implies that women are mostly the owners of chickens in households and this could result in improved household's nutrition.

Table 1. Distribution of respondents' personal and socio-economic characteristics of poultry keepers

Variable	Frequency	Percentage	Mean
Sex			
Male	16	21.20	
Female	63	78.80	
Age			
< 40.00	9	11.25	51±12
40.00 - 59.00	55	68.75	
60.00+	16	20.00	
Primary occupation			
Farming	20	25	
Trading	24	30	
Artisan	6	7.5	
Civil service	27	33.70	
Others	3	3.8	
Years of formal education			
No formal Education	26	32.5	7±3
1-6	18	22.5	
7-13	23	28.8	
13+	13	16.2	
Number of birds			
<10	13	16.25	21±9
10-20	24	30.00	
21-30	32	40.00	
>30	11	13.75	
Type of breed			
Local	76	95	
Local and exotic	4	5	
Reasons for keeping birds			
Income	9	11.20	
Income and consumption	64	80.00	
Income and cultural	1	1.20	
Consumption alone	6	7.50	
Income from birds/month (naira)			
>1,000	7	9.45	NGN 2,800±149 (7.7USD)
1,000-10,000	51	68.92	
10,001 and above	16	21.63	
How often do you hatch eggs			
Rarely	23	28.8	
Occassionally	57	71.2	

Source: Field survey 2019.
Note: (360) NGN was equivalent to 1 USD.

Further results from the survey showed that few (11.25%) of the respondents who owned chicken are youth of less than 40 years of age. The majority (68.75) of them were between 40 and 59 years old and only 20 percent were older than 59 years of age. Local poultry production is not of interest to the youth in the study area, showing that, local birds are largely owned by aged people in the area. The mean age of poultry farmers in the study area was 51±8. The result of respondents' primary occupation revealed that 25 percent of the respondents were farmers, 30% were traders, 7.5% were artisans while 37.5% of them were civil servants. The educational background in terms of years of formal education of the respondents showed that about 33 percent of the respondents had no formal education, 22.5 percent had between 1 and 6 years of formal education, 28.8 percent had between 7 and 12 years of formal education while 16.2 percent had over 12 years of formal education. The mean years of formal education were 7.73±3 years.

Flock size

The proportion of the respondents that has less than 10 birds was 16.25 percent, while 30 percent had between 10 and 20 flock sizes, 40 percent had between 21 and 30 flock size but only 13.75 percent of the respondents' had more than 30 birds. The mean flock size in the study was 21±5. Unlike the report of [11] who indicated that the flock size generally ranged from 5 to 20 fowls per African village household. Almost (95%) of the respondents keep just a local breed of chicken (Yoruba and Fulani ecotypes} while the remaining 5 % of them keep exotic breeds together with their local chicken. This indicates that there is need for breed conservation of these two ecotypes (Yoruba and Fulani) since majority of the household still keeps them under the backyard systems.

Respondents showed their preference for the local breed (Yoruba and Fulani ecotypes) as 67.5 percent indicated that they have quick returns from keeping them, 32.5 percent of the respondents said they are easy to maintain and raise, they incubate and hatch their eggs without any serious technical procedure compared to the exotic stocks.

About 11.2 % of the respondents keep poultry for commercial purposes and as a source of income and 7.5 % raise chickens solely for consumption while 87.5 percent keep chickens for both consumption and income purposes although one respondent indicated that his purpose for raising local chicken was for cultural reasons. These results tallies with the findings of [19] that, in Ethiopia, income generation and household consumption are the main production objectives of keeping local chicken stocks. 71.2 % of respondents indicated that chicken eggs are often incubated aiming at replacing the off-take and loss of chicken from the flock. This finding is close to [19] in the study of the village chickens production system in Ethiopia who reported that over half of eggs produced are incubated to replace the old stocks.

Income

Village poultry keepers who rear chicken for solely income and those that keep for income and other reasons indicated the annual income they realized from the sale of chicken and eggs. 9.45 percent realized less than 1,000 NGN (2.8 USD) while around 70 percent of them realized between 1,000 to 10,000 as annual income from sales, interestingly, 21.63 percent of them get income above 10,000 NGN (27.8 USD) from the sale of chicken and eggs. The mean income from sales of poultry products was 2,800±149 NGN (7.7 USD).

Knowledge of farmers about traditional methods of incubation and hatching of indigenous poultry eggs.

Table 2 shows the absolute figures and percentages (figures in parenthesis) of respondents on various levels of farmer's knowledge about processes of preparing of fertile eggs for incubation and hatching. Most respondents indicated that they have had about the processes as listed in the Table 2. Only few indicated that they have no knowledge, other options: seen and performed, seen and performed by self and possess mastery are as shown in Table 2. This reveals that, farmers in this study area need appropriate training in order to improve their capacity to carry out the processes involved in incubation and hatching under traditional system of poultry production.

Table 2. Process of traditional methods of incubation and hatching of indigenous poultry eggs

Process of traditional methods preparing of eggs for incubation	No knowledge	Heard about	Seen and performed	Performed myself	Possess mastery	Rank
Egg selection by age	2 (2.5)	66(82.5)	11(13.75)	0	1(1.25)	1st
Washing with warm water	3(3.75)	65(81.25)	8(10)	2(2.5)	2(2.5)	2nd
Egg selection by age and size	4(5)	60(75)	9(11.25)	2(2.5)	5(6.25)	3rd
Washing with cold and warm and cleaning with cloths and other material	10(12.5)	58(72.5)	10(12.5)	1(1.25)	1(1.25)	4th
Eggs selection by size	5(6.25)	42(52.5)	12(15)	10(12.5)	11(13.75)	5th
Washing with cold water	5(6.25)	24(30)	22(27.5)	14(17.5)	15(18.75)	6th
Cleaning with cloth or other materials	9(11.25)	15(18.75)	15(18.75)	26(32.5)	15(18.75)	7th
Egg Treatment	13(16.25)	14(17.5)	27(33.75)	20(25)	6(7.5)	8th

Source: Data collected from field survey 2019.

Absolute figures for the respondent's levels of knowledge about testing techniques of fertility of eggs for incubation are as shown in Table 3. Most of the respondents had no knowledge about these practices; few indicated that they heard about it, others responded that, they have seen and performed it, performed by self and some indicated possession of mastery of the testing techniques.

Table 3. Testing techniques of fertility of eggs for traditional methods of incubation of indigenous poultry eggs

Testing Techniques of fertility of eggs for incubation	No knowledge	Heard about	Seen and performed	Performed myself	Possess mastery
Visual examination through sunlight	45	24	6	4	1
By weighing eggs	43	34	2	0	1
By breaking egg sample	34	35	4	1	6
Shaking	33	5	12	18	12
Floating eggs in water	24	6	10	21	19

Source: Data from the field survey 2019.

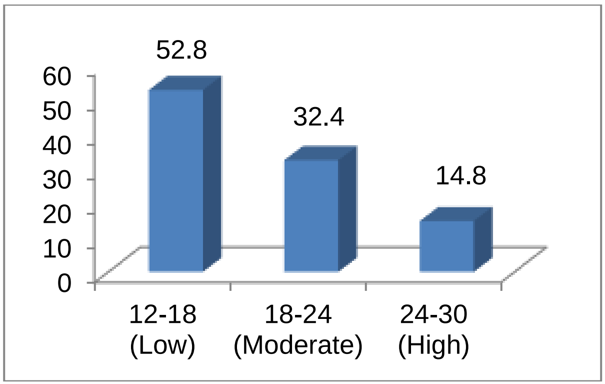

Fig.1. Level of indigenous farmers' knowledge of processes involved in incubation.
Source: Field survey, 2019.

Table 4 presents the result of the ordered logistic regression model used to examine the determinants of farmers' knowledge of incubation processes. The three categories of level of knowledge of incubation processes are low, moderate and high. This formed the dependent variable as ordered 1, 2 and 3 respectively. Four variables were included in the model and three were found to be statistically significant. The likelihood ratio chi square of 16.40 with a p-value of 0.0025 indicates that the model as a whole is statistically significant. The model has a log likelihood of -46.7942. Age (0.128) was positively significant with 0.00611 as p-value. This implies that an increase in the farmers' age by one unit will result in 0.128 increase in likelihood of higher knowledge of incubation processes. Older farmer have more years of experience in indigenous poultry keeping, hence higher knowledge of indigenous incubation methods.

Also, annual income has a positive statistical significance as its p-value was 0.0193. This gives the implication that an increase in income by one unit will result in 0.000212 increase in likelihood of higher knowledge of incubation processes among the farmers in the study area. Years of formal education (0.532) was positively significant because of the p value of 0.0121. This implies that an increase in the years of education by one unit will result in 0.532 increase in the likelihood of higher knowledge of incubation processes among the farmers in the study area. Number of birds owned per farmer is negatively correlated (-0.0963) with knowledge indicating that the higher the number of birds, the lesser the attention for details about processes of incubation and hatching.

Table 4. Ordered logistic regression result for determinants of farmers' knowledge of incubation processes

Variable	Coefficient	Standard error	z-test	P > |z|
Age	0.128***	0.0471	2.73	0.00611
Annual income	0.000212*	0.000111	1.76	0.0193
Years of formal education	0.532**	0.229	2.31	0.0121
Number of birds	-0.0963	0.0696	-1.38	0.166
Log likelihood = -46.7942 Prob > chi^2 = 0.0025		LR chi^2 (4) = 16.40 Pseudo R^2 = 0.15		

Source: Field survey, 2019.

Constraints associated with indigenous poultry production

The poultry farmers identified certain constraints associated with poultry farming that influence the process of incubation and hatching of indigenous chicken eggs in the study area. The identified constraints were ranked based on severity. Results on Table 5 show that predator, inadequate fund, theft, changes in climate, hen laid eggs in unknown locations, diseases infections, marketing problems, external parasites of the hen and internal parasites were ranked 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, and 9th in the order of severity. This result is in line with the findings of [3] and [10] who reported that in the free-range and backyard poultry production system, diseases are the major limiting factor to the production of indigenous chickens but predation is a number one challenge. Also, research work in Benin Republic [8], Burkina Faso [7], Mauritania [6] reported that Newcastle is the most devastating disease in village chickens. [19] reported that price fluctuation was a marketing challenge faced by village poultry farmers. Other challenges such as low egg production and inadequate access to and high cost of veterinary services [1] but were not identified as major challenges by the farmers in the study area.

The result in Table 5 shows that the major constraints associated with indigenous incubation of eggs in the study area were, predator, inadequate fund, theft, change in climate, and eggs laid in unknown location along other constraints ranked on the bases of highest response.

Table 5. Distribution of respondents based on the constraints associated with indigenous incubation of eggs

	Major Constraints		Minor Constraints		
	Frequency	Percentage (%)	Frequency	Percentage (%)	Rank
Predator	60	75.00	20	25.00	1st
Inadequate fund	50	62.50	30	37.50	2nd
Theft	37	46.25	43	53.75	3rd
Change in climate	36	45.00	44	55.00	4th
Eggs laid in unknown locations	14	17.50	66	82.50	5th
Diseases infection	12	15.00	68	85.00	6th
Marketing	8	10.00	72	90.00	7th
External parasites	5	6.25	75	93.75	8th
Internal parasites	4	5.00	76	95.00	9th

Source: Field survey, 2019.

CONCLUSIONS

This study concluded that age, income and years of education of poultry keepers influenced keeper's level of knowledge about the process of incubation and hatching of eggs of indigenous chicken. A large proportion of the poultry farmers in the study area had a low level of knowledge about the process of incubation and hatching of eggs. Appropriate training on the processes of incubation and hatching of eggs must be given to the indigenous poultry farmers. This will aid the rapid multiplication and efficient utilization of poultry birds to improve food and nutritional security for sustainable development. Further results showed that predator, inadequate fund, theft are the three major constraints facing poultry keepers in this study area.

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PROFITABILITY OF SMALL-SCALE CATFISH PRODUCTION IN SOUTHWEST NIGERIA: THE CHALLENGES

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Abstract

Challenges, risks and constraints are intrinsic part of any business; fish farming is not an exception. These limit the potential and expected profit of the business. This study analysed the profitability and the challenges limiting the profitability of catfish production in Southwest Nigeria. A 2-stage random sampling procedure was used to select 400 catfish farmers in four randomly selected states in Southwest Nigeria. Structured questionnaire was designed to collect data. Descriptive statistics, Gross margin analysis, Benefit Cost Ratio (BCR) and Expense Structure Ratio (ESR) were used to analyse data. The results show that on the average, size of catfish at harvest was 1.02Kg, production period was 4.37 months, market price was ₦645.45 and the breakeven price was ₦474.43. Also, the total revenue was ₦1,269,961.60, total cost was ₦933,467.98, profit was ₦336,493.62, BCR was 1.36 and ESR was 0.05. Although catfish farming is profitable in Southwest Nigeria, five categories of challenges limiting the profitability of catfish production were identified; profitability, weather, fish diseases and predators, security, and fish marketing challenges. Lack of technical know-how on the part of fish farmers contribute to the severity of business risks and challenges. These challenges have to be thoroughly analysed and adequate plans have to be made to reduce or eliminate their effects on the expected profit and success of the business. Fish farmers should prepare their business plans, analyze the market and evaluate their strengths and opportunities to minimize or eliminate the weaknesses and threats against the success and profitability in catfish business.

Key words**:** *fish diseases, fish marketing, production cost, security, weather effect*

INTRODUCTION

Challenges, risks and constraints are intrinsic part of any business; fish farming is not an exception. These limit the potential and expected profit of the business. Small-scale aquaculture enterprise has promising potentials in making the dreams of entrepreneurs come true. The major, if not the sole objective of going into any business, is to make profit. Profit is the driving or motivational force of any business that keeps it going. Fish farming is a profitable business (Ajagbe and Ojo-Fakuade, 2019; Alawode and Oluwatayo, 2019; Edet *et al.*, 2018; Ashley-Dejo *et al.*, 2017) [5, 7, 12, 10]. But Engle (2010) [14] reported that the profit potential of small-scale aquaculture enterprise is often accompanied by a variety of risks and challenges, and the large sums of money invested in an aquaculture business can be lost quickly. Therefore, there is need to critically identify any potential or imaginary risks or challenges that can limit the profitability of catfish production. These challenges have to be thoroughly analyzed and adequate plans have to be made on how to deal with them individually (or collectively if possible). This is the best method to reduce or eliminate their effects on the expected profit and success of the business.

There are a number of overarching trends and challenges that prospective aquaculture business owners should consider (Engle, 2010) [14]. These challenges are the limiting factors to the profitability of fish farming. They can be viewed from three points; challenges due to lack of technical know-how of the manager which can be seen in wrong combination of input resources, inherent challenges of fish farming (genetics of the fish), and external challenges. However, Leadway Assurance (2017) [23] classified risks facing fish production in Nigeria as pure risks and business risks. Pure risks are those that arise due to unexpected circumstances such as theft, outbreak of diseases, unexpected extreme climatic factors, malicious damage, legal actions against the farm, and etcetera. Business risks can be seen as inherent parts of a business that need to be technically managed for the success and profitability of the business. They arise as a result of weaknesses and threats analysis of business in SWOT analysis.

Solutions to all anticipated risks and threats can be done on paper, in form of a business plan, before the physical running of the business. This will give the investor or intending fish farmer impetus to go ahead with his plan with higher degree of expected success or to hold on. Business plan is the valid tool or avenue to carry out production or biological, financial and marketing analysis of small-scale aquaculture. It will assess the strengths and opportunities available for the proposed aquaculture business as well as the weakness and threats militating against its success. They must all be weighed together.

Strengths have to be evaluated and compared to the weakness. To be sure of success and profit in the farming business, strengths must outweigh the weaknesses, just as opportunities must outweigh the threats. Moreover, there must be strategy(s) to reduce the severity of threats and weaknesses. But many fish farmers overlook the importance of business plan before going into the business. They are moved only by the advice of the motivational speakers or consultants that convince them that aquaculture business is a profitable venture. These fish farmers are bound to make mistakes.

One of the major challenges of fish farming business is high cost of feed. Feed cost always claim higher percentage than all other input materials cost put together (Engle, 2010) [14]. Therefore, feed cost has direct impact on the output and profitability of catfish production. Many studies had reported that feed and cost of feed are the major constraints of fish production. For example, Olayiwola (2013) [29] identified feed and hired labour as factors influencing technical efficiency of fish production in Ijebu-ode Local Government Area of Ogun state. Osawe *et al*. (2008) [32] observed that feeding is highly contributing to increase in technical inefficiency and decrease technical efficiency of fish production. That is, the more the farmers feed the fish per day with low quality feed, the less their output efficiency. This is an identified weakness of fish farming business. The strategy to combat this is to carefully and appropriately feed the fish to ensure a better feed conversion ratio that will increase the weight gain and eventually increase the chances of profitability and success of the business (Engle, 2010) [14].

This study examined the challenges to the profitability of catfish production in Southwest Nigeria. Specifically, this study:

(i)Examined the performance of catfish over the period of production

(ii)Determined the cost of production (breakeven cost)

(iii)Examined the profitability of catfish farming

(iv)Investigated the challenges to the profitability of catfish farming

MATERIALS AND METHODS

The Study Area

This study was carried out in Southwest Nigeria. The Southwest Nigeria is one of the six geopolitical zones in Nigeria and it is dominated by Yorubas. It comprises of six states; Lagos, Ogun, Oyo, Osun, Ondo and Ekiti. These States have good quality freshwater that easily support abundant fish production unlike other geopolitical zones that either have problems of low water table, scarcity of water or polluted water (due to oil spillage). These problems make fish production in some other geopolitical zones difficult. Therefore, Southwest Nigeria becomes the favourable zone for fish production in Nigeria, in which other geopolitical zones come to source fish to meet their increasing demand for fish.

Sampling procedure

Structured questionnaire was designed to collect the required data for this study. The information sought include various input resources employed in catfish production, performance of catfish over the period of production and challenges encountered by catfish farmers in Southwest Nigeria. A 2-stage random sampling procedure was used to select respondents for the study. The first stage involved the random selection of four states in Southwest Nigeria. The selected States are Lagos, Ogun, Oyo and Osun. The second stage involved the random selection of small-scale catfish farmers from the Catfish Farmers Association of Nigeria (CATFAN) in each state. The sampling frame consists of registered catfish farmers across all the local government areas in each state. In each state, 100 members of CATFAN were randomly selected for the administration of the questionnaire giving a total of 400 respondents.

Analytical Methods

Descriptive statistics were used to examine the performance of catfish over the period of production and investigate the challenges to the profitability of catfish farming. Costs analysis was done to determine the cost of production. On the basis of the performance of catfish over the period of production and the costs and returns analysis, the gross margin was used to determine the gross margin and profitability of catfish enterprise. Benefit Cost Ratio was used to explain the profitability of the small-scale catfish business. Expense Structure Ratio shows the percentage contribution of the fixed cost to the total cost of production.

Performance of catfish over the period of production

Performance of catfish was determined by analysis of minimum and maximum inputs that farmers used to produce minimum and maximum output catfish in a particular production cycle. The mean values of inputs and outputs of catfish were obtained by dividing the overall values of input variables and catfish output by the total number of fish farmers.

Cost of production (breakeven cost)

The average production cost or breakeven price was obtained following Engle (2010) method [14]. It is a measure of the cost of producing a single unit (Kg) of product (catfish). It is obtained by dividing the average total cost of production by the total quantity of catfish output or the total weight of catfish at harvest.

This is given as:

Average production cost (APC)
= ATC (₦)/Total catfish output (Kg).......... (1)

Profitability Analysis

Income statement was prepared using the data collected. From the income statement, costs and returns analysis was done to determine the profitability of small-scale catfish farming business in Southwest Nigeria. Two methods of profitability analysis; cost and return analysis and Benefit-Cost ratio, as described by Alawode and Oluwatayo (2019) [7] were adopted as follows:

Gross Margin (GM):

$TR = P_Q Q$ ……………………………. (2)
$TVC = \sum P_i X_i$ ……………………….... (3)
$TFC = \sum P_n Y_n$ ……………………….…….. (4)
$TC = P_j Z_j$ ……………………………. (5)
$P_j Z_i = \sum P_i X_i + \sum P_n Y_n$ …………………(6)
$TC = TVC + TFC$…………………….. (7)
$GM = TR – TVC$……………………… (8)
$\Pi = GM – TFC$………………………... (9)

By combining equations 8 and 9, then, profit (Π) becomes:

$\Pi = TR – TVC – TFC$ ………………… (10)
$\Pi = TR – (TVC + TFC)$………….……….. (11)

Therefore, profitability can be simply calculated by subtracting total costs of production from total revenue. A positive margin shows a gain or profit for the business while a negative margin shows a loss for the business (Alawode and Oluwatayo, 2019; Engle, 2010) [7, 14].

$\Pi = P_Q Q – P_j Z_j$ …………………….. ...... (12)

where:
Π = Profit or Net farm income (₦)
P_Q = Price (₦) per Kg of catfish,
Q = Total quantity of output of catfish in Kg,
Pi = Price of each ith variable input used in production
X_i, Y_n and Z_j = Quantities of variable, fixed and total inputs used in production
$TR = P_Q Q$ = Total revenue (₦)

TVC= $\sum P_iX_i$ = Total variable cost (₦)
TFC = $\sum P_nY_n$ = Total fixed cost (₦)
TC = P_jZ_j = Total cost of production (₦)

Benefit Cost Ratio (BCR)
BCR = TR / TC
$= P_QQ / P_jZ_j$ ………………………. (13)

If Benefit cost ratio (BCR) is less than 1, the business is not profitable and there will be negative return on investment; if BCR is greater than 1, the business is profitable and there will be positive return on investment. This is called viability test of a business (Ajagbe and Ojo-Fakuade, 2019; Alawode and Oluwatayo, 2019) [5, 7].

Expense Structure Ratio (ESR)
ESR = TFC / TC = P_nY_n / P_jZ_j.................. (14)
Expense Structure Ratio (ESR) shows the percentage contribution of the fixed cost to the total cost of production

RESULTS AND DISCUSSIONS

Performance of catfish over the period of production

Table 1 shows that the size of fish seed stocked was between 4g and 20g with a mean of 8.91±0.55g while the number of fish seed stocked was between 200 and 10,000 catfish with a mean of 2,141.82±237.56. Issa *et al.* (2014) [21] reported that fish seed stocked in small-scale catfish farms in Kaduna state varied between 500 and 6,000 fingerlings. But, Onyekuru *et al.* (2019) [31] reported the number of stocked fish to vary between 50 and more than 1,000 fish seed.

Table 1 shows that quantity of feed given to the fish during production period in the study area varies between 429 Kg and 3,750 Kg with a mean of 1,311 Kg.

The size of fish at harvest varies between 450g and 1,800g with a mean of 1,022.73g±45.94. Onyekuru *et al.* (2019) [31] reported catfish size at harvest to vary between 1,000g and 1,500g.

The price of catfish in the study area varies between ₦500 and ₦910 with a mean of ₦645.45 ± 9.11 per kilogram. But, Issa *et al.* (2014) [21] reported that the price of catfish in Kaduna state varied between ₦300 and ₦450, which is lower than minimum market price of catfish in Southwest Nigeria.

Table 1. Performance of Catfish over the period of production

Variable	Mini	Max	Mean
No of fish stocked	200	10,000	2,141.82 ± 237.56
Cost of fish seed (₦)	25	32	28.5 ± 34
Average size stocked (g)	4	20	8.91 ± 0.55
Average size at harvest (g)	450	1,800	1,022.73 ± 45.95
Production period (Months)	3	6	4.37 ± 0.11
Av. No at harvest	190	9,700	1,923.83 ± 233.69
Feed quantity fed (Kg)	429	4,592	2,510.29 ± 22
Selling price /Kg (₦)	500	910	645.45 ± 9.11

Source: Data Analysis, 2019.

The price regime is fixed with respect to harvest size of the fish. The farmers in the study area produced different sizes of fish ranging between smoked size to Abuja size, with respect to the farmers' ability and customers' preferences. On the average, a catfish farmer stocks 2,142 juvenile catfish per pond and harvest 1,924 table size fish. Also, on the average, a catfish farmer feeds the fish with 2,510Kg of feed and sells at ₦645 per Kg, for a period of 4.37 months. However, Onyekuru *et al.* (2019) [31] reported that the catfish production period in Nsukka Local Government Area of Enugu state, Southeast Nigeria, varied between 6 and 9 months. This is far greater than period of catfish production in the Southwest Nigeria as obtained in this study (Table 1).

Cost of production

Average cost of production of catfish obtained from this study is ₦474.43/Kg. This is the breakeven price. This is the price of producing a kilogram of catfish in the study area. Farmers always watch out for the cost of production and always trying to keep it as low as possible. This is because it is the determinant of profit in catfish production. It must be lower than the minimum market price of catfish. That is, the lower the cost of production, the higher the profit and vice versa. Therefore, to make profit, farmers have to sell their catfish at a price higher than ₦474.43/Kg. It has been stated (Table 1) that catfish is sold between ₦500 and ₦910 with a mean of ₦645.45±9.11. It is then clear that catfish farmers in the study area make profit. The calculations are as follows:

Average total cost (ATC) = ₦933,467.98
Average number of fish stocked= 2,141.82
Average number of fish harvested = 1,923.83
Average weight (g) of fish at harvest = 1,022.73g
Total weight at harvest (Kg) =
Average number fish harvested x Average weight at harvest = 1,923.83 x 1,022.73g = 1,967,559g /1,000 = 1,967.56 Kg
Average production cost (APC) =
(ATC (₦)/Total weight at harvest (kg))=
₦ 933,467.98/1967.56 kg= ₦474.43/Kg

Profitability of Small-Scale Catfish Production

Table 2 shows that the average total revenue obtained from small-scale catfish production in Southwest Nigeria is ₦1,269,961.60 (1967.56 x 645.45). A total variable cost (TVC) of ₦884,893.50 and total fixed cost (TFC) of ₦48,574.48 were incurred during the course of production. The sum of these costs gives the total cost (TC) of catfish production to be ₦933,467.98. The value of TVC was subtracted from the total revenue to obtain the gross margin of ₦385,068.10. Moreover, average net farm income or profit obtainable in small-scale catfish production in Southwest Nigeria is ₦336,493.62 per production period. This is consistent with the findings of Okpeke and Akarue (2015) [27], who reported ₦384,306 as net farm income of fish farming business in Warri South Local Government Area of Delta State, Nigeria. This implies that small-scale catfish production is a profitable business in Southwest Nigeria. This observation corroborates the findings of Ajagbe and Ojo-Fakuade (2019); Edet *et al*. (2018); Iruo *et al*. (2018); Ashley-Dejo *et al*. (2017) [5, 12, 20, 10]. Profit is the major, if not the sole factor that makes the business feasible or viable and keeps it moving over several cycles of production.

The contribution of total variable cost and total fixed cost to the total cost of production were found to be 94.8% and 5.2% respectively. This results indicate that total variable cost that includes the cost of feed, water, labour, fuel, lime, harvesting, and etcetera, is the major factor in catfish production. This observation is consistent with the result of Onyekuru *et al*. (2019) [31], they estimated the contribution of total variable cost and total fixed cost to the cost of catfish production to be 86.58% and 13.42% respectively, in Nsukka Local Government Area of Enugu state, Nigeria. Ashley-Dejo *et al*. (2017) [10] reported that total variable cost contributed 86.6% while total fixed cost contributed 13.4% of the total cost of production in Oyo State. Also, Oluwasola and Ige (2015) [30] observed that total variable cost contributed 96.66% and total fixed cost contributed 3.34% to the cost of catfish production in Ibadan, Oyo State.

However, cost of feed has the largest percentage contribution to the cost of catfish production in Nigeria. Most quality fish feed are imported and this contributes to high cost of fish feed and eventually, high cost of production. This observation is in agreement with Alawode and Oluwatayo (2019); Ashley-Dejo *et al*. (2017); Okpeke and Akarue (2015) [7, 10, 27]. The implication of this is that fish feed is an important factor of catfish production. In addition, if feed is not properly managed by the farmers and efficiently utilized by catfish, it will have negative effect on profit (Robinson and Li, 2015; Engle, 2010) [33, 14]. However, Edet *et al*. (2018) [12] had a contrary observation. They reported that total variable cost contributed 42.86% while total fixed cost contributed 57.14% to the cost of catfish production farming in Calabar metropolis, Cross River state, Nigeria.

The value of benefit cost ratio (BCR) was estimated to be 1.36. This value implies that for every ₦1 invested in catfish production in Southwest Nigeria, there will be a return of 36 kobo (₦0.36) or a profit of 36% on investment made. This shows that catfish farming is a profitable business in Southwest Nigeria. Ajagbe and Ojo-Fakuade (2019) [5] reported BCR of 1.74 for catfish production in Ibadan Metropolis, Oyo state, Nigeria. Alawode and Oluwatayo (2019) [7] reported BCR of 3.95 among Fish Farmers participating in Fadama III in Lagos state, Nigeria. Ashley-Dejo *et al*. (2017) [10] reported a BCR of 1.69 among small-scale catfish farmers in Oyo state, Nigeria. Tunde *et al*. (2015) [35] reported BCR of 1.9 among fish farmers in Saki-East Local Government Area of Oyo state, Nigeria.

The expense structure ratio (ESR) of catfish production in Southwest Nigeria is 0.05. This implies that total fixed cost contributes only 5% to the total cost of catfish production in the study area. But Ajagbe and Ojo-Fakuade (2019) [5] reported an ESR of 0.07 for catfish production in Ibadan Metropolis, Oyo State, Nigeria, and Ashley-Dejo *et al*. (2017) [10] reported an ESR of 0.15 for catfish production from all the four agricultural extension zones of Oyo state. Much more, Ume *et al*. (2016) [36] estimated an ESR of 0.48 for catfish production in Anambra State, Nigeria. These values are greater than what was obtained in this study. However, Oluwasola and Ige (2015) [30] reported an ESR of 0.03 for catfish production in Ibadan, which is lower than what was obtained in this study. Nevertheless, it is obvious that the contribution of the total fixed cost to the total cost of production of catfish in Nigeria is far less than the contribution of total variable cost. This makes catfish farming viable because fixed cost will relatively remain constant during the cause of production. Therefore, revenue and most especially, the profit, is largely determined by the variable cost; that is, increase in revenue is directly proportional to the increase in the variable cost (Ajagbe and Ojo-Fakuade, 2019; Ashley-Dejo *et al*., 2017) [5, 10].

The contribution of total fixed cost appeared to be negligible in the total cost of catfish production in Southwest Nigeria. Most small-scale catfish farmers in Southwest Nigeria have devised an alternative means aimed at reducing the effect of total fixed cost in the cost of production. The major assets or capital investment in catfish fish production are land, ponds (pond construction), harvest (drag) net, well or bore hole and water pump machine. These high level fixed costs make catfish production a capital intensive business (Engle, 2010) [14].

Table 2. Income statement and profitability analysis of catfish farming enterprise

	Average value (₦)
Total revenue	**1,269,961.60**
Variable inputs	
Fish seed	61,018.50
Lime	1,756.52
Fertilizer	1,300.00
Water	225,357.14
Water analysis	14,000.00
Feed	545,611.53
Labour	18,266.67
Harvest	5,375.00
Medication	2,347.06
Fuel	5,095.10
Running Cost	4,765.98
TVC	**884,893.50**
Gross Margin	**385,068.10**
Fixed inputs	
Pond	33,090.91
Dragnet	6,729.17
Water pump machine	6,233.57
Equipment	2,520.83
TFC	**48,574.48**
Total cost	**(933,467.98)**
Net farm income	336,493.62
BCR	1.36
ESR	0.05

Source: Data Analysis, 2019
NB: TVC: Total Variable Cost; TFC: Total Fixed Cost

This is evident in the work of Edet *et al*. (2018) [12] who reported higher fixed cost percentage contribution. In addition, all these assets are difficult to convert to cash if the farmer decided to quit the business (Engle and Stone, 2002) [15]. Therefore, most catfish farmers have opted to rent all these assets either per production cycle or yearly to reduce the cost of maintenance and cost of production. This observation is corroborated by the result of Ajagbe and Ojo-Fakuade (2019) [5]. Likewise, most catfish farms are located along natural water source for regular supply of water. This makes the cost of water very negligible or zero in the cost of production.

Challenges to Catfish Production

In Table 3, five major categories of challenges facing catfish production in Southwest

Nigeria were identified; profitability, weather effects, fish diseases and predators, security, and fish marketing challenges. These challenges limit the profitability of catfish farming business. This study and others had established the profitability of catfish farming business. Engle (2010) [14] stressed it further that the profit potential in catfish farming business is often accompanied by a variety of risks, and the large sums of money invested can be lost quickly. Therefore, there is need for adequate and thorough planning, monitoring, and assessment of the economics and finances to prevent such losses.

The profitability challenges include challenges that mostly and directly contribute to the cost of production. It may sometimes depend on the level of management expertise employed in catfish production (Engle, 2010) [14]. The results showed that all catfish farmers (100%) in the study area agreed that high feed cost contribute negatively to the profitability of catfish production. This implies that feed is the single largest component of cost of production and as such, it is the most significant determinant of profit in catfish production (Engle, 2010) [14]. This observation corroborates the findings of Alawode and Jinad (2014) [6] that feed inputs had negative relationship with output. This also corroborates the findings of Mohammed *et al*. (2015) [24] who found that the most pressing challenge militating against small-scale catfish farming is high cost of feed. Further, Iheke and Nwagbara (2014) [19] recorded that all catfish farmers in Abia state, Nigeria, agreed that the major problem facing catfish production is high feed cost. In the same vein, Asa and Obinaju (2014) [9] ranked cost of feed as most severe among other constraints of catfish fish farming.

Therefore, some farmers adopt many methods to cut the cost by giving their fish maggots, chicken intestine and unhatched chicken eggs. Therefore, 9.2% of the farmers perceived that the business is not highly profitable. All other challenges identified by catfish farmers are potential factors limiting catfish profitability. In order to minimize or eliminate the effects of this challenge, catfish farmers must be thoroughly trained to feed their fish with quality feed and to feed efficiently to keep feed conversion rate (FCR) below 2 (Robinson and Li, 2015) [33].

The second category of challenges is the climate change which is largely determined by flood and temperature variation. The impact of climate change is increasing in fish production in Nigeria. Challenges due to climate change on catfish farming include temperature variability, flooding and lack of abundant water for fish production. These are external challenges that can naturally affect or limit catfish production. The growth and survival of fish are highly correlated with water quality. Fish are cold-blooded animals; the temperature of their environment directly influences all their body metabolic activities. Fish appetite is always reducing when pond water temperature is too low. This observation corroborates the report of Robinson *et al*. (1998) [33] that catfish reduce their feeding activity at colder temperatures and do not readily come to the surface to feed.

Challenges of weather variables on catfish farming include those external challenges that naturally affect or limit catfish production. This makes catfish farmers in Southwest Nigeria vulnerable to climate change. This observation corroborates the report of Barange *et al*. (2018) [11] that Nigeria is one of the African nations in which their fisheries and aquaculture are particularly vulnerable to climate change and the disasters can be up to 80%. The results showed that 10.6% of the farmers were not aware of any effect of weather on catfish production. But the studies of Adeleke and Omoboyeje (2016), Adebayo (2012), and Aphunu and Nwabeze (2012) [4, 2, 8] confirmed that majority of catfish farmers have the knowledge of the effects of climate change on catfish production and are finding ways to mitigate it.

The results show that weather variables affect biological processes of catfish. This observation corroborates the report of Harrod *et al*. (2018) [18]. It shows that 7.0% of the catfish farmers attributed low breeding results to weather variables, 72.5% of the farmers agreed that weather affects fish feeding habit; they may lose appetite if the temperature is too low. The results showed that 59.9% of catfish farmers experienced flooding, and 57.7% lost some of their fish to flood. This is the disadvantage of locating fish farms along river course. But this is unavoidable in some cases as mentioned earlier to reduce the cost of water source. Also, 62.0% of the farmers lacked abundant supply of water to produce fish throughout the year. These are classified as short-term climate change impacts on aquaculture (Barange *et al*., 2018) [11].

Likewise, FAO Training manual highlighted the effects of low temperature of pond water on fish to include; slowing down the development of their eggs; reducing the growth of juveniles and older fish; delaying and even preventing their maturation and spawning; decreasing their food intake and even stopping it completely, and increasing their susceptibility to infections and diseases (www.fao.org) [17]. Also, El-Sayed *et al*. (1996) [13] had earlier reported that fish growth was significantly reduced below 21°C and below 10°C, fish will stop feeding and develop severe stress, fungal infection and high mortality. But Abdul-Halim *et al*. (2017) [1] reported that the main components of climate change that would impact fish farming includes high temperature, less rainfall, salinity intrusion, seasonal fluctuation and prolonged drought. This is climate variability due to geographical locations.

In this study, water is presented as friendly-enemy. This is because water is an indispensable resource in fish farming, without which fish cannot survive. But, water can also cause irreparable loss to farmer through flooding. Most farmers like to site their fish farms close to a reliable water source or waterlogged areas. The aim is to supply abundant water all year round. But, there is also the danger of flood. Therefore, care must be taken to construct effective drainage to convey water out quickly to avoid fish loss to flooding.

The third category of challenges is diseases and predators that can attack fish at any stage of life causing enormous economic loss. Disease is highly determined by the state of pond water quality. Disease prevails in polluted fish ponds while predators are many and include human, alligator, snakes, and etcetera. Fish are diseased when there is imbalance reaction between disease causative agents, the water quality (the fish immediate environment) and fish as the host. Effects of diseases can be seen as loss of appetite, isolation, growth retardation, deformity and mortality. Weather or climate change may also contribute to severity of diseases and parasites in fish ponds. Flood may bring in pathogen into the ponds and abrupt change in water temperature may lower fish immunity against disease. This observation is consistent with the report of Barange *et al*. (2018) [11] that climate change may increase risks of diseases, parasites and harmful algal blooms.

The results in Table 3 show that 86.6% of the farmers experienced early morning mortality in the farms, 80.3% of the farmers experienced fish diseases and lost some fish to disease in their farms, and only 49.3% of them could notice fish disease by observation, while 31.0% of the farmers noticed diseases after their fish are dying. Okaeme *et al*. (1987) [26] had earlier confirmed that diseases and parasitic problems could constitute significant economic losses in fish production. Tavares-Dias and Martins (2017) [34] later reported that accurate estimation of economic impacts of parasitic and infectious diseases on production are difficult. However, they estimated direct and indirect economic costs for freshwater farmed fish to be US$ 84 million per year in the Brazilian fish farms. Issa *et al*. (2014) [21] also identified pest and diseases as one the major problems facing catfish production. The most common predator of fish identified was birds; 69% of the farmers agreed that birds prey on their young fish while 25.5% of the farmers identified alligator. Therefore, majority (88.8%) of the farmers covered their ponds with net, some carry out weeding (3.5%) or use chemicals (3.5%), and set traps to get rid of the predators (4.5%). Unwanted fish constitute another form of predation in fish farms, 5.6% of catfish farmers agreed to this.

The fourth category of challenges is security. Fish farms are vulnerable to the sudden attack of thieves mostly when the fish is matured and near or at harvesting period, when farmers are planning to harvest their fish. The expected profit and the investment capital can be lost within few hours, when farmers least expect the attack. Security challenges involved unlawful entrance of unknown person(s) or individual(s) into a fish farm causing economic damage and loss, and even loss of lives.

The results showed that, 40.1% of catfish farmers experienced poaching or stealing of their fish and 83.8% hired security to guide their farms, 7.0% of the farmers constructed fence round their farms and another 7.0% slept on their farms, providing security by themselves. This is the major reason that catfish farmers form league to construct their ponds together, so that they can bear the security cost together. Adebayo and Daramola (2013), and Olasunkanmi and Yusuf (2014) [3, 28] also identified predators, flood, disease and theft (security) among other challenges facing catfish fish production. The cost of security to fish farms sometimes is another major issue for individual catfish farmers. The issue of security can be securely handled by introduction of clustering fish farming system. This is a situation in which fish famers form a community by coming together at a particular location. They can share some necessary input together, especially, jointly hired security to watch over their fish farms to reduce their individual cost of production.

The fifth category of challenges is the problem of fish marketing which represents the gap between the fish farmers and fish consumers. Fish marketing challenges are the constraints that catfish farmers experience in converting their products to cash, by physical movement of catfish from the point of production to the potential and active consumers. The magnitude of these constraints determines the percentage of harvested catfish that will be sold at breakeven; above breakeven; below breakeven price and/or wasted due to lack of post-harvest facilities. Fish begins to lose quality immediately after harvest. The deterioration continues to increase with time if not processed or consumed, and as a result of this, its price continues to decrease. Lack of post-harvest facilities may even cause fish to lose economic value.

Engle (2010) [14] reported that the marketing challenges are often greater than the production challenges and ultimately more important. The results show that 42.3% of catfish farmers in the study area identified customers buying their catfish on credit as a challenge, 25.4% identified instability of demand and supply of catfish as a challenge, 12.5% identified lack of customers to buy their catfish at profitable price, while 19.8% identified the activities of middlemen and wholesalers as a threat to their profitability. Engle and Stone (2014) [16] cautioned that a small-scale operator must sell fish at retail prices (for example, direct to consumers) to make a profit. Kimathi *et al.* (2013) [22] reported that fish market is one major factor hindering the prosperity of fish farming business which includes where to sell fish. Therefore, Engle (2010) [14] recommended that farmers should analyze the market and marketing before they start fish production.

Marketing challenges can be addressed by formation of fish farmers' marketing groups. Fish farmers may also sell their fish through the help of their cooperative societies (Kimathi *et al.*, 2013) [22]. This emphasizes the importance of business plan in fish marketing. Therefore, individual fish farmers should prepare his/her business plan or carry out market survey before production (Engle, 2010) [14].

Farmer should consider the type of species preferred by their target customers, who their competitors are, the form of catfish preferred (fresh or smoked) by customers, the current market price, the quantity of fish demanded by the market, the marketing strategy that should be adopted, and where they will have the highest sales. All these questions must be sincerely answered by the farmer before production of fish starts (Ngugi *et al.*, 2007) [25].

Based on the Leadway Assurance (2017) [23] classification of risk facing fish production in Nigeria as pure risks and business risks, in this study, weather and climate change challenges, diseases and predators challenges and security challenges are classified as pure risks, while profitability challenges and marketing challenges are classified as business risks.

Table 3. Challenges facing Catfish production in Southwest Nigeria

Variables	Frequency (n=400)	Percentage (%)
1.Profitability challenges		
High feed cost	400	100
Not highly profitable	37	9.2
2.Effects of Weather		
No idea	42	10.6
Low breeding result	28	7.0
Loss of appetite	290	72.5
Flooding	240	59.9
Fish lost to flooding	231	57.7
Lack of abundant supply of water	248	62.0
3. Fish diseases and predators		
Early morning mortality	346	86.6
Awareness of fish diseases	321	80.3
Fish lost to disease	321	80.3
Disease notice		
Observation	197	49.3
Death	124	31.0
Predators		
Birds	276	69.0
Alligator	102	25.5
Unwanted fish	22.4	5.5
Prevention from predators		
Cover with net	355	88.8
Weeding	14	3.5
Chemical	14	3.5
Traps	17	4.3
4. Security challenges		
Risky business	284	71.0
Poaching	160	40.0
Farm security		
No security	9	2.3
Hired security	335	83.8
Fenced the farm	28	7.0
Sleeping in the farm	28	7.0
5.Fish marketing challenges		
Buying on credit	169	42.3
Demand/supply	102	25.5
Lack of customers to buy at profitable price	50	12.5
Middlemen/wholesalers	79	19.8

Source: Field Survey, 2019.

CONCLUSIONS

Catfish farming is a profitable business but there are challenges that can limit the profit and even consume the invested capital. Each of these challenges can reduce catfish performance, increase the cost of production, and eventually reduce the profit margin of the business. Lack of technical know-how on the part of fish farm managers contribute to the severity of business risks and challenges. Therefore, fish farmers need to be taught or trained on best ways to handle these risks and challenges for the success of fish farm enterprise. The farmers should take cautions to minimize the effects of pure risks. Moreover, fish farmers should prepare their business plan, analyze the market and evaluate their strengths and opportunities to minimize or eliminate the weaknesses and threats against the profits as a measure of their success in catfish business.

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POTENTIAL MARKET CAPACITY AS THE BASIS FOR THE DEVELOPMENT OF ORGANIC PRODUCTION IN THE RUSSIAN FEDERATION

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Abstract

The promotion of a healthy lifestyle and objective necessity stimulate a significant growth in demand for organic products around the world. Despite the relevance, demand, and a large number of theoretical and applied research, the opportunities and resource potential of the Russian Federation in this area of agribusiness have not yet been fully identified. As part of our research, was formed interdisciplinary fundamental platform for developing the theory of organic food market. As a result, we determined the elements of scientific methodology (theories, principles, factors, methods) of its functioning, which allowed justifying the potential capacity of the consumer market of organic food in Russia. The calculation was made taking into account dietary intake of food that meet the present-day requirements of healthy nutrition, heterogeneity of consumer preferences, price gap for the staple conventional and organic products in retail and price variance for the latter. Our research is addressed to the world business community operating in the organic food market and industry research institutions.

Key words: *organic products, organic market, food market, market capacity*

INTRODUCTION

The food market at the present stage shows an obvious focus on the growth of the organic segment around the world. A large number of publications in recent years are devoted to various aspects of the functioning of organic food market in describing the results of sociological studies at various scales (from focus-group surveys to national ones, including online shopping), aimed at identifying typical characteristics of a group of potential consumers, motivation when making a purchase decision and the level of the expected price (Magnusson, Arvola, Hursti etc., 2003 [15], Hjelmar, 2011 [10], Xie, Wang, Yang etc., 2015 [26], McCarthy, Liu & Chen, 2016 [16], Aschemann-Witzel & Zielke, 2017 [3], Singh & Verma, 2017 [22], Zhang, Fu, Huang etc., 2018 [27], Bryla, 2018 [5]). Issues of quality and safety, complexity of certification procedures and costs, labeling recognizability, trust to the brand and their influence on willingness to pay (WTP) remain relevant (Krystallis & Chryssohoidis, 2005 [12], Janssen & Hamm, 2012 [11], Leksina, Popova &, Sapogova, 2014 [14], Bryla, 2016 [4], McFadden & Huffman, 2017 [17], Serdobintsev, Leksina, Chernyaev, etc., 2020 [21]).

The main barrier, that holds back the growth of organic products consumption, is its high price and lack of availability (Aertsens, Mondelaers, Verbeke etc., 2011 [1], Buder, Feldmann & Hamm, 2014 [6], Aschemann-Witzel & Zielke, 2017 [3]).

Despite a large number of fundamental and applied research and publications, until the present the opportunities and resource potential of the Russian Federation in this area of agribusiness have not been identified, and it is possible to state the demand for an objective assessment of development prospects of organic market. The accelerators for this process are the global changes in the institutional sphere from January 1, 2020 due to the entry into force of Federal law № 280-FZ "On organic Products and Amendments to Certain Legislative Acts of the Russian Federation"[8] and the Interstate standard

GOST 33980-2016 "Organic production. Production regulations, processing, labeling and sales" [23]. These are the first legal documents in the history of the country's development drafted for regulation and legalization of organic business.

In this regard, our research is unique, since it is an attempt to identify prospects for the formation of the organic market in Russia through its transformation from a segment of the food market to an independent market based on an assessment of its potential capacity. The calculation was made taking into account dietary intakes of food that meet the present-day requirements of healthy nutrition, heterogeneity of consumer preferences, price gap for the staple conventional and organic products in retail and price variance for the latter.

MATERIALS AND METHODS

We have solved the problem of scientific justification of the possibility and expediency of forming the Russian organic products market by developing it from the segment of the food market.

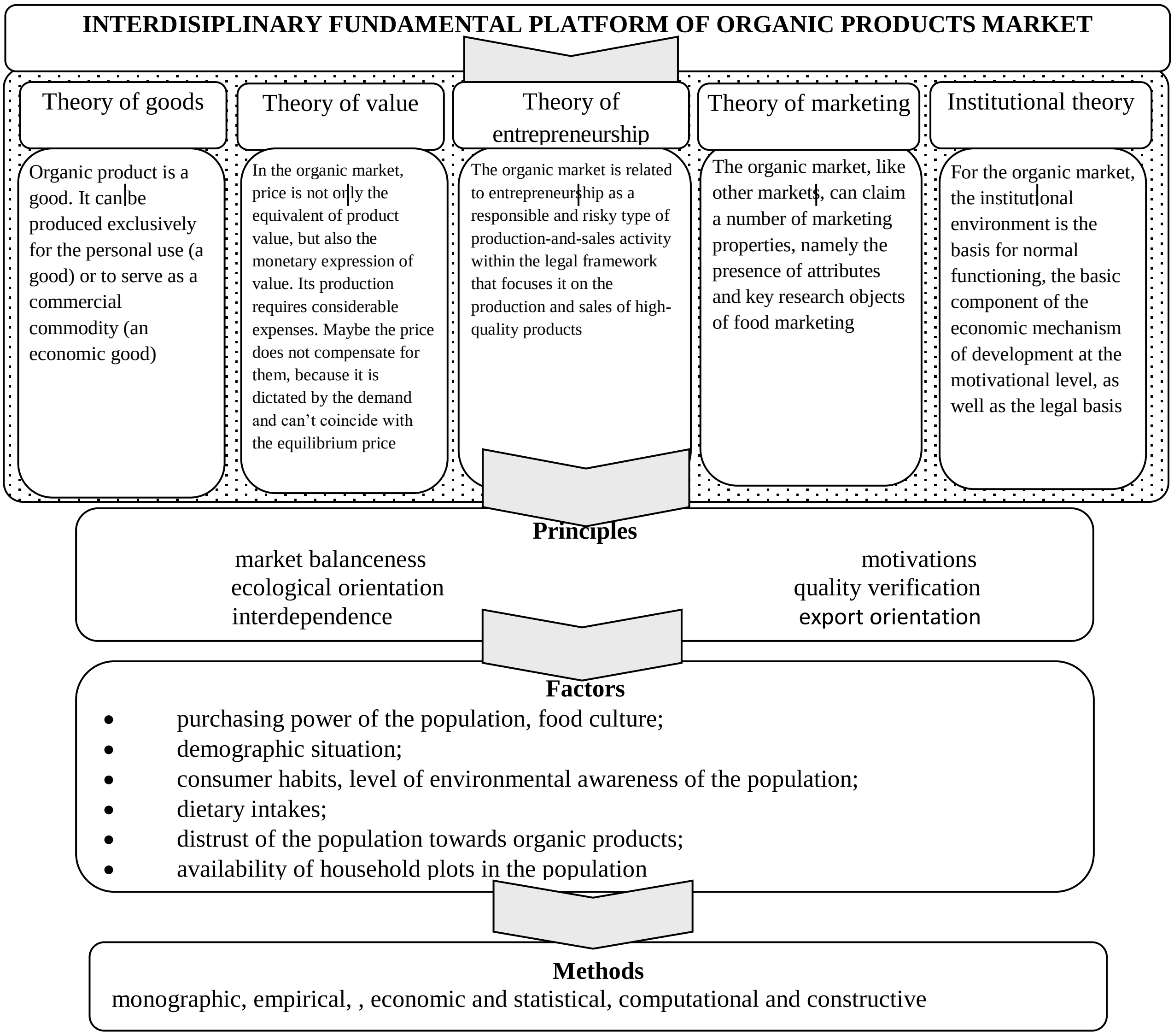

Fig. 1. Theoretical-and-methodological basis of development of food market for organic products
Source: own elaboration.

For this purpose, we have investigated current methodological approaches, organizational-and-economic mechanisms (Leksina, 2019) [13], a system of theories of values and planned behavior (Aertsens, Verbeke, Mondelaers, etc., 2009) [2], as well as the priority hierarchy of theories in logical relationship with the development of the theory of organic market (Rushitskaya, 2019) [20], and finalized to the interdisciplinary platform (Fig. 1).

It contains fundamental theories (of goods, value, entrepreneurship, marketing and institutional), principles (market balanceness, social orientation, interdependence, motivation, quality verification and export orientation), factors (purchasing power of the population, demographic situation, dietary intakes, etc.) and methods (monographic and comparative analysis, empirical, computational-and-constructive, economic-and-statistical, modeling).

In accordance with a new paradigm of the current economic system, development of the theory of organic food market (hereinafter – organic market) is recommended to be considered at an interdisciplinary level, which will allow connecting it with other theories. It should be noted that this relationship is manifested and strengthened against the background of ongoing institutional changes. Since the institutional subsystem as the macroeconomic basis of the market development mechanism builds a system of corresponding requirements for the production technologies, storage and sales of products by improving the legislative framework, therefore it is acceptable to assume that the institutional theory forms the necessary prerequisites for the diffusion of other known theoretical propositions into the theory of the market under study in the framework of a disciplinary approach.

At the same time, an important place is given to other theories logically related to the food market. In relation to the theory of goods, organic agricultural food products are considered as an object characterized by an immanent ability to meet human needs for sound-quality food products and a bifurcational orientation: in the market, they act as a commodity called an economic good, and being produced exclusively for personal use becomes just a good. Thus, the economic aspect of this concept connects this theory with the food market, through which quality food products are sold.

Examining the value of organic products in the neoclassical interpretation, it can be identified with the equilibrium price, making an adjustment for the "non-conformity to utility" of the considered good to its value. The latter is traditionally expressed in monetary terms, while the value illustrates the significance of the good for the consumer. At the same time, the price of organic products on the market acts not only as an equivalent of its value, but also as a monetary form of value. Often, products produced in accordance with organic standards are characterized by a higher cost than conventional ones. At the same time, low purchasing power of the population, food culture and consumer habits determine the demand and the level of market prices which do not coincide with the equilibrium ones. As a result, they do not always compensate for the cost of production of organic products. Thus, from the point of view of producer, the value is represented in the form of stable and high demand, and in the opinion of the consumer – in the form of a possibility of achieving satisfaction from the purchase of organic products.

In accordance with the theory of entrepreneurship, the functioning of the food market of organic products involves the implementation of business activities, the institutional basis of which is the regulatory framework. Strict adherence to the latter is manifested in the production and sales of high-quality products, which, in turn, determines the need for the presence of entrepreneurial abilities.

From the point of view of the theory of marketing, we consider it possible to apply the provisions of food marketing in relation to the processes of production, promotion and sales of organic food products, taking into account the presence of attributes and key research objects. Thus, this theory approaches to the theory of the agricultural market, which includes three main markets: land, food and labor ones.

Considering the organic market in the framework of the institutional theory, it should be noted that the institutional environment is the basis of its normal functioning, a substantial element of the economic mechanism of its development in the motivational aspect, arising from the influence of the institutes of insurance, taxation, credit, state support, etc. on market actors. It is also important to note that this is also the legal basis that formalizes the relations of market actors regarding the level of quality of organic products.

The Russian organic market shows high rates of development: the area of land certified for organic production increased from 34 to 657 thousand hectares (for the period 2007-2017), the number of agricultural producers - from 12 to 89, processors - from 4 to 69, retail sales of organic products in domestic markets increased 4 times (amounted to EUR 120 million), 28 organizations-exporters are operating, and the volume of exports increased from EUR 0.2 million to EUR 4 million (Table 1).

Table 1. Dynamics of the key indicators of the organic products market in the Russian Federation

Market element	Years				2017 to 2007, times	2017 to 2016, %
	2007	2015	2016	2017		
Number of producers of organic products (raw materials)	12	82	66	89	7.4	134.8
Number of processors of organic raw materials	4	37	35	69	17.3	197.1
Number of exporters	…*	11	11	28	x	254.5
Number of importers	12	…*	…*	…*	x	x
Area of land certified for organic production, thousand hectares	33.8	385.1	315.2	656.9	19.4	208.4
Share of land certified under organic production in the total volume of agricultural land, %	0.02	0.18	0.14	0.30	+0.28 pp	+0.16 pp
Consumption of organic products per capita, EUR/person/year	…*	0.80	0.80	0.80	x	100.0
Retail sales of organic products in domestic markets, EUR million	30.0	120.0	120.0	120.0	4.0	100.0
The volume of export, EUR million	0.2	4.0	4.0	4.0	20.0	100.0

Source: own calculation according to FiBL [9]. Note: * Lack of data.

The current state of the Russian agricultural food market can be characterized by the following dynamics: the largest segments of the organic food market are "Milk and Dairy products", "Vegetables and Fruits", while "Meat, Poultry", "Bakery products" and "Beverages" are growing rapidly (Lyubovedskaya, 2019) [25]. The Central, Southern, and Volga Federal districts (Krasnodar krai (territory), Yaroslavl and Moscow regions, as well as the Republic of Tatarstan) are the leaders in organic production in the Russian Federation. For example, the Republic of Tatarstan has adopted the program "Development of Agricultural Production and Creation of an Innovative Cluster "Ecopitanie", for the first time in the country, territories were ranked according to the degree of readiness for transition to organic production.

As of today, the list of Russian certified organic producers who voluntarily provided information about their activities to the National Organic Union includes 82 organizations, most of which have a certificate for the production of crop products. Only 9 of them declared the production of organic livestock products: 7 – dairy, 5 – meat (including from the first nine), 2 – baby food. Most of them are concentrated in the Kaluga and Yaroslavl regions [18]. The Volga Federal district is represented in this list by 9 organizations, but its potential for production and domestic consumption is much greater. We have studied one of its typical agricultural regions – the Saratov region (part of the Volga

Federal district and the Volga economic district, the total area – 101.2 thousand sq. km, population – 2.4 million people, 10th place among Russian regions in terms of agricultural production, agricultural land – 8.4 million hectares). Most of agricultural producers of the region specialize in the production of grain and sunflower.

Statistical information on the volume of production and domestic consumption of organic products is not provided in official sources, but this does not mean that the products are not available in the region. Local producers were not able to obtain the necessary documents in the unavailability of quality proof procedures. And those that are certified according to foreign standards, faced with a cancellation of all previously received certificates for the products intended for the Russian market after the entry into force of Federal law № 280-FZ "On Organic Products and Amendments to Certain Legislative Acts of the Russian Federation" of 01.01.2020 [8]. The certificates can be collected again only in the organization that is accredited to carry out organic certification according to the Interstate standard GOST 33980-2016 "Organic products. Rules of production, processing, labeling and sales" [23] in the Federal Accreditation Service (Rosaccreditation), for the moment it is OOO "Organic expert" (certificate number RA.RU.10HB01).

To diversify the development of rural areas, the contribution of organic crop production is important, in particular, through the use of crop-and-grass rotation farming, and development of organic production in protected natural areas. The region is a border area, so an effective sales channel is the exports of crop products (Nesmyslenov, 2019) [19]. 6 suppliers of organic grains, legumes and oilseeds were revealed as exporters in the region (Table 2). The farms producing certified organic livestock products have not been identified.

Table 2. List of exporters of certified organic products of the Saratov region

Exporter	Type of product	Certificate of quality	Exports destination
OOO «Idolga Agro» (Tatishchevsky district)	cereals, legumes, oilseeds	Organic standard (Ukraine), EU Organic equivalent to EU Regulation (EC) № 834/2007 and № 889/2008	Europe
OOO «RosAgroSaratov» (Saratov district)	cereals, legumes	A CERT	Europe
Sergey Vilademirovich (Balakovsky district)	barley, chickpeas, oats, rapeseed, sunflower, wheat, lolium (ryegrass)	ECOCERT EU Organic equivalent to EU Regulation (EC) №834/2007 and №889/2008, NOP	Europe, USA
IE «Vyazov Victor» (Ekaterinovsky district)	flax, sunflower, poppy, mustard, millet	Ceres (Germany)	Germany
OAO «Selkhoztekhnika» (Perelyubsky district)	red and green lentil, flaxseed, rapeseed, peas, wheat, corn, sunflower	IMO (Switzerland), EU Organic equivalent to EU Regulation, № 834/2007 and № 889/2008, USDA NOP	Europe, USA
Sokolov Alexander Vladimirovich (Perelyubsky district)	corn, flax, soy, sunflower, winter wheat	ECOCERT EU Organic equivalent to EU Regulation (EC) № 834/2007 and № 889/2008, NOP	Europe, USA

Source: own elaboration according to National Organic Union [18].

RESULTS AND DISCUSSIONS

According to the results of the author's study of the retail market of the city of Saratov, it can be noted that products of ecological farms are in guaranteed demand among the solvent part of the population with incomes above the average (Chernyaev, Serdobintsev & Aleshina, 2019) [7]. A number of health food stores are already operating, including chain stores: “Shpinat”, “Olivkovaya roshcha”, “Svoje khozyajstvo”, “Ovsyanka”, “Pyaty urozhai”, and “VkusVill”. Products in such stores are usually significantly more expensive than their analogues, and this pricing policy significantly narrows the circle of potential consumers. The increase in demand is observed during periods of religious fasts, when customers try to diversify their menu. In Europe, the difference in the price of organic products and analogues produced using conventional technologies ranges from 15% to 50%; in Russia this indicator often reaches a value of more than 300%. There is a problem of pricing, which, together with the modest incomes of the population, causes low effective demand. In addition, according to store employees, the concept of "organic products" is not yet familiar to consumers. They do not differentiate between the terms "organic", "natural" or "eco-friendly". In addition, today the issue of greenwashing and falsification is acute. There are practically no organic products in the market the quality of which is confirmed by the relevant certificates.

The developed methodology for calculating the potential capacity of the organic market is based on determining the cost of a food basket formed in accordance with the dietary intakes in energy and nutrients (based on the Order of the Ministry of Health of the Russian Federation № 614 of August 19, 2016 "On Approval of Recommendations for Rational Consumption of Food Products that Meet Current Requirements of Healthy Nutrition" (Table 3).

Table 3. Comparison of the cost of a monthly food basket of staple conventional and organic products (according to the recommended dietary intake in energy and food nutrients) in the Russian Federation

Product category		Cost of a monthly standard basket in the consumer market (according to the Federal State Statistics Service of the Russian Federation [24] as of 13.01.2020), EUR	Cost of monthly standard basket in the online stores of organic products, EUR	
			min.	max
Meat	beef	8.50	21.41	27.32
	pork	5.73	14.22	15.78
	lamb	1.34	4.98	5.85
Poultry	meat	5.37	21.83	25.54
	eggs	15.17	44.86	110.73
Fresh-frozen fish	Alaska pollock	4.54	6.81	11.35
Dairy products	milk	7.56	18.90	38.70
	butter	1.52	3.71	9.24
	sour cream	0.79	2.32	8.66
Bread products		4.96	43.20	66.56
Sunflower unrefined oil		1.30	12.21	37.35
Cereals	buckwheat	0.17	0.86	1.72
	millet	0.16	0.83	2.70
Vegetables	potatoes	2.40	15.30	27.38
	carrot	0.57	1.49	10.37
	white cabbage	1.03	2.40	6.56
	onion	0.30	0.79	3.03
Fruits	apples	6.30	10.93	16.35
Sugar	beet	0.98		
	cane		21.02	42.04
Sault	table	0.05		
	marine live and pink Himalayan crystallized		2.71	11.92
Total		68.75	250.76	479.14

Source: own calculation.

The analysis uses the current prices for traditional for the Russian population conventional food products and revealed price ranges for available organic products presented in online stores ("Ryabinki.ru", "Organic-market.ru", "Ecotopia.ru", "Biostoria.ru", "Delikateska.ru" "BIOmDV", etc.). Due to the lack of information about organic beet sugar and table salt, prices for their possible analogues were used in the calculations. The comparison showed an average excess of prices for organic products over retail prices of conventional products by categories: meat - 3.2 times, fresh-frozen fish - 2 times, dairy products - 5 times, bread products -11 times, cereals - 9.1 times, vegetables - 7.5 times. For the purpose of motivated identification of potential consumer audience, the cost of a monthly food basket of staple conventional and organic products was calculated. The calculation clearly showed that food basket of organic products is more expensive: at the minimum price level – 3.6 times (by EUR 182.01), and at the maximum level –7 times (by EUR 228.38).

Comparison of the obtained values of the price difference and the average per capita income of the Russian population allowed determining the number of residents whose consumer preferences may be directed towards the organic segment of the agricultural food market. We believe that this is 3.4% of the total population (about 5 million people), whose income exceeds EUR 1,460 per month per family member. According to preliminary estimates, the capacity of the potential retail market for organic food products may average EUR 21.9 billion (Table 4, Fig. 2).

Table 4. Preliminary calculation of the potential retail market capacity of organic food products in the Russian Federation

Product category		**Capacity of potential market**			
		in kind, thousand tons (million items)	in terms of value (million EUR)		
			min	max	average
Meat	beef	364	1,284.56	1,639.27	1,461.92
	pork	327.6	853.20	946.80	900
	lamb	54.6	298.95	351.15	325.05
Poultry	meat	564.2	1,309.61	1,532.52	1,421.06
	eggs	4732	2,691.41	6,644.02	4,667.72
Fresh-frozen fish	Alaska pollock	400.4	408.46	680.76	544.61
Dairy products	milk	1,965.6	1,134.00	2,322.00	1,728.00
	butter	36.4	222.46	554.37	388.42
	sour cream	54.6	139.20	519.75	329.48
Bread products		1,747.2	2,592.00	3,993.60	3,292.80
Sunflower unrefined oil		218.4	732.60	2,241.00	1,486.80
Cereals	buckwheat	72.8	51.48	103.36	77.42
	millet	36.4	49.67	162.18	105.93
Vegetables	potatoes	1,638	918.00	1,642.50	1,280.25
	carrot	309.4	89.46	621.96	355.71
	white cabbage	728	143.86	393.61	268.73
	onion	182	47.31	181.77	114.54
Fruits	apples	1,019.2	655.67	980.70	818.18
Sugar	cane	436.8	1,261.20	2,522.40	1,891.80
Sault	marine live and pink Himalayan crystallized	72.8	162.56	714.98	438.77
Total			15,045.66	28,748.69	21,897.18

Source: own calculation.

The reasons for our research were adopted law and the state standard regulating the requirements for the organic sector in Russia.

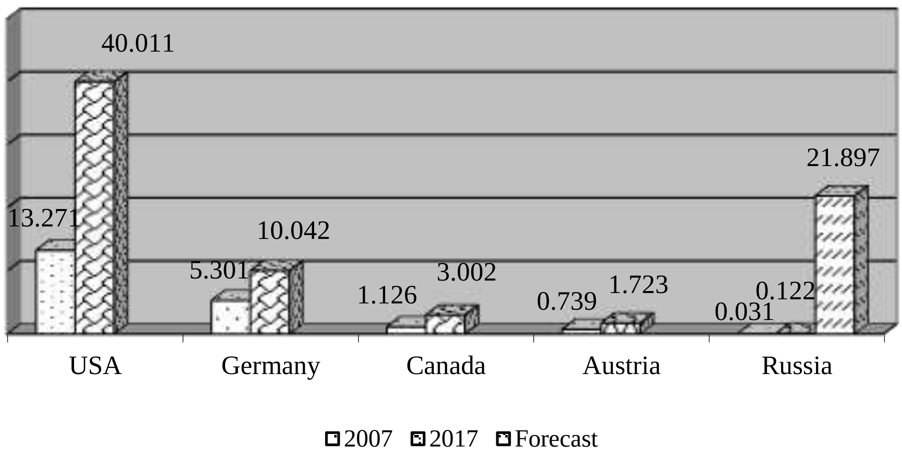

Fig. 2. Dynamics of growth in retail sales of organic products in domestic markets, in EUR million
Source: own calculation according to FiBL [9].

As the basis of the mechanism for the development of the organic food market, we have proposed an interdisciplinary fundamental platform that includes theories (of goods, value, entrepreneurship, marketing and institutional), principles (market balances, motivations, ecological orientation, quality verification, etc.), factors (purchasing power of the population, food culture; demographic situation; consumer habits, level of environmental awareness of the population; dietary intakes; distrust of the population towards organic products; availability of household plots in the population) and methods (monographic and comparative analysis, empirical, computational-and-constructive, economic-and-statistical, modeling).

Production of organic products in Russia should be oriented on the prospective consumer demand both at the national scale and in the popular export area. The potential capacity of the consumer market of organic food products was calculated taking into account the heterogeneity of consumer preferences, average prices for conventional products and price range for organic products on the basis of recommended dietary intake of food that meet present-day requirements of healthy nutrition. Segmentation of consumers by income level and costing of a monthly food basket for staple conventional (EUR 68.75) and organic food products (from EUR 250.76 to EUR 479.14) provides a basis for forecasting the potential market capacity of organic products in the amount of about EUR 22 billion.

The results of our research are addressed to participants of the world organic food market, government agencies and industry research institutions.

CONCLUSIONS

Today, the organic market is one of the most dynamically developing in the world. The production of organic food is an important factor in improving the quality of life and improving the state of the ecosystem.

Our study is the first attempt to form an interdisciplinary fundamental platform for developing the theory of organic food market and justify the potential capacity of the consumer market of organic food in Russia. Among the opportunities for development of the Russian organic market the priorities are the following: a strategically advantageous position of the state (availability of all types of transport networks; possibility of a rapid access to markets of a large number of countries, including along the "Meridian" highway under construction, which will connect China, Kazakhstan, Russia, Belarus and European countries); involvement of unused agricultural land into the land turnover; solving the problem of ensuring the sustainable development of rural areas. Significant threats should be recognized: penetration of products labeled "bio", "eco" into domestic market under the guise of organic products, and, as a result, the substitution of basic concepts of organic production; weak competitiveness of organic products compared to conventional ones due to the wide possibilities of reducing prices for the latter by transnational companies as a result of the use of genetic engineering biotechnologies; widespread deterioration of the overall environmental background.

Although the features of organic agriculture formation are sufficiently studied in the present-day scientific publications, there are still open questions related to the transfer of this positive experience in the field of processing of agricultural raw materials. Many problems lie in the creation of a favorable external environment for organic production, including increasing its investment attractiveness, as well as information-analytical support, simplification and acceleration of certification procedures, targeted state regulation of organic production; all this determines the areas of future research. New developments should be based on a combination of systemic and process approaches and that allows linking managed (producers, consumers, infrastructure) and managing (initiators, coordinators, national network of research institutes) systems, improved processes, methods and performance indicators of organic market development, grouped for producers of raw materials and products, processing organizations, infrastructure facilities, social and environmental spheres.

Despite a large number of publications in recent years devoted to the development of the organic food market in Russia, its total potential (production and consumer) has not yet been identified. Many problems lie in the creation of a favorable external environment for organic production, namely: the development of measures of state support for the organic sector, including those that do not involve direct financing, acceleration of the process of harmonization of Russian legislation in this area and ensuring the equivalence of organic standards and technical rules with international ones in order to simplify access of Russian producers to foreign markets, development of export potential in the organic segment, solving the problem of mimicry of products like organic, and, as a result, promotion of organic food products in the domestic market; all this determines the areas of future research. In addition, there is still an open question related to optimizing the price premium for organic products, which provides an increase in their attractiveness in comparison with industrial analogues in food retail and consumer loyalty.

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ASSESSMENT OF THE RURAL POPULATION ECONOMIC ACTIVITY IN THE SYSTEM OF UNITED TERRITORIAL COMMUNITIES DEVELOPMENT: A CASE STUDY OF VOLYN REGION, UKRAINE

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Abstract

The article evaluates the dynamics of the main indicators of economic activity of the rural population of Volyn region, formed and highlighted trends in their development in the region and compared with neighboring regions within the Polissya economic zone of Ukraine. Particular attention is paid to the analysis of the intensive reduction of employment of the rural population in traditional sectors of economic activity, which leads to an increase, on the one hand, rural unemployment, and on the other – to an increase in employment in personal peasant farms. The study substantiated that employment in the personal economy turned out to be more profitable for the rural population – the income per unit of labour there is now about twice as high with twice as low labour productivity. The explanation for this is the shadow nature of production in peasant farms and the imbalance of the economic mechanism in enterprises. It is substantiated that, taking into account the number of employed persons who produced products for personal consumption in private farms, programs inefficient use not only of their labour resources, but also reduces the average industry efficiency of labour resources of the agricultural sector as a whole. Among other features of the rural labour market of Volyn region, which limits its development, we can point to the non-compact distribution of the rural population in the territory. Peculiarities of the settlement network in Volyn region are that the dominant segment of rural employment is agricultural enterprises. It was found that in the current conditions it is advisable to develop and implement a set of measures to improve demographic processes, optimize employment and improve the living standards of the rural population, which requires effective cooperation between government and research institutions, relevant authorities and interested private entities. It is proved that in the rapidly changing conditions of modern times the optimization of territorial mobility of the working population between types of employment, areas of employment, insufficient and surplus areas, adaptation of statistical information base to the specifics of rural employment to rationalize economic activity and prevent negative phenomena continue to be extremely important and acute issues in Ukraine.

Key words**:** *economic activity, rural labor market, unemployment, peasant farms, united territorial communities*

INTRODUCTION

In modern realities, the underdevelopment of the employment system within the rural sphere limits employment opportunities and mobility of labour resources, encourages them to employment outside the official sector, migration from the countryside. The situation is complicated by the fact that neither the system of active employment policy measures, nor the financial base of the regulation subjects of economic activity, nor the infrastructure of the labour market is directed to the countryside. Under such conditions, negative changes in the economic activity of the rural population are deepening, becoming spontaneous and unregulated, leading to social tensions, and ultimately – to the destruction of the labour potential. These processes have become especially acute in Western Ukraine, where they are further complicated by significant labour migration of the working population to earn money abroad.

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Socio-economic performance, features and problems of increasing of the rural population economic activity in the scientific literature are studied in various aspects and are reflected in the works of many scientists, including Diiesperov V. S. [2], Libanova E. M. [9], Boiar A. O. [1], Petiukh V. M. [10], Popescu A. [11, 12, 13, 14, 15, 16, 17, 18, 19, 20], Sabluk P. T [21], Shmatkovska T. O. [3, 22, 28], Sodoma R. I. [25], Tofan I. N. [27], Yakubiv V. M. [29], Zhurakovska I. V [30] and others. Thus, new trends in employment, their impact on the socio-economic development of the countryside were studied by Diiesperov V. S, who proposes to solve the problem of employment in the countryside by intensifying, i.e. expanding labour-intensive industries, livestock development [23]. Dolishnii M. I emphasizes the importance of socio-economic and regulatory regulation of regional labour markets [23]. The situation of the labour market in the countryside, the peculiarities of the rural population employment studied in her works Kupalova G. I. [8]. She justifies the increase of the age limit for the employed population of Ukraine to 65 years. Sociological survey of Kilnitska O. S indicates extremely low labour mobility in rural areas, especially women [7]. According to Garasym P. M, Bitter O. A, like most scientists, the problems of increasing the income of the rural population and the level and structure of its employees are extremely closely related [6]. Therefore, it is impossible to solve the other without solving one of them.

MATERIALS AND METHODS

Despite the large number of works devoted to the studied issues, we believe that it is necessary to constantly monitor the economic activity of peasants in terms of regions of Ukraine, taking into account the dynamics of socio-economic aspects of agro-industrial development, which is the purpose of our article.

Particularly relevant are the analysis of the current state of the labour market in rural areas in order to determine the main trends of its development, as well as the development of measures for forecasting and regulating informal employment, substantiation of the main directions of optimizing economic activity and increasing rural employment within the system of united territorial communities development in the countryside.

The theoretical and methodological basis of the study is the basic provisions of modern economic theory, the work of leading domestic and foreign scientists. Conducting of the research is based on the use of such methods and methodological approaches: analysis and synthesis, structural analysis, grouping methods, graphical and tabular methods – to display visually the results of the research.

The study was conducted on the basis of official data of the State Statistics Service of Ukraine and the State Statistics Committee in Volyn region of Ukraine. The results are presented and illustrated in graphics, of which just a part is included in this article.

RESULTS AND DISCUSSIONS

Assessment of the main indicators of economic activity dynamics at Volyn region of Ukraine, which belongs to the regions where 76.2% of the population lives in the countryside [26], produces a significant share of agricultural products, and the agricultural sector of the region`s economy is one of the most powerful in Ukraine. It provides an opportunity to form trends of development in the region and comparison with neighbouring regions within the Polissia economic zone.

As of the beginning of 2018 in 2,152 villages of the region (besides the village of Barvinok of the Lutsk district of the Volyn region, in which there is no population at all, but it is not removed from the state register) live 21.8% of children under 15 years, 52.5% – rural population of working age and 25.7% – rural population older than working age.

Together with the Volyn region, the Polissia economic zone includes the Rivne, Zhytomyr and Chernihiv regions of Ukraine. Comparing the indicators of economic activity of these regions, it should be noted that the highest level of economic activity in the study period is observed in Chernihiv region (Fig. 1), which is 5.5% higher compared to Rivne region, where not only the share of the economically inactive rural population its general structure is the largest (34.2%), but also its absolute value (166.8 thousand people).

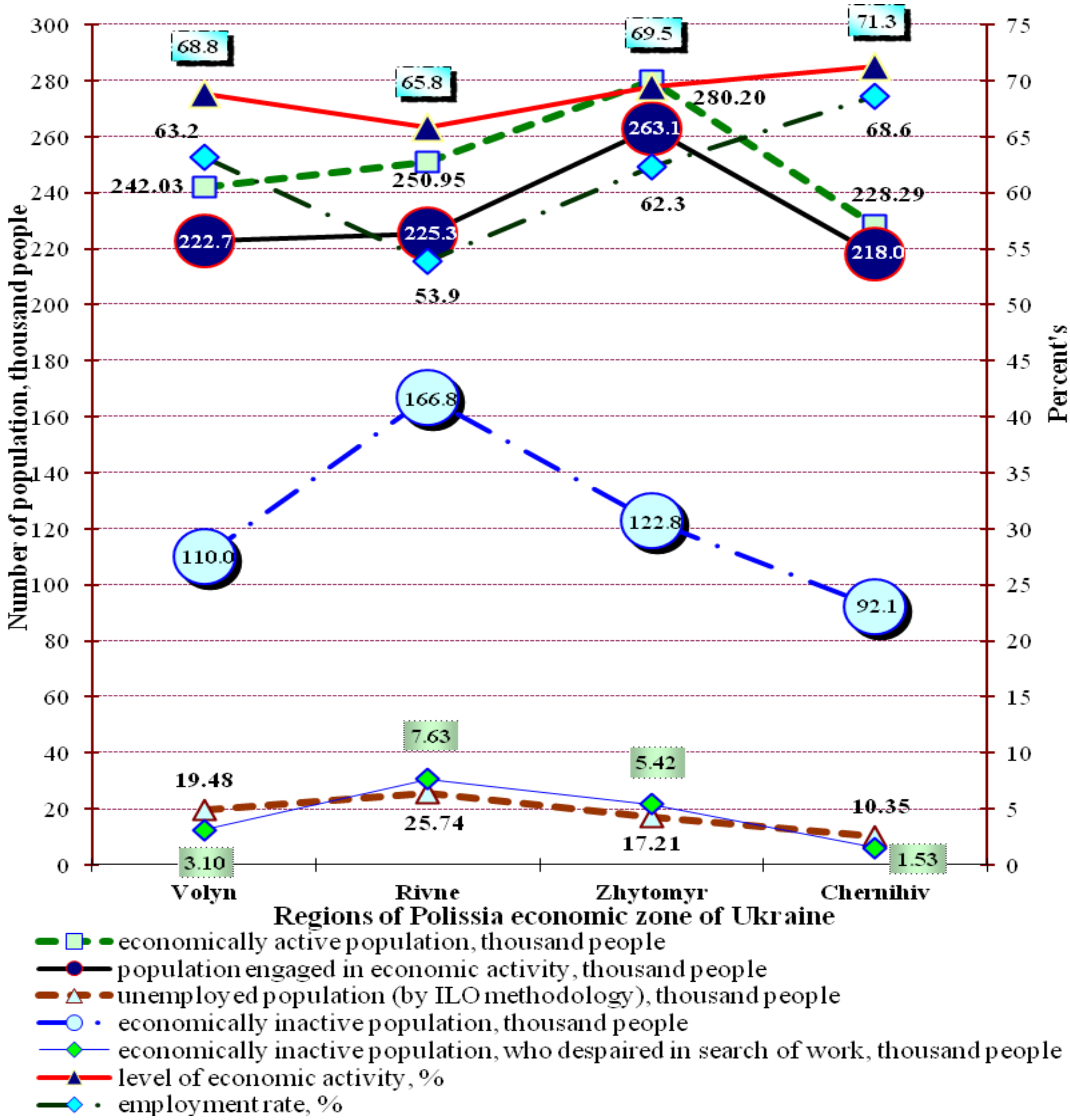

Fig. 1. The main indicators of the rural population of economic activity the Polissia economic zone of Ukraine in 2018
Source: Developed by the authors based on source [4, 24, 26].

Economically active is the able-bodied population that works or is actively looking for work, i.e. is the labour force. The share of the labour force in the structure of the rural population within the Polissia economic zone of Ukraine is highest in Chernihiv (71.3%) and Zhytomyr regions of Ukraine (69.5%), comparing the absolute value of the economically active rural population of these regions, we note that it is the largest is in Zhytomyr (280.2 thousand people) and Rivne (251.0 thousand people) regions of Ukraine. When estimating the level of employment, it turned out that it is highest in Chernihiv (68.6%) and Volyn regions (63.2%), where the number of the economically active rural population in comparison is relatively small (respectively 228.3 thousand people and 242.0 thousand people compared to 280.2 and 251.0 thousand people in Zhytomyr and Rivne regions of Ukraine). Thus, within the Polissia economic zone of Ukraine, there is a clear pattern of much better development of the labour market in those regions where the number of the economically active rural population is relatively low, which, in our opinion, is associated not only with a sound economic policy in this direction, but also with the relative lack of surplus labour in the rural labour market of these regions, which, other things being equal, had a positive effect on employment.

The analysis shows relative backwardness in terms of economic activity in the studied period of Rivne region, although compared to 2017 there are some trends to improve its situation, so the level of economic activity increased by 11%, employment – by 5.5%, the number of the unemployed rural population (according to the methodology of the International Labour Organization) decreased by 17.36 thousand people. However, in general, the situation in Rivne region requires immediate action to improve it, as the low level of economic activity indicates an unfavourable economic situation in the region, in particular the lack of conditions for its full implementation, forcing the rural population to give up work and stay. as part of the economically inactive population. It should be emphasized that the level of economic activity must be sufficient and stable, as too high can be achieved at low wages when the employment of standard duration does not provide a living wage.

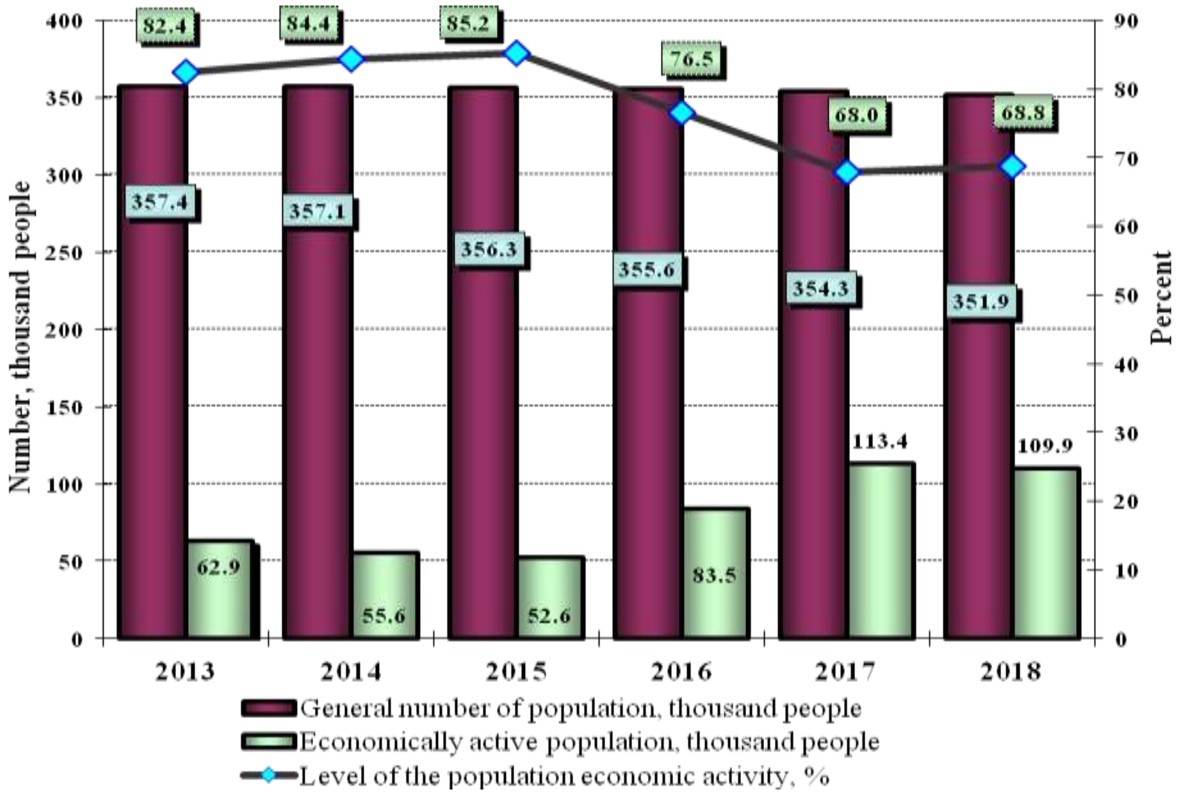

Fig. 2. Dynamics of the rural population economic activity of the Volyn region of Ukraine in 2013 – 2018
Source: Developed by the authors, based on source [4].

Assessment of the level of economic activity dynamics of the rural population of Volyn region of Ukraine in 2013-2018 (Fig. 2) shows that by 2015 there is a trend of its insignificant growth, so compared to 2013 in 2014 the economic activity increased by 2%, and in 2015 compared to 2014 – by 0.8% and amounted to 85.2%. However, since 2016, this trend has changed from positive to clearly negative, in particular, in 2016 compared to 2015, this figure decreased by 10.2%, and in 2017 compared to 2016 – by 8.5% and as a result was 68.0%. Only in 2018, the economic activity rate increased by 0.8%. As a result, according to the results of the study, we found a decrease in the level of economic activity of rural residents of the Volyn region of Ukraine for 2013 – 2018 by 13.6% and the establishment of such a level of 83.5% of its value in 2013. According to the factor analysis results by this indicator, we found that the decrease in the study period of the rural population by 5.5 thousand people. (i.e. by 1.5%) led to an increase in the level of economic activity by 1.3%. At the same time, it was found that the decrease in the number of economically active population by 52.5 thousand people led to a decrease in the level of economic activity of the rural population of the Volyn region of Ukraine in the study period by 14.9%.

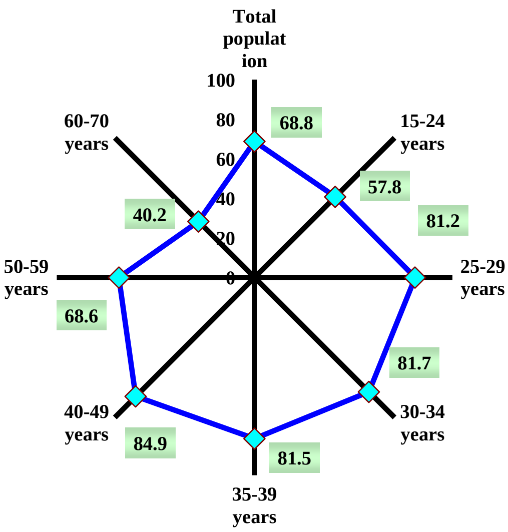

Fig. 3. The level of economic activity of the rural population of Volyn region by age groups in 2018 (as a percentage of the population of the relevant age group)
Source: Developed by the authors based on source [4, 5].

It is important that the economic activity of certain age groups depends on certain factors. In the Volyn region, the highest economic activity is observed in peasants aged 25-49 years (81.2-84.9%), and the lowest – in the rural population older than working age (60-70 years) – at 40.2%. (Fig. 3), which is due, in our opinion, the peculiarities of the pension system. The activity of young people is determined by the term of study, women – by the degree of conditions created in the state to combine employment with family responsibilities, childbearing, as well as gender balance in society. Note that in Ukraine the highest economic activity is observed in people aged 35-39 years, and the lowest – 60-70 years.

Employment, as a form of realization of economic activity of the population, is a complex and historically determined phenomenon. Its immediate cause is a progressive process of increasing labour productivity. Another reason is the free behaviour of employers, who have no obligation to provide employees with work. Because productivity growth allows for fewer workers, the employer is trying to reduce the cost of expensive labour in this way. The surplus of labour, however, is always relative. The impossibility of its full and rational use is the result of an imbalance between the factors of production.

Some scholars believe that the level of employment of the rural population is determined primarily by the level of employment of urban residents. According to the results of the research, it has been established that over the last three years the level of rural employment in the Volyn region significantly exceeded the city level, which is especially noticeable in 2016 (by 22.3%).

Analysing employment by age groups, it should be noted that in the Volyn region of Ukraine in 2018 the rural population at any age of economic activity is characterized by a relatively higher level of employment than urban, especially this difference is felt by age groups 15-24 years (24.5% employed urban population against 50.6% of rural population) and 60-70 years (10.4% of the employed urban population against 40.2% of rural population).

According to scientists in rural areas, employment opportunities for locals are incomparably narrower than in cities. The areas of application of human labour here are much poorer. In cities, even in the conditions of the most severe socioeconomic crises, certain spheres of human activity are revealed, which are expanding and developing. The development of these areas may eventually lead to the creation of an economic base to restore the effective development of the entire economy and solve the problem of employment. However, the current situation in the Volyn region of Ukraine, as in most regions, is due to the fact that in rural areas the level of income is much lower than in the city. The catastrophic decline in family budget revenues forces us to look for additional sources of income by continuing to work for retirees, attempts to employ other members of the household of working age who were previously dependent. Moreover, in the structure of employment of the population of Volyn region, there is also a significant differentiation between urban and rural areas, it is especially noticeable in older age groups (40-70 years), where it reaches 7.4 - 8.0% and young people aged 15-24 years, where is 6.5% (Fig. 4).

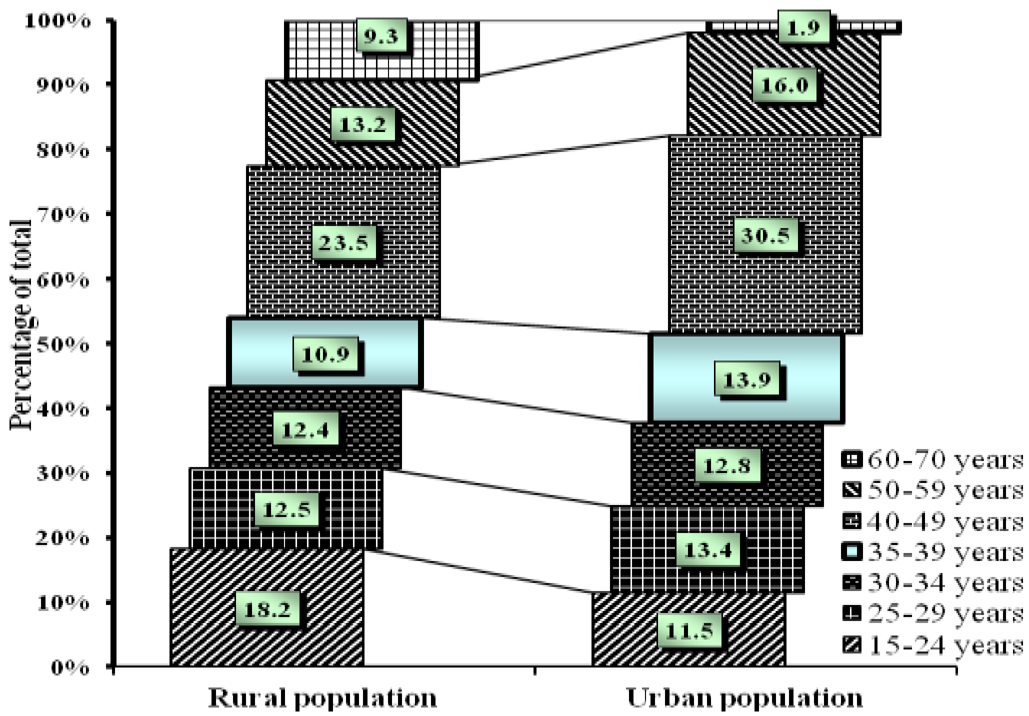

Fig. 4. The structure of employment of the population of Volyn region of Ukraine by age groups and place of residence in 2018 (as a percentage of the total)
Source: Developed by the authors based on source [24, 26].

The results of assessing the dynamics of flows of the rural population of the Volyn region of working age by areas (industries) of employment showed that during the study period (2014 – 2018) there were significant structural changes. Against the background of a general decrease in the number of people employed in economic activities, for example, in construction – 10.4 times (2,597 people), electricity, gas, and water production – 15.7 times (1,217 people), mining and manufacturing – 4.4 and 3.1 times, respectively (for 1,469 and 3,139 people), there are quite dynamic intersegmental overflows of labour in the rural labour market of the Volyn region of Ukraine (Fig. 5). Moreover, such processes can be traced to all types of economic activity without exception, especially they are noticeable in quantitative terms not only in agriculture and forestry but also in the areas of health and social assistance, where the number of employees decreased by 3,904 people, transport, post office. and communications – for 4,188 people.

Regarding the analysis of the structural changes in employment in terms of economic activities of the rural population in the Volyn region of Ukraine for 2014 – 2018, we found an increase in the share of employed in education – by 10.34%, employed in trade – by 2.23% and a decrease in the share employed in the agricultural sector – by 8.75%, employed in construction – by 1.65%, employed in transport, post, and communications – by 1.87%. We believe that with the help of state support levers (preferential taxation, lending, etc.) in rural areas it is advisable to gradually restore the traditional industrial activities located here, such as mining and production of building materials and other mineral products, processing of agricultural products, etc. etc., which will lead to a gradual increase in employment of the rural population in these areas.

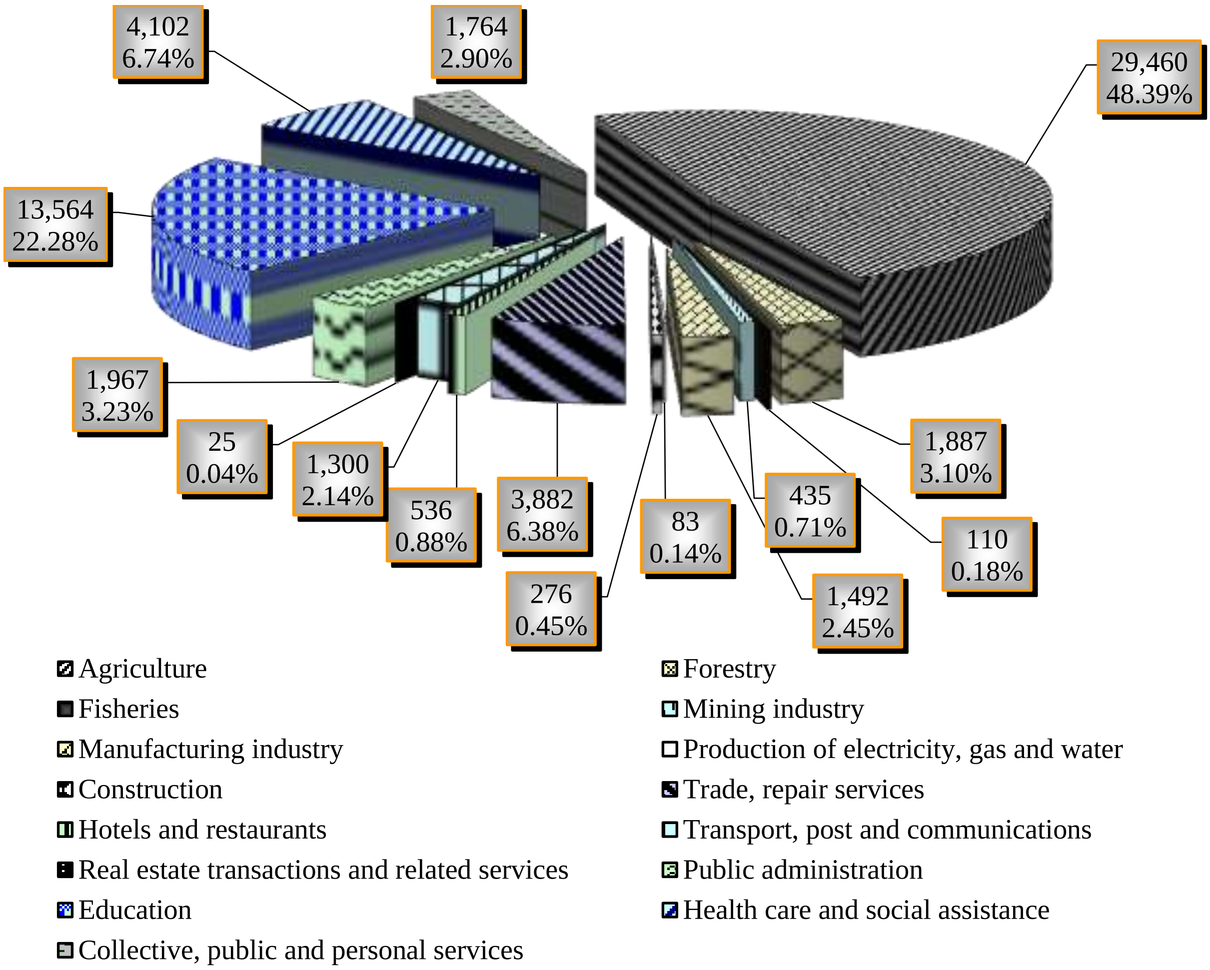

Fig. 5. The structure of employment of the rural population of the Volyn region of Ukraine, employed at their place of residence in terms of economic activities, as of 01.01.2018, persons (%)
Source: Developed by the authors based on source [26].

It is well known that the functions of meeting the social and economic needs of citizens living and working in rural areas must be performed by economic entities located there for various purposes. It should be noted that in a significant number of villages in the study area there are no economic entities at all, in particular, this situation is observed in 56.7% of villages in Ratno district, where 22 thousand peasants live; in 50% of the villages of the Turiisk district, where 9.4 thousand peasants live; in 48.5% of villages of Luboml district with a population of 14 thousand people; in 46.8% of villages of Volodymyr-Volynskyi district with a population of 11.8 thousand people; in 44.8% of villages of Ivanychi district, where 12.8 thousand rural population lives. In general, 36% of rural settlements in the Volyn region, where 187.5 thousand people live, do not have any business entities, so it is inexpedient to talk about the appropriate level of social functions in them.

One of the most important among the business entities operating in modern conditions in the countryside is agricultural production formations of various types. They have a multi-purpose social and industrial purpose, a decisive place among which is occupied, on the one hand, the efficient use of land and other resources, and on the other - the employment of rural residents. In the Volyn region, the largest share of agricultural enterprises is located in the Kivertsi district (9.8% of their total number), Kovel (9.0%), Lutsk (11.2%), Rozhysche (9.3%), and Horokhiv (7.9%) areas. However, as a result of market transformations, agricultural enterprises were relieved of specific functions previously assigned to them for the construction and maintenance of social infrastructure, in general, communal farms as separate production units, which performed various tasks at the request of the population: delivery of construction materials, gas supply, repair and construction of residential buildings, provision of services for farming, etc. Therefore, such services are potential jobs for the rural population of the region. Having no official employment in the service sector, some people are employed on farms, thus overestimating employment in the agricultural sector. After all, the need to ensure the competitiveness of agricultural products and technical and technological progress in agriculture brings labour productivity in it closer to the level of developed countries, and therefore - leads to a gradual decline in employment in this area.

Among other features of the rural labour market of Volyn region, which limits its development, we can point to the non-compact distribution of the rural population in the territory. Peculiarities of the settlement network in Volyn region are that the dominant segment of rural employment is – agricultural enterprises, which is especially noticeable in Horokhiv district – 68.4% of workers at the place of residence are employed in agriculture, Rozhysche – 67%, Lutsk – 60.1%, Kovel districts – 57%, where the share of agricultural formations in their total number is the most significant. In the field of health care, the most employed are in Lyubeshiv – 10.4% of employees at the place of residence, Kamin-Kashyrskyi – 8.2%, Kovel districts of Volyn region – 7.2%.

According to the results of the study, we found a significant imbalance in the employment of the rural population of the Volyn region on a territorial basis and employment areas. The tendencies revealed by us to reduce the indicators of employment of the rural population in the traditional for the village industries both within rural settlements and outside them cause the imbalance of the rural labour market. This leads to an increase, on the one hand, rural unemployment in all its forms, on the other – the number of employed rural residents in other areas, most notably private entrepreneurship, and personal peasant farms.

More than 52.5% of rural residents of Volyn region, who are officially registered as employed, work in farms. The particularly high share of employees in peasant farms is in Kamin-Kashirsky (749 people out of every 1,000 employees), Manevychi (714 people out of every 1,000 employed), Stara Vyzhva (691 people out of every 1,000 employed), Ratno districts (668 people out of every 1,000). employed) Volyn region of Ukraine. Thus, a specific adaptation of the rural population to the new situation was found - their employment and income were restored. However, such a transformation had negative consequences for Ukraine`s economy – a sharp decline in social efficiency.

CONCLUSIONS

However, the loss of permanent employment in official production results in social losses for rural workers, and income from personal farming cannot be considered satisfactory, as it is much lower than earnings in other sectors of the economy. In addition, taking into account the number of employed persons who produced products for personal consumption in private farms, programs inefficient use not only of their labour resources, but also reduces the average industry efficiency of labour resources of the agricultural sector as a whole.

Given the above, it should be emphasized the need to recognize rural workers as a «liquid commodity», ensuring the value of their labour, sufficient for the systematic reproduction of human resources, improving the intellectual level and quality of human capital in rural areas. It is advisable to develop and implement a set of measures to improve demographic processes, optimize employment and improve the living standards of the rural population, which requires effective cooperation between government and research institutions, relevant authorities and interested private entities.

We consider it expedient to emphasize that in the rapidly changing conditions of modern times the optimization of territorial mobility of the working population between types of employment, areas of employment, insufficient and surplus areas, adaptation of statistical information base to the specifics of rural employment to rationalize economic activity and prevent negative phenomena continue to be extremely important and acute issues in Ukraine, the solution of which should be the result of a set external, systematic approach and effective, effective cooperation of scientific institutions, business entities and government agencies. The above requires from the institutions of science hard work to intensify research activities on the issues under study in the short and long term.

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TECHNICAL AND ECONOMIC EFFICIENCY OF ANCIENT WHEAT SPECIES, GROWN UNDER DIFFERENT TECHNOLOGIES OF ORGANIC FERTILIZATION

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Abstract

The consumer awareness and interest in food quality is growing which leads to greater demand for organic products. Organic farming is helping to maintain biodiversity in the agro-ecosystems, as well as to preserve traditional species and varieties of crops and rare breeds of animals in certain regions or countries. The main objective of the paper is to observe the technical and economic efficiency of the three species of ancient wheat, grown under different technologies of organic fertilization and sowing rates. The study is conducted at the experimental centre for organic production at the Agricultural University – Plovdiv during the period 2014 – 2017. The analysis of results showed different levels of technical efficiency of the three wheat species, grown under different technologies of bio fertilizer treatment. On the other hand, the high prices of the approved fertilizers for organic production do not guarantee the economic efficiency of their application. In fact better economic results were observed without use of fertilizers. It was also concluded that higher sowing rates of the wheat species impacts positively on yields.

Key words: *Triticum monococcum L., Triticum dicoccum Sch. and Triticum spelta L.,average yields; organic fertilizers*

INTRODUCTION

The intensification and chemicalization of agriculture in the past decades had a negative impact on the environment, soil, landscape and biodiversity of ecosystems. These agronomic practices have led also to air pollution, soil and groundwater pollution [3, 5]. Nowadays there are serious challenges related to the growing population and consumption on the one hand and reduced natural resources, climate change and worsening living environment on the other. It is necessary to transform agricultural production patterns to more sustainable ones. This is combined with the growing consumer awareness in the field of food quality and safety.

Organic agriculture is an alternative to the conventional production. In the last years demand for organically produced food is growing [4]. In many countries worldwide farmers are getting more and more interested in the environmentally friendly organic production technologies. One of the reasons is associated with the governmental support, but the wider application of these practices is related also to the possibilities for greater economic efficiency.

According to Eurostat the total area under organic farming in the EU continues to increase, and in 2018 covered 13.4 million hectares of agricultural land [9].

In the European Union, the largest markets for organic products are Germany, with 10 billion EUR and France, with 7.9 billion EUR. Organic farming is priority area in the European common agricultural policy beyond 2020 [8]. In Bulgaria, organic farming is becoming more important, as the demand for organic products is gradually increasing.

Organic farming is helping to maintain biodiversity in the agro-ecosystems, as well as to preserve traditional species and varieties of crops and rare breeds of animals in certain regions or countries. The role of agriculture for the economy and the sustainability of rural regions are really important [14, 20].

In the technologies of organic production, chemical fertilizers are almost prohibited, but some soil additives and leaf fertilizers are approved for application, which is an effective option for farmers to improve quantity and quality of production.

Therefore it is important to study the effect of organic fertilization on crop productivity and efficiency.

Advantages of organic farming are related to the opportunity to grow such varieties of crops or keep animal breeds that are more resistant (durable) to diseases and are more adapted to regional and local conditions.

Triticum monococcum L., *Triticum dicoccum* Sch. and *Triticum spelta* L. are ancient species of wheat, grown in Bulgaria since centuries ago.

Triticum monococcum L. is old cereal crop that has been grown 9,000 years ago in the Balkans and the Central Europe. It has valuable characteristics as resistance to many diseases and the grain contains 17.0 – 22.5% protein [1, 13].

Triticum dicoccum Sch. has been traditionally grown and used as a part of the human diet [17]. *Triticum spelta* L. is considered old European cultural wheat. It contains more proteins, mineral elements, lipids, fibre and vitamins [1].

These wheat species along with the growing interest for organic food, are gaining popularity in the last decades.

Their importance has increased due to the significant change in consumers` perceptions related to healthy diet and food quality.

Some authors analyse the effect of ancient wheat types as a new source of healthy food [2, 6, 15].

Food safety and food quality become matter of global concern [10, 11]. Innovations and adoption of new technologies are considered as an option to solve the emerging challenges. However, the answer of the global issues could be found also by looking back to the past.

The aim of the paper is to observe the technical and economic efficiency of the three species of ancient wheat treated with different organic fertilizers and sown at different sowing rate.

MATERIALS AND METHODS

The study can be divided into two stages– theoretical analysis and practical experiments. During the first one, an extensive review of the scientific literature, related to *Triticum monococcum* L., *Triticum dicoccum* Sch. and *Triticum spelta* L. is done. Various theories and methodologies are examined and adapted for the specifics of this research.

The practical part of the study was conducted at the Agro-ecological Field (Demonstration Centre for Organic Farming) at the Agricultural University – Plovdiv during the period 2014 – 2017. The agro-ecological centre has been a member of the International Federation of Organic Agriculture (IFOAM) since 1993 and it was the first certified organic farm in Bulgaria.

The sowing was conducted in mid-October using a block method in three repetitions with a size of the reported parcel of 10.5 m^2, with sowing rate of 500 g.s./m^2 and 700 g.s./m^2 (germinating seeds per sq.m.) after a pepper as a predecessor. The seeds are from biological origins and are provided by the Institute of Plant Genetic Resources "K. Malkov" – Sadovo, accompanied by the required documents for organic farming.

Three factors analyse was made:

Factor A – growing season:

A1 – 2014/15; A2 – 2015/16; A3 – 2016/17.

Factor B – species if ancient wheat:

B1 – *Triticum dicoccum* Sch.;

B2 – *Triticum spelta* L.;

B3 – *Triticum monococcum* L.

Factor C – types of fertilizers:

C1 – Control (0) – without fertilizers;

C2 – Control (C) – adding to the soil of Agriorgan pellet – 100 kg/da;

C3 – Amalgerol;

C4 – Litovit;

C5 – Baikal M – 1U;

C6 - Tryven;

C7 – (CH-700) – higher sowing rate (700 g.s./m^2) and including Agriorgan pellet – 100 kg/da.

Amalgerol® is a liquid concentrated fertilizer with a large amount of hydrocarbons and natural plant growth hormones. It increases the resistance of plants to drought and improves their condition after frost, drought, hail, etc. Amalgerol accelerates the decomposition of plant residues in the soil and improves microbial activity, in particular mycorrhiza, as well as the structural condition of the soil.

Litovit® is a high-quality nanotechnology product created by tribodynamic activation and micronization. Spryed on the surface of the leaves, it is absorbed directly and is converted into CO_2, which significantly increases photosynthesis. This leads to higher yields and reduced water needs. The additional micronutrients, such as manganese, lead, zinc, etc. also improve the physiology of plants. Not suitable for plants that prefer acidic soil.

Baikal EM-1U is probiotic product containing a large number of beneficial microorganisms. This bacterial fertilizer stimulates microbiological processes in the soil and leads to higher yields of the crops.

Tryven is organic fertilizer. It is a complex mixture of NPK, intended for use through foliar feeding. It is suitable for all types of crops - vegetable, fruit, vineyards, cereals, fodder, technical, citrus, etc., especially efficient for crops with large leafs.

Agriorgan pellet is an organic fertilizer made from sheep manure, enriched with microorganisms and a supplement of trace elements. Improves the structure and quality of the soil, increases fertility and stimulates the humification of organic matter. Agriorgan pellet is a product with an exceptional impact on the physical, chemical and biological characteristics of the soil. It supports the reproduction of microorganisms, increases the biological activity in the soil and thus "rejuvenates" the tired soil.

For each growing season of the analysed period, three repetition of each of the three wheats with the abovementioned foliar fertilizers are made. In order to differentiate the influence of fertilizers as a factor for efficiency and profitability, two more variants were included – Control (C), which represents production method without fertilization and Control (0) which is without foliar fertilization and without Agriorgan pellet. In order to isolate the influence of sowing rate on the technical and economic efficiency of the three crops one more variant, called (CH 700) was tested. It represents repetitions of the three wheats, sown at 700 g.s./m^2.

Each type of wheat was tested in 7 variants and 3 repetitions. Consequently, 21 pitches with *Triticum monococcum* L., 21 pitches with *Triticum dicoccum* Sch. and 21 pitches with *Triticum spelta* L. are evaluated. The study is based on average data for each of the three wheats, based on the three repetitions, in the three year periods.

The analysis of efficiency focuses on the optimization of the production function [19].

Farrell [12] is one of the first authors that define that economic efficiency and link the term to the combination of production factors and optimal output. According to [12] two types of efficiency can be distinguished – allocative and technical efficiency. The allocative efficiency is related to choice of input combination [7, 18]. Technical efficiency refers to the proper choice of production function among all those actively in use by farmers [16].

The study focuses on the analysis of technical and economic efficiency. Economic efficiency in this case measures the difference between revenue and costs for the production of the crops, grown under different technologies of organic fertilization. For the purpose of the analysis, the gross economic result was calculated. That is the value of grain produced (yield multiplied by market price) plus income from selling the straw minus production cost (seeds, fertilizers, chemicals, cultivation, peeling).

The other elements of the revenues and costs are not included in the analysis. Farm subsidies, wages, etc., differ among enterprises. However, all of these potential revenues or costs are not related to the species of wheat or the applied fertilizer. This methodology provides sufficient information on the efficiency of each variant of leaf fertilization.

Technical and economic efficiency of the production of *Triticum monococcum* L., *Triticum dicoccum* Sch. and *Triticum spelta* L. grown under different technologies of organic fertilization is estimated and analysed

for three consecutive vegetation years 2014/15; 2015/16 and 2016/17. The results are also averaged for the three year period.
Experimental data is processed with MS Excel and SPSS V.13.0, using the Duncan, Anova method.

RESULTS AND DISCUSSIONS

During the period 2014/2015, five variants of technology are tested for each of the three wheats – a control (C) without any fertilizers and four variants leaf fertilizers- Amalgerol, Litovit, Baikal EM and Tryven. In all five variants for all of the three wheats is applied organic fertilizer Agriorgan pellet.
The results indicated that *Triticum monococcum* L. has the highest yield even in control (C), without fertilization (247 kg/da unpeeled grain), followed by *Triticum dicoccum* Sch. (193 kg/da unpeeled grain). *Triticum spelta* L. registered the lowest yield (183 kg/da unpeeled grain).
The application of different fertilizers showed different level of technical efficiency. The highest yield (205 kg/da) of *Triticum dicoccum* Sch. is registered from the technology based on application of Amalgerol. The yields of the other variants of fertilization were around 199 kg/da. The comparison of the different variants of foliar fertilization and the control (C) shows relatively small differences. Therefore from economic point of view the application of foliar fertilizers depends on their prices.
For *Triticum spelta* L., the only efficient technology of fertilization was the one with Amalgerol. The yield is 185 kg/da, which is higher than the Control (C), where the result was 183 kg/da. The application of Litovit did not improve the results, achieved in Control (C). Triven and Baikal EM contributed to lower yields than the Control (C) – 178 kg/da and 170 kg/da respectively.
Data from the research showed that *Triticum monococcum* L. had potential during 2014/15 to react greatly on leaf fertilization. All studied fertilizers increased the yield compared to the Control (C). The most effective was the application of Tryven, with average yield 312 kg/da., followed by Amalgerol (275 kg/da), Litovit (264 kg/da) and Baikal EM (264 kg/da).
Economic efficiency differed among wheats and technologies used during the 2014/15 growing season.
Economic results from *Triticum dicoccum* Sch., under all variants of fertilization were positive, but only the application of Amargerol and Baikal EM contributed to gross revenue (216 BGN/da) and (222 BGN/da) respectively, higher than the one of Control (C) – 194 BGN/da.
Based on the technological and market conditions in 2014/15 it can be concluded that *Triticum spelta* L. in all five variants of fertilization was economically inefficient. The main reasons are associated with the lower yields and the lower market price of the wheat species (2 BGN/kg).
During the 2014/15 season it was most economically efficient to grow *Triticum monococcum* L. and especially by using Tryven as organic fertilizer. Despite its relatively high price, the yield ensured the best gross revenue (BGN 359/da). The technology variants with Amalgerol, Baikal EM and Litovit were also more efficient than Control (C). Their gross economic benefits were BGN 264/da, 242 BGN/da and 182 BGN/da respectively.
In the second year 2015/2016, two more controls are introduced in order to survey the impact of organic fertilization, as a factor of productivity and economic efficiency- Control (0) with no fertilizer and no Agriorgan Pellet, and variant (CH 700) – with higher sowing rate -700 g.s./m^2.
Triticum monococcum L. had the highest results (152 kg/da) in Control (0), followed by *Triticum dicoccum* Sch. (130 kg/da.) and *Triticum spelta* L. (113 kg/da).
When soil fertilizer Agriorgan pellet is introduced – Control (C), yields were significantly higher. The yield of *Triticum spelta* L. increased by 53%, while the *Triticum monococcum* L. and *Triticum dicoccum* Sch.- by 35% and 30% respectively.
The Agriorgan pellet has positive impact on the yields for the three wheats, but its technical efficiency was higher when higher

sowing rate is applied. The variant (CH 700) increased the yield of *Triticum monococcum* L. by 52%, *Triticum dicoccum* Sch. by 83% and *Triticum spelta* L.by 111%.

The application of organic fertilizers showed different level of technical efficiency. The use of Amalgerol, Litovit and Tryven provided similar results for *Triticum dicoccum* Sch. (178-179 kg/da). The application of Baikal EM, did not contribute to higher yields, compared to the Control (C).

Triticum spelta L. achieved the highest results by the application of Litovit (204 kg/da), Amalgerol (193 kg/da) and Tryven (187 kg/da). The application of Baikal EM, did not improve the yields compared to the Control (C).

The survey of *Triticum monococcum* L. registered positive effects of all four bio fertilizers. The highest results are achieved by the application of Litovit (253 kg/da), followed by Amalgerol (238 kg/da), Tryven (231 kg/da) and Baikal EM (223 kg/da).

Economic efficiency of *Triticum dicoccum* Sch. was highest in the variant with higher sowing rate (CH 700) with gross revenue 288 BGN/da. Organic fertilization with Amalgerol provided economic result of 108 BGN/da, followed by Litovit and Tryven – about 95 BGN/da. The economic result of Baikal EM (53 BGN/da) was lower than the Control (C) with 93 BGN/da. Control (0) recorded the lowest efficiency - 55 BGN/da.

Triticum spelta L. grown under all variants of leaf and soil fertilization is not economically efficient because of the higher production costs.

Triticum monococcum L. in all variants had positive economic results. The highest economic efficiency is registered by the application of Litovit (201 BGN/da), followed by Amalgerol (169 BGN/da), Baikal EM (133 BGN/da) and Triven (120 BGN/da). Control (0) and Control (C) returned gross benefits respectively 54 BGN/da and 102 BGN/da. Variant (CH 700) is not economically justified, because gross revenue was relatively low (68 BGN/da).

In the last year of the analysis 2016/17 the data shows that *Triticum spelta* L. had the highest yield without foliar fertilizers and Agriorgan pellet – 309 kg/da.

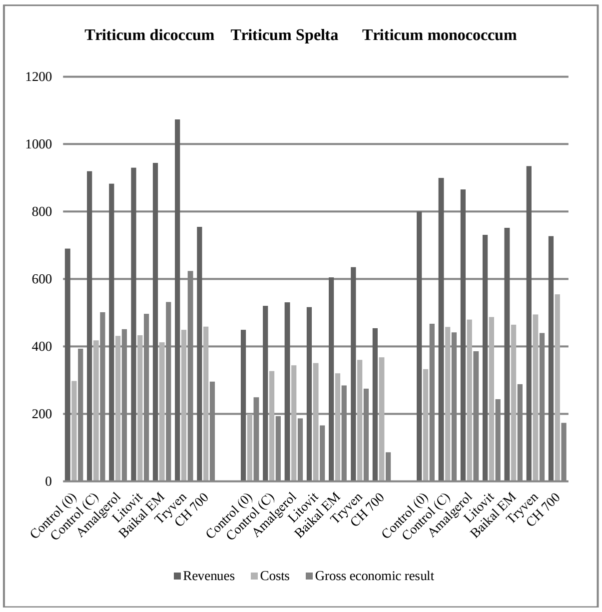

Fig. 1.Economic results, growing season 2016/2017 (BGN/da)
Source: Own Survey.

It is followed by Triticum monococcum – 273 kg/da and Triticum dicoccum – 212 kg/da. The application of Agriorgan pellet increased the yield of all three wheats substantially, with major effect on the Triticum dicoccum (+36%). Triticum monococcum yield is 20% higher and that of Triticum spelta – 16% higher.

On the other hand, the results from the application of CH 700 were lower than of Control (C). In this case, the yields from Triticum dicoccum decreased by 22%, from Triticum monococcum by 11.6% and from Triticum spelta by 2.5%.

The survey of Triticum dicoccum indicated that the application of Tryven led to the highest results (336 kg/da), followed by Baikal EM (303 kg/da). By contrast, Litovit and Amalgerol showed lower results compared to Control (C).

The analysis of *Triticum spelta* showed that Tryven led to the highest yield (445 kg/da), followed by Baikal EM (384 kg/da), Litovit (384kg/da) and Almagerol (366 kg/da).

The study of *Triticum monococcum* in all variants registered lower technical efficiency than Control (C).

Economic efficiency differed among wheats and technologies. The greatest gross revenue was achieved from *Triticum dicoccum* Sch, grown under the technology with application of Tryven (624 BGN/da), followed by Baikal EM (523 BGN/da). The use of Litovit (497 BGN/da) and Amalgerol (451 BGN/da) had lower economic efficiency than Control (C) with 502 BGN/da.

The lowest economic result was registered in the variant (CH 700) – 295 BGN/da, which is 25% lower than the variant without fertilization.

Averaged results for the period 2014-2017

Results for the yields, averaged for the period 2014-2017 are presented in Figure 2.

The highest levels of technical efficiency for the 3-year period was observed for *Triticum monococcum* L., followed by *Triticum spelta* L. and *Triticum dicoccum*.

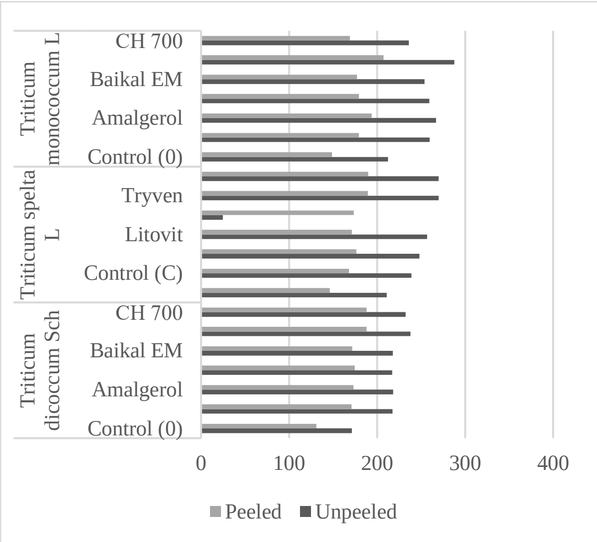

Fig. 2. Technical efficiency (kg/da)
Source: Own survey.

Triticum monococcum L. registered the highest average yield (unpeeled grain) with the application of Tryven (287.7 kg/da), followed by Amalgerol (267.1 kg/da). The technologies with Baikal EM and Control (C) had similar level of efficiency with about 250-260 kg/da. CH 700 returned 236 kg/da and the lowest result was achieved from Control (0) – 212.4 kg/da. Triticum spelta L. registered the best technical efficiency, when higher sowing rate (CH 700) and Tryven (270 kg/da unpeeled grain) were applied. The other three fertilizers – Amalgerol, Litovit and Baikal EM indicated similar results (around 250 kg/da). The average yield was lowest in Control (0) – 211 kg/da,

Triticum dicoccum achieved lower yields during the period, compared to the other two wheats. The technologies of Tryven and CH 700 performed better than the others, with average result 230-240 kg/da unpeeled grain.

Amalgerol, Litovit and Baikal EM returned the same yield as the Control (C) – around 218 kg/da. Control (0) had significantly lower yield – 171.2 kg/da.

The data allow some conclusions to be drawn. The study showed serious variations in technical efficiency between wheats species and between fertilization technologies.

The economic results observed by the application of different organic fertilizers are illustrated on Figures 3, 4 and 5.

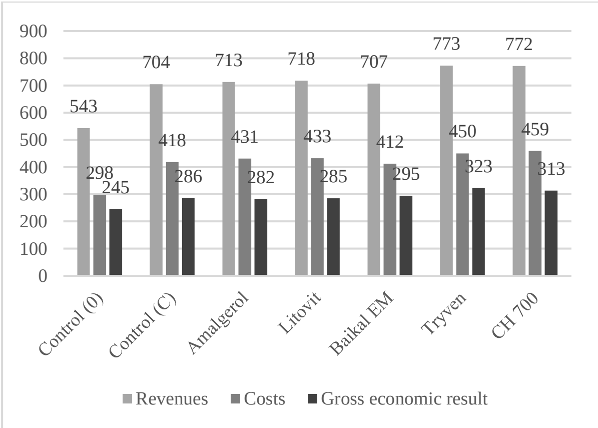

Fig. 3. Economic efficiency of *Triticum dicoccum* Sch 2014-2017 (BGN/da)
Source: Own survey.

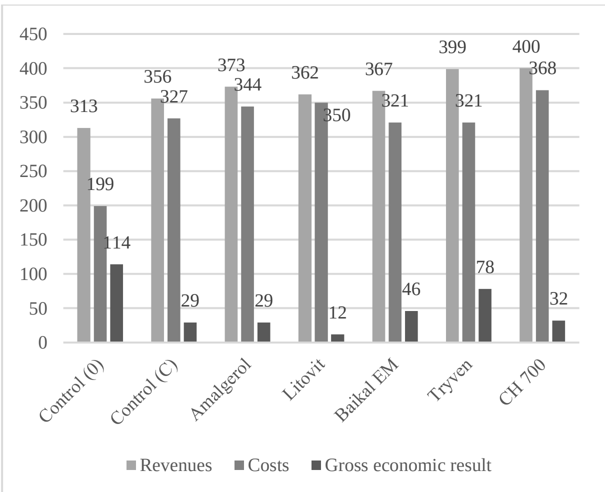

Fig. 4. Economic efficiency *Triticum spelta* L 2014-2017(BGN/da)
Source: Own survey.

The application of Litovit has higher costs, which however do not contribute to higher average yields. The higher sowing rate does not bring a better economic result, but the indicator is higher than Control (C) by 6.8%.
Based on the results it can conclude that is economically unjustified to apply fertilizers, because the efficiency is higher in Control (0).

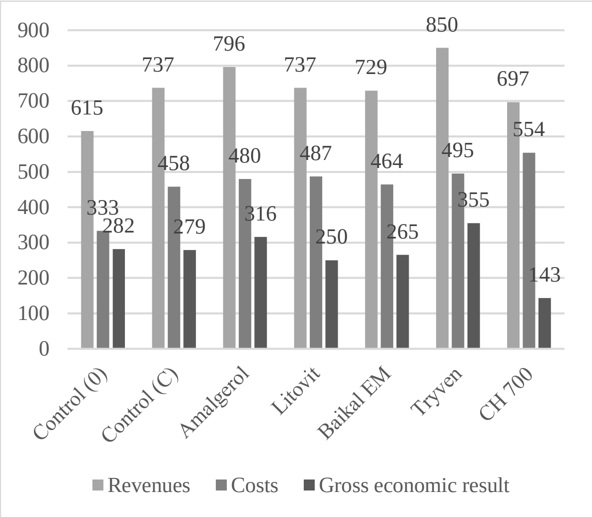

Fig. 5. Economic efficiency *Triticum monococcum* L. 2014-2017 (BGN/dca)
Source: Own survey.

For Triticum monococcum L all variants register positive economic results. The efficiency was the highest from application of Tryven (BGN 355/da) and Amalgerol (BGN 316/da). The application of Baikal EM and Litovit led to lower results in comparison with the levels of Control (0) and Control (C).

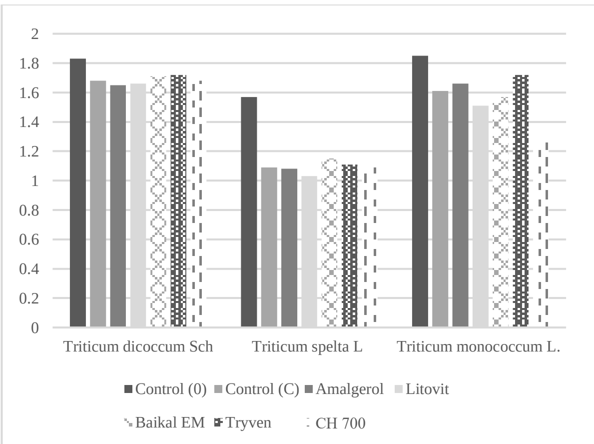

Fig. 6. Economic efficiency coefficient 2014-2017
Source: Own survey.

In addition to the analysis, the efficiency coefficient is observed. It should be emphasized that not all production costs are included, but nevertheless the indicator demonstrates the effect of different types of fertilizers application (Figure 6).
The analysis of the data shows that the highest economic efficiency is registered by the variants without the application of fertilizers. The application of a higher sowing rate (CH 700) can increase yields, but is also associated with higher costs.
In Control (C) the results vary considerably. While for *Triticum monococcum* L the efficiency levels were close to Control (0), for *Triticum Spelta* L the lowest levels of the indicator are observed.
Different variants of application of fertilizers are related to different results for the analysed wheats. Therefore it is not possible to determine a variant of application with the highest efficiency coefficient.
The use of Tryven is associated with the highest results for the *Triticum monococcum* L. and *Triticum dicoccum* Sch. On the other hand, - the application of Baikal EM brings the best economic results for *Triticum spelta* L.

CONCLUSIONS

Triticum monococcum L., *Triticum dicoccum* Sch. and *Triticum spelta* L. are old species of wheat that are gaining popularity in the past decades.
They are related to the healthy lifestyle and changes in consumer's perceptions and demand. Based on the survey some conclusions can be highlighted:
(1)The highest levels of technical efficiency for the three year period are registered by *Triticum monococcum* L., followed by *Triticum spelta* L. and *Triticum dicoccum* Sch
(2)The application of Agriorgan pellet increased the yield of all three wheats species, with major effect on the *Triticum dicoccum* (+36%). *Triticum monococcum* yield is 20% higher and Triticum *spelta* – 16%.
(3)The highest level of efficiency was achieved from *Triticum dicoccum* Sch. The best gross economic result was registered from the technology variant with the application of Tryven (BGN 323/da).

(4)Triticum spelta L. grown under all variants of leaf and soil fertilization is not economically efficient because of the higher production costs. Triticum spelta L. has the highest economic efficiency without fertilizer application (BGN 113/da).

(5)The analysis of *Triticum monococcum* L shows that all variants registered positive economic results. The indicator was the highest with application of Tryven (BGN 355/da) and Amalgerol (BGN 316/da).

(6)The highest economic efficiency is observed by the variants without the application of fertilizers. The application of a higher sowing rate (CH 700) can increase yields, but is also associated with higher costs.

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AGRICULTURAL EXTENSION SERVICES AND FARM INPUT SUPPLY LINKAGE IN OGUN STATE, NIGERIA

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Abstract

This study was carried out to examine the agricultural extension services and farm input supply linkage in Ogun State, Nigeria. Data was obtained from interviewing sixty farmers randomly in Ifo Local Government Area, Ogun State. All the extension agents for the two block offices in the locality were also interviewed to corroborate the data obtained from farmers. Socio-economic characteristics of the respondents were ascertained to have positive influence on agricultural production. Inputs were found out to be supplied mainly by Ogun State Agro-Services Corporation (OGASC) and Ogun State Agricultural Development Programme (OGADEP), but these inputs are not always available at the required time and quantity while the linkage between OGADEP and OGASC was confirmed to be inexistence i.e. OGASC being the commercial arm of OGADEP supplies inputs directly to farmers through the Farm Service Centres (FSCs) and Input Sales Centre at the OGADEP Headquarters. Through these Centres, the farm inputs get to the Block Offices via the Zonal Office, from where the farmers are expected to purchase them. On the other hand, OGADEP supplies information on input needs of farmers to OGASC which assists the latter in making inputs available at the right time and in the right quantity. In addition to this, OGADEP also supply information on input availability to the farmers through the Village Extension Agents (VEAs) who also take recommended practices to these farmers. However, apart from their above mentioned roles, the VEAs are also involved in actual purchase of inputs to the farmers. This deviation from the "professionalism" dictate of the Training and Visit System of Extension Services would have good influence in boosting agricultural production in the study area.

Key words**:** *farm, input, linkage, extension*

INTRODUCTION

The Central focus of the Training and Visit System of Extension is to put in place, a professional extension service, organized around the concept of continuous training of field staff and a regularized visit to farmers, thereby impacting into them improved agricultural practices [7] and [10]. The success of Ogun State Agricultural Development Programme (OGADEP) following this pattern of operations has been acclaimed by farmers, government, non-governmental organizations and practitioners [5]. Despite this well acclaimed success, manifestations of this trend in terms of the total hectare carrying these improved practices in the state are not so glaring. The reasons for this, still need to be investigated. In operationalizing the Training and Visit System of Extension Services, OGADEP has always maintained a close linkage with research institutes such as Institute for Agricultural Research and Training (IAR&T), National Cereal Research Institute (NCRI), International Institute for Tropical Agriculture (IITA), Universities (Olabisi Onabanjo University and The Federal University of Agriculture) and other governmental agencies such as Ogun State Agro-Services Corporation (OGASC) [8] and [10].
Non-availability of extension messages from research-oriented recommendations is one possibility, but field experiences show that

this is not the case. But rather, there is insufficiency in the supply of inputs required to satisfy wide-spread adoption of these recommendations. It also follows that the link between these organizations in particular among others be examined. Government investment in agricultural extension and rural development is very enormous. The World Bank; Food and Agricultural Organisation (FAO) and other bodies of the United Nations encouraged further investment in the education and training of local farmers in the use of new and improved agricultural innovations. Many studies have shown that extension efforts cannot succeed without an interdependent by play of research and input supply with extension [2] and [11]. Improved agricultural practices usually require more fertilizers, pesticides, tractor hiring service and above all, improved cultivars (seeds, stem cuttings, buds, seedlings, fingerlings, etc.). Extension agents, not only have to be aware of the availability and prices of these inputs but also, where, when and how farmers can obtain them.

OGADEP is linked with the commercial arm of Ogun State Agro-Services Corporation. Many field experiences have shown that this commercial arm do not always have in stock items demanded by farmers, hence, farmers have resolve to patronizing other agencies such as National Seed Service (NSS), Ministry of Agriculture and Natural Resources (MANR) and private input supply establishments. However, available literature has emphasized the need for a link between the extension and input supply services [3] and has been silent on the extent of the linkage and the overall benefits to the farmers. Besides, this is an area which this research project intends to focus. Hence, there is a need for a study to be carried out.

The general objective of the study was to examine the agricultural extension services and farm input supply linkage in Ogun State, Nigeria.

In order to achieve the general objective, the following specific objectives were considered:

(i) to assess farmers' weaknesses perceived from the preferred input sources.

(ii) to assess farmers' perception of availability of input and input sources.

(iii) to examine the agricultural extension services and farm input supply linkages in the study area.

MATERIALS AND METHODS

The study area was Ifo Local Government Area, Ogun State. It lies within the eastern part of the state and it is bounded to the north by Abeokuta North and South Local Government Areas, to the east by Obafemi-Owode Local Government Area and to the south by Ado-Odo/Ota Local Government Area and to the west by both Egbado North and South Local Government Areas. The study area with its tropical climate falls within the rain forest region of Nigeria and has a bimodal rainfall pattern which reaches its peak in July and September.

Ifo Local Government consist of several villages, hence, major occupation of inhabitants is predominantly farming – particularly arable farming and to a lesser extent, livestock (poultry, pig, sheep and goat) production. However, inhabitants in the urban areas of the study area engage more in trading, transporting, lumbering and artisanship. Considerable number also earns their living as employees in industries and government parastatals in neighboring towns and cities. The study area, though, not industrially based, can be said to be in nature due despite presence of fairly good road network, electricity, potable water, telecommunication facilities, postal services, health services and so on.

The food crops mostly produced include cassava, maize, vegetables, citrus, plantain, banana, cocoyam and yam while the cash crops found also include kolanut, cocoa and oil palm. The popular natural resource found in the local government is limestone.

OGADEP comprises of four zones, viz: Abeokuta, Ilaro, Ikenne and Ijebu. Abeokuta zone with Kotopo as its head-quarters is administratively divided into six blocks, namely Olorunda and Ilewo (Abeokuta North Local government Area), Opeji and Ilugun (Odeda Local Government Area) and Ifo and

Wasinmi (Ifo Local Government Area). Ifo block consists of Akinsinde, Coker, Egbeda, Ososun, Ajibode, Sojuoolu, Iju and Iyesi cells while Wasinmi block consists of Wasinmi, Obada-Oko, Itori, Owowo, Onigbedu, Ajegunle, Arigbajo and Papalanto cells.

Simple random sampling method was used to select three cells from each of the blocks and the cells so selected include Coker, Akinside and Sojuoolu for Ifo Block and Wasinmi, Obada-Oko and Ajegunle for Wasinmi Block. Ten farmers were then selected from each of these cells from farmers list as obtained from the VEA (Village Extension Agent) of each selected cells. Hence, a total of sixty farmers were interviewed in the study area.

Purposive sampling was also done for the BES (Block Extension Supervisors) and VEAs/BEAs (Village Extension Agents/Block Extension Agents) by getting the list of all the BES, VEAs and BEAs in the study area. Two BES (one for each block) and sixteen VEAs (one for each cell), as well as two BEAs (one for each block), were interviewed. Data collected were subsequently subjected to descriptive statistics.

RESULTS AND DISCUSSIONS

Table 1 shows that a larger percentage of the farmers are between the ages of 46 years and above (58.33%), closely followed by those less than the ages of 45 years and below (41.67%). This means that majority of the farmers are in the active age group, and thus they can maximize their productive potential if given the necessary resources in the right quantity and quality as well as at the right time [1]. However, 90 percent of the respondents are married. Thus, implying that they will get family support in the form of family labour to help on their farm [4]. Also, they will be more dedicated to their farm work so that they can support their family better [9]; hence, they are expected to show more enthusiasm to the services rendered by OGASC and OGADEP in a bid to increase their output [6]. Only 10 percent of the farmers in the study area are single and widowed respectively.

Notably, 65% of the respondents had formal education compared with 35% who had no formal education. This is an indication that extension agents' agricultural innovation and information and technologies dissemination would be highly appreciated and perceived by the farmers in the study area and they will be more responsive to the services provided by OGASC [5]. This will in essence help to boost production.

Furthermore, 65% of the farmers engaged solely in crop farming only while 1.7% engaged in livestock and fisheries respectively. Conversely, 31.6% of the farmers engage in mixed farming in which case, they rear mostly goats. It follows that some of the farmers have diversified farming activities and they use proceed from these to augment income from crop production.

Most of the farmers (58.6%) have farms which are between and 2 and 4.9 hectares in size, closely followed are those having farms less than 2 hectares in size (18.97%). Some of the farmers have fairly large farms from 5ha and above and they constituted 22.41% of the farmers in the study area. This indicated that farmers in the study area contribute their own quota to the food supply in the state and hence, the need for extension messages and services of OGASC to reach them continuously.

Table 1. Socio Economic Characteristics of Respondents

Variable		Percentage
Age (Years)	≤ 45	41.67
	≥46	58.33
Marital Status	Not Married	10
	Married	90
Educational level	No formal education	35
	Primary school education	48.34
	Secondary school education	8.33
	Post-secondary school education	8.33
Type of Farming	Crop only	65
	Livestock only	1.67
	Crop and livestock	31.67
	Fish farming only	1.67
Farm size (Ha)	< 2	18.97
	2 – 4.9	58.62
	≥5	22.41

Source: Own calculation.

Table 2 brought to light that most of the inputs when available are got at the source in the right quantity. However, 65% of the farmers did not get these inputs at the right time needed for production purpose. Hence, the weakness identified is the fact that most of the farmers in the study area could not obtain their input at the source, at the right time, and this will have effect on their farming activities.

Table 2. Distribution of farmers showing weaknesses perceived from the preferred input sources

Weaknesses	Yes	%	No	%
Obtaining inputs at the source?	54	90	6	10
Obtaining inputs in the right quantity?	48	80	12	20
Obtaining inputs at the right time?	21	35	39	65

Source: Own calculation.

Table 3 indicates that nearly all the farmers in the study area patronize both OGADEP and OGASC, but the level of patronage is a bit higher for OGADEP as compared to OGASC farmers. The reason for this is that the farmers are mostly exposed to the Village Extension Agents (VEAs) who work directly with OGADEP, and it is these VEAs who supply information to the farmers with regards to input availability. Hence, we can conclude that these two establishments are the major input sources to farmers in the study area. Apart from these, the remaining farmers obtain their inputs from private traders, National Seed Service (NSS), Ministry of Agriculture and Water Resources (MAWR) and other sources.

Nearly all the farmers obtain information on input availability from the VEAs attached to their villages. Additionally, 45% of the farmers also get to know from the radio and television while about 20 percent also get additional information from contact farmers. This means that information on input availability is obtained from many sources, but mostly through the VEAs.

Most of the farmers (85 percent) prefer to purchase their farm inputs themselves. They also prefer to combine this with sending the VEAs, who assist in helping them procure these inputs from their source. This is an additional job which can be seen as an humanitarian gesture on the part of the VEAs, as they are only responsible in telling farmers how, where and when to obtain their inputs. The farmers prefer sending their fellow farmers least.

Table 3. Perception of Availability of Inputs and Input Sources

	Variables	Percentage
Sources Preferred	OGADEP	96.67
	OGASC	61.67
	MAWR	3.33
	NSS	1.67
	Private traders	13.33
	Others	3.33
Sources of Information	Through the VEA	98.34
	From Radio/Television	45
	Through contact farmers	8.33
	From fellow farmers	20
	Others	13.33
Procurement Method	Personal purchase	85
	Sending the VEA	60
	Sending other farmers	11.67
	Others	1.67

Source: Own calculation

Figure 1 shows the linkage between the input supply agency (OGASC) to farmers and the role the extension agents (ZEO, BES and VEA - Zonal Extension Officer, Block Extension Supervisor and Village Extension Agents) of OGADEP are playing with the farmers. OGASC is the sole supplier of inputs to farmers in Ifo Local Government Area. It supplies inputs to farmers directly through the Farm Service Centres (FSC) and Input Sales Centre at OGADEP Headquarters (Commercial arm of OGADEP). This Input Sales Centre also supply indirectly to farmers by distributing inputs to the Zonal Offices, where they are sold to identified farmers and also distributed to the Block Offices. These Block Offices are within easy reach of the farmers for procurement of inputs when needed; this, they do mainly by personal purchase and by sending the VEAs. It should be noted that each of the two FASCs in the study area is located beside each of the Block Offices (Wasinmi and Ifo).

The VEAs on their own part took recommended practices or new innovations to farmers. They also gave feedback on the adoption of these innovations to OGADEP for improvement; this is the major function of the VEAs. The feedback is given through the BES (at block meetings), then through the

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ZEO (at fortnightly Training Sessions) and finally the ZEO reports this at the Monthly Technology Review Meeting (MTRMs).

In addition, the VEAs provide relevant information on input availability to farmers and also give feedback on this to OGASC through the same channel highlighted above. In essence, the extension agents, while discharging their normal duties, complement the effort of OGASC in the supply of recommended inputs to farmers. They ensure that farmers get first-hand information on input availability through them and are used appropriately through their advice and supervision.

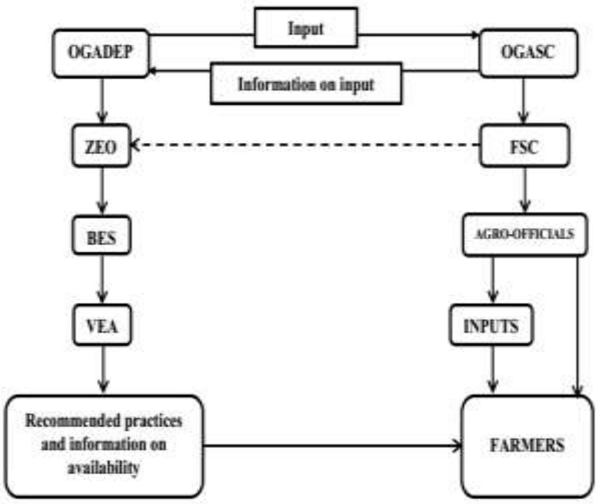

Fig.1. Agricultural Extension Services and Farm Input Supply Linkage
Source: Own Survey.

CONCLUSIONS

It is pertinent to conclude at this juncture that both the input supply services of OGASC and the extension services of OGADEP are indispensable tools to the progress of agricultural development in the study area. However, the participation of the VEAs in supplying inputs to farmers negates the "professionalism" dictate of the TRAINING AND VISIT system of extension services which forbids the extension workers to participate in other activities outside the normal extension services. But with reference to the finding of this study, this has proved a worthwhile deviation.

In order to improve the services of both OGASC and OGADEP as agents of agricultural development in the study area as well as to strengthen the linkage between them with a view to increasing their efficiency, the following suggestions are advocated:

(i)Some of the inputs (especially fertilizer) are not supplied in the right quantity and at the right time to farmers in the study area. In view of this fact, it is essential that the Agro-Services Corporation should ensure prompt and adequate supply of these inputs to the farmers since timeliness of operation is very important in agricultural production.

(ii)A common feature is the inefficiency or near absence of tractor hiring service for land preparation in the study area, the OGASC should try and explore the avenue of making this service available as it would go a long way in improving agricultural production in the study area. In addition, the federal and state governments should provide OGASC with adequate fund to facilitate the maintenance and repair of broken-down farm equipment and machineries.

(iii)Construction of warehouses coupled with mobilization of funds will allow inputs to be purchased in large quantities which can be stored for regular supply as at when needed by the farmers. This will eliminate non-availability of these inputs when the need for them arises.

(iv)Subsidy on inputs, particularly agrochemicals (fertilizers, herbicides, etc.) should be improved upon to make it easier and less costly for the farmers to procure the inputs.

(v)Farmers should be advised on production recommendations involving inputs usage, only when these inputs are available. To ensure this, representative of OGASC should participate more intensively in pre-seasonal, fortnightly and monthly extension planning and training meetings.

(vi)The VEAs should also avoid information overload on the part of the farmers. They should be able to screen and select the most relevant messages for the farmers.

(vii)Feedback on extension agent activities should be stepped up to give more information on farm situations vis-à-vis inputs and extension services that will be needed most at any particular point in time to boost agricultural production.

(viii)In general, since the additional responsibility of assisting in the procurement of inputs by VEAs have been ascertained to be of great importance, this study suggests that OGADEP should assist supplying improved seeds since these are needed most often by the farmers they actually work with while keeping focus of actual extension activities. OGASC should concentrate more on the supply of agrochemicals, farm machineries and in particular, mechanization services in order to keep the farmers more than hitherto.

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THE BIOENERGY POTENTIAL OF AGRICULTURAL RESIDUES IN ROMANIA

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Abstract

One of the main concerns worldwide is the production of renewable energy based on agricultural waste, in most countries the agricultural sector is the basis of the national economy. The most important amount of biomass residues is generated by agricultural crops. The energy potential of biomass residues from agricultural crops depends to a large extent on the amount of resources available and their characteristics. The purpose of this paper was to evaluate the energic and theoretical potential of biomass result. A mathematical calculation model for all indicators was defined in the paper. Maximum total amounts of biomass residues obtained from the studied crops are estimated at 9,985.18 kilotons, 11,105.04 kilotons, 2,542.03 kilotons and 1,564.56 kilotons. Due to the pedoclimatic conditions and the agricultural production, Romania has a high biomass potential, having a great diversity of types of crops that can be found in the field.

Key words*: *biomass, agricultural residues, potential

INTRODUCTION

The framework for climate and energy policy for 2030 aimed at setting the following targets for all EU member states: "reducing GHG emissions by 40% from 1990 levels, using at least 27% of total renewable energy consumption and at least 27% of stored energy [6]. Both the European Parliament and the European Council jointly agreed in June 2018 that a mandatory target should be renewable energy production, with a percentage of 32% by 2030". "By the end of 2019, each Member State had to presents an integrated national energy and climate plan for a period of 10 years, containing objectives, contributions, policies and national measures".
In the case of bioenergy, it is estimated that it will contribute in 2020, by about 140 Mtoe to the final consumption of raw energy, being 20.6% higher than in 2016 (116 Mtoe) [7].
For 2030, the estimated values of bioenergy may vary between 160-180Mtoe, which represents 14% -16% of GFEC [8].
Among the main major concerns of policy development and implementation of bioenergy are the availability of biomass, the alternative use of biomass and sustainability issues. At EU level, the biomass potential estimated by the EEA (European Environment Agency) has been estimated for 2020 at 235 Mtoe, of which: 100 Mtoe goes to waste, 96 Mtoe to agriculture and 39 Mtoe to forestry [5, 10].
To achieve the target it is necessary to increase substantially the level of biomass in the EU and for this you can use waste resources (agricultural residues, manure, municipal solid waste, etc.) that can effectively contribute to energy supply.
The main potential raw materials for obtaining organic energy are agricultural and crop residues. Agricultural waste is an opportunity to increase bioenergy production, without the need to apply for land to obtain raw materials for biomass [19].

MATERIALS AND METHODS

The quantities of agricultural residues resulting from crop production, as well as their characteristics vary depending on different factors such as: climatic conditions, differences between appling good agricultural practices, type of crop, yield per hectare and production [12, 15]. Thus, the properties and

quantities of agricultural crops may differed depending on the region, country.
In this paper, the authors determined the theoretical potential of biomass obtained from agricultural residues, the theoretical energy potential and energy potential available at national level for the period 2007-2018, highlighting the minimum, maximum and average values for this period.
The data used to determine these parameters were obtained from the INSSE site and analysed taking into account the following characteristics: production obtained, type of residue resulting (stem, straw, leaves, etc.), humidity, residue ratio, and lower heating values of dry matter of residue.
Table 1 shows the characteristics of agricultural residues for the following crops: wheat, corn, sunflower, oats and rapeseed.

Table 1. Characteristics of agricultural crop residues

Crop	Agricultural residue	Humidity (%)	Residual Report	LHV (Heating Lower value) (MJ/kg)	Availability (%)
Wheat	Straw	12.5	1.12	18.50	40
Maize	Cobs	15	0.70	17.40	50
Maize	Stalks	40	1.29	15.70	50
Sunflower	Stalks	17	1	16.55	50
Rapeseed	Stalks	45	1.7	17.10	50

Source: [4, 13,14,17].

The theoretical potential of biomass indicates the total annual amount of biomass obtained from agricultural residues. The following formula was used to determine the theoretical biomass potential (TBP):

$$TBP = \sum_{i=1}^{n} CP(i) * RPR(i) * \left[\frac{100 - M(i)}{100}\right]$$

where:
CP (i) - annual crop production (tonnes);
RPR (i) - the ratio of residue to production;
M (i) - relative humidity content (%).
The following formula was used to calculate the theoretical energy potential (TEP) of the dry mass of biomass:

$$TEP = \sum_{i=1}^{n} TBP\,(i) * LHV(i)$$

where:
LHV (i) is the lower heating value of plant (MJ/kg).
The available energy potential is determined by the formula:

$$AEP = \sum_{i=1}^{n} TEP\,(i) * A(i)$$

where:
A (i) is the ratio of available residues (%) [1].

RESULTS AND DISCUSSIONS

Biomass is that biodegradable part of products and residues that can be transformed by various processes into energy. It can be composed of various plant and animal elements (agriculture, animals, forestry, other industries) but also industrial and urban waste [9, 3].
In Romania, biomass is a source of raw materials for all energy sectors: electricity, heat, biofuels and bioliquids [16]. It comes from:
-plant products from agriculture or forestry activities, which can be used as fuel in order to recover their energy content;
-wastes from agriculture, forestry and food industry (if the thermal energy generated is recovered), from the production process of primary pulp and pulp, cork waste, construction and demolition waste wood).
Depending on the origin, biomass can be classified into: primary, secondary and residual biomass and fossil.
Residual biomass is produced in human activities: straw, sawdust, slaughterhouse waste, urban waste, etc. From the point of view of biomass residues can be classified into:
-*primary residues* - are produced from energy plans, agricultural crops or forest products, are found in the field and must be collected for later use;
-*secondary residues* - generated following the processing of biomass for the production of agri-food products or other wood products, being available in the food industry, at paper mills, etc.;
-*tertiary residues* - various wastes, with variations of the organic fraction, these being available after a biomass product has been used.
Romania has varied and rich renewable energy resources. These resources are distributed throughout the country and can be

widely exploited depending on the performance potential of the technologies and equipment used [2].

For Romania, biomass is a promising source of renewable energy, given its high potential and its varied use.

In Romania, the technical energy potential of biomass is approx. 518,400 TJ and includes the distribution in the territory of energy values (TJ) expected to be obtained by energy recovery of plant biomass [9].

The areas with the highest technical energy potential of biomass are: Southern Plain (126 639 TJ), Subcarpathians (110,198 TJ) and Moldova (81,357 TJ).

The biomass resources that can be used to produce energy are very diverse. At the national level, biomass resources consist of agricultural crops, plant residues, forest resources and special energy plants.

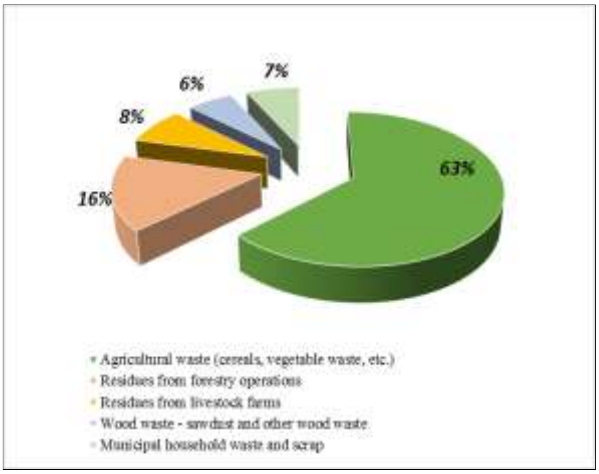

Fig. 2. Percentage distribution of residues in Romania, Source: [18].

The biomass resources that can be used to produce energy are very diverse. At the national level, biomass resources consist of crops, plant residues, forest resources and special energy plants.

In this context, the distribution of the agricultural area according to crop is analyzed in the first phase (Fig. 1). The total agricultural area cultivated with cereals in 2018 was 8.5 million ha, of which the largest share was occupied by maize cultivation of 29% (2.43 million ha), followed by wheat cultivation, with 25% (2.1 million ha) and 12% sunflower (1 million ha).

At the level of 2018, the total production of cereals harvested from the agricultural area of Romania was 31.55 kilotons.

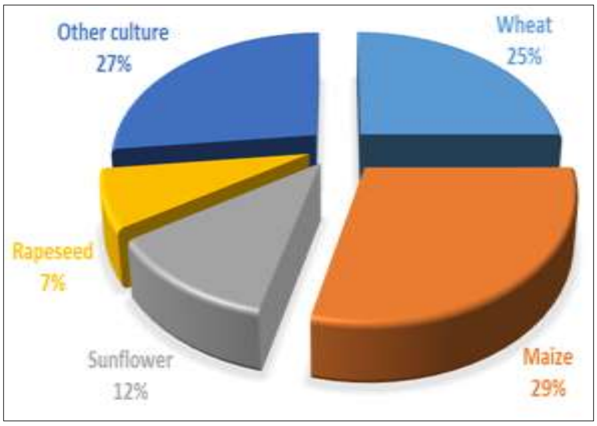

Fig. 1. Distribution of agricultural area by crops at national level
Source: INSSE processed data, Accessed on 14.06.2020 [11].

Evaluating the production situation for different types of agricultural crops for the period 2007-2018, it can be seen in Fig. 2, that the wheat crop registered the minimum production 3,044.47 kilotons, while the maximum of the period was of 10,143.67 kilotons. In the case of corn cultivation, the maximum production was 18,663.94 kilotons, and the minimum 3,853.92 kilotons. The sunflower and rapeseed crop recorded an average production in the period 2007-2018 of 178.53 kilotons and, respectively, 888.78 kilotons, while the tobacco crop recorded 1.66 kilotons.

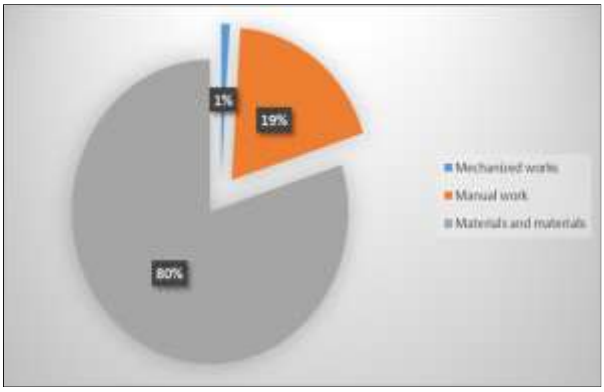

Fig. 3. Production of agricultural products (kilotons) 2007-2018
Source: calculations based on INSSE statistical data [11].

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Using the calculation methodology described above, the value of the energy potential of biomass, theoretical energy potential and AEP, from Romania, was obtained for all 5 agricultural crops studied, depending on the type of residue obtained during 2007-2018 (Table 2).

Table 2. Theoretical biomass, energy and available energy potential

Specification		TBP (Theoretical potential of biomass) kilotons	TEP (Theoretical energy potential) TJ	AEP (Available energy potential) TJ
Wheat	min	2,996.90	55,442.56	22,177.02
	max	9,985.18	184,725.76	73,890.30
	average	6,982.70	129,180.03	51,672.01
Maize (Cobs)	min	2,293.08	39,899.61	19,949.81
	max	11,105.04	19,3227.76	96,613.88
	average	6,071.02	95,314.99	47,657.49
Maize (Stalks)	min	34,68.53	54,455.86	27,227.93
	max	14,501.88	227,679.53	113,839.76
	average	7,928.04	124,470.16	62,235.08
Sunflower	min	453.95	7,512.79	3,756.40
	max	2,542.03	42,070.64	2,1035.32
	average	1,479.50	24,485.65	12,242.83
Rapeseed	min	1,47.27	2,518.36	1,259.18
	max	1,564.56	26,753.99	13,376.99
	average	831.01	14,210.26	7,105.13

Source: own calculations.

Determining the theoretical potential of dry biomass for wheat and corn cultivation, it can be seen in figure no1. the fact that for wheat there was an average value of 6,982.7 kilotons, for corn (cobs), 6,071.01 kilotons and corn (stem) 7,928.08
 kilotons. Wheat and corn are the most important crops that produce significant amounts of residues. The theoretical energy potential is estimated for the two crops at maximum values of the period of 129,180.03 TJ, 95,314.99 TJ and 227,679 TJ respectively (maize-residue stem).

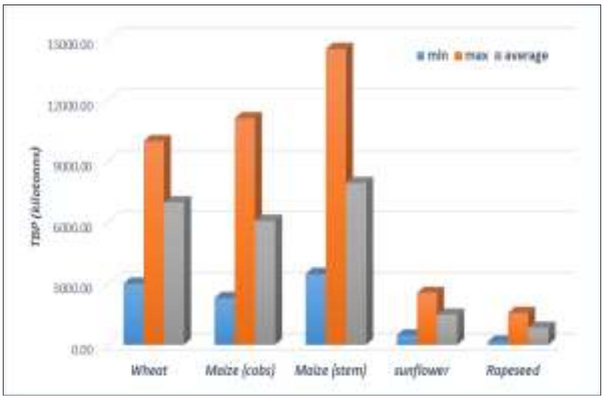

Fig. 4. Theoretical potential of biomass
Source: own calculations.

Regarding the agricultural residues resulting from the cultivation of sunflower and rapeseed, namely the stems left after the harvesting process to obtain the raw material (seeds, oils), their recovery could lead to an increase in biomass material.

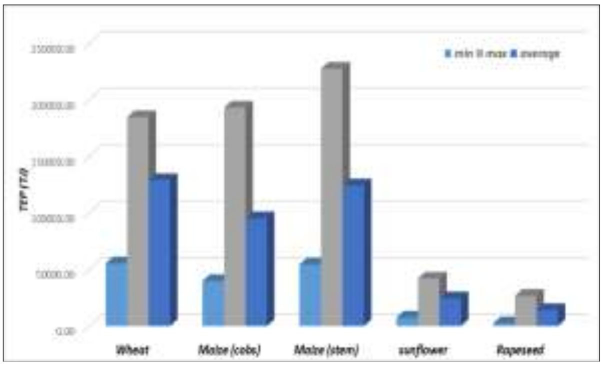

Fig. 5. Theoretical energy potential
Source: own calculations.

The average values of the theoretical potential of biomass resulting from the cultivation of sunflower and rapeseed were 1,479.50 kilotons and 831.01 kilotons, respectively, these being up to 4 times lower than the wheat and corn crop (these being the predominant crops in Romanian agriculture). Calculating the theoretical energy potential, it is observed that it is smaller compared to other crops, recording maximum values of 42,070.64 TJ and 26,753.99 TJ respectively.

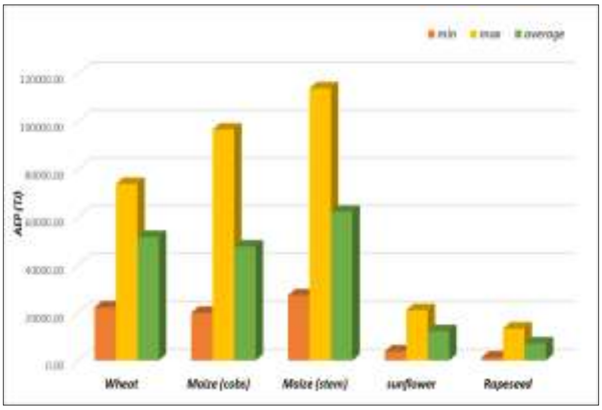

Figure 6. AEP (Available energy potential) TJ
Source: own calculations.

The available energy potential can represent the energy stock we can have following the recovery of agricultural waste. Analyzing the results obtained for the 4 crops, the highest value of the available energy potential is held by the residues resulting from the corn crop (strain), of 113,839.76 T. For the wheat and sunflower crop during the study period, an average available energy potential of 51,672.0 TJ and 12,242.83 TJ respectively.

CONCLUSIONS

Significant amounts of agricultural residues are available at EU level, which are estimated at an average annual value of 1,530 PJ, contributing to bioenergy production. The largest quantities of agricultural residues are available in Germany, Romania, France, Spain and Italy.

Romania has a very high biomass potential that can come from the agricultural and livestock sector.

The diversity of types of agricultural crops is quite large in Romania due to its climatic conditions and agricultural production. In addition to the geographical area in which the plants are grown, characteristics such as the value of crop yield and the method of harvesting may affect the amount of residues obtained from the crop. By capitalizing on agricultural residues, there is a high available energy potential, and the crops taken for analysis reveal this fact. The future recovery of agricultural waste through the use of conversion methods for the production of energy from biomass is an efficient method will have positive effects on the environment.

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PRECISION TECHNOLOGIES IN SOFT FRUIT PRODUCTION

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Abstract

The industrialization and mechanization of the agriculture in the 20th century led to an increase in productivity and efficiency and development of large-scale farms. The environmental concerns and resource scarcity transform the models of agricultural production. The implementation of new technologies and digitalization led to evolution of precision farming. The aim of the study is to analyse the economic efficiency of precision technologies in soft fruit production and discuss the possibility of their implementation. The survey focuses on case studies analysis and presents the economic benefits of precision technologies. Opportunities for adoption of innovation in Bulgaria are also outlined. The methodological framework is based on the "Case study" approach. The survey shows positive economic effect of precision technologies on agriculture. On the other hand, the analysis indicated that there are significant differences in total costs and especially in the investment costs. This in many cases this is the main reason related to the limited implementation of innovations by farmers. The application of precision technologies is concentrated mainly in extensive production with larger holdings. It is necessary to encourage their application in high value-added sectors and benefit from the EU funds in the field of innovation.

Key words*: *precision farming, innovations, sustainable development

INTRODUCTION

The industrialization and mechanization of the agriculture in the 20th century led to an increase in productivity and efficiency and development of large-scale farms. On the other hand, farmers sacrificed the ability to manage efficiently the spatial and temporal heterogeneity of farm fields [8]. The environmental concerns and resource scarcity transform the models of agricultural production. There is a need for a resource efficient global food system that takes into consideration the aspect of sustainability [1]. The implementation of new technologies and digitalization led to evolution of precision farming. Precision agriculture addresses the challenge of adapting management to site, crop, and environmental traits [13, 17].
From economic point of view precision agriculture is associated with different benefits. According to the European Commission the benefits from precision farming are related to: crop yield improvements; optimization of inputs; and improvement of the management and quality of the work [6].
Although the scientific interest and the conducted studies in the past twenty years, precision technologies are not widely applied [3, 18, 19].
The precision technology implementation and adoption vary significantly both by type of technologies and by sectors.
The global change in dietary patterns and consumer's perceptions led to increase in soft fruit production. Different studies point out the benefits from consumption of soft fruits - a greater life span [2] and weight management [14], among others. [9] The importance of these fruits is increasing based on benefits for human health and their role as antioxidants.
Precision technologies in soft fruit sector transformed their production patterns and led to wide range of advantages. The aim of the study is to observe the economic efficiency of precision technologies in soft fruit production and to discuss the possibility of their implementation.
The survey focuses on case studies analysis and presents the economic benefits of precision technologies. Opportunities for adoption of innovation in Bulgaria are also highlighted.

MATERIALS AND METHODS

The paper is based on the results from own survey for the period 2016-2019. The study is part of PhD thesis and project related to the impact of precision technologies on soft fruit production. The analysis is based on survey of four farms in the UK and one farm in Bulgaria. These holdings grow the same variety of blackberries, which allows comparison of the results.

The methodological framework is based on the "Case study" approach. For many reasons, econometric methods are preferred in the agricultural economy, as they provide a wide range of information covering a large sample [4]. The purpose of such a choice is to draw some general conclusions. Case study analysis involves more in-depth research. The aim is to survey a small number of operating systems in different perspectives and angles.

Yin [20] considers that this method is necessary to understand complex social phenomena because case studies allow researchers to "focus on the 'case 'while maintaining a holistic and realistic perspective". In this regard, according to Schramm, the essence of the case is that "it tries to shed light on a decision or set of decisions: why they were taken, how they were implemented and with what result" [15].

The analysis is based on interviews with different farmers. The focus is on the effect of precision technologies and comparison between different production systems.

RESULTS AND DISCUSSIONS

The survey is based on the analysis of UK-based Company. It has five farms in different parts of the country. The study was conducted in four of them. The company is international and develops a farming business in the UK, Portugal, China and South Africa.

The owner of the company, as a student worked on a course project in which tried to analyse the efficiency of strawberries production. After a few years, he implemented one of his ideas, the cultivation of strawberries and raspberries under high polyethylene tunnels.

Based on years of experience the engineers and agronomist found that the technology of glasshouse production of soft fruits allows control of environmental impact, maximizes productivity and product quality, protects plants from extreme low or high temperatures, hail, heavy rains, snow, frosts and strong solar radiation, diseases and pests.

The survey is based on interviews with farmers and agronomist in four farms in the UK and one in Bulgaria. Farm A in the UK grows soft fruits in open fields. The technology in Farm B, also located in the UK, is related to the standard tunnels. The fruits are grown in coconut fibre raised beds. Farm C has advanced tunnels production system. In Farm D the technology is associated with glasshouses. In this UK-based holding the plants are also grown in coconut fibre.

Farm E is located in Bulgaria and has two different production technologies. In the first one the plants are grown in open field with soil raised beds. The other one is associated with standard tunnels technology similar to Farm C in the Great Britain.

The results of the economic efficiency in the four farms in the United Kingdom are illustrated on Figure 1. The results are averaged for the period 2016-2019.

Based on the indicator there are substantial differences in the farms in the UK.

The lowest efficiency is registered in farm A and the highest in farm D.

In Farm A the lowest total cost are observed. The main reason is associated with the implemented technology. In this holding there are not any tunnels or any precise control or precise management systems. The investments in farm A are related only to supporting plant construction and drip irrigation.

In the farms with standard and advanced tunnels (holdings B and C) the total costs include investments in technologies for microclimate control in the tunnels. There are also investment costs for irrigation system. On the other hand, in all farms in the Great Britain excluding farm A, the fruits are grown in pots with coconut fibre. Therefore substantial difference in investment cost is registered.

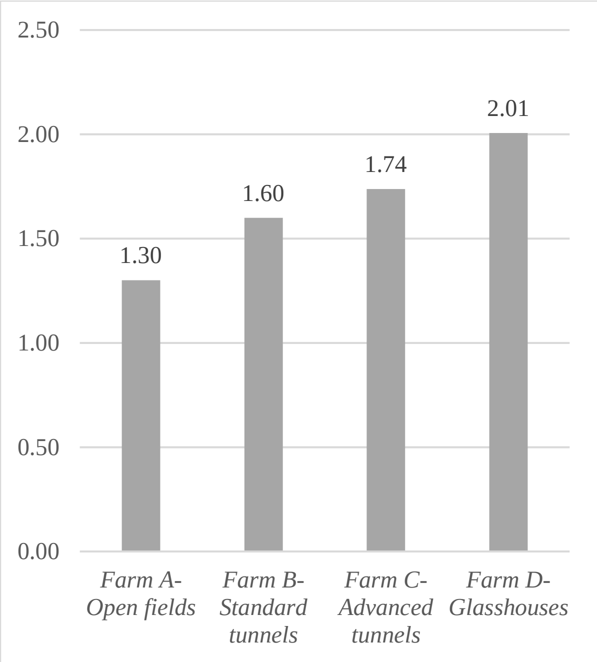

Fig. 1. Economic efficiency (coefficient) in the UK farms
Source: Own survey.

However, the highest levels of total costs are recorded in the holding D. The implemented technologies in this farm are related to the latest generation of precision systems that allow Climate management, Water management, Energy management and Data management. It also includes systems for pests and diseases control. The glasshouse construction is more expensive than the standard and advanced tunnels.
The revenue per hectare is the lowest in holding A. By contrast, the highest results of the indicator are registered in farm D. The observed tendencies are related both to the higher selling price and higher average yields in this holding.
The three holdings in the Great Britain, except farm D, have the same selling price of the production is 6.72 EUR /kg. They deliver their products to the market at the same time of year.
The selling price of holding D is 36% higher compared to the other three farms. The trend can be explained with the production technologies and implemented innovations.
The precision technologies provide the opportunity for extended harvest season. It could be lengthen from early spring and late autumn. The market prices of soft fruits are higher in this time of the year.
In open fields, the natural conditions have significant impact on soft fruits production. Although there are good drip irrigation and fertilization system in farm A, the natural factors can ruin the production quantity and quality. However, it should be noted that the optimal results of average yield are used for the analysis. The bad weather condition may lead to much lower average yields. In farm D is implemented of one of the most modern technologies of precision agriculture. These production systems ensure optimal conditions for plants [5].
Other important comparison is related to the standard tunnels (Farm B) and advanced tunnels (Farm C). The better growing conditions, which are one of the benefits of advanced tunnels, guarantee higher technical efficiency. Based on the production system of farm C, an increase of yield (13 t./ha) is registered.
Other important element of the comparison between the technologies is the production quality. The changes in consumer perceptions and demand transform production systems and remodel the quality standards in the farms. In order to compare the quality level in the different farms and systems the fruits are divided into two classes. Class 1 meets the quality standards and requirements of the supermarket, while Class 2 fruits are used for processing or thrown away. The production quality of the three farms in the UK is presented on Figure 2.
The data shows that in the production system of farm A (open field system) the lowest percentage of Class 1 fruits is observed.
The natural conditions damaged the fruits which are cultivated outdoors. Only 65% of the produced blackberries are Class 1. It should be noted that the results are registered under favourable conditions. By contrast, the bad weather conditions could lead to much lower results. The poor quality of produced fruits could cause serious financial losses.
In the other three farms that implement innovation technologies, the production quality is higher. In Farm B, which has standard tunnels, 87% of the cultivated

blackberries are Class 1. The observed trends outline the advantages of the new technologies. They reduced the farmers` risk and lead to higher yield and quality.

On the other hand, in Farm C and D are registered the highest results. The advanced tunnels production system has 93% Class 1 fruits. An even higher result is recorded in glasshouses where 96% of the produced blackberries are Class 1.

The registered results in Farm C and D are evidence for the advantages of precision technologies implementation and adoption.

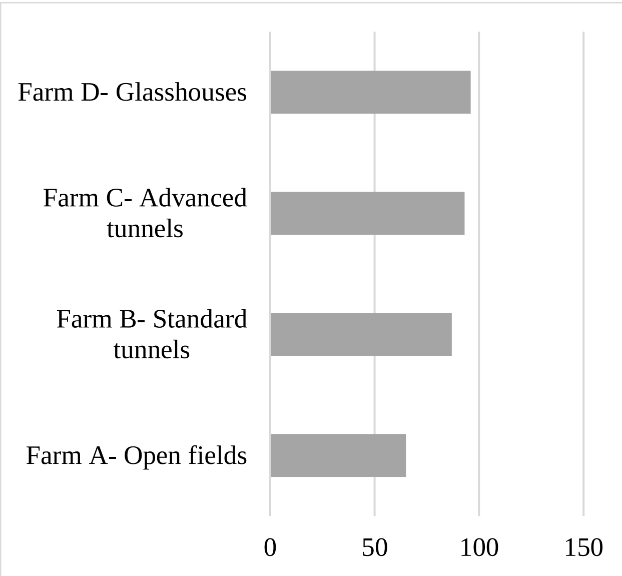

Fig. 2. Quality of the production, % Class 1 in the UK farms
Source: Own survey.

The technical and economic efficiency, as well as the production quality of the farms located in the UK highlight the positive economic impact of innovation and precision farming. On the other hand, the differences in the investment costs should be noted. The higher investments are one of the main reasons for the limited implementation of precision technologies.

The survey in Bulgaria is based on interviews with the owner and the agronomist of Farm E. The holding is located in Strelcha, South Central Region. It has 20 ha of utilized agricultural area. In 2013 the holding is established. The main purpose was to implement precision farming technologies and innovation in soft fruit sector.

Due the financial situation of the farmer, until 2016 the blackberries are cultivated in open field. During the period 2013-2016 the production system outdoors led to low yields and quality of the fruits. The blackberries could not be sold in the supermarket because the quality was poor and did not meet the requirements in the stores. Furthermore in unfavourable climatic conditions the required quantities could not be guaranteed.

In 2016 the farmer invested in standard tunnel structures similar to the technologies in Farm C in the Great Britain. The blackberries in open fields and standard tunnels are grown in raised beds [5].

The substrate of the raised beds is based on coconut fibres which are preferred by farmers due their qualities. On the other hand, drip irrigation systems provide precision growing condition for blackberries cultivation. The holding also has sensors that ensure accurate temperature and humidity in the tunnels. In Farm E a meteorological station is installed. The tunnels in the farm have shading nets. They are necessary for the production of soft fruits in Bulgaria. The reason is related to the strong solar radiation from mid-June to late August in the country [5].

Figure 3 presents the economic efficiency in the Bulgarian farm. It is calculated for the period 2016-2019.

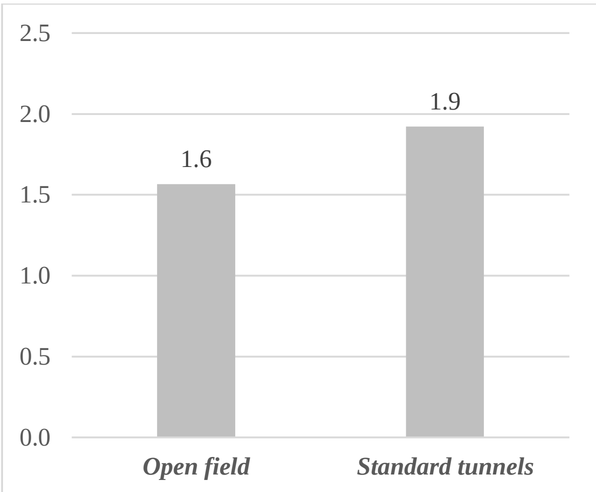

Fig.3. Economic efficiency (coefficient) in Farm E
Source: Own survey.

The observed trends in Farm E are similar to the results in the UK-based holdings. The comparison of the investment cost show that they are lower in open field system. The costs include investments in support structure and drip irrigation. In other production technology, significant elements of the investments are the costs for tunnel structures and microclimate monitoring.

The registered average yields in the Bulgarian farm indicate large differences. Standard tunnels are three times more productive. The main reasons are related to the growing conditions, combined with the risk reduction. Precise management of the irrigation and fertilization ensures higher yields and efficiency.

Figure 4 illustrates the quality of produced blackberries in standard tunnels and open field.

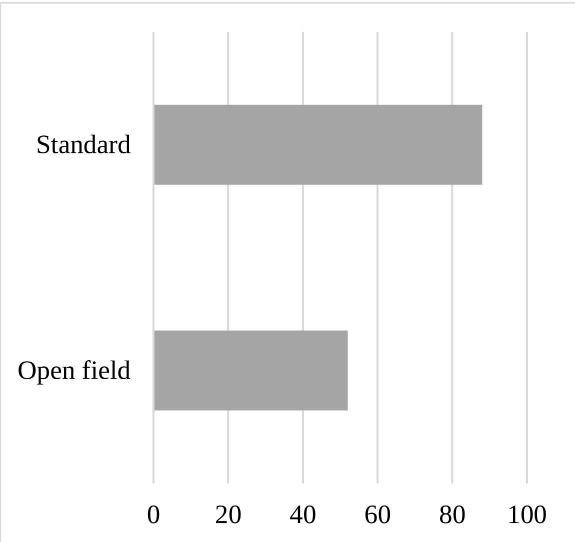

Fig. 4. Quality of the production, % Class 1 in Farm E
Source: Own survey.

In open field production system only 53% of the fruits are Class 1. The bad weather conditions in 2018 caused serious financial losses for the holding.

By contrast, the other technologies lead to better level of quality. The data shows that 88% of the cultivated blackberries are Class 1. Based on the results it can be concluded that the standard tunnels technology is more productive and effective.

The farmer intent to invest in advanced precision technologies and will not continue to cultivate blackberries in open field.

The higher investment costs are obstacle for adoption of innovation technologies in Bulgaria. However, the farmers should consider their implementation in order to compete on the EU market and ensure the required quality standards.

Although not object of the paper it should be noted that precision technologies led not only to higher economic efficiency, but also help in resolving challenges as food security and environmental issues [11].

The application, adoption and diffusion of the precision technologies in Bulgaria are associated with major issues. The low education level and qualification, combined with higher investment costs and lack of consulting services are one of the main obstacles for the process [10, 12, and 21].

The precision technologies in Bulgaria are applied mainly in larger structures and extensive producers. Therefore it is necessary to encourage their implementation and adoption in high value-added sectors.

The EU considers as one of its priorities the implementation of the precision agriculture systems. The LEADER approach is direct reflection of changes in Common Agricultural Policy [16] and also supports precision farming. Horizon Europe - the next research and innovation framework program also will encourage innovation and adoption of precision technologies [7].

In order to realize the opportunities of the EU funds post 2020, it is necessary to build institutional capacity for project implementation and stimulate the improvement of educational level and practical experience of the agricultural producers.

CONCLUSIONS

Based on the survey some conclusions can be drawn:

-Precision technologies in soft fruit production have developed rapidly over the last two decades in parallel with the transformation and digitalization in other agricultural sectors.

-The production of soft fruits outdoors is considered as inefficient in the UK and other Western European countries. In Bulgaria, this is the main system for growing soft fruits, which is a prerequisite for low yields and poor fruit quality.

-Based on a comparison of the different soft fruit technologies in the UK, the highest yields are registered in glasshouses, followed by advanced tunnels, standard tunnels and open fields.

-After the adoption of standard tunnels in Bulgaria, a significant improvement in terms economic efficiency are achieved.

-The other advantage of precision technologies application is the greater quality, which allows sales of fresh blackberries in supermarkets.

-In Bulgaria, the benefits of precision technologies are widely discussed. However, there is no official information on their perception by farmers and their implementation and diffusion.

-The adoption of precision technologies in Bulgaria is concentrated mainly in large farms specialized in the production of cereals and oilseeds.

-In Bulgaria several large fruit and vegetable producers implement precision irrigation systems.

-On the other hand, small and very small farms do not adopt precision systems and their access to new technologies is limited.

-The new programming period 2021-2027 provides opportunities for financial support and Bulgaria should to improve coordination between ministries, agencies and other actors in the system in order to benefit from the EU funds.

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FOOD SELF-SUPPLY AS A FORM OF SATISFYING CONSUMER NEEDS - AN EXAMPLE OF RURAL HOUSEHOLDS IN POLAND

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Abstract

Recent studies on consumer behavior have shown that there is an increase in consumer interest in natural food from their own farm or plot. In practice, the share of households, where the concern for the health of family members and the state of the natural environment is increasing. Polish consumers, which use food self-supply, used to choose this form of satisfying their consumption needs for economic reasons in the past, and now they choose it for health or environmental reasons. Analysing the role of the consumer behaviour is decisive for the development of new consumption trends, to which food self-supply largely fits. A quantitative and qualitative study was conducted based on a questionnaire to determine the behaviour of Polish consumers related to food self-supply, which allowed to determine how many households consume products from their own production among the surveyed population and what factors determine the choice of this form of consumption. The level of food self-supply in the surveyed rural households was high, and their members also declared that they would continue to use this form of satisfying consumption needs in the future. They justified their choice by assuming care for their and their family's health, traditions passed down from generation to generation, and financial considerations.

Key words: *food self-supply, consumption, rural households, Poland*

INTRODUCTION

Consumption issues are a current and growing research problem in economics. There is an increase in consumer interest in natural food from their own farm or plot (so-called return to nature), and in turn the share of consumers who care about the health of family members or the condition of the natural environment is increasing.

In Poland and other countries of Central and Eastern Europe, changes in consumption trends are a special subject for observation, because consumers have come a long way from food shortages through habits of buing products to excess, to the current trends of sustainable consumption or its greening [5].

A household has, at its base a special place in the economy, hence it is most often defined as a key unit in the sphere of consumption, the purpose of which is to meet the individual and common consumption needs of its constituents [11].

The most common ways of meeting the various needs of a household are [2]:

-Production of household goods (e.g. home building, production and preparation of food for consumption, sewing and maintenance of clothing, repair of household appliances, other various domestic services – tangible and intangible);

-Purchase on the market (purchases) of ready consumer goods and items that require processing and preparation for consumption;

-Acquiring consumer goods in a different way than their production or acquisition, and in particular through the social security and benefit system (medical services and social protection), inheritance, donations, use of public goods (education, use of municipal infrastructure), etc.

The part of food consumed that is obtained by the household without the market is called in the scientific literature food self-supply [4]. This is the oldest form of obtaining raw materials and products to meet the needs of the household [13].

Issues related to food self-supply are part of economic theories regarding consumption [12]. In the most synthetic approach, consumption is defined as all human activities and behaviors aimed at satisfying needs using goods and services [3]. The beginnings of interest in economics in consumption fall at the turn of the 18th and 19th centuries. In the 1870s, many economists became interested in the problem of making consumer decisions by households. An example of one of the microeconomic theories of consumption that treats rural households in a special way is the theory of consumption by Gary Becker, which assumes that households are both consumers and producers of goods, because they produce a specific set of "products", i.e. food, cleaning, cooking, which contribute directly to meeting the needs [1].

There are many types and forms of consumption described in the literature. One of the classification criteria for consumption is the source of consumer goods. Taking them into account, market and natural consumption can be distinguished [14]. Food self-supply is an example of natural consumption, which is part of the food consumed, produced independently bypassing the market, i.e. most often from own allotments, from own production (farm) or independent processing (preparation) of food from products from own production or previously purchased.

In the literature on the subject there is little research related to food self-supply, and the existing ones mainly concern farmers' households, and not all households located in rural areas. Chmielewska conducted one of the first detailed studies on self-supply in agriculture [4]. The author showed differences in the level of food self-supply due to the socio-economic characteristics of households.

Interesting research on the role of food self-supply in the theory of sustainable development and sustainable consumption was presented by Głowicka-Wołoszyn and co-authors [6]. Noteworthy is the Strzelecka study, where the data source was the FADN database. Studies have shown that during the economic crisis, as a result of a decrease in income from business activity, there is an increase in self-supply of agricultural households [9].

Food self-supply from its own farm or garden is one of the main factors influencing the pattern of food consumption patterns, especially in rural areas.

MATERIALS AND METHODS

The aim of the study was to determine the level of natural consumption in total food consumption in households. For this purpose, a consumption structure meter was used to determine the share of food from self-supply in total consumption. The respondents declared the level of food self-supply in their households in percentage in the ranges given in the questionnaire. The study also aimed to show the factors determining such behavior as well as the benefits and costs resulting from the use of food self-supply.

The subject of the study were rural households, i.e. farms where the permanent residence is a village, which can be distinguished: typically agricultural farms, agricultural and labor farms, rural farms not associated with agriculture at all [14].

Surveys were conducted in 2017 on a deliberately selected group of 302 rural households located in ten selected municipalities of the Mazowieckie voivodship, in Poland. The Masovian Voivodeship was chosen deliberately as an area of empirical research. This choice was dictated by the fact that, although it is the richest region in Poland assessed according to the level of GDP per capita, it is also the most spatially diversified in terms of socio-economic development. In turn, household self-supply according to the Central Statistical Office data in the Mazowieckie voivodship is at an average level across the country.

The research was carried out using the diagnostic survey method, survey technique, the questionnaire was the tool.

Descriptive and comparative methods of information processing were used in the work. In the process of processing research material in the form of quantitative data, a Microsoft Excel spreadsheet was used [8].

RESULTS AND DISCUSSIONS

The questionnaires on food self-supply have been applied to a number of 302 respondents.

Women predominated among the respondents (59%).

The researched farms are mainly two- and three-generation families, where four-person households predominated. The structure of households by persons on a household was as follows: 1-person – 2.7%, 2-person – 7.8%, 3-person – 14.5%, 4-person-29.1%, 5-person - 25.7%, 6- and more persons – 20.3%.

Around 32% of the households surveyed had children up to the age of 14. Households without children up to 14 years old constituted 68% of the respondents, with one child 18%, with two – 10%, with three and more – 4%.

One of the most differentiating social categories is the education of the respondents. The vast majority (52%) of the respondents were people with secondary education, of which 13.8% of respondents had vocational secondary education, 38.3% of general secondary education, and 4.7% post-secondary education. About 4.4% of respondents had basic vocational education, slightly less – 2.2% had higher primary education, while the remaining 18.5% had higher education.

The primary factor determining the share of each member of society in the division of the social consumption fund is the income per 1 person. Thus, income is the basis for the intensity of feelings and the degree of satisfaction of needs, therefore it is the basic determinant of the development of the consumption structure [7]. Taking into account the entire surveyed population, the income of the surveyed households was as follows: below PLN 500 – 9.3%, PLN 501-1,000 – 28.8%, PLN 1,001-1,500 – 22.5%, PLN 1,501-2,000 – 15.6 %, above PLN 2,001 – 17.5%. About 6% of respondents did not answer the income question.

Respondents were also asked about the size of their farms, the average area of the surveyed farms was 22.8 ha, which significantly exceeds the national average. In every fourth farm, both plant and animal production was carried out, in 54% only plant production was carried out, and in 27% - only animal production.

Asking the respondents what was the percentage share of food consumption from their own household in the total food consumption in the household 35% declared that it was from 26-50% of food. Only in every tenth household declared consumption of food from self-supply was below 10% (Fig. 1).

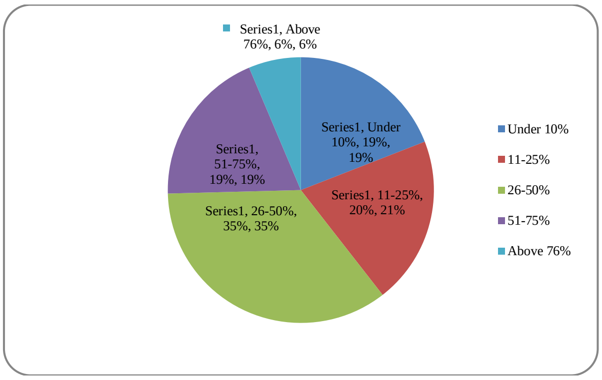

Fig. 1. Percentage share of food consumption from own farm in total food consumption in the household
Source: Own calculation.

Respondents who declared the use of self-supply were also asked about the frequency of consumption of such products. 35% of respondents said that they consumed food from self-supply at least 4 times a week. Every fourth respondent did it every day. Two to three times a month, 12% of respondents used self-supply, and less than once a month – 8%.

Respondents most often prepared as part of food self-supply fruit jams (92%) and vegetable preserves (90%). About 90% of the respondents reached for fresh vegetables and fruits from their own plot. 77% of respondents declared that they eat eggs from their own farming. The products that least often manage to produce themselves according to the respondents are cream and butter (Table 1).

The next question in the questionnaire concerned the indication of which of the factors had the greatest impact on household production of food by itself (a maximum of 3 answers could be given).

Every fourth respondent replied that he produces food on his own due to his and his family's health and because of family traditions and habits.

Table 1. Types of products made under self-supply

Types of products made under self-supply	% of respondents who declare consumption of products
Fruit preserves (e.g. jams)	92%
Vegetable preserves (e.g. pickled cucumbers)	90%
Fresh vegetables	90%
Baking cakes	88%
Fresh fruit	88%
Eggs	77%
Potatoes	75%
Poultry	67%
Fruit / vegetable juices	66%
Herbs	66%
Sausage, sausage, offal	64%
Pork meat	56%
Dried fruits and vegetables	56%
Fresh Milk	51%
Cottage cheese cheeses	45%
Baking Bread	45%
Sour cream	35%
Butter	30%

Source: Own calculation.

Another most frequently mentioned reason is low production cost (19% of respondents), hobby (9%) and use of free time (9%). Less than 5% of respondents said that they still produce for sale, so they could transfer the surplus to the household. Few indicated concern for the state of the natural environment, creativity or the need to personalize the product offer (Fig. 2).

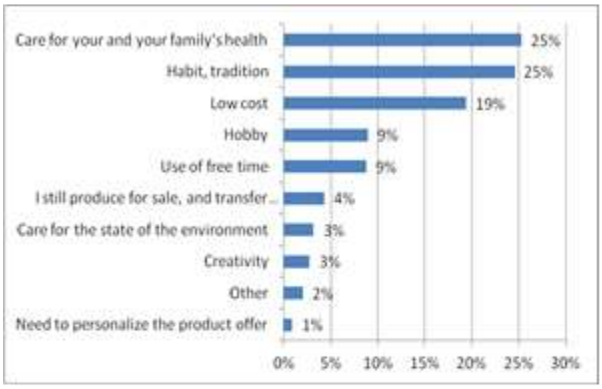

Fig. 2. Factors determining the use of self-supply in the respondents' opinion
Source: Own calculation.

In addition to factors influencing the decision to use self-supply, consumers are also affected by the properties of food products from their own production. Respondents mentioned the features that in their opinion had the greatest impact on household production of food on their own (a maximum of 3 answers could be given). The most popular are: freshness (that's what 29% responded to), taste (25%), smell (24%) and nutritional value (12%). The durability and lack of preservatives or chemicals in such foods were indicated by 5% and 4% of respondents, respectively.

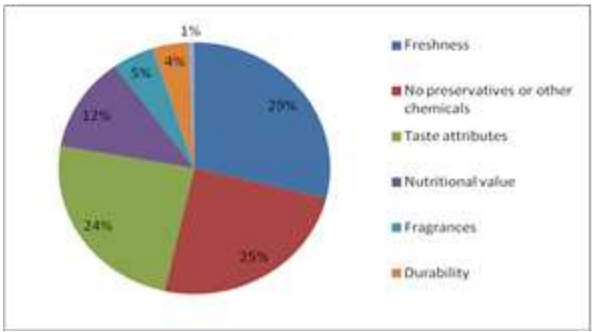

Fig. 3. Product features, in the respondents' opinion, which have the greatest impact on food production on their own
Source: Own calculation.

According to respondents, the biggest disadvantages of food self-supply include the seasonality of food produced (31%), labor consumption (26%) and production time consumed (21%). 15% of respondents indicated the answer regarding the difficulty in producing some products, while the small variety of products was a disadvantage for only 6%.

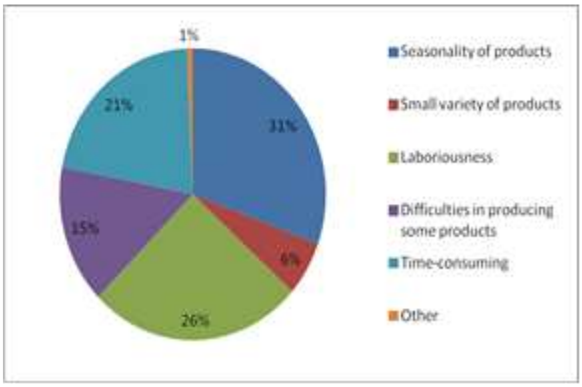

Fig. 4. Disadvantages of food self-supply in the respondents' opinion
Source: Own calculation.

Seasonality of products is a characteristic feature of fruit and vegetable consumption in Poland. Fresh fruit is available only practically at the time of harvest, i.e. from June to September.

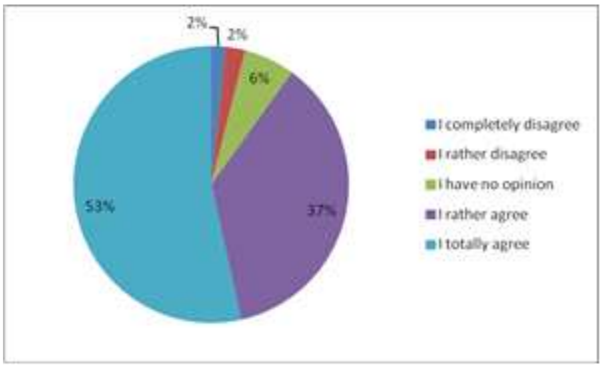

Fig. 5. Respondents' opinions on the statement: "Products under food self-supply are of better quality than those bought in the store"
Source: Own calculation.

Respondents were also asked to what extent they agree with the statement that products under food self-supply are of better quality than those bought in the store. Over half of the respondents (53%) completely agree with this statement (Fig. 5).

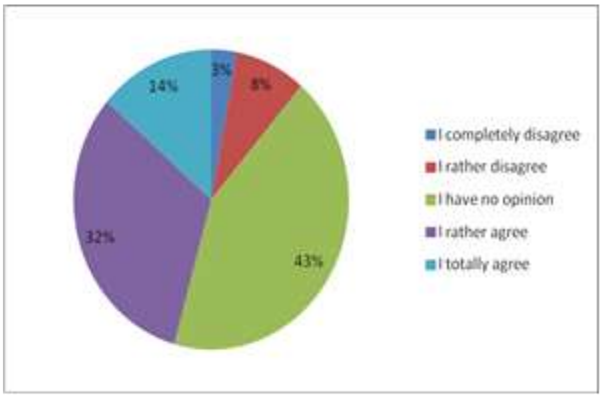

Fig. 6. Respondents' opinions on the statement: "Food self-supply is currently fashionable"
Source: Own calculation.

Currently, there is a lot of media coverage about fashion for natural food from its own production. Respondents were asked what they think about it. 43% of respondents have no opinion whether food self-supply is currently fashionable. 14% of respondents completely agree with this statement, and 3% completely disagree (Fig. 6).

Table 2. Opinions of respondents on the following statements

	I completely disagree	I rather disagree	I have no opinion	I rather agree	I totally agree	Total
A healthy diet is important to me	1%	3%	17%	44%	36%	100%
I prefer natural food	1%	2%	12%	36%	49%	100%
Producing food for your own use is a waste of time	49%	37%	10%	2%	2%	100%

Source: Own calculation.

The research shows that it is not the fashion for food self-supply that determines the choice of this form of satisfying consumer needs, but the choice of a healthy diet based on natural and organic food for yourself and your family. Half of the respondents prefer natural foods, and a healthy diet is important for every third respondent (Table 2).

Food self-supply is also considered as a hobby, creative leisure activities in nature. Respondents were asked to what extent they agreed with the statement that food self-supply is a waste of time. Half of the respondents completely disagree with this statement.

Modern consumers belong to the group of conscious consumers. Consumer decisions are based on knowledge of their social, ecological and political consequences. The conscious use of the benefits of the environment is the most important element of sustainable consumption [10].

CONCLUSIONS

The role of self-supply in rural households in Poland is still very important. This is due to the traditions and consumption patterns that have been shaped over many years. Natural consumption of food is one of the main determinants influencing the formation of food consumption patterns, especially in farmers' households. We can assume that this phenomenon will continue for not only economic but also pro-health and environmental reasons. Respondents declared their willingness to use self-supply in the future. Respondents valued food from self-supply most for freshness, taste and smell. The disadvantages of food self-supply most frequently mentioned by the respondents are: seasonality of food produced, labor consumption and time consumption of production. Surveys of opinions on food self-supply among consumers representing rural households show that both the phenomenon itself and opinions about products from own production are very positive. According to the respondents' opinions, products from food self-supply are of better quality than those bought in the store. Their production resulted not from fashion for this form of satisfying food needs, but from food preferences, because they prefer to eat natural food, and a healthy diet was very important for them.

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PHENOLOGY, YIELD AND PROTEIN CONTENT OF MAIZE (*Zea mays* L.) HYBRIDS AS AFFECTED BY DIFFERENT SOWING DATES

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Abstract

The optimum sowing time and the suitable hybrid are agronomic management practices that play a major role in determining the quantity and quality of maize yield. In this study, a randomized field experiment was established at ARDS Simnic, Craiova to assess the influence of sowing dates and hybrids on phenology, grain yield and protein content of maize. The research included three sowing dates: 9th April, 16th April and 23th April. The results showed that the delayed sowing dates had higher impacts on the phenology of maize, shortened the all plant growing stages and reduced the accumulated heat units (GDD), especially after the silking stage. In early sowing date (9th April), the grain yield (GY) and heat use efficiency (HUE) were significantly higher compared to two other sowing dates, for all hybrids. Protein content of maize grain increased with delay in sowing date due to the modifications of thermal conditions during grain-filling period. Maize hybrids PR39D81 and LG3350 that produced the maximum grain yield (11.47 t/ha and 11.42 t/ha, respectively) when sown in 9th April, were the most suitable hybrids for this region.

Key words**:** *growing degree days (GDD), heat use efficiency (HUE), protein content*

INTRODUCTION

Maize (*Zea mays*. L) is an important cereal crop cultivated in almost all countries, occupying an area of approximately 194 million hectares [9] .

For Romania, maize is one of the strategic cereal crops for internal and foreign market. Therefore for Romanian farmers, the increasing maize yield must be the main objective [12, 13].

Maize grain yield and quality of maize grains are two important factors concerned in maize production because its plays a significant role in ensuring food security and in people's dietary health [14].

Maize grains are considered to be a valuable source of energy. Its protein content is of 8-12% and this value is influenced by weather factors and by genotypes [7, 10].

The sowing time is a key factor that influencing farming activities and that is highly associated with grain yield and quality of grains [1, 20].

Many previous studies have demonstrated that delayed sowing dates can result in substantial yield loss in most cases, due to shorter duration of vegetative and reproductive period [3, 18]. On the contrary, [19] demonstrated that winter maize sown at later sowing date (25 October) enhanced grain yield, quality parameters and the growth compared to early sowing (15 October). [8], also reported that delayed sowing date did not affect grain yield and protein content of maize.

Thus, the previous results were not always in consistent due to the some factors *viz.*, agronomic practices, environmental conditions and genotypes.

The Oltenia region is often affected by drought and heat, only two years out of ten are favourable to agricultural crops [5].

The phenology and grain yield under rain-fed condition are higher influenced by temperature.

Temperature based indices such as accumulated heat units or growing degree days (GDD) and heat use efficiency (HUE) can by useful for predicting crop production and growth in different environmental conditions [3].

Therefore, the main objective of this research was to assess the influence of different sowing dates and hybrids on phenology, grain yield and protein content of maize using several thermal indices.

MATERIALS AND METHODS

In 2016, the field experiment was performed at Agricultural Research and Development Station (ARDS) Simnic – Craiova, situated in the central part of the Oltenia region.

It was a two-factorial experiment, conducted in three replications. The first studied factor: (A) was the date of sowing: 9th April, 16th April and 23th April) and second factor: (B) was the hybrid: PR38A24 (FAO 300), PR39D81 (FAO 200) and LG3350 (FAO 370).

The soil of the experiment is a reddish preluvosoil with pH = 5.08 (moderately acidic) and humus content of 2.68 % (low).

The climatic conditions during the growing period were favourable for maize crop. The precipitation of the growing season was around the multiannual average value, while temperature deviated from the multiannual average by +0.3°C.

Crop maize was fertilized with 250 kg/ha NPK 20:20:0 and 250 kg/ha ammonium nitrate. Weeds were controlled by applying DUAL GOLD 960 - 1.5 l/ha, just after sowing and EQUIP 1.5 l/ha + BUCTRIL 1.0 l/ha post emergent

Protein content of maize grains was analyzed by using Perten AM 5200-A (NIR).

Maize crop growth period was studied at three phenophases: silking stage; physiological maturity: grain-filling period (from silking to physiological maturity period).

Days to silking were recorded while 75% were visible in each plot.

Days to maturity were recorded by the appearance of black layer at the base of the grains.

The daily weather data (maximum and minimum temperature) was obtained from the Craiova Meteorological Station

The thermal indices were calculated according to the following formulas [3]:

Heat units or growing degree days (GDD):

$$GDD = \Sigma\, [(Tmax + Tmin)/2 - Tb]$$

where,

Tb = Base temperature (10°C).

Heat use efficiency (HUE):

$$HUE = \text{Grain yield (kg/ha)}/GDD$$

The data were subjected to Fisher’s analysis of variance technique (ANOVA) for two factors.

The means were compared using Duncan’s multiple range tests at 5% probability. Pearson's correlation coefficients were calculated on the basis of tolerant indices [15].

RESULTS AND DISCUSSIONS

Days to different phenological stages and growing degree days

Data collected on days to all phenological stages indicated significant differences ($p \leq 0.05$) for all sowing dates and for all hybrids except with physiological maturity stage when differences between hybrids were non-significant (Table 1).

The sowing date of 9 April showed higher days to silking stage (83.0), to physiological maturity stage (137.7) and to grain-filling period (54.0) for all hybrids as compared to other later sowing dates. The result indicated that delay in sowing decreased the time to attain different phenological stages of maize crop. Similar results have been reported by others studies [2, 3, 11].

Among maize hybrids, PR39D81 took longer days to silking stage (81.7), but for grain-filling period, the hybrids LG3350 and PR38A24 took longer days (53.7 and 53.3, respectively).

In term of GDD, the sowing date exhibited significant different ($p \leq 0.05$) on GDD accumulation only at grain-filling period. GDD at this period was higher for all hybrids which were sown in 9th April (733.9) and 16th April (720.7) followed by 23tth April (709.0).

Maize hybrids had significant different ($p \leq 0.05$) in GDD at silking stage and at grain-filling period.

Among maize hybrids, similar results were observed: PR39D81 had higher GDD at silking stage (679.2), but at grain-filling period, the hybrids LG3350 and PR38A24 had higher GDD (735.9 and 729.9, respectively).

Table 1. Influence of sowing dates and hybrids on days and accumulated GDD to phenological stages of maize (after sowing)

Factors	Silking		Physiological maturity		Grain –filling period	
	Days	GDD	Days	GDD	Days	GDD
			Sowing dates (A)			
9th April	83.0a	648.7	137.7a	1,370.9	54.0a	733.9a
16th April	79.3b	656.7	132.0b	1,365.2	52.3b	720.7a
23th April	74.0c	644.5	125.3c	1,349.2	51.3b	709.0ab
F test	*	NS	*	NS	*	*
			Hybrids (B)			
PR38A24	77.0b	632.3b	131.0	1,349.9	53.3a	729.9a
PR39D81	81.7a	679.2a	132.3	1,372.2	50.7b	697.8b
LG3350	77.7b	638.3b	131.7	1,363.2	53.7a	735.9a
F test	*	*	NS	NS	*	*

*Significance at $p \leq 0.05$; NS =Non-significant; Means followed by different letters in each column are significantly different from each other at 5% level of significance
Source: Own calculation.

Grain yield and protein content of maize

From the data presented in the Table 2 showed that the grain yield and protein content were significantly (at $p \leq 0.05$) affected for all sowing dates and for all maize hybrids tested.

Table 2. Influence of sowing dates and hybrids on grain yield and protein content of maize

Factors	Grain yield (t/ha)	Protein content (%)
	Sowing dates (A)	
9th April	11.31a	12.94b
16th April	11.01b	12.94b
23th April	10.26c	13.29a
F test	*	*
	Hybrids (B)	
PR38A24	10.65b	13.28a
PR39D81	11.03a	12.91b
LG3350	10.90a	12.99b
F test	*	*

*Significance at $p \leq 0.05$;
Means followed by different letters in each column are significantly different from each other at 5% level of significance
Source: Own calculation.

Grain yield obtained in 9th April (11.31 t/ha) was recorded highest as compared to other sowing dates (11.01 t/ha and 10.26 t/ha, respectively).

Higher yield in early sowing can be due to longer growth cycle and favourable temperatures during grain-filling period. Similar observations under delayed sowing have been reported by [2, 21].

Among maize hybrids, PR39D81 and LG 3350 have had highest grain yield (11.03 t/ha and 10.90 t/ha, respectively) compared to PR38A24 (10.65 t/ha)

In term of protein content, 23th April sowing maize hybrids had highest ($p \leq 0.05$) protein content (13.29%) but remaining both sowing dates (9th April and 16th April) that had similar protein content (12.94%).

Thus, higher delay in sowing increases the content of protein in grains due to the modifications of thermal conditions during grain-filling period.

A similar result was found to the findings of [18], according to low temperature in the early stages of development reduces protein content of maize grains.

On the contrary, [11] reported that the protein content was decreased with the delaying sowing date due to decreasing the time of growth period and seed filling. [8], also reported that delayed sowing date did not affect yield and protein content of maize.

This result confirms the impact of weather conditions in the different regions.

Among maize hybrids, PR38A24 (13.28%) have higher protein content compared to other hybrids.

[4], reported that the grain yield of maize was negative and significant correlated with

protein content and with air temperature for the maize crop sown in the central part of the Oltenia region.

[6], also confirmed that the average temperature during grain-filling period is one the dominant climatic factors which explains 94.6% of inter-annual variability of maize yield.

Heat use efficiency

In terms of HUE was observed that all the maize hybrids were more efficient in using heat units at early sowing date (9th April) than the late sowing dates (16th April and 23th April) as presented in Table 3. Similar results have been reported for maize by [3, 16].

Table 3. Heat use efficiency (HUE) for grain yield of different maize hybrids as affected by sowing dates

Hybrids	HUE			Reduction or increase (%) due to late sowing		
	9th April	16th April	23th April	9th April *vs* 16th April	9th April *vs* 23th April	16th April *vs* 23th April
PR38A24	8.11	7.76	7.78	4.32	4.06	+0.25
PR39D81	8.34	8.13	7.63	2.52	8.51	6.15
LG3350	8.30	8.29	7.39	0.12	10.96	10.85

Source: Own calculation.

A higher value HUE represents that plants utilized the heat units more efficiently by increasing biological activity and productivity [17].

Under late sowing dates (16th April and 23th April), all maize hybrids had reduced HUE at different magnitude compared to early sowing date, following the same trend, except the hybrid PR38A24.

The reductions in HUE for hybrids PR39D81 and LG3350 were higher for 9th April *versus* 23th April (8.51% and 10.96%, respectively) and for 16th April *versus* 23th April (6.15 and 10.85%, respectively) and were less for 9th April *versus* 16th April (2.52% and 0.12%, respectively). Therefore, it can be concluded that these hybrids are the more suitable hybrids for early spring sowing.

For hybrid PR38A24, the HUE reduction was higher for 9th April *versus* 16th April (4.32%) and for 9th April *versus* 23th April (4.06%), but for 16th April *versus* 23th April HUE was little increased (+0.25%), which confirmed that this hybrid can be sown at any time.

Correlation analysis

From the data presented in Table 4 showed that the grain yield of maize was highly significant positive correlated with days at physiological maturity stage (r = 0.751**; p = 0.01), with days at silking stage (r = 0.789**; p = 0.01) and with HUE (r = 0.950**; p = 0.01), and also was significant negative correlated with protein content (r = -0.414^{0}; p = 0.05).

This result indicated that maize hybrids with had a longer growing cycle (sowing to maturity period) achieved a higher grain yield because they used more efficient heat units.

In this study, the hybrid PR39D81 took longer time to attain these stages and showed the highest grain yield followed by LG3350.

Similar results have been reported by [1] for maize sowing in spring season at Multan, Punjab, Pakistan.

Protein content had negative and significant correlattions with days at silking stage (r = -0.556^{00}; p = 0.01), with days at physiological maturity stage (r = -0.505^{00}; p = 0.01), with GDD at silking stage (r = -0.482^{0}; p = 0.05) and with GDD at physiological maturity stage (r = -0.614^{00}; p = 0.01) –Table 4.

Days at silking stage had positive and significant correlations with days to maturity stage (r = 0.865**; p = 0.01), with GDD at silking stage (r = 0.568**; p = 0.01), with GDD at physiological maturity stage (r = 0.580**; p = 0.01) and with HUE (r = 0.640**; p = 0.01).

Days at maturity stage had positive and significant correlations with GDD at physiological maturity stage (r = 0.629**; p = 0.01) with days during grain-filling period (r = 0.479*; p = 0.05) and with HUE (r = 0.585**; p = 0.01).

Days during grain-filling period had a significant negative correlation with GDD at silking stage (r = -0.423^{0}; p = 0.05), but had a significant positive correlation with GDD

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during grain-filling period (r = 0.962**; p = 0.01).

GDD at silking stage was significant negative correlated with GDD during grain-filling period (r = -0.471^{0}; p = 0.05).

Table 4. Pearson correlation coefficients of grain yield and protein content with thermal indices at different phenological stages under different sowing dates (n = 27)

Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GY(1)	-	-0.414^{0}	0.789**	0.751**	0.168	0.270	0.321	0.060	0.950**
PC (2)		-	-0.556^{00}	-0.505^{00}	-0.026	-0.482^{0}	-0.614^{00}	0.037	-0.236
Days at S (3)			-	0.865**	0.153	0.568**	0.580**	0.050	0.640**
Days at PM (4)				-	0.479*	0.157	0.629**	0.365	0.585**
Days at GF (5)					-	-0.423^{0}	0.158	0.962**	0.127
GDD at S (6)						-	0.357	-0.471^{0}	0.166
GDD at PM (7)							-	0.137	0.010
GDD at GF (8)								-	0.021
HUE at PM (9)									-

*, ^{0}, **, ^{00} = significant positive or negative at 0.05 and 0.01 levels, respectively; GY = grain yield; PC = protein content; S = silking stage; PM = physiological maturity stage; GF = grain-filling period
Source: Own calculation.

CONCLUSIONS

This study showed that the delayed sowing dates had higher impacts on the phenology of maize, shortened the all plant growing stages and reduced the GDD especially in grain-filling period. Thus, early sowing of maize hybrids can be recommended to the farmers for this area.

Maize sowing on 9th April had higher grain yield, GDD and HUE for all hybrids as compared to other later sowing dates.

Among the maize hybrids, PR39D81 and LG3350 obtained the better grain yields but with a lower protein content.

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SCREENING FOR DROUGHT TOLERANCE IN MAIZE HYBRIDS USING NEW INDICES BASED ON RESILIENCE AND PRODUCTION CAPACITY

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Abstract

Drought is a major abiotic factor limiting the grain yield and yield stability of maize throughout the world therefore, the development of drought tolerant genotypes is an important breeding objective. In this study, an experimental field was conducted at Agricultural Research and Development Station Simnic in the water-stressed (2017) and non-stressed conditions (2018) to select the best performing maize hybrids. For this purpose, the new indices: RCI (the resilience capacity index), PCI (the production capacity index), YSSI (the yield susceptibility score index) and YPSI (the yield production score index) were used. The results indicated that using this new selection method, maize hybrids can be easy identified and classified in four categories of tolerance. The hybrids from category 1: HS 880-13, HS 1158-14, HS 1156-14 were selected as combining high resilience with high productivity.

Key words: *drought, grain yield, maize, tolerance indices*

INTRODUCTION

Drought or water deficit is one of the major abiotic stresses which determine the important production constraints in cereals crops, including in maize, especially under rainfed conditions. The loss of grain yield due to the drought varies from 1% to 76% depending on the duration, severity and crop stage [20].

Maize or corn (*Zea mays* L.) is one of the most important cereal crops in Romania and it plays an important role in the country's economy [13].

In the Oltenia region and in other part of the country, maize crop is frequently affected by drought [3, 5].

Thus, the identification and development of genotypes with tolerance to drought stress are the important objectives in maize breeding programs.

The efficiency of breeding programme for tolerance to abiotic stresses depends upon the breeder's ability to find a compromise among the three conflicting response factors: yield obtained under non-stress conditions, yield obtained under stress conditions and yield losses due to stress [2].

Screening for drought tolerance in maize facilitates selection of genotypes, which will eventually help in breeding programs [1].

Numerous studies reported that the most effective selection techniques for drought tolerance in rain fed conditions are those based on levels of yields obtained in both water-stressed and non-stressed conditions [12].

In this regard, five tolerance indices have been proposed by [6, 7, and 14]. These were the most used indices for drought tolerance screening in sorghum [11], maize [4, 19], wheat [10] and canola [15].

However, the use of these indices also has some disadvantages such as the different rankings of the genotypes tested their different ability to highlight genotypes with good yield and the impossibility of highlighting genotypes with overlapping responses in drought conditions.

For this reason, other studies have suggested that the selection methods used for improving drought tolerance should be based on a combination of different indices [17].

Recently, [18] suggested screening for tolerance based on resilience and production capacity of tested genotypes using two new indices: YSSI (the yield susceptibility score index) and YPSI (the yield production score index).

These indices combine the tolerance indices proposed by many authors into two classes: Class 1 (SSI and TOL) and Class 2 (MP, GMP and STI), thus are more effective in understanding the basis of any yield limitations under stress.

In light of the above, the objectives of this study were to screen several maize hybrids for identify the most suitable hybrids for drought-prone areas and also to evaluate the use of new indices in breeding programmes.

MATERIALS AND METHODS

A total of ten new hybrid creations of maize obtained to NARDI (National Agricultural Research and Development Institute) Fundulea, were selected and used in the present study to determine their drought tolerance.

The field experiment was carried out during two consecutive years at the ARDS (Agricultural Research and Development Station) Simnic and was arranged in Randomized Blok Design with three replications.

Experimental area is located in the central part of the Oltenia region.

The first year of study (2017) was characterized by well-defined drought in June and August and the second year (2018) was favourable for growing of maize (non-stressed conditions) - Table 1.

Table 1. Mean monthly rainfall recorded during two cropping seasons (2017and 2018)

Months	Rainfall (mm) 2017	2018	Multiannual average
April	64.0	32.0	53.1
May	71.0	51.0	71.7
June	24.0	141.0	73.6
July	100.0	135.0	82.2
August	9.0	41.0	47.0
Total	268	388	327.6

Source: Craiova Meteorological Station.

The tolerance indices were calculated using the formulas cited in Table 2.

Table 2. The calculate tolerance indices

Indices	Formulas
SSI (The stress susceptibility index) [7]	$SSI = [1 - (Ys/Yp)]/SI$ where $SI = 1 - (Ysi/Ypi)$
TOL (The tolerance index) [14]	$TOL = (Yp - Ys)$
MP (The mean productivity) [14]	$MP = (Ys + Yp)/2$
GMP (The geometric mean productivity) [6]	$GMP = \sqrt{Ys \times Yp}$
STI (The stress tolerance index) [6]	$STI = (Yp) \times (Ys)/(Ypi)^2$
YSSI (The yield susceptibility score index) [18]	$YSSI = (STIs + SSIs)/2$
YPSI (The yield production score index) [18]	$YPSI = (MPs + STIs)/2 - (SSIs + TOLs)/2$

Yp = grain yield of maize hybrid in non-stressed conditions (t/ha); Ys = grain yield of maize hybrid in water-stressed conditions (t/ha); Ypi and Ysi = mean grain yield of all maize hybrids in non-stressed and water-stressed conditions, respectively.

Source: Completed by the author according to the references.

Data were statistically processing by regression and correlation analysis using EXCEL program.

RESULTS AND DISCUSSIONS

In Table 3 are presented the data on grain yields obtained in the both conditions (Ys and Yp), the tolerance indices and the rank of indices.

Table 3. Grain yield in the water-stressed (Ys) and non-stressed conditions (Yp), tolerance indices and rank of indices in maize hybrids

Hybrid	Ys		YP		SSI		TOL		MP		GMP		STI	
HS 1154-14	5.91	2	7.37	10	0.51	1	1.46	1	6.64	9	6.60	7	0.54	7
HS 1158-14	6.16	1	8.48	6	0.71	2	2.32	2	7.32	5	7.23	4	0.64	4
HS 1191-14	5.64	5	11.31	1	1.30	10	5.67	10	8.47	1	7,99	1	0.78	1
HS1128-14	5.11	9	8.21	8	0.97	6	3.10	6	6.66	8	6,48	9	0.52	9
HS 734-13	5.52	6	10.16	3	1.17	7	4.64	8	7.84	2	7.49	2	0.69	2
HS 570-15	5.21	8	7.98	9	0.89	5	2.77	4	6.59	10	6.45	10	0.51	10
HS 880-13	5.81	3	8.85	5	0.88	4	3.04	5	7.33	4	7.17	5	0.63	5
HS 580-15	4.72	10	8.90	4	1.20	8	4.18	7	6.81	7	6.48	8	0.52	8
HS 1156-14	5.70	4	8.22	7	0.79	3	2.52	3	6.96	6	6.84	6	0.57	6
HS 141-14	5.26	7	10.43	2	1.28	9	5.17	9	7.84	3	7.41	3	0.67	3

Source: Own calculation.

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In this study, all the selection indices showed different rankings for tested hybrids, except the rankings for GMP and STI indices which showed similarity.

According to [18], for define the resilience and production capacity, is necessary that the original indices used in the Table 3 to be divided into two classes: Class 1 (SSI and TOL) and Class 2 (MP, GMP and STI) and a the score index should be calculated for the each individual index (by a scoring scale from 1 to 10) - Table 4.

The results showed small differences of scores between SSI and TOL and between MP and (GMP, STI), while between GMP and STI score differences have been very similar.

Table 4. Scores of indices for used tolerance indices (SSI, TOL, MP, GMP, STI) in maize hybrids

Hybrid	Class 1		Class 2		
	SSI	TOL	MP	GMP	STI
HS 1154-14	10	10	2	4	4
HS 1158-14	9	9	6	7	7
HS 1191-14	1	1	10	10	10
HS1128-14	5	5	3	2	2
HS 734-13	4	3	8	9	9
HS 570-15	6	7	1	1	1
HS 880-13	7	6	7	6	6
HS 580-15	3	4	4	3	3
HS 1156-14	8	8	5	5	5
HS 141-14	2	2	9	8	8

Source: Own calculation.

For verify the relationships between the value of the tolerance indices used in this study and their scores, the simple correlation coefficients were calculated (Table 5).

Table 5. The correlation coefficients between the tolerance indices and their score

Correlations	Correlation coefficients (r)
Class 1	
SSI with SSIs	-0.983^{00}
TOL with TOLs	-0.980^{00}
Class 2	
MP with MPs	0.958**
GMP with GMPs	0.968**
STI with STIs	0.962**

*and ** or ^{0} and ^{00} = significant positive or negative at 5% and 1% probability, respectively
Source: Own calculation.

The results obtained showed that, in general, for Class 1 of indices the correlations were negative and for Class 2 of indices the correlations were positive.

The tolerance indices SSI and TOL were highly significant negative correlated with their scores SSIs and TOLs (r = -0.983^{00} and r = -0.980^{00}, respectively).

The associations between the values of the other tolerance indices (MP, GMP and STI) and their scores (MPs, GMPs and STIs) were significantly positive (r = 0.958**, r = 0.968** and r = 0.962**, respectively).

According to [18] and based on these results, it can be concluded that these calculated score indices can be used to screening of drought tolerance as substitutes for their original indices.

Also, the values of the score indices and the correlation coefficients demonstrated that these two classes of indices address two different characteristics: the resilience capacity (RC) and the production capacity (PC), respectively.

In order, for more results and to development a better selection index or a better combination of indices, the relationships between the score indices and grain yield in both conditions (Ys and Yp), were calculated. These relationships were expressed by linear regression (Y) and by the coefficients of determination (R^2) - Table 6.

Table 6. The relationships results between score indices and grain yield in the water-stressed (Ys) and non-stressed conditions (Yp) in maize hybrids

Correlations	Regression equation (Y)	Coefficient of determination (R^2)
SSIs with Ys	Y = 0.088x + 5.017	0.388
SSIs with Yp	Y = -0.343x + 10.88	0.697
TOLs with Ys	Y = 0.071x + 5.110	0.253
TOLs with Yp	Y = -0.369x + 11.02	0.806
MPs with Ys	Y = 0.030x + 5.334	0.047
MPs with Yp	Y = 0.371x + 6.949	0.814
GMPs with Ys	Y = 0.062x + 5.160	0.193
GMPs with Yp	Y = 0.334x + 7.15	0.662
STIs with Ys	Y = 0.062x + 5.160	0.193
STIs with Yp	Y = 0.334x + 7.15	0.662

Source: Own calculation.

The results obtained demonstrated that the high yielding hybrids in both conditions could not be clearly identified if these indices have been used individually.

Among the calculated scores indices from different classes, SSIs, TOLs, GMPs and STIs indices registered close but weak relationships with Ys (R^2 = 0.388, R^2 = 0.253 and R^2 = 0.193, respectively), while SSIs, TOLs, MPs, GMPs and STIs indices registered close and strong relationship with Yp (R^2 = 0.697, R^2 = 0.806, R^2 = 0.814, R^2 = 0.662, respectively). Similar results were reported by [16] in common bean, by [9] in wheat and by [8] in cowpea.

Therefore, among maize hybrids with the highest score in Class 1, HS 1154-14, HS 1158-14, HS 1156-14, HS 880-13 and HS 570-15 proved to be superior maize hybrids. Similarly, in terms of Class 2, HS 1191-14, HS 734-13, HS 141-14, HS 1158-14 and HS 880-13 proved to be superior maize hybrids (Table 5).

In order to make a comparative analysis of resilience and productivity, the two indices RCI and PCI as proposed by [18] that are based on the combination of five score indices were calculated (Table 7).

In addition, the two indices: yield stress score index (YSSI) and yield potential score index (YPCI), based on these two components (RC and PC) were calculated for all tested hybrids.

Table 7. Values of RCI and PCI and their combination into YSSI and YPSI in maize hybrids

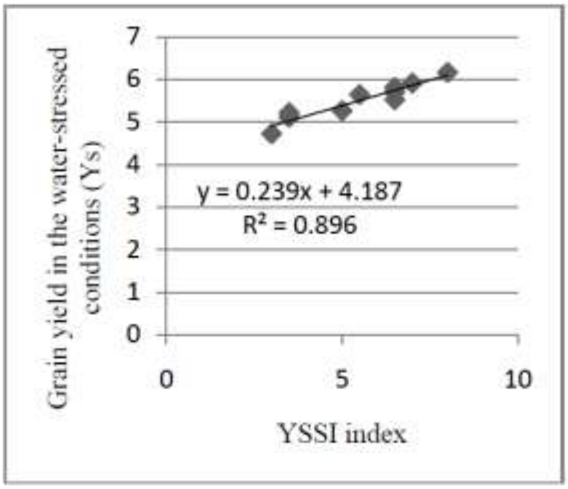
Hybrids	RCI	PCI	YSSI	YPSI
HS 1154-14	10	4	7	-7
HS 1158-14	9	7	8	-1.5
HS 1191-14	1	10	5.5	9
HS1128-14	5	2	3.5	-2.5
HS 734-13	4	9	6.5	5
HS 570-15	6	1	3.5	-5.5
HS 880-13	7	6	6.5	0
HS 580-15	3	3	3	0
HS 1156-14	8	5	6.5	-3
HS 141-14	2	8	5	6.5

Source: Own calculation.

The relationships between grain yield in both conditions (Ys and Yp) and new indices (YSSI and YPSI) were highly positive (R^2 = 0.896 and R^2 = 0.938, respectively) – Fig. 1.

The results confirmed ability of these new indices for selection of high yielding hybrids.

[8], reported that these new indices offer a simple and easy visualization and identification of genotypes with/none resilience and productivity or both.



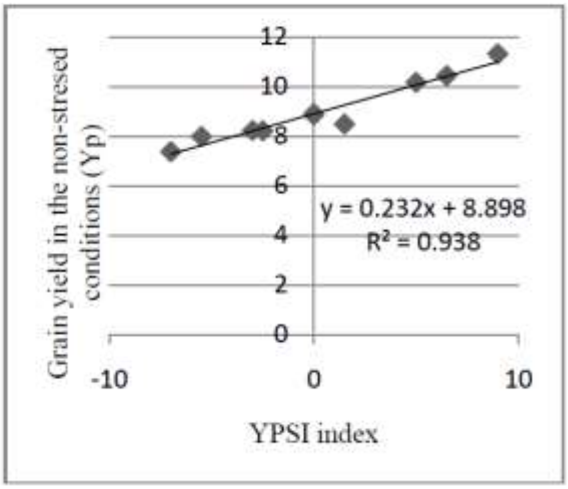


Fig. 1. The relationships between new score indices (YSSI and YPSI) and grain yield (Ys and Yp) in maize hybrids
Source: Own calculation.

Based on RCI index, hybrids HS 1154-14, HS 1158-14, HS 1156-14 and HS 880-13 were identified as having a better resilience as compared to hybrids HS 1191-14, HS 141-14 and HS 580-15.

Similar, based on PCI, hybrids HS 1191-14, HS 734-13 and HS 141-14 were identified as having a better productivity as compared to HS 570-15, HS 1128-14 and HS 580-15.

Based on YSSI and YPSI indices the hybrids HS 1158-14, HS 1156-14 and HS 880-13 were identified as having a better resilience, but HS 880-13 was identified as having and a better productivity as compared to these hybrids.

For YSSI and YPSI indices, the hybrids HS 734-13 and HS 141-14 have had close values which indicates that these hybrids had similar capacities of resilience and productivity. On the contrary, HS 1154-14 and HS 734-13 had close values of YSSI index, but very different values of YPSI index.

Thus, this study showed that using the new indices based on resilience and productivity, the tested hybrids can be classified into four categories:

(1) hybrids with higher resilience and productivity, including: HS 1158-14, HS 1156-14 and HS 880-13;

(2) hybrids with higher resilience and lower productivity, including: HS 1154-14, HS 570-15, HS 1128-14;

(3) hybrids with lower resilience and higher productivity, including: HS 1191-14; HS 141-14, HS 734-13; and

(4) hybrids with lower resilience and productivity, including HS 580-15.

According to [2], hybrids of categories 2 and 3 may be used in breeding programs while hybrids of category 1 could be used for cultivation.

CONCLUSIONS

The new selection method based on RCI and PCI, YSSI and YPSI indices can help maize breeders by defining more effective criteria to identify genotypes with high resilience and high productivity.

Among maize hybrids tested, HS 880-13, HS 1158-14, HS 1156-14 classified in category 1 are the most suitable for drought-prone areas.

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EVALUATION OF THE QUALITY OF THE OUTPUTS OF THE VOCATIONAL EDUCATION SYSTEM WITH AGRICULTURAL PROFILE BASED ON ITS CONTRIBUTION TO THE ACHIEVEMENT OF THE TASKS FOR SUSTAINABLE RURAL AREAS DEVELOPMENT

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Abstract

The main objective of this article was to assess the quality of skills held by graduates of agricultural specialties in the Republic of Moldova in terms of contribution to the tasks of sustainable development of the rural environment. For this purpose, an empirical study was conduct on the contribution of managers and specialists in the agricultural field in order to solve the tasks of sustainable development of economic units in which they operate based on their own perception. Starting from this premise, an opinion poll was conduct on a total sample of 157 specialists, graduates of various vocational education programs with an agricultural profile of levels 4-7 ECTS. As result of the data processing, a number of problems were deduced regarding the transfer of the quality of the outputs of the vocational education system with an agricultural profile in the performance of the agricultural production sector and, implicitly, the sustainable development at enterprise level.

Key words: *vocational education, sustainable development, rural areas*

INTRODUCTION

Today, the relationship between the content and quality of education and the complex process of sustainable development is a recognized one, being approached at multiple international events. Of particular note is the United Nations Conference on Environment and Development, held in Rio de Janeiro from 3 to 14 June 1992 [10]. The significance and magnitude of the event is accentuated by the fact that the participants represented about 98% of the world's population.

Main product of the Rio de Janeiro Conference (also called the Earth Summit) is the famous Agenda 21 - an extensive work schedule for cen. XXI, which covers all areas of sustainable development. In this context, along with other aspects covered by that program, we note the statement of education, training and awareness of the public as a means of implementing the actions provided by it.

In order to mobilize optimally this important means of achieving the goals of sustainable development in terms of education for sustainable development, the Earth Summit was followed by a series of international events:

-Decade of Education for Sustainable Development, 2005-2014, declared by the United Nations General Assembly in December 2002 by Resolution 57/254 [8];

-World Conference on Education for Sustainable Development, organized by UNESCO in Aichi-Nagoya, Japan, November 10-12, 2014 [11];

-World Education Forum, organized by UNESCO in cooperation with the United Nations International Children's Emergency Fund (UNICEF), the World Bank, the United Nations Population Fund (UNFPA), the United Nations Development Program (UNDP), UN Women and the UN Agency for Refugees (UNHCR), 19-22 May 2015 in Incheon, Republic of Korea [9].

Currently, as a provider of skilled labor, especially for the agricultural production sector, the vocational education system being represented by a number of technical and higher vocational education institutions, is one of the important actors in the process of sustainable development of the rural environment.

In the current conditions of society's development, when economic thinking and marketing reasoning are increasingly prominent and active at all levels of government, the contribution of the system in achieving the general development objectives and, implicitly, its relevance is increasingly questioned, reaching options to exclude from the system certain profile institutions through forced merger measures. In this context, we deduce the need to specify that accurately estimating the results and impacts of vocational education, respectively, is an extremely difficult, if not impossible, task due to the following circumstances:

(a)the benefits of education are manifested in a wide time horizon, but it does not represent a good that can be quantified immediately after finishing the studies;

(b)the benefits of education are reflected not only by contributing to economic growth, but also have a wide range of non-economic impacts (reducing crime and poverty, increasing the general level of culture, promoting democracy, etc.), their monetary value being insufficiently noted;

(c)transposing the quality of education into concrete results achieved at the level of society is a process as long as it is complex.

We note, with regret, that the quantitative insufficiency of qualified staff in the agricultural production sector is not the only problem related to the transfer of vocational education performance in the real sector [1, 6]. In the same vein, we must mention that, along with the quantitative reflection of vocational education outcomes, the quality of these outputs is of significant importance, expressed by the skills of graduates and being found in their contribution to the performance of the sector/enterprises and organizations where they work after graduation. For example, several studies have highlighted the link between the level, quality of vocational training and labor productivity [3, 2, 7]. After observing a number of companies, it was concluded that, for the majority of workers, the percentage of compliance with the work rules increases in proportion to the increase in the level of education [3]. In this regard, with reference to the Republic of Moldova, we must mention the existence of substantial gaps between the requirements of the sector and the quality of educational provision [4, 6]. In this context, we will repeatedly refer to the said opinion poll [6]. Thus, as a result of the examination of the appreciation by the employers of the quality of the specialists' training on the fields related to the researched programs (phytotechny, horticulture, pedology and soil protection, production of agricultural crops and livestock breeding, animal husbandry and veterinary medicine, products of plant origin technology), it was found that out of the total number of programs, only one (Agronomy, level 6, ECTS) obtained an average score of 4.7 points, the maximum possible score being 5 points. 13 evaluated programs obtained average marks within the limits of 3.6-4.5 points, 4 programs obtained average marks between 2.1-2 points, and two programs were rated with grades between 1.1-2 points. We thus deduce on the need for qualitative interventions in the study programs, so that they are optimally connected to the needs of the sectors, thus creating later premises for an optimal contribution in achieving the objectives of sustainable development of the rural environment.

MATERIALS AND METHODS

In order to achieve the objectives of the investigation, it was initially analyzed the subject of the need to address the link between vocational education and sustainable development, taking place in a series of international events. Subsequently, we found a major difficulty, if not impossible, regarding the specification of the impacts of vocational education in achieving the objectives of sustainable development. Also, an empirical study was conducted on the evaluation of the quality of skills held by graduates of agricultural specialties in the Republic of Moldova in terms of its contribution to the tasks of sustainable development of the rural environment. The study reflects an opinion poll on a total sample of 157 people, including 126 specialists in plant culture and 31 specialists in animal husbandry, graduates of

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various vocational education programs with agricultural profile levels 4-7 ECTS. Out of these, 84 holders of positions of managers of agricultural enterprises. The investigation was carried out through a questionnaire, the completion of which was carried out both on paper and online, subsequently being complemented by the unstructured telephone interview.

Following the data processing, it was found that there are a number of problems regarding the transfer of the quality of the outputs of the vocational education system with an agricultural profile in the performance of the agricultural production sector and, implicitly, sustainable development at enterprise level.

RESULTS AND DISCUSSIONS

Aware of the difficulty of accurately measuring the contribution of each manager or specialist in the performance indicators of a company, one possible way to quantify the impact of professional potential and the performance of each, is to evaluate them through their own perception by respondents.

The basic objective of the investigation was to evaluate the contribution of managers and specialists involved in research in order to solve the tasks of sustainable development of economic units in which they operate based on their own perception. The respective tasks, in turn, were deduced based on the approach of sustainable development indicators at enterprise level [5], being formulated as follows:

(1)Tasks for sustainable development of the production environment (ecological aspect): diversification of agricultural crops; diversification of livestock; assessment and improvement of genetic heritage; maintaining and increasing soil fertility; rational water management; application of ecological production technologies;

(2)Tasks for sustainable economic development: increasing plant productivity; increase animal productivity; increasing the level of income of the enterprise;

(3)Tasks for sustainable social development: increasing the quality of agricultural products obtained; agricultural waste processing; optimal use of buildings and landscapes; increasing the quality of roads; development of rural services; human resources development; ensuring adequate working conditions; ensuring decent salaries for employed staff.

When processing the surveys, the role of each respondent in the economic unit in which he/she works was considered, being analyzed only the tasks relevant to his / her professional duties. As a result, it was possible to reflect on the quality of the involvement of specialists in plant and animal breeding in carrying out ecological, economic and social tasks (according to the approach) [5], while business managers have been able to expose themselves to a wider range of tasks, by virtue of their wider area of professional responsibilities.

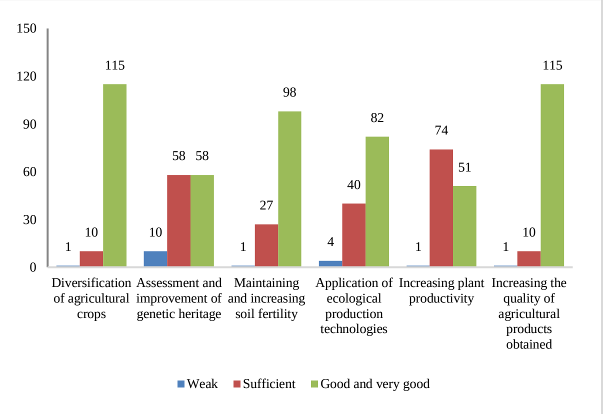

Fig. 1. The evaluation by the specialists in plant culture of the extent to which the competencies obtained in the process of professional education helped them to accomplish the tasks of sustainable development, pers.
Source: Own calculation.

Through the interview, some concretizations were possible, as well as the distinct identification of the contribution of professional and managerial competencies in solving the tasks of sustainable development by the managers who simultaneously exercise the attributions of the specialists in the respective branches.

The basic limitations of the research can be referred to: the small sample of people involved in animal husbandry; subjectivism in the evaluation by the respondents of their own contribution in increasing the indicators of the sustainable development of the economic unit.

The results of the systematization of the opinions of the managers and specialists trained in the survey are presented in Figures 1-4.

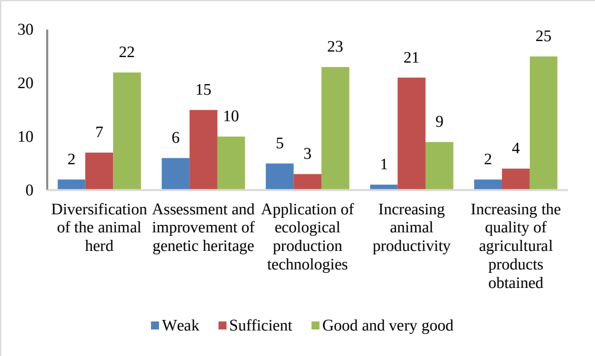

Fig. 2. Evaluation by animal husbandry specialists of the extent to which the skills obtained in the process of vocational education have helped them to achieve the tasks of sustainable development, pers.
Source: Own calculation.

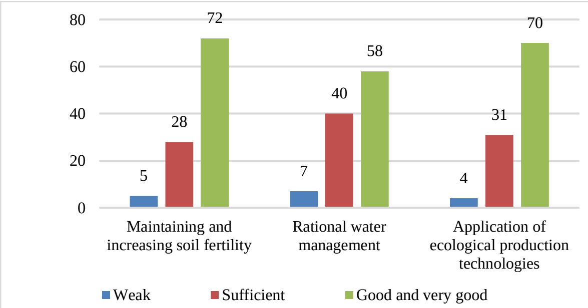

Fig. 3. The evaluation by the managers of the agricultural enterprises of the extent to which the managerial competencies obtained in the process of professional education helped them to achieve the ecological tasks of sustainable development, pers.
Source: Own calculation.

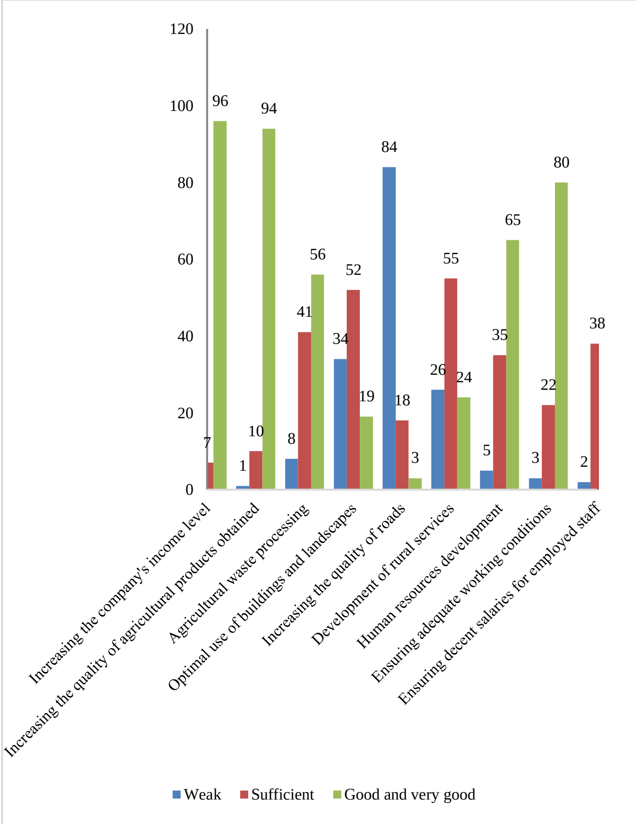

Fig. 4. The evaluation by the managers of the agricultural enterprises of the extent to which the managerial competencies obtained in the process of professional education helped them to achieve the economic and social tasks of sustainable development, pers.
Source: Own calculation.

The findings of the analysis of the results of the survey of specialists and managers of agricultural enterprises are set out in Table 1.

Table 1. Analysis of the results of the opinion poll of managers and specialists of agricultural enterprises

Groups of respondents	Tasks, the involvement in which it was appreciated mainly with the qualifications "good" and "very good"	Tasks, the involvement in which it was appreciated mainly with the qualifier "sufficient"	Tasks, the involvement in which it was appreciated mainly with the qualifier "weak"
Specialists in plant culture	*Tasks for sustainable development of the production environment (ecological)*		
	Diversification of agricultural crops; Assessment and improvement of genetic heritage; Maintaining and increasing soil fertility; Application of ecological production technologies.	-	-
	Tasks for sustainable economic and social development		
	Increasing the quality of agricultural products obtained.	Increasing plant productivity.	-
Specialists in animal husbandry	*Tasks for sustainable development of the production environment (ecological)*		
	Diversification of livestock; Application of ecological production technologies	Assessment and improvement of genetic heritage.	-
	Tasks for sustainable economic and social development		
	Increasing the quality of agricultural products obtained.	Increasing animal productivity.	-
Managers	*Tasks for sustainable development of the production environment (ecological)*		
	Maintaining and increasing soil fertility; Rational water management; Application of ecological production technologies.	-	-
	Tasks for sustainable economic and social development		
	Increasing the level of enterprise income; Increasing the quality of agricultural products obtained; Agricultural waste processing; Human resources development; Ensuring adequate working conditions; Ensuring decent salaries for employed staff.	Optimal use of buildings and landscapes; Development of rural services.	Increasing the quality of roads.

Source: Own determination.

From the data in Table 1, taking into account the potential subjectivism that can generate an overestimation of the contribution of skills in achieving the tasks of sustainable development, we find, however, the existence of a number of vulnerable aspects in their exercise, especially in relation to the following tasks:

(a)sustainable development of the production environment (ecological): evaluation and improvement of genetic heritage;

(b)sustainable economic development: increasing plant productivity; increase animal productivity;

(c0sustainable social development: optimal capitalization of buildings and landscapes; development of rural services; increasing the quality of roads.

Admitting that the tasks highlighted above are complex and depend on several factors, both endogenous and exogenous, the role of competencies, especially managerial, is to contribute to an accurate assessment of those factors, as well as the optimal use of resources available in terms of effectiveness and efficiency.

CONCLUSIONS

Generalizing the information regarding the transfer of the quality of the outputs of the vocational education system with agricultural profile in the performance of the agricultural production sector and, implicitly, the sustainable development at enterprise level, we deduce the existence of the following problems:

-the labor market for the agricultural production sector faces an unsatisfied demand in terms of quality, the conclusion being argued by the results of the evaluation of the quality of specialist training by employers, which shows a low quality of skills offered in most curricula with agrarian profile;

-the existence of the problem of the quality of professional and managerial skills is also argued by identifying a series of vulnerable aspects in ensuring the fulfillment of important tasks of sustainable development at enterprise level, such as: evaluation and improvement of genetic heritage; increase plant productivity; increase animal productivity; optimal use of buildings and landscapes; development of rural services; increasing the quality of roads;

-issues highlighted above are a key impediment to achieving the sustainable development objectives assumed by the Republic of Moldova in relation to the 2030 Agenda.

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JOB SATISFACTION OF EMPLOYEES IN PRIVATE TOURISM ORGANIZATIONS IN OSUN STATE, NIGERIA

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Abstract

Job satisfaction is an aggregate of employees' consideration on the sort of work they accomplish, the tasks that make up their activities and work conditions. This study surveyed the job satisfaction of employees in private tourism organizations in Osun State, Nigeria. The technique used in selecting two hundred and eighty six employees in the study area was achieved by using the multistage sampling method. Primary data were picked up on employees' job satisfaction via a structured questionnaire. Descriptive statistics and mean score were used for to analyse the data. Major employees' intrinsic (motivator) factors identified were: responsibility ($\bar{x}$ = 4.31), the work itself ($\bar{x}$ = 4.15) and recognition ($\bar{x}$ = 4.13) while major employees' extrinsic (hygiene) factors identified were: security ($\bar{x}$ = 4.2), quality of supervision ($\bar{x}$ = 4.2) and relationship with peers ($\bar{x}$ = 4.12). The result showed that there was a substantial difference ($F = 15.973$, $p < 0.05$) in the job satisfaction of employees through the segments of the private tourism organizations. The study established that the job satisfaction of employees are not the similar crosswise the private tourism organizations in the study area. It was suggested that the studied organizations should create better opportunities for personal growth of employees in their organization by ensuring that their work load is manageable.

Key words: *employees, tourism, organization, job satisfaction*

INTRODUCTION

Job satisfaction is the mentalities, emotions, and discernments that people have about their work [4]. Satisfaction with work having two basics is said to be a natural fulfillments with the activity while other is said to be the extraneous [14]. Physical aspects of wages, work, and advantages remembered for pay are said to be the outward fulfillments with employment. There is a complete scope of both these variables through which fulfillment of an individual is influenced for their work wherein nature of supervisory help, alliance inside gatherings and the measure on which people achievement and disappointment rely upon their activity are incorporated [4].

Achievement with work having a few features, for example, a concurrence with existing employment, pay approaches, supervisory help, nature of the work-life, contribution, commitment towards the association and hierarchical environment. It has been checked from numerous scientists that in order to decide work fulfillment, pay strategies, working conditions and hierarchical situations have major and significant commitments [7; 8; 9; 10]. These highlights are said to be interlinked in spite of the fact that happiness with one element doesn't affirm the satisfaction with the various perspectives [8; 10].

It has additionally been proposed by numerous specialists that through a joint effort with people, for example, their immediate supervisors in connection with the workplace, representatives' can set up the degree of fulfillment among them and can raise the odds of remaining with the association [15 and 16].

This implies if a representative is dedicated and completely faithful to his/her chief, it will clearly impact his fulfillment with employment and it can raise the likelihood to remain with. This finding goes next to each other with the findings of [22] and [23], who distinguished that great relations with administrators are connected with an individual activity fulfillment which has a direct bearing over worker plan to remain with or stop. The definition substance having a solid effect on sentiments which is designated, "influence". These evaluative segments portray an individual positive or negative inclination towards something which is said to be a mentality [3]. At whatever point a worker feels disappointed with his/her activity then there are the greatest odds of that representative to stop or leave.

Conspicuously, numerous researchers' recognized that to define job satisfaction, payment guiding principle, job operational settings and organizational environments are principal and key providers [16; 8; 7; 10; 9; 16 and 15]. They submitted that through the association with individuals, for instance, their close administrators and superiors with respect with the work environment, workers' can come about the level of gratification in the midst of them and this could upturn the odds of continuing with the organization [21].

On the other hand, the interconnectivity with the unambiguous job satisfaction having a continuous comportment over employee on to quit or stay with has a restored affiliation with directors [19 and 1].

It is conversely of note that managerial undertakings can influence meaningfully on job satisfaction. In various developing countries, mostly in the Sub-Saharan Africa, this facts is often required, making forecasting a thought-provoking workout and charge. There is a deficiency in information at present on job satisfaction of employees in the private tourism sector in Nigeria since the inception, which has made working scheme a harsh obligation and ineffective. It is on the other hand of importance to execute an investigation if the enhancement and the purposes of the organizations in the sector are to be accomplished.

To achieve the general aim of the study, it is necessary to job satisfaction of employees in the private tourism sector in Osun State, Nigeria. The following specific objectives were considered. To:

(i)examine the employees' intrinsic (motivator) factors in private tourism organizations.

(ii)examine the employees' extrinsic (hygiene) factors in private tourism organizations.

Hypotheses of the study.

H_{01}: There is no significant difference in job satisfaction among stakeholders in the private tourism organizations.

MATERIALS AND METHODS

The study was carried out in Osogbo metropolis in Osun State, Nigeria. Osogbo is the capital city of Osun State. Osogbo doubles as headquarter to Osogbo and Olorunda Local Governments in the State. The town is inhabited by Yoruba speaking people and predominant traditional occupations of the people are farming, herbal medicine, art and crafts. The people of Osogbo practice Christianity, Islam and Traditional religions. It is a community that pays high premium to cultural activities and this is reflected in their Osun-Osogbo annual festival that gives Osogbo prominence as an internationally acclaim cultural tourist destination in Nigeria.

Osogbo is located within the rain forest belt in south-western part of Nigeria. It has two predominant climate seasons: the wet season which is usually experienced between the months of April – October, and the dry season which covers the months of November – March with intermittent dry cold weather (hamattan). The geographical coordinates of Osogbo is 7° 46' 0" North, 4° 34' 0" East. Within Osun State, Osogbo maintains boundaries with: Egbedore and Ede North Local Governments in the west, Irepodun and Boripe Local Governments in the north, Obokun Local Government in the east and Atakunmosa Local Government to the south. Osogbo is accessible by roads and rail. [2] and [2] asserted that Osogbo is a prominent tourist destination in Nigeria and has high level of private sector involvement. Tourism private sector in the study area provides tourist services such as accommodation, food and drink, souvenirs, event management, transport and varieties of attractions. Hence, tourism is an important sector through which job is being created to the community.

A research design is the plan containing the structure and the strategy of investigation that are conceived in order to obtain answers to research questions and to control the variance [5]. Conclusive research design was adopted. It is descriptive and cross-sectional. This study adopts probability method (simple random) to draw representative sample from the population. Data were collected with structured questionnaire and personal observation. Data obtained were subjected to quantitative analysis. [18] cited [17] recommended conclusive research design for studies that seek to assist the decision maker in determining, evaluating and selecting the best course of action to take in a given situation.

Due to the heterogeneous nature of the tourism sectors in the population, multi-stage sampling technique involving purposive and simple random was used. Osogbo, the study area was purposively selected because the town is a prominent tourism destination in Osun State and Nigeria and also has the only world heritage site in the southern part of the country.

The study population consisted of employees 7 Hotels from the Hotel Sector, 3 Attraction Centres from the Attraction Sector, 3 Restaurants/Eateries from the Restaurants/ Eateries Sector and 4 Events Management Centres from the Events Management Sector. The structured questionnaire with closed and open-ended questions was used to collect the data of employees in the private tourism organizations. The sampling procedure for selection in the tourism sectors was simple random process.

The sampling procedure is as follows.

For the hotel sector, twenty one (21) hotels were identified and seven (7) were randomly selected. The employees' population in the selected hotels were one hundred and ninety eight (198). None of the selected hotels had more than thirty (30) employees. One hundred and thirty three (133) employees were randomly selected as sample size for the sector.

For the events Sector, there were eleven (11) organizations in the sector and four (4) were randomly selected. The total population in the selected events management organizations were eighty-seven (87) employees and sixty (60) were randomly selected.

For the restaurant sector, three (3) restaurants were randomly picked out of eight (8) that were identified in the study area. The selected restaurants have a population size of seventy two (72) employees out of which forty eight (48) were randomly selected.

For the attraction sector, three (3) attraction organizations were randomly selected out of seven (7) that were identified. The total population of employees in the selected organizations were sixty eight (68). Simple random was used to select forty five (45). In all, a set of two hundred and eighty six (286) questionnaires were administered but only two hundred and forty seven (247) were validly returned. This constituted about 58% of the sample frame and about 86% of the sample size. These recovered set of survey instrument were further used in the later examination. This research survey instrument used reports embraced from earlier studies.

Respondents were requested to agree on a 5-point Likert-type scale the extent to which they agreed with the comments. Queries in the instrument (questionnaire) were worded to tap the level of respondents' agreement to determine their intrinsic or motivator factors and extrinsic or hygiene factors. A little statements were undesirably worded and later reverse-scored to check response predisposition. Job satisfaction was measured on a 14-item job satisfaction scale. This was revised from the study of [6 and 11]. Mean score and Analysis of Variance were further used to analyse the data collected and test the stated hypothesis respectively.

RESULTS AND DISCUSSIONS

On the source of the approach presented above, the levels of respondents' job satisfaction (Intrinsic (motivator) factors is as shown in Table 1 below. The result revealed that the job satisfaction of employees in private tourism organizations in Osogbo was high, going by the mean values attracted by each of the intrinsic factors. However, the feeling of 'Responsibility in the Job' has the highest mean value of 4.13 while 'Job Complexity' has the lowest mean value of 3.46. Going by Hertzberg's Two Factor theory, the intrinsic factors are the 'satisfiers' and are the core or indigenous variables to motivation for job performance. These factors brings the benefits and satisfaction to employees mostly on the long run. With this result, the implication is that the employees in private tourism organizations in Osogbo are inherently motivated on the job and satisfied with it. An employee that enjoys recognition, responsibility, achievement, advancement in career, growth and enjoys job challenges will be very happy with the job and this will inspire him for a better performance on the job place. This argument is equally in consonance with Maslow's Theory of Needs Hierarchy.

Table 1. Levels of employees' intrinsic (motivator) factors

Intrinsic (motivator) factors	$\bar{x}$	σ
Responsibility	4.31	0.57
Work itself	4.15	0.61
Recognition	4.13	0.67
Achievement	4.1	0.79
Advancement	4.05	0.79
Growth	4.02	0.77
Job complexity	3.46	1.22

Source: Field Survey, 2019.

Table 2 showed that security (safe and comfortable working environment) and quality of job supervision (trust in organization leadership) have the highest mean of 4.20 each among the extrinsic factors, followed by relationship with peers (4.12), relationship with supervisors (4.10), organization policy and administration (4.07), work load (4.06) while salary issue is the least with a mean of 3.36. On a broad note, the employees could be said to have extrinsic satisfaction in their job except on the issue of salaries. Extrinsic factors according to Hertzberg can satisfy at one time and dis-satisfy at another. They are extraneous or are of less importance to influencing job satisfaction. For instance, the least position of salary in this result may bring dissatisfaction to the employees but may not affect the overall satisfaction level of individuals. It was maintain in [12] that people with high-level of self-control, responsibility and high level of challenge derive more satisfaction from the job. So, employees may be given good welfare and salary packages yet may remain unsatisfied with the job.

Table 2. Levels of employees' extrinsic (hygiene) factors

Extrinsic (hygiene) factors	$\bar{x}$	σ
Security	4.2	0.5
Quality of supervision	4.2	0.58
Relationship with peers	4.12	0.6
Relationship with supervisor	4.1	0.61
Organization policy and administration	4.07	0.63
Personal life	4.06	0.74
Salary	3.36	1.42

Source: Field Survey, 2019.

Table 3 showed the Analysis of Variance of job satisfaction of employees among the sectors of private tourism organizations in Osogbo, Osun State, Nigeria. The study tested the hypothesis for the substantial change in the employees' job satisfaction through the sectors of private tourism organizations sampled for the study. The result disclosed a weighty variance ($F = 15.973$, $p < 0.05$) in the employees' job satisfaction through the sectors of private tourism organizations.

Table 3. Differences in job satisfaction of employees across the sectors of private tourism organizations

Job Satisfaction			
	Between Groups	Within Groups	Total
Sum of Squares	8.601	43.617	52.217
df	3	243	246
Mean Square	2.867	0.179	
F	15.973		
Sig.	0.000		
Decision	Significant		

Note: The mean difference is sig. @ the 0.05 level.
Source: Own results based on Field Survey, 2019.

The inference is that the satisfaction of employees with their job across the sectors of private tourism organizations is not the same but significantly varies across their respective organizations. Therefore, the null hypothesis is rejected while the alternative is accepted. This assertion supports the findings of [13; 15; 16; 20].

CONCLUSIONS

This study had contributed to research by understanding the intrinsic and extrinsic factors of motivation in a well-structured organization such as the sectors of private tourism organizations. From the result of the examination, the findings conveyed the pragmatic help that the major inherent elements of job satisfaction are work itself and responsibility; similarly, quality of supervision on the job and job security are the main hygiene elements of job satisfaction. Furthermore, the job satisfaction of employees' levels are not the same athwart the private tourism organizations in the sector. Positioned on the responses of this study, it is recommended that private tourism organizations should improve on the intrinsic factors of job satisfaction by making their job intellectually challenging and creating better opportunities for personal growth in their organizations. Also, should enhance the extrinsic factors of job satisfaction by paying enough for the job done and ensuring that their work load is manageable. These are towards having an optimum job satisfaction of employees in the sectors of private tourism for a better organizational sustainability, performance and efficiency.

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THE CLIMATE VARIABILITY OF THE AGRICULTURAL YEAR 2016-2017 CASE STUDY: THE SOUTH-WEST OLTENIA REGION, ROMANIA

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Abstract

The agro-climatic resources, especially the thermic and precipitation resources of a territory, are the main natural factor influencing the health status of the vegetation and the productivity of a crop. The main objective of this study is to analyze the thermic and precipitation resources of the agricultural year 2016-2017(01.09.2016-31.08.2017), for the South-West Oltenia Region, in relation to the value of the barley and the two-row barley crops. The analysis will be carried out using the climatological data from 15 meteorological stations belonging to the National Meteorological Administration and the production data from the National Statistics Institute. The methods used in the data analysis are logical, spatial and comparative analyzes, operations in GIS environment and climatic indices (spring arrival Index). The 2016-2017 agricultural year, from a thermic point of view, was a warm year, with an annual average of 10.3°C for the entire region. The spring 2017 was excessively early with the average spring arrival index of 464.4°C. In terms of precipitation, throughout the agricultural year 2016-2017, there were six months of excessively droughty. As a whole, the agricultural year was droughty in most of the region, with an average annual rainfall of 587.4 mm. On this climatic fund, in the study area, there was an average production per hectare, for barley and two-row barley crops of 4,438 kg/ha. The variability of the main thermic and water parameters, of each agricultural year, determines the fluctuation of the crops. The analysis of these resources represents the sine qua non conditions for an efficient agricultural management.

Key words**:** *barley, precipitation resources, the South-West Oltenia Region, thermic resources, two-row barley*

INTRODUCTION

In the current context of climate change, the level of the North hemisphere, the year 2017, was the second warmest year in the history of the temperature recordings on Earth [14]. Also, the year 2017 was the warmest in the history of recordings without the influence of the El Nino climate process [10].

In the South –West Oltenia Region, in 2017, the annual average air temperature was 11.6°C, exceeded by 1.3°C the multiannual average of the reference period 1901-1990, being one of the warmest years in the history of the meteorological observations.

The climatic variability has direct consequences on the agricultural crops, so that the analysis of the main agro-climatic resources (thermic and precipitation resources) of a territory is a sine qua non condition in implementing the agricultural management strategies [11; 3].

The South-West Oltenia Region represents 12% of Romania's surface [4] (Fig. 1). The region is part of the temperate-continental climate, with an average temperature of 9.9°C and an average amount of precipitation of 680 mm, for the period 1901-1990 [5].

The main purpose of this study is to analyze the agro-climatic temperature and precipitation resources of the 2016-2017 agricultural year and their impact on the barley and two-row barley crops in the South-Western Romania. Barley and two-row barley are cereals used in the crop rotation in Romania, without having a technology very different from that of the winter wheat [9].

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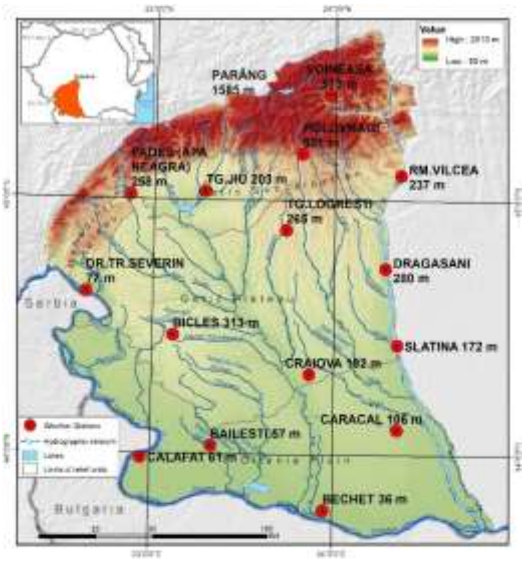

Fig. 1. The location of the study area and of the meteorological stations.
Source: own processing from GIS open sources.

MATERIALS AND METHODS

In the analysis of the thermic and precipitation resources of the agricultural year 2016-2017 (01.09.2016-31.08.2017), for the South-West Oltenia Region, there were used the meteorological-climatic data from 15 meteorological stations (MS) belonging to the National Meteorological Administration (NMA) (Fig. 1) and the production data from the National Institute of Statistics (NIS).

The methods used in data analysis are logical, spatial and comparative analysis, operations in GIS environment and climatic indices (Spring Arrival Index).

The statistical analysis and climate criteria were used in determining the types of weather, according to the Hellmann Criterion [6].

RESULTS AND DISCUSSIONS

The analysis of the thermic and precipitation resources of the autumn 2016

The average temperature for the autumn season, in the South-West Oltenia Region, varied between 9.5°C at Padeș and 12.3°C at Dr. Tr. Severin (Table 1). The deviations of these values from the climatological normal, calculated for the period 1901-1990, varied between -0.8°C at Padeș and 0.5°C at Voineasa, an aspect that is reflected in the predominance of the normal thermic time (N) in the study area and cool time (CO) at Padeș, Polovragi and Tg. Logreşti. For the entire study area, the average seasonal temperature was 10.7°C, with a deviation from the period 1901-1990 of -0.2°C, which determined that the autumn 2016 to be thermally normal (N) in the South-West Oltenia Region.

At the level of the autumn months, September registered values between 13.8°C at Voineasa and 20.0°C at Dr. Tr. Severin, so that the month, in most of the study area, was a slightly warm month (SW). The extreme temperatures of the month registered values between 33.6°C at Dr. Tr. Severin and 28.8°C at Voineasa for the maximum temperature, and for the minimum temperature the recorded values were between 6.7°C at Dr. Tr. Severin and 0.7°C at Padeș. As a result, there is an extension of the summer season over the first month of autumn. The ground surface temperature registered, in September, values between 40.4°C at Băilești and 55.6°C at Rm. Vâlcea for the maximum temperature, and values of 1.1°C at Tg. Lotrești and 7.1°C at Caracal for the minimum temperature.

The second month of autumn, October, recorded averages of air temperature that varied between 10.9°C at Dr. Tr. Severin and 7.1°C at Voineasa, with deviations from the period 1901–1990, by -0.1 °C at Voineasa and -2.4°C at Polovragi. According to the Hellmann Criterion, October was cool (CO) and cold (CL) for most parts of the study area, at Drăgășani and Polovragi and normal in the areas: Bechet, Băilești and Voineasa. The monthly maximum air temperature was between 23.2°C at Voineasa and 28.2°C at Bechet. The monthly minimum air temperatures were between -5.1°C at Padeș and 1.4°C at Dr. Tr. Severin. At the ground surface, the temperature of the monthly maximums has recorded values between 28.9°C at Bechet 43.4°C at Craiova, and the monthly minimums have ranged from -4.5°C at Polovragi to 1.7°C at Bechet.

In the last month of autumn, November, there were recorded air temperature values between 6.1℃ at Dr. Tr. Severin and 2.1℃ at Voineasa, with deviations from the period 1901–1990 between 0.0°C at Caracal and -

1.3°C at Polovragi. In most of the South-West Oltenia Region, November was a normal thermic month (N) according to the Hellmann Criterion. The maximum air temperature recorded values between 15.8°C at Polovragi and 18.5°C at Dr. Tr. Severin and the minimum values have fluctuated between -13.0°C at Calafat to -3.7°C at Caracal. At the ground surface, the maximum temperatures were between 17.2°C at Bechet and 23.8°C at Calafat, and the monthly minimums recorded values of -20.0°C at Calafat and -0.1°C at Bechet. As a result, the thermic potential of the autumn 2016 was within normal limits and in combination with the amounts of excess precipitation has determined a very good development of the autumn agricultural crops, established by barley and two-row barley.

The seasonal amounts of precipitation were between 174.7 mm at Bâcleș and 234.0 mm at Padeș (Table 1), and after the percentage deviations of this deviation from normal, the autumn was from normally rainy (N) at Tg. Jiu to very rainy (VR) and excessively rainy (ER) on extensive areas of the hills and Oltenia Plain (except for two restrict areas at Dr. Tr. Severin and Voineasa). The monthly amounts of precipitation in September 2016 were between 15.2 mm at Dr. Tr. Severin and 94.0 mm at Drăgășani. The percentage deviations of the precipitation quantities, compared to the norms calculated for the reference period 1901-1990 were between -68.6% at Dr. Tr. Severin and 93.3% at Băilești, and according to the Hellmann Criterion, the classifications of the types of precipitation were from excessively droughty (ED) and very droughty (VD) at Dr. Tr. Severin, Tg. Logrești, Padeș, Tg. Jiu and Voineasa to very rainy (VR) and excessively rainy (ER) at Calafat, Băilești, Bechet, Slatina, Bâcleș and Drăgășani. The monthly average of precipitation for the entire region was 50.9 mm, and its deviation from the normal percentage was 7.6%, which after Hellmann Criterion indicates that, on average, it was normally rainy month. The precipitation started in the first decade of the month between September 6th–September7th, when significant precipitation were recorded for agriculture.

Table 1. The thermic and precipitation regime of autumn 2016

The meteorological station	Altitude (m)	The thermic regime (°C)				
		NT	T	Δ =T-NT	HCr	
Dr. Tr. Severin	77	12.3	12.3	0.0	N	
Calafat	66	12.1	11.9	-0.2	N	
Bechet	65	11.5	11.3	-0.2	N	
Băilești	56	11.5	11.4	-0.1	N	
Caracal	112	11.6	11.9	0.3	N	
Craiova	190	11.5	11.3	-0.2	N	
Slatina	165	11.6	11.3	-0.3	N	
Bâcleș	309	10.8	10.7	-0.1	N	
Tg. Logrești	262	10.3	9.6	-0.7	CO	
Drăgășani	280	11.6	11.2	-0.4	N	
Padeș	250	10.3	9.5	-0.8	CO	
Tg. Jiu	210	10.8	10.5	-0.3	N	
Polovragi	546	10.2	9.5	-0.7	CO	
Rm. Vâlcea	243	10.7	11.0	0.3	N	
Voineasa	587	7.2	7.7	0.5	N	
Parâng	1585	2.6	-	-	-	
Oltenia average	-	10.9	10.7	-0.2	N	
The meteorological station	The precipitation regime (mm)					
	S	NS	Δ=S-NS	Δ%	HCr	
Dr. Tr. Severin	147.4	186.3	-38.9	-20.9	D	
Calafat	229.3	141.8	87.5	61.7	ER	
Bechet	213	134.7	78.3	58.1	ER	
Băilești	224.3	137.9	86.4	62.7	ER	
Caracal	138.0	123.4	14.6	11.8	SR	
Craiova	165.1	122.1	43.0	35.2	VR	
Slatina	172.4	132.2	40.2	30.4	VR	
Bâcleș	174.7	144.2	30.5	21.2	R	
Tg. Logrești	164.8	135.7	29.1	21.4	R	
Drăgășani	226.6	153.2	73.4	47.9	ER	
Padeș	234.0	214.3	19.7	9.2	SR	
Tg. Jiu	186.9	180.1	6.8	3.8	N	
Polovragi	244.0	209.0	35.0	16.7	SR	
Rm. Vâlcea	189.6	156.8	32.8	20.9	R	
Voineasa	63.1	164.5	-101.4	-61.6	ED	
Parâng	281.3	197.9	83.4	42.1	VR	
Oltenia average	190.9	187.1	3.8	2.0	N	

NT – the normal values of the autumn seasonal average temperatures (calculated over the period 1901-1990) (°C); T – the average values of the temperature of the autumn (°C); Δ = T-NT, the deviations from normal (°C); S – the sum of the precipitation in autumn (mm); NS – the normal values of the autumn precipitation (mm); Δ = S-NS, the deviations from normal (mm); Δ% – the percentage deviations from normal; HCr – the Hellmann Criterion.
Source: processed data from NMA, 2020.

In October 2016, the monthly precipitation amounts ranged from 49.5 mm at Caracal to 110.4 mm at Polovragi and the percentage deviations were positive in most of Oltenia and were placed between -60.4 % at Voineasa and 126.3% at Bechet, and according to the Hellmann Criterion, it was a very rainy month (VR) and excessively rainy (ER) in most of Oltenia.

Significant quantities were recorded for agriculture on October 7th, 10th–12th, 16th, 21st–22nd and October 26th. The monthly average quantity for the entire region was 75.3 mm, and the percent deviation to normal was -0.1%, which shows that October 2016 has been normal rainy (N).

In November 2016, the monthly precipitation amounts were between 34.7 mm at Caracal and 92.5 mm at Padeș, and their percentage deviations from normal were between -28.5% at Caracal and 54.6 % at Calafat, determining according to the Hellmann Criterion, classifications of the precipitation time types from normal (N) at Slatina, Padeș, Tg. Jiu Polovragi and Rm. Vâlcea to very rainy (VR) and the exceptionally rainy (ER) at Calafat, Băilești, Craiova, Tg. Logrești and Parâng. At the level of the South-West Oltenia Region, November recorded an average amount of 69.2 mm and a percentage deviation of 19.0%, thus, being, according to the Hellmann Criterion, a slightly rainy month (SR).

The analysis of the thermic and precipitation resources of the winter 2016-2017

In the winter season, the average temperatures, as shown in Table 2, are negative, except for the meteorological station Dr. Tr. Severin, which recorded the value of 0.3°C. The thermic deviation compared to the period 1901–1990, at the level of the South-West Oltenia Region was -0.2°C, so that the winter was thermally normal (N), according to Hellmann Criterion (Table 2).

The average winter season temperature was -1.4°C, with a deviation from normal of -0.2°C, which confirmed that, on average, the winter 2016–201 7 was normally thermic (N) (Table 2).

In the first month of winter, the average values of the air temperature ranged between 2.2°C at Calafat and -3.5°C at Voineasa. December 2016, according to the Hellmann Criterion, was normal (N) from a thermic point of view, for most of the study area, due to the deviations from the period 1901–1990, which ranged between 1.2°C at Calafat and - 2.3°C at Padeș. In terms of the extreme air temperatures, December recorded a monthly maximum of 15.0°C, and a minimum of -11.1°C at the level of the South-West Oltenia Region.

At the ground level, the maximum monthly temperature recorded an average value of 17.1°C for the entire study region. The minimum monthly average ground surface temperature was -5.3°C for the entire study area, so the soil was thawed for most of December.

Table 2. The thermic and precipitation regime of winter 2016-2017

The meteorological station	Altitude (m)	The thermic regime (°C)			
		NT	T	Δ =T-NT	HCr
Dr. Tr. Severin	77	0.4	0.3	-0.1	N
Calafat	66	-0.1	-0.5	-0.4	N
Bechet	65	-0.6	-1.6	-1.0	CO
Băilești	56	-0.7	-1.7	-1.0	CO
Caracal	112	-1.2	-1.8	-0.6	CO
Craiova	190	-1.0	-1.4	-0.4	N
Slatina	165	-0.8	-1.5	-0.7	CO
Bâcleș	309	-1.4	-1.3	0.1	N
Tg. Logrești	262	-1.1	-2.0	-0.9	CO
Drăgășani	280	-0.6	-0.6	0.0	N
Padeș	250	-1.0	-2.0	-1.0	CO
Tg. Jiu	210	-1.0	-1.1	-0.1	N
Polovragi	546	-1.5	-1.5	0.0	N
Rm. Vâlcea	243	-0.6	-0.5	0.1	N
Voineasa	587	-3.0	-3.2	-0.2	N
Parâng	1585	-5.1	-	-	-
Oltenia average	-	-1.2	-1.4	-0.2	N
The meteorological station	**The precipitation regime (mm)**				
	S	**NS**	**Δ=S-NS**	**Δ%**	**HCr**
Dr. Tr. Severin	56.8	160.5	-103.7	-64.6	ED
Calafat	67.3	123.9	-56.6	-45.7	ED
Bechet	61.7	104.6	-42.9	-41.0	VD
Băilești	65.4	121.4	-56.0	-46.1	ED
Caracal	71.8	108.7	-36.9	-33.9	VD
Craiova	69.0	109.7	-40.7	-37.1	VD
Slatina	59.0	117.2	-58.2	-49.7	ED
Bâcleș	-	-	-	-	-
Tg. Logrești	55.2	121.7	-66.5	-54.6	ED
Drăgășani	45.9	114.1	-68.2	-59.8	ED
Padeș	63.8	219.6	-155.8	-70.9	ED
Tg. Jiu	57.0	169.9	-112.9	-66.5	ED
Polovragi	46.6	153.4	-106.8	-69.6	ED
Rm. Vâlcea	40.2	120.1	-79.9	-66.5	ED
Voineasa	-	-	-	-	-
Parâng	83.9	160.0	-76.1	-47.6	ED
Oltenia average	60.3	136.1	-75.8	-55.7	ED

NT – the normal values of the seasonal winter averages temperature (calculated over the period 1901-1990) (°C); T – the average values of the temperature of the winter (°C); Δ = T-NT, deviations of the average temperatures from normal (°C); S – the sum of winter precipitation (mm); NS – the normal values of winter precipitation (mm); Δ = S-NS, the deviations from normal (mm); Δ% – the percentage deviations from normal; HCr – the Hellmann Criterion.
Source: processed data from NMA, 2020.

January 2017 was, according to the Hellmann Criterion, a cold month (CL) for most of the study area, due to thermic deviations compared to the period 1901–1990, which varied between -1.4°C at Polovragi and Rm. Vâlcea and -4.0°C at Băilești. The average monthly temperature recorded a temperature difference between -3.3°C at Dr. Tr. Severin and -6.5°C at Voineasa.

In the South-West Oltenia Region, January recorded a monthly average air temperature of -5.1°C and a deviation from the period 1901–1990 of -2.3°C, which determined that the month is cold (CL), according to the Hellmann Criterion.

Most values of the maximum monthly temperature were recorded on January 2nd and 3rd, being between 5.1°C at Voineasa and 12.5°C at Calafat. January recorded values of the minimum monthly temperature between -15.1°C at Dr. Tr. Severin and -25.4°C at Tg. Logreşti.

In conclusion, January 2017 was a cold winter month for the South-West Oltenia Region, from agro-meteorological point of view.

The second month of winter was characterized by average monthly temperatures between 2.7°C at Dr. Tr. Severin and 0.5°C at Voineasa and deviations, compared to the period 1901–1990, between 2.4°C at Polovragi, Bâcleș and Tg. Jiu and 0.9°C at Bechet and Băilești. For most of the study area, February 2017 was a warm month (W) according to the Hellmann Criterion.

In the winter season, the amounts of the seasonal precipitation varied between 40.2 mm at Rm. Vâlcea and 71.8 mm at Caracal, with percentage deviations from the period 1901–1990 between -33.9% at Caracal and -70.9% at Padeș (Table 2).

After the Hellmann Criterion, the winter 2016–2017 was excessively droughty (ED) in most parts of Oltenia.

The average of the seasonal quantities calculated for the whole region was 60.3 mm with the percentage deviation of -55.7%, which designates, on average, an excessively droughty winter (ED) for the whole region.

In December 2016, the monthly precipitation amounts ranged between 0.0 mm at Dr. Tr. Severin and Bâcleş to 9.5 mm Caracal and their percentage deviations from the normal ranged from -100.0% at Dr. Tr. Severin and Bâcleş to -75.9% at Caracal.

After the Hellmann Criterion, December was an excessively droughty month (ED) in all Oltenia. Snow missed throughout the month.

In January 2017, the monthly precipitation were between 4.7 mm at Polovragi and 49.8 mm at Caracal, and the percentage deviations from normal were between -90.4% at Polovragi and 43.5% at Caracal. After the Hellmann Criterion, January 2017 was excessively droughty (ED) and very droughty (VD) in the most part of Oltenia, except the area Bechet, Băilești and Caracal where it was at slightly rainy (SR) at Băilești, and very rainy (VR) at Caracal. The monthly average quantity for the whole region was 25.6 mm, and its percentage deviation from normal was -41.1%, which confirms that January 2017 was very droughty (VD), on average, for the whole region. Snow persisted due to the negative temperatures, with the maximum thickness included, between 5 cm at Tg. Jiu and 38 cm at Caracal.

In the last month of winter, the precipitations registered monthly quantities between 51.8 mm at Padeș and 0.5 mm at Voineasa, with percentage deviations between 3.6% at Craiova and -98.9% at Voineasa, so that February was a deficient precipitation month for most much of the study area. In a small area, at Craiova, February 2017 was normal, according to the Hellmann Criterion. For the whole South-West Oltenia Region, the monthly amount of precipitation was 26.9 mm, with a percentage deviation of -36.5%, thus, being, according to Hellmann Criterion, a very droughty month (VD).

The snow layer, in February 2017, recorded maximum thicknesses between 2 cm at Dr. Tr. Severin and 18 cm at Caracal.

The analysis of the thermic and precipitation resources of spring 2017

The spring season recorded average air temperature values between 9.0°C at Voineasa and 13.6°C at Dr. Tr. Severin and a regional average of 12.1°C (Table 3). The average seasonal air temperature, for the whole region, registered a deviation of 1.6°C compared to the period 1901-1990, being characterized, according to Hellmann Criterion, a warm spring (W) (Table 3).

In the first month of spring, the air temperature was characterized by monthly averages between 6.3°C at Voineasa and 10.8°C at Dr. Tr. Severin. Compared to the period 1901–1990, the thermic deviations oscillated between 3.6°C at Padeș and 5.2°C at Polovragi and Drăgășani.
As a result, March was warm (W) in most of the region and very warm (VW) at Tg. Jiu and Polovragi. The extreme temperatures of March were between 21.8°C at Polovragi and 25.7°C at Calafat in terms of the maximum monthly temperature and between 0.9°C at Bâcleș and -5.0°C at Voineasa, in terms of the minimum temperature monthly. The maximum monthly temperature at the ground surface oscillated between 29.1°C at Padeș and 47.0°C at Dr. Tr. Severin, and the minimum monthly temperature varied between 0.4°C at Drăgășani and -5.0°C at Tg. Logreşti.
April was thermally normal throughout the South-West Oltenia Region, according to the Hellmann Criterion. This aspect resulted from the values of the average monthly temperatures that oscillated between 7.8°C at Voineasa and 12.2°C at Dr. Tr. Severin, with deviations from the period 1901–1990 between 0.3°C at Dr. tr. Severin and -0.8°C at Polovragi.The extreme temperatures of this month registered values between -4.1°C at Voineasa and 1.9°C la Dr. Tr. Severin for the minimum air temperature, and for the maximum air temperature the values varied between 24.4°C at Polovragi and 30.3°C la Bechet. At the ground surface, the monthly maximum temperatures were between 27.7°C at Padeș and 50.4°C at Dr. Tr. Severin.
For April, the minimum temperatures on the ground surface varied between 0.9°C at Slatina, Băilești and Bechet and -4.4°C at Polovragi.
The average temperature of the last month of spring recorded values between 13.0°C at Voineasa and 17.9°C at Dr. Tr. Severin, and its deviations from the period 1901–1990 ranged between 0.3°C at Slatina, Bechet and Băilești and 11.0°C at Rm. Vâlcea. According to the Hellmann Criterion, May 2017 was thermally normal (N) throughout Oltenia. The monthly maximum air temperature has recorded a difference between 25.2°C at Polovragi and 32.2°C at Dr. Tr. Severin, which shows that the temperature reached values specific to summer. The monthly minimum air temperature in May was between 1.4°C at Voineasa and 6.5°C at Rm. Vâlcea. The ground surface monthly maximum temperature fluctuated between 33.2°C at Padeş to 63.4°C at Dr. Tr. Severin and the monthly minimum temperatures ranged from 1.0°C to 6.8°C at Polovragi and Drăgăşani.

Table 3. The thermic and precipitation regime of spring 2017

The meteorological station	Altitude (m)	The thermic regime (°C)			
		NT	T	Δ =T-NT	HCr
Dr. Tr. Severin	77	11.6	13.6	2.0	W
Calafat	66	11.6	13.3	1.7	W
Bechet	65	11.6	12.8	1.2	W
Băilești	56	11.6	12.7	1.1	W
Caracal	112	11.2	12.5	1.3	W
Craiova	190	11.2	12.4	1.2	W
Slatina	165	11.1	12.3	1.2	W
Bâcleş	309	10.1	11.9	1.8	W
Tg. Logreşti	262	9.7	11.3	1.6	W
Drăgăşani	280	10.5	12.4	1.9	W
Padeș	250	9.8	11.1	1.3	W
Tg. Jiu	210	10.5	12.5	2.0	W
Polovragi	546	9.2	10.9	1.7	W
Rm. Vâlcea	243	10.4	12.4	2.0	W
Voineasa	587	7.4	9.0	1.6	W
Parâng	1585	-	-	-	-
Oltenia average	-	10.5	12.1	1.6	W
The meteorological station	The precipitation regime (mm)				
	S	NS	Δ=S-NS	Δ%	HCr
Dr. Tr. Severin	135.1	186.5	-51.4	-27.6	VD
Calafat	182.5	146.2	36.3	24.8	R
Bechet	148.2	143.5	4.7	3.3	N
Băilești	117.4	157.8	-40.4	-25.6	D
Caracal	134.3	142.2	-7.9	-5.6	N
Craiova	148.0	135.2	12.8	9.5	SR
Slatina	142.9	149.7	-6.8	-4.5	N
Bâcleş	100.4	172.5	-72.1	-41.8	VD
Tg. Logreşti	213.9	161.2	52.7	32.7	VR
Drăgăşani	205.5	147.2	58.3	39.6	VR
Padeș	192.3	248.8	-56.5	-22.7	D
Tg. Jiu	177.7	193.1	-15.4	-8.0	N
Polovragi	232.3	225.2	7.1	3.2	N
Rm. Vâlcea	264.0	192.6	71.4	37.1	VR
Voineasa	153.3	200.6	-47.3	-23.6	D
Parâng	308.8	254.1	54.7	21.5	R
Oltenia average	185.9	177.4	8.5	4.8	N

NT – the normal values of the spring season temperature averages (calculated over the period 1901-1990) (°C); T – the average spring temperature values (°C); Δ = T-NT, the deviations of average temperatures from normal (°C); S – the sum of spring precipitation (mm); NS – the normal values of spring precipitation (mm); Δ = S-NS, the deviations of precipitation from normal (mm); Δ% – the percentage deviations of precipitation from normal; HCr = the Hellmann Criterion.
Source: processed data from NMA, 2020.

Spring Arrival was excessively early in most of Oltenia with spring arrival indices between

313.9°C at Voineasa and 542.2°C at Dr. Tr. Severin, and the average for the entire region was 464.4°C being a sixth in descending order from 1998-2019. This was due the month March was warm. The Spring Arrival index is calculated for the period February 1st–April 10th, 2015, as the sum of the positive daily average values of the air temperature [7; 2].

The seasonal amounts of precipitation were between 100.4 mm at Bâcleș and 264.0 mm at Rm. Vâlcea, and their percentage deviations from normal were between -41.8% in Bâcleș and 39.6% at Drăgășani (Table 3). According to the Hellmann Criterion, in spring 2017, the types of precipitation time regime were very droughty (VD) at Dr. Tr. Severin and Bâcleș, droughty (D) at Voineasa, Padeș and Băilești, normal (N) at Bechet, Caracal, Slatina, Tg. Jiu and Polovragi, slightly rainy (SR) at Craiova, rainy (R) at Calafat and Parâng and very rainy (VR) at Drăgășani, Rm. Vâlcea and Tg. Logrești (Table 3).

The seasonal amount of precipitation for the entire South-West Oltenia Region was 185.9 mm, with a percentage deviation compared to the period 1901–1990 of 4.8%, which makes the spring 2017 be normal rainfall (N), according to the Hellmann Criterion (Table 3).

The precipitation amounts in March ranged between 6.9 mm at Voineasa and 47.5 mm at Calafat and by percentage deviations, between -84.9% at Polovragi and 24.8% at Calafat, thus, being especially a very droughty (VD) and excessive droughty month (ED). At the level of the study area, the average monthly amount of precipitation was 26.7 mm, with a deviation from the period 1901–1990 of -36.4%, thus, being a very droughty month (VD).

In April 2017, the monthly precipitation amounts were trapped between 34.2 mm at Caracal, and 91.1 mm at Padeș, and their percentage deviations from normal were between -78.0% at Voineasa and 55.6% at Drăgășani. According to the Hellmann Criterion, April was with rainy deficit at Bechet, Băilești, Caracal, Bâcleș, Polovragi and Voineasa and the precipitation surplus was at Dr. Tr. Severin, Calafat, Craiova, Tg Logrești, Drăgășani, Padeș, Rm. Vâlcea and Parâng. The average precipitation for the whole region has been 57.2 mm and its percentage deviation from normal was 1.1%, which shows that April was, on average, a normal precipitation month (N) for all Oltenia. There was only an interval with significant precipitation for agriculture: April 16th–April 19th.

In May 2017, the monthly precipitation amounts were between 38.2 mm at Băilești and 170.0 mm at Rm. Vâlcea, and their percentage deviations from normal were between -45.5% at Băilești and 88% at Drăgășani. According to the Hellmann Criterion, May 2017 was: very droughty (VD) at Dr. Tr. Severin and Bailesti, droughty (D) at Slatina and Padeş, normally rainy (N) at Bechet Craiova, rainy (R) at Tg Jiu, very rainy (VR) at Calafat and Parâng and excessively rainy (ER) at Drăgășani, Polovragi and Slatina. For the study area, May was rainy (R) according to the Hellmann Criterion, with an average monthly precipitation of 95.5 mm and a percentage deviation of 20.5%.

Analysis of the thermic and precipitation resources of summer 2017

In the South-West Oltenia Region, the summer was characterized by average monthly air temperatures between 18.1°C at Voineasa and 25.6°C at Dr. Tr. Severin and deviations, compared to the period 1901–1990, between 3.6°C at Dr. Tr. Severin and 1.6°C at Tg. Logreşti (Table 4).

As a result, summer was warm (W) in most of the study area, according to the Hellmann Criterion (Table 4).

In the South-West Oltenia Region, July was characterized by average monthly air temperature values between 17.9°C at Voineasa and 24.8°C at Dr. Tr. Severin and with deviations between 2.2°C at Băilești and Bechet and 5.2°C at Padeș. For the whole region, the average air temperature was 22.5°C and its deviation from the period 1901–1990 was 3.1°C, so that June was warm (W) according to Hellmann Criterion. The extreme temperatures of June recorded values between 32.5°C at Voineasa and 39.9°C at Calafat for the maximum temperature, and for the minimum temperature, the values varied between 6.5°C at Padeș and Voineasa and 13.5°C at Dr. Tr. Severin.

At the ground surface, the temperature registered extreme monthly values of 7.6°C at Polovragi and 14.4°C at Calafat for the minimum temperature, and the maximum temperature oscillated between 43.7°C at Drăgășani and 67.3°C at Dr. Tr. Severin.

July has an average monthly temperature of 23.0°C and a deviation of 1.5°C for the South-West Oltenia Region, so the month is slightly warm (SW), according to Hellmann Criterion. Within the study area, the average monthly temperature varied between 17.9°C at Voineasa and 25.8°C at Dr. Tr. Severin. Its deviations from the period 1901–1990 were between 0.7°C at Tg. Logrești and 2.8°C at Dr. Tr. Severin.

The minimum air temperatures in July varied between 8.1°C at Voineasa and 14.4°C at Băilești and Calafat, and the maximum temperatures between 32.5°C at Polovragi and 39.1°C at Caracal.

The minimum temperatures on the ground surface ranged between 9.1°C at Polovragi and 14.9°C at Caracal, and the maximum temperatures between 41.5°C at Drăgășani and 66.6°C at Dr. Tr. Severin.

The last month of summer registered a value of 23.7°C at the level of the study area and a deviation of 2.6°C. The monthly average temperature in August was the highest value of the annual average of the monthly averages in the agricultural year 2016–2017. Within the region, the average air temperature for August recorded values between 18.4°C at Voineasa and 26.1°C at Dr. Tr. Severin and deviations between 1.7°C at Tg. Logrești and 3.9°C at Dr. Tr. Severin. According to the Hellmann Criterion, August was warm (W) for most of the study region.

Across the country, August 2017 is in the first three warmest months in the history of meteorological records [1]. The monthly minimum air temperature for August has recorded values between 3.5°C at Padeș and 11.6°C at Dr. Tr. Severin. The extreme ground surface temperatures recorded values between 4.6°C at Polovragi and 13.6°C at Caracal for the minimum temperature, and for the maximum temperature, the values ranged between 41.7°C at Caracal and 69.0°C at Dr. Tr. Severin.

Table 4. The thermic and precipitation regime of summer 2017

The meteorological station	Altitude (m)	The thermic regime (°C)			
		NT	T	Δ =T-NT	HCr
Dr. Tr. Severin	77	22.0	25.6	3.6	VW
Calafat	66	22.3	24.8	2.5	W
Bechet	65	22.2	23.9	1.7	SW
Băilești	56	22.1	24.0	1.9	SW
Caracal	112	22.0	24.4	2.4	W
Craiova	190	21.7	24.4	2.7	W
Slatina	165	21.6	23.7	2.1	W
Bâcleș	309	20.4	23.2	2.8	W
Tg. Logrești	262	19.9	21.5	1.6	SW
Drăgășani	280	20.9	23.6	2.7	W
Padeș	250	19.1	22.1	3.0	W
Tg. Jiu	210	20.5	23.4	2.9	W
Polovragi	546	18.9	21.1	2.2	W
Rm. Vâlcea	243	20.2	22.6	2.4	W
Voineasa	587	16.2	18.1	1.9	SW
Parâng	1585	-	-	-	-
Oltenia average	-	20.7	23.1	2.4	W
The meteorological station	**The precipitation regime (mm)**				
	S	**NS**	**Δ=S-NS**	**Δ%**	**HCr**
Dr. Tr. Severin	66.0	160.0	-94.0	-58.8	ED
Calafat	89.2	146.8	-57.6	-39.2	VD
Bechet	153.8	146.8	7.0	4.8	N
Băilești	100.8	e	-49.7	-33.0	VD
Caracal	105.8	167.4	-61.6	-36.8	VD
Craiova	96.6	164.7	-68.1	-41.3	VD
Slatina	148.8	184.9	-36.1	-19.5	D
Bâcleș	120.9	152.5	-31.6	-20.7	D
Tg. Logrești	158.2	165.4	-7.2	-4.4	N
Drăgășani	149.0	185.6	-36.6	-19.7	D
Padeș	104.8	232.0	-127.2	-54.8	ED
Tg. Jiu	158.2	219.2	-61.0	-27.8	VD
Polovragi	265.2	277.7	-12.5	-4.5	N
Rm. Vâlcea	293.6	254.3	39.3	15.5	SR
Voineasa	352.3	268.1	84.2	31.4	VR
Parâng	246.0	346.8	-100.8	-29.1	VD
Oltenia average	163.1	201.5	-38.4	-19.1	D

NT – the normal values of the seasonal averages of summer temperature (calculated over the period 1901-1990) (°C); T – the average of the temperature of the summer (°C); Δ = T-NT, the deviations from normal (°C); S – the sum of summer precipitation (mm); NS – the normal values of summer precipitation (mm); Δ = S-NS, the deviations from normal (mm); Δ% – the percentage deviations from normal; HCr = the Hellmann Criterion.
Source: processed data from NMA, 2020.

August, in terms of the precipitation resources, was characterized by values between 5.0 mm at Caracal and 110.3 mm at Voineasa, with deviations from the period 1901–1990 between 51.5% at Voineasa and -88.5% at Tg. Jiu. According to the Hellmann Criterion, only on a small area, at Voineasa, the month was excessively rainy (ER), otherwise the month was excessively droughty (ED).

At the level of the South-West Oltenia Region, for August, the average monthly amount of precipitation registered the value of 38.1 mm, with a percentage deviation of -27.2%, thus, being on average, a droughty month (D).

For the summer of the agricultural year 2016-2017, at the level of the South-West Oltenia Region, the seasonal amount of precipitation was 163.1 mm, with a percentage deviation from the normal of -19.1%, thus, being a droughty summer (D) according to the Hellmann Criterion (Table 4).

The summer drought has affected the water sources not only in the southwestern part of Romania, but even in European continent [8].

The thermic and precipitation resources which are outside the optimum need of growing barley and two-row barley are considered stress factors [12].

In this climatic context of the agricultural year 2016-2017, the average production of barley and two-row barley was 4.438 kg/ha, according to Table 5 [13]. As a result, barley and two-row barley crops are better suited to a thermic context with higher values and lower amounts of precipitation compared to wheat, rye and oat [9].

Table 5. The cultivated area and the agricultural production of barley and two-row barley in the South-West Oltenia Region

Culture	Year	Surface (ha)	Production (tone)	Average of production (kg/ha)
Barley & two-row barley	2016	51,679	183,135	3,544
	2017	48,355	214,617	**4,438**
	2018	49,284	219,507	4,454

Source: processed data from NIS, 2020.

CONCLUSIONS

The agricultural year 2016-2017, at the level of the South-West Oltenia Region, was characterized by positive monthly average air temperatures for 10 of the months of the year.

The warmest month is August, with an average of 23.7°C, and the coldest month is January with an average of -5.1°C, being the 4th coldest month of January in the period 1961-2019. Autumn and winter were normal and spring and summer were warm.

For the whole agricultural year, the space-time extension of the warm weather was 47.2%, of the normal one of 33.9% and of the cold one of 18.9%.

The overall precipitation regime was deficient at almost all meteorological stations in Oltenia, with an annual average for the entire region of 587.4 mm, which percentage deviation from normal was -13.1%, which according to the Hellmann Criterion, it confirms that the agricultural year 2016–2017 was, on average, a droughty year (D).

There were six months of low rain, of which five were excessively droughty and very droughty (ED and VD), and the rainiest month was July. The rainy autumn 2016 and July 2017 are the periods that mainly contributed to the agricultural production of this agricultural year.

The space-time extension of the precipitation excess time was of 36.3%, of the normal rain of 12.1% and of the rain deficient of 51.6 %.

The thermic-precipitation conditions from the region of South-West Oltenia, for the agricultural year 2016-2017, reflect a greater resistance of barley and two-row barley crops to warm and droughty weather, compared to other cereals.

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DETERMINANTS OF RURAL HOUSEHOLD SAVINGS BEHAVIOR: THE CASE OF AMBO DISTRICT, OROMIA NATIONAL REGIONAL STATE, ETHIOPIA

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Abstract

The study was conducted to identify factors affecting household saving behavior of rural households in the district of Ambo district. Data for the study was collected from 370 households from two Kebeles. Both primary and secondary sources were used for this study and multi-stage sampling technique was used to contact with the study units (households). To attain the objectives of the study the researcher used both descriptive and econometric analysis. With descriptive analysis percentages, figures, graphs, charts and tables were used to present determinants of private saving. The results ultimately reveals that the Sex of the head of the household, Family size, land size, Access to credit and annual income are significantly influencing the saving behavior in the entire study area. Based on these findings, we recommend that government policy intervention should focus on increasing the availability and accessibility of financial institutions, awareness creation and education on the importance saving and saving modalities, planning and expenditure controlling habit, socio-cultural saving barriers, increasing interest rate, and inflation and unemployment combating strategies to augment saving capacity, investment and then economic growth.

Key words: *household saving, Binary Logit Model, Ambo town, Ethiopia*

INTRODUCTION

Saving is an important instrument to enhance economic growth by providing sufficient funds for investors. The low level of saving is a typical feature of low-income economies such as Ethiopia. It represents a key impediment to development as it limits investment. Development economists have been concerned for decades about the crucial role of mobilization of domestic savings in the sustenance and reinforcement of the savings investment growth chain in developing economies. This is because the growth rate registered in most developing countries is often not commensurate with the level of investment [19].

However, household saving practice and culture in Ethiopia is very low and found at worst level as compared to the saving rate of developed countries households [1]. In addition, no adequate practice has been performed to educate the community about saving behavior. This was happened due to lack of adequate empirical result about the public savings practice and factors hindering the public to save. Even though there is full consideration of domestic savings contribution to economic reform, no adequate researches have been made in this area.

Regarding to empirical studies [1] analyzed the determinants of the saving behaviors among rural households in East Hararghe Zone has investigated the determinants of saving behavior of cooperative member households in Tigray region of Ethiopia. A common characteristic of these empirical studies is their employment of data obtained from rural households and cooperative members only. The saving practices of urban households and non-member of cooperatives were not addressed by these studies. Furthermore [14] assessed the knowledge, practice and factors affecting households saving behavior in North Gondar zone using survey data obtained from three districts and [3] examined households' saving culture in Ethiopia taking households sample from three towns. These empirical researches have similar characteristics of using simple descriptive statistics analysis. Simple descriptive statistics might fail to find out the complete attributes of households saving behavior due to its complexity.

Therefore this study was conducted t access the factors that affect the household saving situation Ambo district.

The nature and need for financial intermediaries

Finance is one of the most crucial inputs for economic activity, growth and development. If finance through own accumulated resources or equity is neither available, nor sufficient either external debt will assume a major significance or productive investment will be severely restricted. Financial institutions play an important role in this regard by channelling funds from surplus sector (savers) to deficit sectors (investors). However, these institutions do not show much enthusiasm to put their resources in rural and backward areas for the benefit of poor people as these are commercial organizations and are basically interested in profitability and sustainability for two reasons: a) incentive for functioning and b) for safeguarding the interest of stakeholders [19].

Rural cash flows are complex, varied, and heterogeneous. The presence of numerous activities in the farm and non-farm sectors and in households in different stages of life, composition, and level of income, affords a very fertile environment for the financial innovation, experimentation, and intermediation to suit different preferences and needs [18].

Microfinance institutions have emerged as popular mode of finance for the poor and small-scale producers in many countries. Small loan from a microfinance institution generates employment for the poor and women. With an easy access to a microfinance programme, the poor save regularly to build financial and physical capital [13].

Financial services integrate markets, encourage savers to hold larger production of their wealth in the form of financial assets than unproductive inflation hedges, and allocate ingestible resources more efficiently. Financial deepening is achieved by reducing risks and minimizing transaction costs through exploitation of economies of scale and scope, professional portfolio management and diversification, systematic collection of information, and fostering a better lender - borrower relationship [18].

Formal microfinance institutions are regulated by the financial authorities of a country –with special microfinance windows, semi formal microfinance institutions (savings and credit cooperatives, village banks, etc) are under the control of non-financial authorities and informal micro financial institutions are controlled by customary law and peer pressure [12].

The various microfinance institutions differ among themselves in the service they offer to their clientele. Some only offer productive credit while others provide clients with consumer credit and offer deposit services to safeguard savings. In some cases, micro financial institutions also offer services other than savings and credit. Certain microfinance institutions provide consulting services to member entrepreneurs, while others take a more minimalist approach limiting themselves to financial activities. The factors which most distinguish microfinance institutions from each other are without doubt their credit methodologies condition for access, interest rates, types of guarantees, and utilization of credit vary from one microfinance institution to another [4].

Many microfinance programs are involved in both lending and savings mobilization. To be self sufficient, micro finance programs ought to depend on mobilized savings rather than donor resources for on lending. But microfinance programs mostly mobilize involuntary savings from customers

Microfinance borrowing can increase the informal borrowing if the micro credit borrower is unable to repay microfinance loan and take resort to informal sources to repay the micro credit loan. On the other hand, micro credit borrowers may tend to borrow from informal sources if the economic activity demands higher loan than is provided by micro credit organizations. In contrast, informal borrowing is reduced if microfinance is an effective source of finance for the poor [13].

Rural Savings Mobilization

Funds for investing in agriculture, in developing countries, come from three major sources: public investment, private investment, and foreign aid. The share of public investment would be roughly 70 per cent in a typical developing country, private investment at around 10-15 per cent, and the balance of 10-15 per cent comes from foreign aid [17]. To meet these investment commitments, government mobilizes resource, partly through land revenue agricultural income tax, betterment levies, import/export duties and other income and non-income taxes. Household savings are the major source of private investment. The shortfall in the mobilization of domestic savings, both public and private, is met by foreign aid and investment.

Although the share of these different sources varies from institution to institution and from country to country, two general trends have been visible in the structure of these resources, firstly a heavy reliance on concession funds from central banks or aid agencies and secondly, a relative neglect of savings mobilization from the public [20].

Savings is a mechanism by which economic agents make deliberate choice to allocate a portion of their current income for the purpose of making investment and increasing their future earning capacity. Theory suggests that household total savings depend on the rate of return on savings, on uncertainty of future incomes, on risk aversion of households, on lifetime or permanent income or wealth, on family characteristics, and on the availability of borrowing [7]. In particular, increases in uncertainty in the face of liquidity and borrowing constraint will increase the total volume of household savings and particularly the portion of precautionary savings [8].

Since the definition of savings is not consistent throughout sectors, and according [6] to comprehend what rural savings are, there are two distinct patterns of savings. These are: (a) Savings made from absolute surplus, which the saver can spare beyond his budgetary allotments for fulfilling his day-to-day needs and, (b) savings as temporarily postponed consumption, which cannot be beyond a certain limit and are therefore not real surplus. Instead, these are just protected from a premature alternative use. A saver just imposes a constraining act upon him.

In households and business sector savings represents the difference between income and consumption. Income includes earnings from all sources during a year and is net of all costs incurred in producing that income. Consumption is the total amount of goods and services consumed by the rural household during a year and include expenditure on food, clothing, housing, travel, health care, social ceremonies, etc. Savings may be made in kind such as jewellery, livestock, grain, or some other commodities or may be in the form of currency notes deposited in a bank (or most often hoarded) [5].

Savings in the form of assets has limitations. Grain can deteriorate in storage or be lost to pests, animals require looking after and can die; moreover, when they are held as insurance against crises such as drought, they are often sold at a loss if the crisis occurs, because of deteriorating terms of trade or for a quick sale. Finally, holding a visible and available form of savings, such as grain or assets, can make it hard to resist demands and claims from other relatives [7].

The experience with microfinance all over the world has belied the myths that the poor do not save, and that they are not creditworthy. Despite having low paid jobs, the poor save, and the savings rate among the poor are not as low as one would contemplate. Similarly, contrary to the belief that the poor are bad credit risk, it is now established that the poor can be creditworthy that in some countries, the loan repayment rate is even higher among the poor than the non-poor [9].

A common feature of economic growth theories is the premise that capital accumulation is a prerequisite of economic growth, and that the savings of individual and households are an essential part of the process of capital accumulation. Savings determine, to a large extent, the rate at which productive capacity and income grow. An effective smoothly functioning financial system will increase the mobilization of savings, lower transaction costs, disperse risks and direct the allocation of resources to the most productive uses [8].

[18] Stated, mobilization of local savings would enlarge the resource base of lending agencies and correspondingly reduce their external dependence. It would also reduce loan defaults, as borrowers would be more careful with neighbors' savings than with government funds.

Evidence suggests that there is far more liquidity in rural areas than is generally assumed. This is partly due to seasonality in agricultural production. Moreover, rural people are responsive to interest rate changes and appropriate financial services. Hence, mobilization of voluntary financial savings in rural areas should be the first priority of financial institutions. Contrary to this, there is another approach, which is stated as follows; in the rural areas a vicious circle of low capital, low productivity, low income, and low savings could be broken through an instrument called credit, if used appropriately.

Determinants of Household Savings

Theory

Economic theory states that savings represents the difference between income and consumption. Income includes earning from all activities during a year and is net of cost incurred in producing that income (imputed costs, however, constitute income of the farm family). In a two sector economy consisting of households and business sector, income is either spent or saved. When this occurs, one can explain the behaviour of savings if one knows about consumption.

Consumption is the total amount of goods and services consumed by the rural household during a year and include expenditures on food, clothing, housing, heat, lighting, travel, education, health care, social ceremonies, and recreations, litigation and charity, etc. Savings may be made in kind, such as jewelry, land, livestock or some other commodities, or may be in the form of currency notes deposited in financial institutions and savings are fundamental to sustainable economic development.

Household savings literature is based on two major hypotheses [9] following the pioneering work of Keynes which defines savings as a linear function of income, the first major breakthrough in savings literature is the permanent income hypothesis of Friedman. This hypothesis differentiates permanent income and transitory income as determinants of savings. Permanent income is defined in terms of the long time income expectation over a planning period and a steady rate of consumption maintained over lifetime given the present value of wealth. Transitory income is the difference between actual and permanent income and since individuals are assumed not to consume out of this income category, marginal propensity to save on transitory income will be unity.

The second major contribution to savings literature comes from Ando and Modigliani's lifecycle hypothesis, whose basic assumption is that individuals spread their lifetime consumption evenly over their lives by accumulating savings during earning years and maintaining consumption levels during retirement.

The life cycle theory suggests that age has an impact on savings. The young and the retired people are dissevering. Therefore the higher the dependency ratio of a nation, the lower will be the saving rate thus implying what is called the level of effect of the life-cycle theory. Macroeconomic and political stability affect expectation and thus, also the saving rate. The services provided by government, such as social security, the availability and the quality of financial services can affect saving rate.

There are two sides of mobilization of rural savings. The supply side- the circumstances under which rural clientele are most likely to entrust their savings to financial institutions- and the demand side- the effort and range of services of financial intermediaries to institutionalize surplus funds.

[18] Stated the extent of monetization in an economy is a crucial factor in deposit mobilization. When farmers produce for market, their ability and willingness to interact with the market, particularly with financial institutions will increase. On the

other, during high inflation and economic instability rural households would prefer physical assets to financial savings.

Confidence is the basis of any financial transaction. Safety, continuity, and secrecy are some of the factors that foster confidence. Some government intervention may help in creating a sense of safety and confidence. When deposits are covered by insurance, it increases savers' confidence [8].

Rural people are rational in their approach to financial matters and they do take advantage of attractive interest incomes on deposits, if offered. In effect, an increase in interest rates makes current consumption more expensive than future consumption, and consequently promotes deferment of consumption.

Accessibility to the financial institutions is an important factor in the promotion of savings. When financial institutions/banks are opened near market centers and operate at convenient hours, rural people opt to institutionalize their surpluses. When they are confident as in its liquidity, they would prefer to earn something on the surplus other than keeping it idle. Stipulating low minimum transaction and balance limits would attract smaller depositors. Provision of financial services like money transfer from one center to another can encourage depositors. Similarly, non-financial services like payment for purchase of crops, payment of bills, etc, can increase deposits. Payment for crops presents an opportunity for intermediation because the buyer could establish an account payable in favour of the farmer. When there is a linkage between savings and lending, rural households will be prompted to hold deposits with a view to availing a loan when needed [10].

Empirical evidences

Household savings in rural areas appear to be difficult variable to measure [15] They are not always quantifiable. Saving methods are practiced according to the need for ensuring a long term security for the households. One must, therefore, differentiate the savings potential of the rural community in cash, kind, or livestock etc.

Empirical evidences of household savings in Pakistan [5] indicated that methods of savings are categorized as savings in cash, saving in bond holding, saving in agricultural products and saving in livestock. Saving in agricultural products is preferably practiced because of its higher flexibility. Saving in livestock represents the most practiced form. It has dual impact on the household economy, firstly, as a source of extra income and, secondly, by acting as cash which is always available at home. Factors that influence the form and extent of saving are divided into four categories. These are: economical, psychological, socio-cultural, and institutional factors. Some of the results from [5] study are presented as follows.

Income determines the extent as well as the form of savings. Landholding, especially the size of citrus orchards, strongly influence the rate of total saving, since the size of land holding influences income and income influences savings positively. A large family size exerts a negative influence on saving in kind. Cash savings remains neutral but livestock keeping is proved to be positively influenced by the availability of household labor.

The age of the household members exerts an uncertain impact on savings; if they are productive, the influence is positive. Underemployed or unemployed members are a burden on the household income and have a negative impact on savings. Empirical evidences proved that education is quite an uncertain factor in the case of savings. In most of the cases, better education gave better exposure which induced a demonstration effect and increased the propensity to consume.

The empirical survey of gender- specific savings aptitude indicated that women are found to be financially conservative and try to hold money for the family's security, whereas men prefer to concentrate upon the accumulation of social capital.

[11] has conducted a study in South Pacific region in an island nation called Fiji in two ethnic groups, the native Fijians and the Indo-Fijians, living side by side but demonstrating contrasting behaviour with respect to savings, investment, and business. Using the Tobit techniques, the result of the analysis revealed that the variable gender, Ethnicity, income

and Bank account were highly significant to the annual savings amounts.

The results of the study conducted by [19] entitled savings habits, needs and priorities in rural Uganda indicated that hindrance of rural savings were: low income level of rural households was the most significant factor; high fee charged by the financial institutions was the second most significant factor; the third most important impediment to savings was low personal interest in savings. Low interest rate paid on savings was a relatively insignificant impediment of savings. Though clients find interest rate too low, they nonetheless remain clients as this is not enough of a disincentive to cause them to exit.

[8] studies indicated that, on average, rapidly growing countries have higher savings rates than slower-growing countries. These rates are influenced by many factors: the level of income per capita, the rate of income growth, the age composition of the population and attitude toward thrift.

The results of the study conducted by [16] indicated that demographic variables such as age groups, birth rates, dependency ratio and financial variables such as interest rates, inflation rates, available financial instruments and initial wealth levels affected the decision of household savings significantly. Similarly, models simulation results of [19] studies revealed that income uncertainty has positive impact on household savings.

MATERIALS AND METHODS

Description of the Study Area

Ambo district is Located in West shewa Zone, Oromiya regional state, Ethiopia.

The District is situated at 8^0 47'N to 9^0 21'N and 3^0 3'E to 37^0 32'E with total area of 83598.69 hectare, out of the total area 46.5% is used Crop production, 34.5% for grazing, 1.05% covered under forest and shrubs and 18% is used for other different purpose [2].

The boundaries of Ambo district are Ilfata and Gindbaret districts from North Wanchi district from South, Dandi district from East and Toke kutaye district from west as well as Mida kenyi in North West. The altitude of the district range from 1,500m to 3,000m masl. Heterogeneity in altitudinal zone causes the area to follow different livelihood strategies and make use of various coping mechanism at the time of food shortage.

Agro ecologically, the district is categorized into three: Dega, Woina-Dega and Kolla constituting 23%, 60% and 17% of the total area of the district, respectively. The major types of soil the district are red soil (36.25%), Black soil (34.37%) and mixed soil type (29.38%). The major crops produced by the local people are *teff*, wheat, Maize, sorghum, and barley are the major food crops grown in the area.

Sampling Technique

A Multistage sampling technique was employed to get the required primary data. At the first stage, Ambo District was selected purposively, in the second stage, 2 kebeles were selected by simple random sampling techniques. A probability proportion to size (PPS) was employed to determine sample size from each kebele. Accordingly 4,900 households were selected through systematic random sampling techniques. In order to collect reliable and representative sample out of the target population the sample size was decided or determined by applying the scientific formula [20] as shown below.

Finally, the following formulas of sample size determination adopted from [20] $n = \frac{N}{1+N(e)^2}$

where:

n = Sample size;

N= Total number of households in the selected Kebeles;

e = precision level or sampling of error 9% (0.09)

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{4900}{1 + 4900(0.05)^2} = 370$$

where:

n = number of sample size

N =number of population in sampled *kebeles*

e^2 = is precision level.

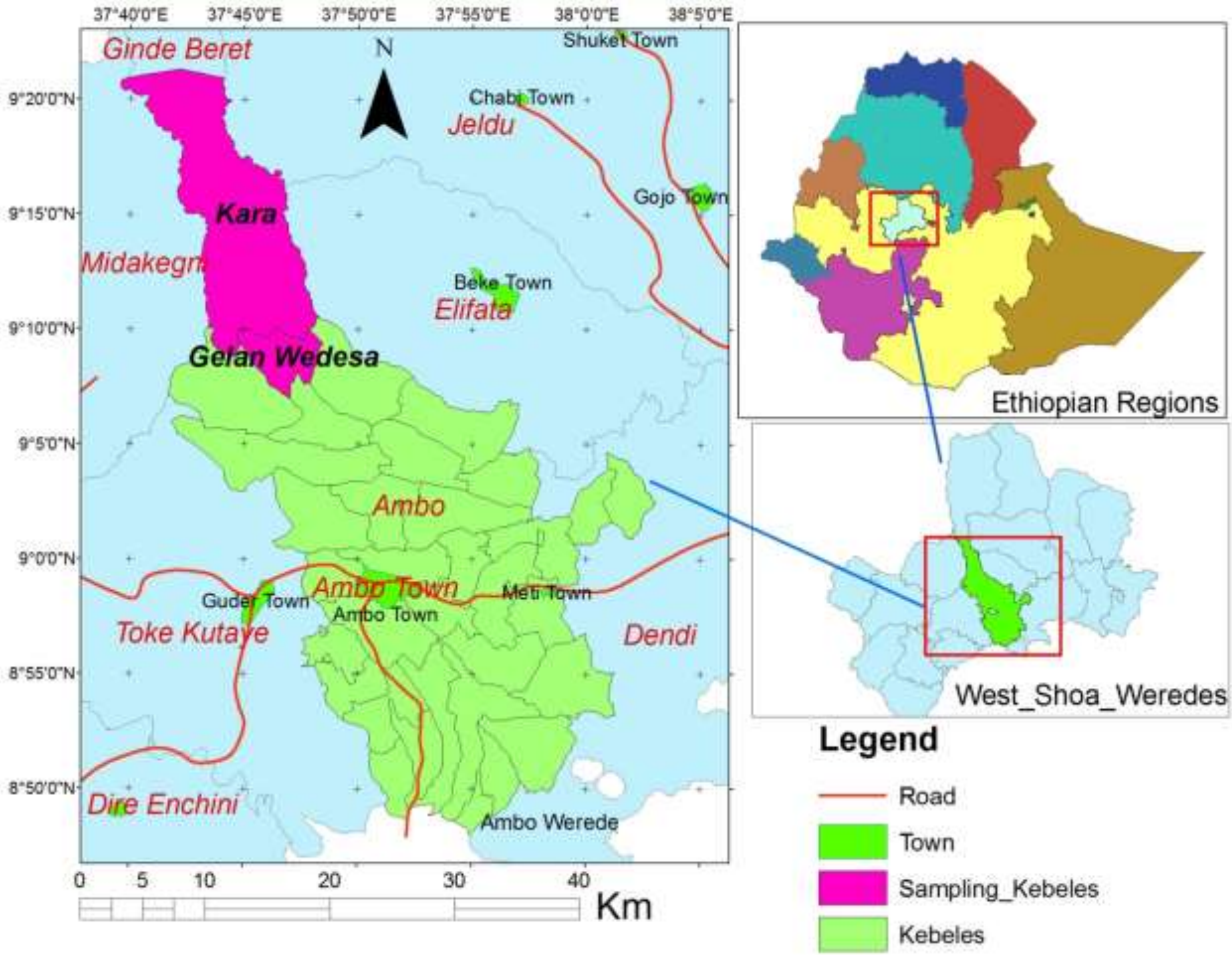

Fig. 1. Map of Ambo district, Ethiopia
Source: Ethio GIS.

Data Sources and Collection Methods

In this study both primary and secondary data were used. The primary data were collected from the sample farmers through structured questionnaire prepared for this purpose. In addition to the structured questionnaire, personal observations and group discussion with the members.

Secondary data were gathered from the different records of Rural Savings, Woreda Cooperatives Promotion Team, and Regional Cooperatives Promotion.

The survey was administered over 8 week period in September and October 2018. A total of 92 households, who were randomly selected were interviewed using the questionnaire.

Method of Data Analysis

To achieve the objectives of the study the researcher employed both descriptive and econometric analysis. Descriptive analysis used percentages, graphs and tabulations to explain different socio economic characteristics of the households and binary logistic regression modal was used to identify the effect of explanatory variables on household saving in the study area. Tools and statistics used in descriptive and econometric are generated with the help of econometric software STATA version

Econometric Model

When the dependant variable in regression is binary the analysis could be conducted by using linear probability and index models i.e. logit or probit. But the result of linear probability model may generate predicted values less than zero or greater than one, which violate the basic principles of probability. However, the index models logit or probit models generate predicted values between 0 and 1, they fit well to the nonlinear relationship between the probabilities and the explanatory variable. Each model has its own strength and weaknesses, but in this study logit model is preferable to probit model as it has more plausible feature such as simplicity: The equation of the logit is very simple, inverse linearzing transformation for the logit model is directly interpretable as log-odds, while the inverse transformation probit model does not have a direct interpretation (Gujarati, 2009), Hosmer and Leme show (1989) [9]the functional form of logistic model is specified as follows:

$$P(x) = E(y = 1/x) = 1/(1 + e^{-(Bo + BiXi)}) \quad \ldots\ldots(1)$$

For ease of exposition, we write (1) as:-

$$P(x) = \frac{1}{1+e^{-zi}} \quad \ldots\ldots(2)$$

where:

P(x) = is a probability of being saving ranges from 0 to 1.
Zi = is a function of n-explanatory variables (x) which is also expressed as:

$$Zi = Bo+B_1X_1 + B_2X_2 + \ldots\ldots + B_nX_n$$

Bo = is intercept
B_1, B_2 .... Bn = are slopes of the equation in the model.
This particular study was deal about the probability of saving or not-saving and this expression
expressed in mathematical form as follows: The probability of Saving (an event occurring) as the form:

$$1- P(x) = \frac{1}{1 + e^{zi}} \quad \ldots\ldots(3)$$

Therefore we can write:

$$\frac{P(x)}{1-P(x)} = \left[\frac{1+ e^{zi}}{1+ e^{-zi}}\right] = e^{zi} \quad \ldots\ldots(4)$$

Now P(x) / (1-P(x)) is simply the odds ratio in favor of saving. The ratio of the probability that a household saving to the probability of that it not saving .
Finally, taking the natural log of equation (4) we obtain:

$$Li = \ln \frac{P(x)}{1-P(x)} = Zi \quad \ldots\ldots (5)$$

$$Zi = Bo+ B_1X_1 + B_2X_2 + \text{-----------} + BnXn$$

If the disturbance term, (Ui) is introduced the logit model becomes:

$$Zi = Bo + B_1 X_1 + B_2 X_2 + \ldots\ldots + BnXn + Ui \quad \ldots\ldots(6).$$

Li = is log of the odds ratio, which is not only linear in X_i but also linear in the parameters.
Xi = Vector of relevant explanatory variables.
The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. This procedure yields unbiased and asymptotically efficient and consistent parameter estimates [9]. The collected data will be coded and entered into Statistical Package for Social Science (SPSS) version 20.0 software for statistical analysis.

Variable Description and Their Expected Sign

Table 1. Definition of hypothesized explanatory variables

Variables	Types of variables	Description of variables	Expected sign
Size of hh	Continuous	Household size	-
Age hh	Continuous	Age of household head	+
Sex hh	Discrete	Sex of the household head ("1" for male, and"0"	+
Edulv	Continuous	Education level of the household head	-/+
Land size	Continuous	Measured by hect.	+
Annualfi	Continuous	The amount of annual farm household income generated from on-farming activities	+
Total livestock	Continuous	Measured by TLU	+
Access to Credit	Dummy	Whether the household head receives credit, it take 1 if she receives it and 0 otherwise.	+

Source: Own interpretation and summary of definition Variables and their Expected Sign.

Dependent variable: There are two components for dependent variable; the first is the decision to save. It has a dichotomous nature measuring rural households' decision to save which takes a value of 1 if the household decides to save at formal financial institutions and 0 otherwise.

The second dependent variable is the extent or amount of saving by households at formal financial institutions conditional on the decision to save and is of truncated regression.

RESULTS AND DISCUSSIONS

Saving performances of households

House hold savings is value deposited at the time of survey by households. Farmers usually save from their proceeds for consumption smoothing purposes throughout the year, accumulation of wealth, and for contingency purposes in case of bad harvest or accident.

Accordingly, the survey result shows that about 218 (58.9%) of the respondents were saver, whereas the rest 152 (41.00 %) were non saver.

Among surveyed households, the average amount of household savings was 80,430.5 Birr with standard deviation of birr 28,701.6. The lowest saving level among the savers was 150 Birr and the highest reaches 323,050 Birr.

Descriptive Results

Demographic and Socio-economic Characteristics of the Sampled Households

Age of the Sampled Households

The average age of sample rural household was about 36 years with the minimum and maximum ages of 20 and 55 years, respectively. The average number of years during which the respondents carried out agricultural activities independently was about 16 and the average length of time in experience was about 2 years.

Table 2 indicates that of the total sample respondents, 218 were saver, whereas 152 were non-saver. Similarly, the table shows clearly that 43 and 34.59 percent of the sample respondents were within the age brackets of 20-35 and 36-45 years, respectively.

Sex of the Sampled Households

Among the total sampled household, the proportion of male-headed and female-headed households with savings was 78 (35%) and 140 (52%) respectively. This indicates that female headed households were relatively better in their saving status than male headed households. The chi-square test ($\chi2$=15.898 revealed that there is statistically significant difference between male-headed and female-headed households in their saving (Table 3).

Table 2. Ages of the Sampled Households

Age group	*Saver*		*Non-saver*		Total	
	Number	Percent	Number	Percent	Number	Percent
20-35	90	42	70	46	160	43.24
36-45	72	33	56	36.8	128	34.59
>45	56	25	26	17	82	21.89
Total	218	100.00	152	100.00	370	100.0

Source: Survey results.

Table 3. Sex of the Sampled Households

Description	*Saver*		*Non-saver*		χ^2-value	*Total*	
	Number	Percent	Number	Percent		Number	Percent
Female	140	64.52	52	23.9	15.898***	192	51.89
Male	78	35.48	100	46.1		178	47.9
Total	218	100	152	100		370	100

***Significant at 1% probability level

Source: Survey results.

Family size of respondents

Table 4 shows the family size of the sample respondents. Accordingly, the average family size of the sample borrowers was found to be 6 persons. This was higher than the national average of 5 persons (CSA, 1994). The largest family size was 11 and the smallest was 1.

Table 4. Family size of the respondents

Family Size	*Saver*		*Non-saver*		Total	
	Number	Percent	Number	Percent	Number	Percent
1-5	90	41.4	68	44.73	158	42.7
6-8	75	34.56	52	34.2	127	34.3
>8	53	23.96	32	21	85	22.7
Total	217	100	152	100	370	100

Source: Survey results.

The above table shows that about 42.7 and 34.3 percent of the sample respondents had the family size that ranges from 1-5 and 6-8 respectively.

While the percentage of respondents having more than 8 family size was only 22.7. The corresponding figures for saver and non-saver group were about 41.4, 35.6, and 23.9 and 44.7, 34 and 21 percent, respectively.

Educational status

The survey results revealed that 37.5 percent of the sample respondents were illiterate, whereas only 62.16 percent were able to read and write (Table 5).

Table 5. Education level of respondents by borrower group

Literacy level	*Saver*		*Non-saver*		Total	
	Number	Percent	Number	Percent	Number	Percent
Can read and write	130	59.9	100	65.78	230	62.16
Illiterate	88	40.1	53	34.2	139	37.56
Total	218	100	152	100	370	100

Source: Survey results, 2019.

This result calls for the necessity of basic education for rural women in the area.

Of the total sample respondents, about 40 percent of the Saver and about 34.2 percent of non-saver were illiterate, while only about 59.9 and 34.2 percent of saver and non- saver could read and write.

Farm size

The average land holding of the sample respondents was 0.53 hectare.

Table 6. Distribution of sample respondents by size of holding and borrower group

Land size (ha)	**Saver**		**Non-saver**		**Total**	
	Number	Percent	Number	Percent	Number	Percent
≤ 0.5	97	44.7	60	39.47	157	42.4
>0.5≤1	87	39.6	76	50	163	43.7
>1	34	15.66	16	10.52	50	13.51
Total	218	100	152	100	370	100

Source: Survey results.

The minimum and maximum holding sizes were 0.13 and 6 hectares, respectively. The average farm sizes of the Saver and non saver were 2.54 and 0.51 hectares, respectively.

Livestock situation

Farmers in the study area undertake both crop and livestock production activities. Though the holding size varied among the sampled borrowers and between saver and non saver, 99 percent of the total respondents owned livestock. In the area, livestock are kept for various economic and social reasons. The major economic reasons include provision or supply of draught power, generation of cash income and food. Table 7 shows livestock type held by the sample respondents. It is evident from the table that respondents in the area keep more goats and cattle than other categories of livestock. Oxen are the most important source of draught power for cultivation of land in the area.

Table 7. Average size of livestock (TLU/household) for sample respondents

Livestock type	Head	TLU	Mean	Average per valid observation
Cattle	358	250.6	3.89	4.16(86)*
Camels	50	50.0	0.54	1.72(29)
Donkeys	64	32.0	0.70	1.23(52)
Sheep	198	19.8	2.15	3.54(56)
Goats	510	51.0	5.54	7.08(72)
Total	1,180	403.4		

* Figures in parenthesis indicate number of valid observations
Source: Survey results.

The total livestock owned by the respondents were 1,180 and 403.4 in number and TLU, respectively (Table 7).
In examining the livestock ownership of respondents group (Table 7), it was found that saver had on the average 5.1, while the non-saver had 3.4 TLU with standard deviation of 3.05 and 2.48, respectively. It is apparent from Table 11 that about 54 percent of the saver had livestock size of greater than 4 TLU whereas only about 26 percent of the non-saver had a livestock size of greater than 4 TLU.

Table 8. Size of livestock holding, by borrowers group

Size (TLU)	*Saver*		*Non-saver*		Total	
	Number	Percent	Number	*Percent*	Number	Percent
≤4	83	38	68	44.7	151	40.8
4.10-7.40	77	35.4	46	30	123	33.24
7.41-9.20	40	18.4	30	19.7	70	18.9
9.21-13.20	18	7.83	8	5.26	26	6.75
Total	218	100	152	100	370	100.0
Average TLU	5.06		3.43		4.38	

Source: Survey results.

Total annual farm income

Livestock, crops and off-farm activities were important income sources for the sampled household. The average income earned by respondent from all crops (mainly, fruits, vegetables, and livestock was 3,337 Birr per annum. Saver reaped more cash from crops and livestock than non saver. The difference between the mean of the two groups was significant at less than 1% probability level (Table 9).

Table 9. Analysis of income sources of Respondent group

Description	*Saver*		*Non-saver*		t-Value	Total	
	Mean	SD	Mean	SD		Mean	SD
Annual Income	4,038	3,224	2,340	1874	-2.915***	3,337	2,862

*** and ** significant at 1% and 5% levels, respectively
Source: Survey results, 2019.

Access to credit

The results of the survey indicate that 52.2 % of the respondents had user, while 47.8 % did not use e credit. GroupWise, 66.7% of the saver and 31.6% of the non saver reported that they had access to credit. The Chi-square value, revealing differences between the two groups, was significant at 1% probability level (Table 10).

Table 10. Distribution of sample borrowers by extension contact

Description	*Saver*		*Non-saver*		χ^2-value	Total	
	Number	Percent	Number	Percent		Number	Percent
User	180	66.7	54	31.6	11.005***	234	63.34
Non-user	38	33.3	98	68.4		136	36.7
Total	218	100	152	100		370	100

*** Significant at 1% probability level
Source: Survey results.

Econometrics results

As outlined in methodology section, this study used the double hurdle model to identify the determinants of household saving. The model analyzed the household's decision to save and their extent of saving independently by using maximum likelihood method of estimation. Before going any further, it is important to present different tests conducted as required by the methodology. First, the Wald chi2 statistics as indicted by statistically significant p-value (P <0.0000) indicates that the model has a strong explanatory power. Second, the likelihood ratio test for Tobit restrictions revealed that the computed values are greater than critical values showing rejection of Tobit model. As a result the decision to save and amount of saving are not based on the same set of decision making process.

Five variables out of the eight potential variables that were entered into the binary logistic regression model were found to be positively and significantly influencing rural house hold saving. The variables which have significant relationship with rural house hold saving were the sex of household head, land size, amount of Annual income, and access to extension contact.

The variables sex of the household head positively related to probability of saving and the coefficient was significantly different from zero at 1 percent level. Keeping other variables constant, change in sex of household head from "female to male" probability of saving increase at about 0.95 percent. Therefore, Male headed households are expected to have better chance of earning income and when income increases saving level of the household increases.

The size of household was negatively related with probability of household saving.

Table 11. The maximum likelihood estimates of binary logit model

VARIABLE	B	S.E.	Wald	Sig.	Exp(B)
AGEHH	0.577	0.536	1.159	0.282	1.781
SEXHH	0.044	0.017	6.438	0.011**	0.957
FAMILY SIZE	-0.632	0.169	14.081	0.000***	0.531
EDUCL	0.749	0.457	2.687	0.101	2.115
ACCESS TO CREDIT	0.400	0.154	6.790	0.009***	1.492
LAND	1.539	0.287	28.820	0.000***	4.659
TLU	0.000	0.000	0.284	0.594	1.000
ANNUAL INCOME	0.001	0.000	2.904	0.088*	1.001
CONST	-6.617	2.112	9.819	0.002	.001

Source: Survey results, 2019.
Note; ***, **, * significant at one, five and ten percent probability level, respectively

Holding all other variables constant at their mean values, when household family size increase by one individual, probability of households saving decrease by about 0.531.

This is result is due to the fact that when family size increases with its existing high rate of fertility, less employment opportunity, weak work habit members of the family become unemployed and coupled with low rate of payment. Therefore, additional household member shares the limited resources that lead the household to save less.

Land size was one of the factor that affect households saving in the study area. When land size increases by one hectare, Probability of households saving increase at about 4.65 percent other variables remains constant.

In this study annual income of the household was positively related and coefficient is significantly different from zero at 10 percent level. Other things remain constant, when annual income of the household increase by a unit, probability of household saving increase at about 1.001 percent. This is due to the fact that when income increases households' tendency to save increase it means as income increase proportion of income saved also increases which are because share of income consumed decreases.

One of the model variables in this study is households' access to Extension contact . As it was hypothesized the variable is positively related and coefficient is statistically different from zero at less than 5 percent level. Holding other variables constant, when access to extension contact change from "**no access**" to "**access"** probability of saving increases at about 1.492 percent. The result was due to the fact that access to extension contact increase an opportunity to invest and participate in different income generating activity which can enhance income and saving level at the same time.

CONCLUSIONS

The main objective of the study was to assess the determinants of rural household saving among small holders farmers household in Ambo district of West Shewa Zone, Ethiopia. A three-stage sampling technique was utilized to obtain a sample size of 92 rural farm households. Cross sectional data were collected through structured questionnaire, focus group discussion, key informant and field observation. The data were analyzed using descriptive statistics such as mean, standard deviation, percentage and frequency distribution and descriptive statistics, binary logistic regression models were used to identify determinants of rural household food security.

Accordingly, the survey result shows that about 54 (58.7%) of the respondents were saver, whereas the rest 38 (41.3 %) were non saver.

The study examined determinants of rural household food security among small holders farmers household in the study area. The study was conducted using descriptive statistics and binary logistic regression models to identify factors determining household saving status of rural households in Ambo district.

The binary logistic regression model result revealed that from the total nine (9) independent variables, five variables significantly influence saving in the study area. These are Sex of household head, family size in, land cultivated, Annual income and Access to extension contact. In the study area family size negatively influences household saving. On the other hand, land cultivated and Annual income, Access to training, Sex oh household head positively influence saving. This means that a unit increase in these variables Increases the saving of the households in the study area.

On the basis of the findings the results of the study, the following recommendations are made in an attempt to improve the saving status of households.

-The size of household was negatively related with probability of household saving. Therefore Family planning and related measures should be taken to limit household family size.

-Household's probability of saving and can enhance households' information accessibility to the institution, give location advantage and help to save money easily, hence concerned body should establish financial institution in the vicinities of households.

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THE LEVEL AND QUALITY OF INCLUSIVE GROWTH AGRI-FOOD SYSTEM IN MODERN CONDITIONS

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Abstract

With regard to the agri-food system, the theoretical and methodological basis for the study of inclusive development has been substantiated. The study reveals the concept of inclusive development of the agri-food system, substantiates criteria and indicators, and proposes assessment methods. New risks associated with the COVID-19 pandemic are analyzed in the development of the agro-food system, which has aggravated the existing systemic problems and negatively affected the quality of life of Russians. A comparative analysis of the quality of inclusive development of the agri-food systems of the Saratov region and Russia in the context of the main blocks: growth and development, the fairness of distribution of public goods between all strata and groups of the population, the involvement of all forms of management, food security, environmental sustainability. An integral indicator of the level and quality of inclusive development of the agri-food system of Russia and the Saratov region was calculated. Measures are formulated to facilitate the transition of the agri-food system to an inclusive development model and overcome negative trends in the post-pandemic economy.

Key words: *model of inclusive growth, agri-food system, sustainable development, food security, post-pandemic economy*

INTRODUCTION

At the present stage, the COVID-19 pandemic has become a serious challenge to the sustainable development of the agri-food system both in Russia and around the world. New risks were actualized related to food supply chain disruptions; with the vulnerability of small forms of agribusiness, including the self-employed; with trade restrictions and problems in the operation of transport and logistics infrastructure; with an increase in the financial burden on the budgets of the federal and regional levels; with a change in demand for food products due to a decrease in the level of income and quality of life of the population. In the context of uncertainty, global and national challenges, the problem of choosing adequate models for the modernization of the agrarian economy, preventing a decrease in the sustainability of socio-economic development, becomes especially urgent. An inclusive model of economic development meets the requirements of modern realities.

The transition to an inclusive model is actively discussed by the world community. This model not only corresponds to the paradigm of sustainable growth and is aimed at solving key systemic problems in the face of great challenges. The transition of the agri-food system of Russia to an inclusive growth model will be aimed at solving the spectrum of problems that have accumulated in recent decades. Among such problems, it is advisable to note the following:

- inconsistency of the technological level of development of the material and technical base of the agrarian sector of the economy with current world trends;
- low level of labor productivity and qualifications of the labor force, associated with insufficient investment in human capital;

- a significant differentiation of population groups by the level of physical and economic availability of food;
- social polarization, exacerbation of social problems and depopulation of rural areas, etc.
- ineffectiveness of competition mechanisms, self-regulation, public administration, asymmetric support.

In the current conditions, it is the inclusive model of development of the agri-food system that contributes to attracting all resources and activating the institutions of innovative development; fair distribution of public goods, taking into account the interests of all strata and groups of the population; ensuring not only self-sufficiency in the provision of food but also its economic and physical accessibility; reduction of the level of poverty of welfare not only in the short-term but also in the long-term period [8].

In a post-pandemic economy, in order to ensure food security, transform food chains, and increase the sustainability of the agro-food system, it is advisable to form the inclusiveness of the agri-food system and improve the quality of life of the rural population to reduce poverty, preserve and develop small forms of agribusiness. Updating research related to the substantiation of a new concept of socio-economic development of agri-food systems involves analyzing and assessing the level and quality of inclusive growth at all levels of management, which will allow identifying priority areas of sustainable development and developing a methodology and tools for achieving strategic goals in operating economic institutions of our time [5].

At present, world science has accumulated a wealth of experience in research on the inclusive development of the economy, including many theoretical approaches and methodological provisions proving the existence of a significant connection between the rates of economic growth and the solution of a wide range of social problems [4]. The methodology for assessing the level of inclusive development is presented in the studies of such international organizations like the UN, IMF, OECD, the World Bank, etc. The model of inclusive development is relevant in the context of studying the problems of sustainable development and the transition to a “green economy” based on innovation and structural reforms.

FAO has developed a series of social protection policies for the poor to ensure inclusive sustainable growth in the agricultural sector of the economy [15, 29].

According to foreign researchers, sustainable development is a process that preserves the basic determinants of the territorial system and ensures a balance of economic, social, and environmental measures [13, 31].

Modern economists Acemoglu D., Robinson J.A. outlined the essence of the concept of "inclusiveness" using the terms extractive and inclusive [1].

The studies were based on evolutionary, institutional, systemic, and logical approaches, which made it possible to comprehensively assess the interaction of extractive and inclusive institutions. Inclusive development is based on scientific and technological progress and innovative growth [7].

Inclusive development models are effective for both developing and developed countries. For countries that are considering hidden opportunities for economic growth, inclusive development is an effective tool for the transition from imitation to an innovative model of economic development [2, 18].

Inclusive development of the agri-food system provides the ability to manage social, environmental, geopolitical risks with a high degree of efficiency [17]. In the context of the digital transformation of the economy, special attention deserves the study of the relationship between inclusive development and the use of digital methods and means in agricultural production [19].

The transition to an inclusive model of socio-economic growth aimed at increasing growth rates is possible provided the expanded use of the totality of resources, including human resources [16, 20].

A new round of interest in this issue is associated with overcoming the consequences of the COVID-19 pandemic. This is how FAO unveils a new response agenda that aims to create new and strengthened partnerships for international food and agricultural responses that support the country, regional, and global efforts to combat hunger and malnutrition. To limit the impact of the pandemic, recover and accelerate progress towards the Sustainable Development Goals (SDGs), key priority areas have been identified, including economic inclusion and social protection for poverty alleviation, improving trade and food safety standards, making smallholder farmers more resilient to recovery, preventing next zoonotic pandemic [14,26].

We believe that the model of inclusive development is also relevant to the agri-food system. However, the specificity of this sphere of the economy presupposes adaptation of the existing theoretical and methodological basis for the study of inclusive growth (including the concept, criteria, indicators, assessment methods, etc.). Considering the special social significance of the agri-food system, a feature of the inclusive model of its development should be an orientation towards human interests, towards achieving not only self-sufficiency of food supply but also the physical and economic accessibility of food to all segments of the population. It is from these positions that economic, social, political transformations in the agricultural sector of the economy should be assessed [10].

MATERIALS AND METHODS

The methodological basis of the research is the works of Russian and foreign economists in the field of research on sustainable development of the agri-food complex based on the concept of inclusive growth.

In order to analyze and assess the level and quality of inclusive processes, foreign scientists have formulated key and institutional performance indicators [3, 21].

Key indicators of inclusive economic development according to the index of inclusive development according to the World Economic Forum (WEF) are growth and development; inclusion; fairness and sustainability between generations. WEF calculates indicators considering the dynamics of GDP growth, labor force participation in labor productivity and life expectancy; average household income, poverty, and others [27].

The study of foreign experience has revealed different points of view on the main provisions of the concept of inclusive development at the macro, middle, and micro levels. So, at the macro level, inclusive development is assessed by such indicators as an increase in the average living standard of the population, an increase in the average real income per capita, and equal access of all segments of the population to public goods [6, 25].

The concept of inclusive development is associated with the transformation of the priorities of agri-food policy. To assess the effectiveness of existing policies, it is necessary to form a system of indicators and indicators to assess the level and quality of inclusive growth.

We consider it necessary to include five blocks of indicators in the system of indicators of inclusive development of the agri-food system. The first block, which characterizes growth and development, the role and place of the agricultural sector in the country's economy, the efficiency of using human capital, includes the following indicators:

gross added value of agriculture per capita as a percentage of GDP,%;

labor productivity in agriculture as a percentage of the average for the economy,%;

change in the share of profitable organizations of the current year to the previous one, %;

change in the number of people employed in agriculture of the current year to the previous one, %;

change in the level of employment of the rural population of the current year to the previous one, %.

The second block of indicators aimed at assessing the harmony of resource sharing between different segments of the population includes the following indicators:

- the proportion of the population with money incomes below the subsistence minimum of the total population,%;
- the ratio of the median income to the average per capita income of the entire population,%;

-the ratio of average monthly wages in agriculture to wages in the economy as a whole,%;
-change in the number of rural percent of the population of the current year to the previous year,%
-population income concentration index (Gini coefficient);
-the level and structure of state support for the development of rural areas, including social and engineering infrastructure;
-subsidies for sustainable development of rural areas per 1 rural resident, rub.
The third block of indicators characterizes the involvement of all forms of management, including small agribusiness, in the formation of food resources. The following indicators can be used as such:
-arable land area for the total number of peasant farms (KFH) and individual entrepreneurs (IP), ha;
-the share of small agribusiness in the production of basic types of food;
-the amount of state support for small agribusiness;
-the share of peasant farms and households in the production of the main types of agricultural products (grain, potatoes, vegetables, livestock and poultry, milk), %.
A special place in assessing the inclusive development of agri-food systems belongs to the indicators of the fourth block, characterizing the level of food independence, physical and economic accessibility of food [23].
This group includes the following indicators:
-the level of self-sufficiency of the population with food (the ratio of the level of production and consumption for the main types of food), %;
-the level of physical availability (the ratio of the actual level of consumption of basic types of food to the recommended standards), %;
-the level of economic accessibility of food (the share of food costs in consumer spending), %.
Indicators of environmental sustainability, which constituted the fifth block of indicators of inclusive development, are no less important for assessing the inclusive development of the agri-food system. These include indicators:
-the proportion of organizations that carried out innovations that ensure an increase in environmental safety in the production of goods, works, services, %;
-emissions of pollutants from stationary sources;
-the proportion of captured and neutralized air pollutants escaping from stationary sources, %;
-greenhouse intensity of agricultural production (carbon dioxide emissions per ruble of GVA);
-use and disposal of production and consumption waste;
-index of the physical volume of environmental expenditures (in comparable prices); in% to the previous year;
-investments in fixed assets aimed at environmental protection and rational use of natural resources, per 1 rub. GRP, RUB.
With the help of the presented methodological approach, it is possible to assess the level of inclusive development both at the federal and regional levels, which will allow ranking and rating of agri-food systems at the regional level, to carry out their typology to improve the existing agri-food policy [11].

RESULTS AND DISCUSSIONS

Inclusive development of the agri-food system is a process of economic, social, institutional transformations aimed at creating non-discriminatory conditions, including the possibility of participation of all actors in the processes of production, distribution and consumption of food, as well as access of all groups of the population to social infrastructure, provided that decent quality of life (including nutrition) of the population as a whole and its individual groups [22].
Approbation of the methodology for assessing the inclusive development of the agri-food system was carried out on the example of such a region as the Saratov region. The indicators presented in table 1 make it possible to identify the Saratov region as an agrarian region. According to the indicator "Share of agricultural production per capita" Saratov

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region is more than 1.4 times higher than the average for Russia. The share of agricultural products in Russia's GDP is 3.5%, and in the Saratov region this value is 15.3%. It should be noted that there is a difference in the dynamics of this indicator: if in the Russian Federation the share of agricultural products in GDP in 2016-2018 decreased by 1.43 times, then in the Saratov region a slight increase is evident.

Table 1. Indicators of inclusive development of the agri-food system of the Saratov region for the block «Growth and Development»

Indicators	Subjects	2016	2017	2018
Agricultural production per capita, thousand rubles	Russia	34.9	34.9	36.4
	Saratov region	57.1	54.5	52.5
Share of agricultural products in GDP (GRP),%	Russia	5.0	4.6	3.5
	Saratov region	14.2	12.3	15.3
Labor productivity in the economy, thousand rubles / person	Russia	1,188.0	1,278.4	1,458.0
	Saratov region	565.7	618.5	686.2
Labor productivity in agriculture, thousand rubles / person	Russia	933.8	1,008.9	1,083.5
	Saratov region	1,291.0	1,506.4	1,677.6
Labor productivity in agriculture as a percentage of the average for the economy, %	Russia	78.6	78.9	74.3
	Saratov region	228.2	243.6	244.5
Change in the share of profitable organizations of the current year to the previous one, %	Russia	100.1	97.4	100.4
	Saratov region	108.4	94.4	105.9
Change in the number of people employed in agriculture this year to the previous year, %	Russia	99.54	92.57	97.28
	Saratov region	92.20	81.45	85.94
Change in the level of employment of the rural population of the current year to the previous one, %.	Russia	100.0	88.5	100.4
	Saratov region	101.7	82.5	95.1
Change in the volume of investments in agriculture, the current year to the previous, %.	Russia	123.2	102.8	112.9
	Saratov region	160.0	90.9	91.4
Integral indicator for the block "Growth and Development"	Russia	**1.000**	**0.961**	**0.973**
	Saratov region	**1.000**	**0.908**	**0.993**

Source: Own determination.

The analysis of such an important indicator characterizing the efficiency of economic development as labor productivity deserves attention. If labor productivity on average in the economy of the Saratov region is lower than the average Russian level, then labor productivity in agriculture in the region is significantly higher than that in Russia.

At the same time, the ratio of labor productivity in agriculture and the economy as a whole in the Saratov region and Russia is fundamentally different. So in the Saratov region, labor productivity in agriculture is almost 2.5 times higher than the average for the regional economy. In the Russian Federation, the differentiation between similar indicators is not so pronounced.

However, the positive dynamics of labor productivity in agriculture in the Saratov region can be explained not so much by an increase in production as by a sharp decrease in the number of employed.

Causes certain caution and a significant decline in investment in agriculture. Despite the increase in this indicator in the agriculture of the Russian Federation, in the Saratov region over the past few years, there has been an almost ten percent annual decline. We believe that this is a significant obstacle to the inclusive development of the region's agri-food system.

Analysis of the integral indicator for the block "Growth and development of the agri-food system" of the author's methodology characterizes the stable position of the Saratov region.

At the same time, the existing model of socio-economic development is characterized by the differentiation of the level of income and life of the rural and urban population.

The proportion of the population with incomes below the subsistence level in the countryside is more than three times higher than the urban level. In 2018, the average monthly nominal accrued wages in agriculture amounted to 65.6% of the average for the economy (Table 2).

Table 2. Indicators of inclusive development of the agri-food system of the Saratov region for the block «Equity in the distribution of public goods»

Indicators	Subjects	2016	2017	2018
The proportion of the population with money incomes below the subsistence level of the total population, %	Russia	13.3	13.2	12.9
	Saratov region	17.4	16.8	16.1
The ratio of the median income to the average per capita income of the entire population, %	Russia	74.71	74.84	74.61
	Saratov region	79.90	80.65	79.88
The ratio of average monthly wages in agriculture to wages in the economy as a whole, %	Russia	59.3	65.5	65.6
	Saratov region	68.0	70.4	70.0
Income concentration index (Gini coefficient)	Russia	0.412	0.411	0.413
	Saratov region	0.365	0.365	0.362
Change in the rural population of the current year to the previous one, %	Russia	99.7	99.4	99.4
	Saratov region	99.0	98.6	98.2
The share of subsidies in the direction of "Sustainable development of rural areas" in the total volume of state support, %	Russia	7.8	7.9	10.2
	Saratov region	5.1	6.0	2.0
Share of subsidies for improving the housing conditions of citizens living in rural areas, in the amount of financing for sustainable development of rural areas, %	Russia	46.5	48.7	49.5
	Saratov region	0.0	30.2	18.4
The share of subsidies for the complex arrangement of social and engineering infrastructure in settlements located in rural areas, financing of sustainable development of rural areas, %	Russia	52.5	26.9	22.9
	Saratov region	100.0	61.2	53.2
Subsidies for sustainable development of rural areas per 1 rural resident, rubles	Russia	417.0	364.6	319.2
	Saratov region	198.0	256.0	58.6
Integral indicator for the block "Fairness of distribution of public goods"	Russia	**1.000**	**0.918**	**0.916**

Source: Own determination.

For a number of indicators of the direction "Fairness of distribution of public goods" Saratov region is inferior to the Russian Federation. The population with a specific income below the subsistence level is more than 20% above the national average. The level of concentration of income of the population, using the Gini coefficient, remained practically unchanged, which may indicate a stable situation in the distribution of income.

This is confirmed by the smaller gap in the level of wages in agriculture and in the regional economy as a whole. The low level of wages in agriculture, which is almost a third lower than the average wage in the economy, does not contribute to the solution of social problems in the countryside.

The following reasons impede the fair distribution of public goods: inconsistency of all levels of rural management; lack of effective mechanisms for overcoming poverty, inequality, and unemployment in rural areas; underdeveloped rural infrastructure and poor staffing; poor diversification of the rural economy and an insufficient level of development of non-agricultural activities; insufficient entrepreneurial activity and low efficiency of measures of state support for the development of rural areas [12]. In the structure of state support for the development of the agro-industrial complex, the share of subsidies in the direction of "Sustainable Development of Rural Areas" was in 2018 in the Russian Federation - 10.2%, and in the Saratov region - 2%. At the same time, subsidies for sustainable development of rural areas in 2018 in the Russian Federation amounted to 319.2 rubles per one rural resident and only 58.6 rubles in the Saratov region.

There is reason to believe that the use of an inclusive model helps to solve these problems. Inclusive growth means the involvement of not only high-tech sectors of the economy but also the agricultural sector in the process of modernization and innovative development of the Russian economy, which will diversify sources of income, create decent jobs, ensure the availability of social protection means and expand the opportunities of the rural population. These questions are important in informing pro-poor agri-food policies, strategies, and programs. We believe that such an approach will contribute to the inclusive growth of the agri-food system and sustainable development of rural areas.

The assessment of the indicators of the involvement of all forms of management in the formation of food resources made it possible to conclude that the institutional structure of the agri-food system of the Saratov region is quite stable (Table 3). A large contribution to the formation of food resources belongs to peasant farms in the Saratov region, the share of which in agricultural production reaches almost one third, which is almost three times higher than the same indicator in Russia. The maximum contribution of peasant farms in the Saratov region is made in the formation of resources for crop production (cereals and legumes, sunflower, vegetables).

Table 3. Indicators of inclusive development of the agri-food system of the Saratov region for the block «Involvement of all forms of management in the formation of food resources»

Indicators	Subjects	2016	2017	2018
Share of agricultural products of peasant (farmer) households, %	Russia	11.1	12.1	12.4
	Saratov region	30.2	30.6	28.9
The share of peasant (private) households in the sown area, %	Russia	27.7	28.9	29.7
	Saratov region	21.5	21.9	22.8
Share of peasant farms in the production of cereals and legumes, %	Russia	27.7	29.1	29.0
	Saratov region	49.7	49.9	51.3
Share of peasant farms in the production of sunflower for grain, %	Russia	30.9	31.5	33.2
	Saratov region	45.2	44.2	47.5
Share of peasant farms in vegetable production, %	Russia	18.1	19.0	18.7
	Saratov region	41.9	41.5	40.1
Share of peasant farms in livestock and poultry meat production in slaughter weight, %	Russia	3.0	3.0	3.0
	Saratov region	5.8	6.1	6.2
Share of peasant farms in milk production, %	Russia	7.3	7.9	8.2
	Saratov region	6.1	6.2	8.2
Share of households in total potato production, %	Russia	69.4	68.9	68.0
	Saratov region	88.2	88.7	89.5
The share of households in the total production of vegetables, %	Russia	58.6	55.4	55.1
	Saratov region	36.1	33.2	34.5
Share of households in the total volume of livestock and poultry meat production (slaughter weight), %	Russia	20.8	19.1	18.0
	Saratov region	59.1	53.8	52.1
Share of households in the total milk production, %	Russia	42.1	40.2	38.7
	Saratov region	77.6	77.1	75.6
Share of households in total egg production, %	Russia	19.6	18.8	18.5
	Saratov region	44.1	45.2	47.6
Integral indicator for the block "Involvement of all forms of management in the formation of food resources"	Russia	**1.000**	**1.007**	**0.999**
	Saratov region	**1.000**	**0.993**	**1.033**

Source: Own determination.

A feature of the agri-food system of the Saratov region is the dependence of the formation of food resources on the production of livestock products in households. This sector in the Saratov region provides more than three-quarters of the milk produced, more than half of the volume of livestock and poultry meat produced, and more than 40% of eggs.

The calculation of the integral indicator for the block "Involvement of all forms of management in the formation of food resources" revealed that the agri-food system of the Saratov region is characterized by a multitude of structures and the involvement of all groups of farms in the formation of food resources. Recognizing the priority of the formation of the country's food resources by large agricultural enterprises, we believe that small agribusiness should occupy a certain niche, creating conditions for sustainable development of rural areas. Prospects for the development of small businesses are due to the implementation of such public services as the production of environmentally-friendly (or organic) products, reducing the load on natural ecosystems, preserving rural culture and traditions, and sustainable development of rural areas.

The development of the potential of regional producers of all forms of farming, including small agribusiness, will increase the volume of food supplies, as well as meet the needs of the population in nutrition in proportion to the level of income of all segments of the population. Analysis and assessment in the direction of "Food security" presented in Table 4 include indicators reflecting the level of self-sufficiency, as well as the physical and economic accessibility of food.

According to the results of the calculations, it can be concluded that for meat and meat products, potatoes, and eggs, the self-sufficiency coefficient exceeds 100% in Russia. In the Saratov region, this figure exceeds 100% for milk, potatoes, vegetables, and eggs and exceeds the national average. However, the region is characterized by a downward trend in self-sufficiency in meat and meat products from 2016 to 2018.

Table 4. Indicators of inclusive development of the agri-food system of the Saratov region for the block «Food security»

Indicators	Subjects	2016	2017	2018
Self-sufficiency indicators (ratio of production to consumption)				
Self-sufficiency coefficient in meat and meat products	Russia	0.988	1.019	1.043
	Saratov region	0.976	0.934	0.891
Self-sufficiency ratio for milk and dairy products	Russia	0.879	0.894	0.908
	Saratov region	1.233	1.247	1.297
Potato self-sufficiency coefficient	Russia	1.702	1.642	1.719
	Saratov region	1.043	1.056	1.035
Coefficient of self-sufficiency in vegetables and melons	Russia	0.881	0.891	0.869
	Saratov region	1.452	1.451	1.438
Egg self-sufficiency ratio	Russia	1.087	1.094	1.093
	Saratov region	1.253	1.215	1.187
Integral indicator of food self-sufficiency	Russia	**1.072**	**1.078**	**1.091**
	Saratov region	**1.180**	**1.168**	**1.153**
Indicators of physical accessibility by food groups (the ratio of the actual consumption to the rational rate)				
Sufficiency ratio of consumption of meat and meat products	Russia	0.932	0.945	0.945
	Saratov region	0.699	0.726	0.753
Sufficiency ratio of milk and dairy products consumption	Russia	0.711	0.708	0.705
	Saratov region	0.711	0.711	0.714
Potato consumption sufficiency ratio	Russia	1.000	1.000	0.989
	Saratov region	0.644	0.633	0.633
The coefficient of sufficiency of consumption of vegetables and melons	Russia	0.729	0.743	0.764
	Saratov region	0.729	0.750	0.750
Egg consumption sufficiency ratio	Russia	1.050	1.073	1.077
	Saratov region	1.215	1.231	1.215
Integral indicator of sufficiency of food consumption	Russia	**0.873**	**0.882**	**0.885**
	Saratov region	**0.777**	**0.787**	**0.791**
Economic affordability of food (food costs in consumer spending of households),%	Russia	35.5	31.2	30.2
	Saratov region	43.8	42.2	38.7
Integral indicator for the block «Food Security»	Russia	**1.000**	**0.850**	**0.845**
	Saratov region	**1.000**	**0.829**	**0.802**

Source: Own determination.

The indicator of physical accessibility by food groups was calculated as the ratio of the actual volume of consumption to the national rate. The integral indicator of the sufficiency of food products in the Saratov region is more than 10% lower than in Russia. The greatest lag behind the rational nutritional norm was found in the consumption of meat, milk, vegetables. According to the results of calculations for Russia, the most important physical accessibility of food is meat and meat products, potatoes, eggs. The coefficient of sufficient consumption in the Saratov region exceeds 100% only for eggs. The indicator of the affordability of food, calculated as the share of food expenditures in the structure of total consumer spending, does not coincide with the indicator of the physical availability of food. So, the Saratov region is characterized by high costs for food products, which are almost 10 percentage points. exceeds the average Russian level.

Factors affecting food security include the level of technological development of the food industry, the state of the logistics infrastructure, the level of income of the population, and the quality of life. The analysis of the agri-food system of the Saratov region revealed paradoxical contradictions: on the one hand, the region is characterized by a high level of agricultural development, and on the other hand, low indicators of the physical and economic accessibility of food. These contradictions do not fit into the trends of national agricultural development and contradict the concept of inclusive development. In our opinion, territories that make a large contribution to the formation of food resources should have the necessary level of physical and economic accessibility of food. Solving the problems of inclusive development involves not only ensuring high rates of economic growth, taking into account social constraints but also harmonizing economic dynamics with environmental imperatives. Within the framework of the concept of inclusive development, many problems have a complex solution due to the interaction of economic, social, and environmental factors, which leads to the emergence of multiplier effects and predetermines a new quality of the inclusive growth model.

The last decades have enriched the concept of sustainable development, complementing it with new goals and guidelines. For example, the need is ripe and there is a real opportunity for the transition to a "green economy", which implies strict adherence to the norms of environmental safety and resource conservation. Indicators of inclusive development of the agri-food system for the block "Environmental sustainability" are shown in Table 5.

Table 5. Indicators of inclusive development of the agri-food system of the Saratov region for the block «Environmental sustainability»

Indicators	Subjects	2016	2017	2018
GRP water capacity (the ratio of the volume of water intake to the produced GRP), cubic meters/1 million rubles. GRP	Russia	638.2	582.2	507.6
	Saratov region	681.0	671.1	622.0
Specific emissions of air pollutants from stationary and mobile sources, ton/1 thousand rubles GRP	Russia	369.3	349.2	309.8
	Saratov region	572.5	562.4	518.2
Specific discharge of contaminated wastewater into surface objects, cubic meters/1 rub. GRP	Russia	171.9	148.0	125.9
	Saratov region	20.2	14.9	128.7
The share of captured and neutralized air pollutants in the total amount of waste pollutants from stationary sources,%	Russia	73.9	74.4	73.3
	Saratov region	74.2	76.0	68.5
Utilization and neutralization of waste in the total volume of generated production and consumption waste, %	Russia	59.6	52.2	52.6
	Saratov region	13.0	13.6	15.5
Index of the physical volume of environmental protection costs (in comparable prices; in% to the previous year)	Russia	92.8	102.7	98.6
	Saratov region	99.0	130.0	80.5
Investments in fixed assets aimed at environmental protection and rational use of natural resources, per 1 rub. GRP, rub	Russia	1631	1677	1511
	Saratov region	231	2142	680
Investments in fixed assets aimed at environmental protection and rational use of natural resources, per 1 rub. GRP, rub	Russia	788.0	1677.2	601.4
	Saratov region	83.8	301.6	240.4
Investments in fixed assets aimed at the protection and rational use of land, per 1 rub. GRP, rub	Russia	142.8	111.2	95.9
	Saratov region	90.5	66.7	26.3
Integral indicator for the block «Environmental sustainability»	Russia	**1.000**	**1.094**	**0.904**
	Saratov region	**1.000**	**1.539**	**0.590**

Source: Own determination.

In the Saratov region in 2018, the total volume of pollutant emissions (including emissions from railway transport) amounted to 382.4 thousand tons, which is 1.6% more than in 2017. Emissions from stationary sources in 2018 amounted to 118, 0 thousand tons, compared to 2017, decreased by 3.75%. Emissions from road transport amounted to 259.2 thousand tons, compared with 2017 increased by 4.2% [28].

In comparison with the average Russian level, the indicators of the environmental sustainability of the Saratov region indicate a deterioration in the quality of the natural environment and the ecological conditions of human life. Freshwater withdrawal in 2018 amounted to 835.7 million cubic meters, which is 4.0% less than in 2017. Despite the fact that for the period 2016-2018. indicators of water intake per 1 rub. GRP produced in the Saratov region improved by almost 10%, they are 23% behind the average for the Russian Federation. A similar trend is also true for the indicator of the emission of air pollutants from stationary and mobile sources, only the lag from the average level increases by 67%.

The amount of waste generated in the Saratov region in 2018 amounted to 6.561 million tons and, compared to 2017, decreased by 2.8%. The amount of recycled waste in 2018 amounted to 0.884 million tons, which is 23.6% higher than in 2017. The amount of neutralized waste in 2018 increased by 53.3% over the year. It should be noted that the share of captured and neutralized air pollutants in the total amount of waste pollutants from stationary sources in the Saratov region and the Russian Federation are close both in terms of their values and to the target indicators of the state program "Environmental Protection". The determining factors of such a relatively favorable situation in this case were: insignificant rates of economic growth, modernization of production processes, accompanied by a decrease in the number of pollutants formed, the use of more environmentally “cleaner” fuels or raw materials. It is characteristic that for the type of activity "agriculture, hunting and forestry" there was an increase in the amount of captured/neutralized pollutants by 3.5 times.

Particular importance in the analysis of environmental sustainability should be given to the structure and dynamics of costs. In the Saratov region, the index of the physical volume of environmental expenditures (in comparable prices) in 2018 amounted to 80.5% of the level of 2017, although on average in the Russian Federation such a decline was not observed.

Investments in environmental protection in 2018 in the Saratov region amounted to 501,988 thousand rubles. At the same time, in their structure, the most significant investments are in the protection of atmospheric air (55%) and water resources (35%).

The analysis confirms the need to change the development model and shift priorities towards increasing welfare and ensuring social justice while reducing risks to the environment. These requirements are met by the current concept of a "green" economy, ie. an economy focused on low carbon emissions, efficient use of energy and resources, conservation of biodiversity, reduction of anthropogenic pressure on the ecosystem, which meets the interests of the whole society. This model of economic development ensures the growth of income and employment not only through public but also private investment. It is important to note that agri-food policy should be aimed at increasing investment activity and maintaining the required level of targeted government spending. The concept of a “green economy”, combined with an inclusive model for the development of the agri-food system, can contribute not only to the preservation but even restoration or growth of natural capital as a key economic asset and the main source of public goods. This is of particular importance for the poor, whose sources of income and security depend on nature [24, 30].

The balance of economic, social, and environmental characteristics of the inclusive development of the agri-food system can be assessed based on the calculation of the integral indicator presented in Table 6. We

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consider it important to analyze both the dynamics of indicators in the context of the identified blocks of indicators and the ratio of regional with the national average.

The study of economic growth rates testifies to the formation of negative trends both in Russia and in the Saratov region. At the same time, the depth of the decline in Russia on average is higher than in the Saratov region (by 2.1% in 2018). Economic growth in the Saratov region is largely based on the use of the absolute competitive advantages of the regional agrosystem. Economic growth rates are constrained by weak financial security, unfavorable investment climate, constraints on the part of population demand, low innovation susceptibility in the agricultural sector.

Table 6. Integral indicator of inclusive development agri-food system of the Saratov region

Indicator block	Subjects	2016	2017	2018	*Saratov region in% to RF*	
					2017	*2018*
Growth and development	Russia	1.000	0.961	0.973	*94.5*	*102.1*
	Saratov region	1.000	0.908	0.993		
Equity in the distribution of public goods	Russia	1.000	0.918	0.916	*108.7*	*78.3*
	Saratov region	1.000	0.998	0.717		
Involvement of all forms of management in the formation of food resources	Russia	1.000	1.007	0.999	*98.6*	*103.4*
	Saratov region	1.000	0.993	1.033		
Food security	Russia	1.000	0.850	0.845	*97.5*	*94.9*
	Saratov region	1.000	0.829	0.802		
Environmental sustainability	Russia	1.000	1.094	0.904	*140.7*	*65.3*
	Saratov region	1.000	1.539	0.590		
Integral indicator	**Russia**	**1.000**	**0.979**	**0.926**	*10.8*	*87.5*
	Saratov region	**1.000**	**1.028**	**0.810**		

Source: Own determination.

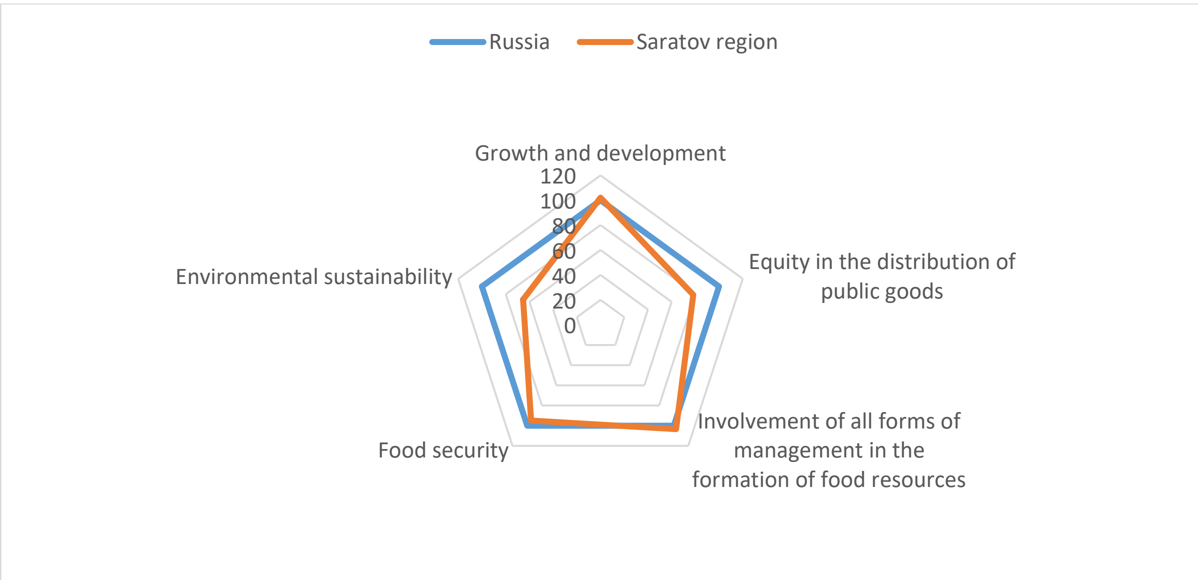

Fig. 1. The ratio of the integral indicator of inclusive development of the agri-food system of the Saratov region and Russia in 2018
Source: Own determination.

In the context of the identified blocks of indicators of inclusive development of the agri-food system, the following conclusions can be drawn. Relatively high values of inclusiveness indicators are typical for the blocks "Growth and development" and "Involvement of all forms of management in the formation of food resources", and the lowest values are typical for the blocks "Food security" and "Environmental sustainability".

The weakness of the state agri-food policy, which does not meet the criteria of inclusive development, as evidenced by the significant differentiation of the constituent entities of the Russian Federation in terms of the level of socio-economic development of regional agri-food systems. There are many reasons for this differentiation of regional development - from resource and financial security to the unfair distribution of public goods and the inequality of regions in the distribution of budget funds).

CONCLUSIONS

The model of inclusive growth as a modern paradigm for the development of the agri-food system can be considered a synthesis of the concepts of sustainable and innovative development, updated taking into account modern challenges. There is a shift in the center of gravity from quantitative and volumetric indicators towards qualitative and intensive characteristics. The importance of structural indicators is increasing, which makes it possible to assess the proportionality and balance of the ongoing changes. In the concept of inclusive development, the emphasis is shifting towards the environmental and social components. Therefore, the level of inclusive development should be assessed not only by the ability to ensure sustainable economic dynamics but also by the growth of the welfare of citizens and the solution of social and environmental problems.

The inclusive development model has already proven its effectiveness in developed economies. However, due to the peculiarities of the Russian institutional environment, the specifics of the agricultural sector, and its special social significance, the basic principles of the transition to the trajectory of inclusive development of the agri-food system should be:

- full involvement and effective use of all resources (especially human);
- focus on economic growth based on the activation of innovative activities of Russian enterprises [9];
- adherence to the requirements of environmental friendliness of production, which will effectively integrate into global food chains with products with high added value;
- compliance with the requirements of equity in the distribution of public goods and the principles of food security, including food independence, physical and economic accessibility of food for all segments and groups of the population.

The COVID-19 pandemic is an indirect driver of the development of a modern agri-food system. In this regard, it is advisable to implement a complex of short-term, medium-term, and long-term measures, such as:

- overcoming technical and technological backwardness in the system of Russian agricultural engineering;
- elimination of the lag behind the world level in the areas of production of plant protection products, veterinary drugs, selection and seed production, livestock breeding, etc .;
- preventing a decrease in budgetary support for all forms of agribusiness;
- social support for low-income families and implementation of a direct food assistance program for vulnerable groups of the population;
- development of a cooperative trade system along with large trade networks;
- transition to digital platforms for the development of the agri-food system.

In conclusion, we note that despite the aggravation of existing problems and the emergence of new risks in the post-pandemic economy, the Russian agri-food system has sufficient potential for sustainable development, provided that the model of inclusive growth is implemented.

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AGRICULTURE AND RURAL DEVELOPMENT: PATHS OF CHANGE AND CONSEQUENCES

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Abstract

The paper studied the impact of agriculture on rural development. The emphasis is on the changes in the development of agriculture in the conditions of Bulgaria's membership in the EU and on their impacts on the economic, social and environmental indicators for the status and development of the rural areas. The object of analysis is the South Central Planning Region of Bulgaria (BG42) at the NUTS-2 level. This study employed mixed quantitative and qualitative research design. The quantitative part presupposes the presentation and analysis of statistics on agriculture and rural development at the level of planning region, district and rural area (municipality) in the period of EU membership (2007-2017). Qualitative methods include the use of the experts evaluation method and in-depth interviews with 25 specialists from the regional office "Agriculture" and the regional office of the National Agricultural Advisory System. The conclusions of the analysis reveal that the model of agriculture in the study area is close to the characteristics of the Southern model of agriculture in Europe. Evidence for the more favorable effects of the emerging model of agriculture on rural development compared to other regions in the country (especially the three northern ones) are the slower migration processes, lower unemployment rates in some municipalities and etc.

Key words: *model of agriculture, farms, rural development, rural areas, diversification*

INTRODUCTION

Rural areas of Bulgaria occupy 80.9% of the territory and include 232 municipalities (87.5% of the total number of municipalities) with 38% share of the population. For the period 2010-2017, the population in rural municipalities decreased by 11%, which is more than three times faster than the 3% decrease in the urban population. As one of the main reasons for these trends are recognized the changes in the model of agriculture.

In recent decades, researchers and experts have acknowledged that the rapid concentration of agricultural production and the growing polarization of agricultural structures have led to significant problems in both intensive agricultural areas and disadvantaged areas [4], [5]. Some studies highlight the great risk that these problems will be exacerbated by significant public and private sector investment in the "knowledge-based bioeconomy" [6]. Climate change, which according to some researchers [17] change both the impact of agriculture on rural development and its role in the development of regions, also has an impact in this direction.

From the point of view of more balanced rural development, it is essential to make structural changes in directions that promote more sustainable development in general and that contribute to tackling social, environmental and economic imbalances and challenges. Therefore, the transformation and adaptability of the agricultural sector and rural economies have become key issues [9], [8], [14]. Agriculture in a number of countries continues to be the main driving force for rural development, for increasing the incomes of the poor and for the sources from which they earn their living [1].

In this regard, rural development is regarded by a number of authors as seeking a new model for agricultural development [15]. Its main elements such as production of high-quality products, new short chains involving producers and consumers, organic farming, nature and landscape management by farmers, agritourism and more should all be considered as key building blocks.

In the last two programming periods, these elements and trends have been supported by the Common Agricultural Policy and changed regional agricultural models by improving the market infrastructure of agricultural holdings, expanding farmers' sources of income and diversifying the rural economy.

To what extent are these elements and (or) trends in their development are characteristic for the model of Bulgarian agriculture? How is assessed the impact of these trends on rural development and viability of rural regions? To what extent does the changing agricultural model have a positive impact on the economic, social and economic aspects of rural development?

In order to answer these questions, the aim of the study is to assess the importance and impacts of the model of agriculture on rural development.

MATERIALS AND METHODS

This study employed mixed quantitative and qualitative research design. The quantitative part presupposes the presentation and analysis of statistics on agriculture and rural development at the level of planning region, district and rural area (municipality) in the period of EU membership (2007-2017). Qualitative methods include the use of the experts evaluation method and in-depth interviews with 25 specialists from regional office “Agriculture” and the regional office of the National Agricultural Advisory System in the South Central Planning Region (BG42). Respondents are from the five districts of the region (NUTS-3) and are distributed as follows: 24% from Pazardzhik, 28% from Plovdiv; 12% of Kardzhali; 24% from Smolyan and 12% from Haskovo.

To assess the importance of agriculture for rural development and the trends in its development, the experts used a five-point positive Likert scale, in which 5 indicates complete agreement and 1 indicates complete disagreement with the assessed statement.

The object of study is the South Central Region (NUTS-2), and the subject is the model of agriculture and its impact on the socio-economic and environmental characteristics of rural areas. A number of publications are devoted to these issues, [7], [2], [3], which analyze the changes in the characteristics and results of Bulgarian agriculture that have occurred over the last decade under the influence of the Common Agricultural Policy.

The Study Area

The area of the South Central Region is 18.6% of the country's territory. The agricultural territories are 48.1%, the forest ones - 45.1%, and the urbanized territories occupy only 3.9% of its territory. The South Central region is among the richest in biodiversity in the country.

In 2018, the population was 1,310.8 thousand inhabitants (20% of the total number in the country) living in 1,316 settlements, organized in 57 municipalities and 5 districts (Fig. 1). In terms of population, the region ranks second in the country.

Fig. 1. Map of Republic Bulgaria
Source: Wikipedia,
https://bg.wikipedia.org/wiki/Южен_централен_район_за_планиране, Accessed on 20 Jan.2020 [18].

The study area ranks fourth in the country in terms of gross domestic product per capita. The data for 2017 show that it is 10,009 BGN, in the range between 12,112 BGN for Plovdiv district and 7,485 for Kardzhali district (Fig. 2). These data are significantly lower than the national average (14,280 BGN) and from leading areas.

One of the reasons for this is the structure of Gross added value, in which the share of services is 55.66% (compared to 66.86% on average for the country) and industry - 37.5%.

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The lowest gross salary in the country of BGN 9,439 was formed in the region in 2017.

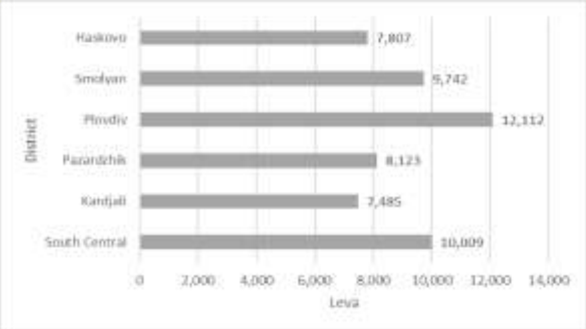

Fig. 2. Gross domestic product per capita (BGN)
Source: National Statistics Institute, 2019 [13].

In four of the municipalities it is even below BGN 7,000. Under these conditions, the migration processes and the deteriorating age structure of the population are logical. In total for the region the relative share of the inhabitants over 60 years is 28%, and of those under 20 years is 18.8%.

The relative share of the inhabitants whose incomes are below the poverty line is high, mostly in two of the districts - Pazardzhik and Kardzhali, where in some years they exceed 50% of the population (Table 1).

Table 1. Share of the inhabitants whose incomes are below the poverty line

Regions	2008	2009	2013	2016	2017
Kardjali	36.5	29.5	60.1	39.5	37.7
Pazardjil	32.9	27.7	50.2	44.0	41.4
Plovdiv	20.8	13.7	23.1	22.7	19.9
Smolyan	23.9	19.1	30.8	26.9	20.9
Haskovo	21.8	27.2	19.8	30.2	28.5
South Central	27.2	23.4	36.8	32.7	29.7

Source: National Statistics Institute, 2019 [13].

In the cluster analysis of the rural areas [12] made a few months ago, the municipalities on the territory of the South Central Planning Region were referred to three of the four formed groups (Table 2). None of the municipalities fell into the first group of developed municipalities, and 7.8% are in the group of "catching up" municipalities, as 3 of them are in Plovdiv district and one - in Pazardzhik. 35.3% are the municipalities in the group "municipalities in development" - half of them in Plovdiv district. These are municipalities with high unemployment (characterized by more than 2 times higher unemployment compared to developed municipalities – in the cluster center 14.95%), low relative share of the labor force from the overall population (39.82%), significantly lower productivity of small and medium enterprises, etc.

Even more unfavorable are the indicators of the lagging municipalities - high unemployment rate (18.22%), lower share of the labor force (38.98%) and lower average gross salary (BGN 7,795) and others.

Most numerous are the "lagging behind municipalities" - 56.8% - in Haskovo district they are nine, in Pazardzhik and Smolyan districts six each.

Table 2. Distribution of municipalities in the South Central Region by level of development

Regions	catching munici-palities	munici-palities in deve-lopment	lagging munici-palities	All
Kardjali		2	4	6
Pazar-dzhik	1	4	6	11
Plovdiv	3	9	4	16
Smolyan		3	6	9
Haskovo			9	9
South Central	4	18	29	51

Source: Own calculations.

The selected region is a major producer of agricultural products, and in recent years it is the largest producer in the country of milk, meat, vegetables, most types of fruit, fodder crops and others. Takes second place in the production of grapes, oilseeds and others.

RESULTS AND DISCUSSIONS

In 2018, 21.4% of the gross added value of the Bulgarian agricultural sector was produced in the region and 32% of the labor force in the sector was employed. At the same time, the gross added value created by agriculture and forestry is 6.85% and continues to decrease annually, varying by districts between 3.95% in Plovdiv district till 15.28% in Kardzhali district (Fig. 3).

Favorable soil and natural and climatic conditions are a prerequisite for a diverse production structure. 9.9% of the area is irrigated, which is 51.88% of all irrigated agricultural land in Bulgaria.

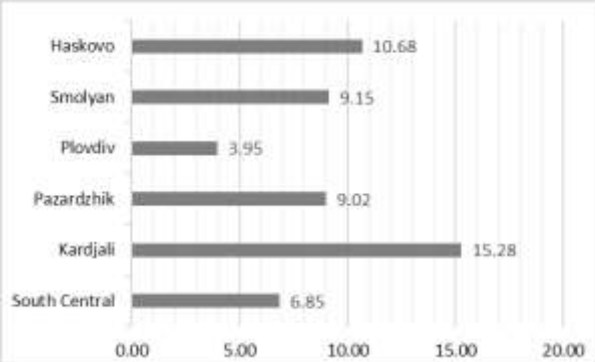

Fig. 3. Relative share of agriculture in the gross value added by districts of South-Central region
Source: National Statistics Institute, 2019 [13].

In the years of our country's membership in the EU there is a tendency to reduce the production and income from livestock products. From a ratio between the value of crop and livestock production 55:45 at the beginning of the period, in 2018 it reached 75.6:24.4 (Fig. 4). In the studied area the observed trend is less pronounced and in 2018 the relative share of animal production in the South Central region is 36.78%. The latter is almost three times higher than the same indicator in other areas.

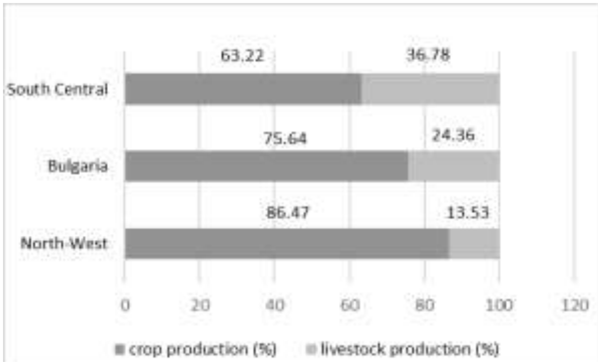

Fig. 4. Ratio between crop and livestock production
Source: Ministry of Agriculture, Foods and Forestry, Agrostatistics [11].

The data on the number and distribution of animals by regions of the country show the leading place of the South Central Region in the country. In it are located 33.24% of the livestock units in 25.56% of the livestock farms. By species, the region ranks first in the number of raised cattle, buffaloes and sheep.

In the region are registered the largest number of functioning agricultural holdings in the country - about 30% of the total number in the country. They also account for 29.93% of annual work units in Bulgarian agriculture. In recent years, the number of agricultural holdings has continued to decline at a high rate, falling from 130 thousand (2007) to 61 thousand (Table 3). This logically leads to an increase in the average size of utilized agricultural land by 2.9 times over the ten year period 2007-2016.

Table 3. Agricultural holdings by legal status (2007-2016)

Type of farming	Number of holdings				2016/ 2007 (%)
	2007	2010	2013	2016	
Natural persons	129,453	104,772	75,588	59,509	45.97
Sole traders	232	336	327	342	147.41
Coopera-tives	233	157	151	136	58.36
Compa-nies	369	734	813	1,006	2,726.3
Civil asso-ciations	36	55	44	40	111.11
South Central Region	130,323	106,054	76,923	61,033	46.83

Source: Ministry of Agriculture, Foods and Forestry, Agrostatistics [11].

The data in Table 2 show significant changes in the organizational structure of agriculture in the area. The largest decrease was recorded in holdings of individuals (by 43.2%), followed by associations and cooperatives. At the same time, the number and importance of trading companies (by 37%) and sole traders is increasing.

The average size of the holdings by legal status is in the range from 389.31 ha in the cooperatives to 3.66 ha in the holdings of individuals. The latter have the lowest average size of utilized agricultural land compared to all other regions of the country.

Nevertheless, the average farm size remains low - 7.96 ha compared to the national average of 20.58 ha (Fig. 5). The reasons for this are related to the production specialization and the considerable number of produced products, which require high labor costs, as well as family character of the holdings. Evidence for the latter is that in 2016, 90% of the workforce in the South Central region is family.

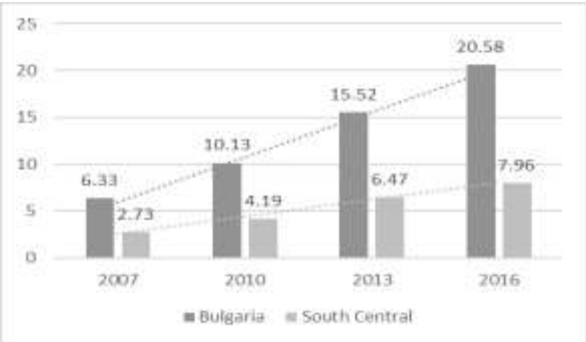

Fig. 5. Average size of utilized agricultural areas (hectares)
Source: Ministry of Agriculture, Foods and Forestry, Agrostatistics [11].

There are big differences between the number and the average size of utilized agricultural land by districts of the country. According to data from the last census held in 2010, the average size ranges from 1.12 ha in Kardzhali to 7.58 ha in Haskovo. Moreover, between the two censuses, this amount increased 2.4 times in Plovdiv district and 2.3 times in Haskovo and only by 73.9% in Smolyan and 79.4% in Kardzhali. The reasons are both the significant reduction in the number of agricultural holdings and the increase in the amount of utilized agricultural land in the years after the accession to the EU.

In the years of our country's EU membership, the number of agricultural enterprises registered under the Trade Act has gradually increased (Table 4). From 1,652 in 2008, at the end of the period, their number reached 4,127. The deepening of the analysis on regional level shows significant differences between the five districts. The most significant is the increase in the districts with favorable agricultural areas - Plovdiv, Pazardzhik and Haskovo and the retention of the number in the districts with semi-mountainous and mountainous areas - Kardzhali and Smolyan.

Most significant is the increase in the number of companies and sole traders in the Pazardzhik region (6.1 times), followed by Haskovo (2.1 times) and Plovdiv. The changes in the districts of Kardjali and Smolyan are minimal.

Table 4. Number of agricultural enterprises in South Central Region (2008-2017)

District	2008	2011	2014	2017	2017/ 2008 (%)
Kardjali	84	86	70	88	105
Pazardjil	260	1287	1356	1608	618
Plovdiv	697	1141	1334	1437	206
Smolyan	243	229	199	208	86
Haskovo	368	589	680	786	214
South Central	1652	3332	3639	4127	250

Source: National Statistics Institute, 2019 [13].

The structure of holdings by economic size (Fig. 6) shows the strong predominance of small holdings up to 2 economic units (56%) and between 2 and 4 economic units (20%). This data, together with the legal status information, shows the importance of family farming for the development of the South Central Region. 40.23% of these farms consume more than 50% of the production, and 38.42% make direct sales.

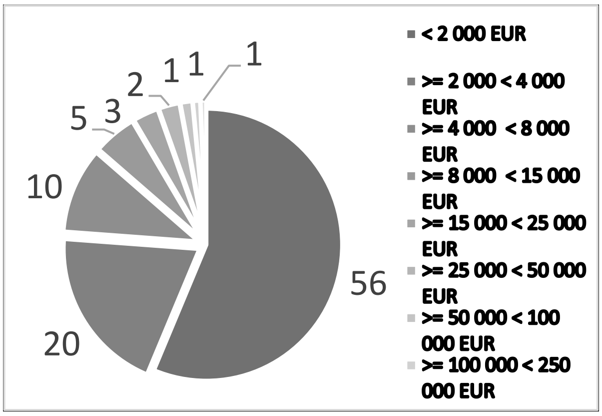

Fig. 6. Structure of agricultural holdings by economic size in South Central Region
Source: Ministry of Agriculture, Foods and Forestry, Agrostatistics [11].

This structure and the average size of the farms also determine the lower performance indicators - net income and net added value per annual work unit. According to the first indicator, the South Central Region ranks last among the regions of Bulgaria (Fig. 7), and for the second is on a penultimate place lagging far after the three northern regions and the Southeast.

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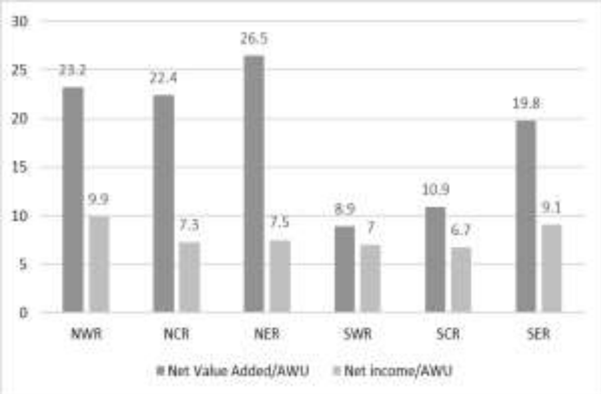

Fig. 7. Net income and net value added per annual work unit in thous. leva (2015)
Source: Ministry of Agriculture, Foods and Forestry, Agrostatistics [11].

The characteristics and trends outlined above have been analyzed and evaluated by 25 experts with average professional experience between 11 and 20 years and qualifications in agriculture (84%), social sciences (12%) and technical sciences (4%).

The importance of agriculture in all five districts is highly evaluated by most experts. (Table 5).

Table 5. Experts evaluation of importance of agriculture

Regions	Agriculture			
	Impor-tance in rural areas	provi-des income	provi des jobs	positive impact on the environ ment
Pazardzhik	3.8	3.67	3.5	3.33
Plovdiv	4.6	4.0	3.58	3.28
Haskovo	4.6	4.36	4.33	4.0
Smolyan	4.0	4.0	3.83	5.0
Kardjali	3.0	2.6	2.66	4.0
South Central	4.04	3.72	3.56	3.88

Source: Own study.

Overall for the planning region, the estimate is 4.04 (max 5), ranging from 4.6 for Haskovo and Plovdiv districts to 3 for Kardzhali district.

The social function of agriculture is rated lower. The average mark is 3.72 for his ability to generate income, the highest in the district of Haskovo, followed by Plovdiv and Smolyan. Similarly are arranged job creation estimates.

The positive environmental impact of agriculture is estimated to be 3.88. The maximum score was chosen by the experts from the region of Smolyan, in Plovdiv it is only 3.28.

Experts do not appreciate that farm specialization is appropriate in the context of the competitive advantages of rural areas. According to them, the average score for the South Central region is only 2.96 (Table 6). Even in the regions with high scores, it is only 3.5 for Pazardzhik and 3.33 for Plovdiv.

Table 6. Experts evaluation of specialization of the farms

Regions	Specializa-tion of the farms is appropriate for the rural area	Insufficient irrigation areas cause vegetable and fruit production to be curtailed	Labor shortages are a reason for limiting labor-intensive industries
Pazardzhik	3.5	3.82	4.16
Plovdiv	3.33	4.28	4.58
Haskovo	3	4	3
Smolyan	3	5	5
Kardjali	2.33	5	4.33
South Central	2.96	4.4	4.16

Source: Own study.

These values are explained by:

-labor shortages for the development of intensive labor-consuming industries. The experts selected a rating of 5 for Smolyan district, 4.58 for Plovdiv, 4.33 for Kardzhali and 4.16 for Pazardzhik.

-insufficient irrigation areas and unmaintained irrigation facilities are the reason for the limitation of vegetable and fruit production, according to experts (4.4). In the districts of Smolyan and Kardzhali the highest rating was chosen, and only in Pazardzhik district the rating was below 4 (3.82).

-High support (4.16) has received the claim that labor shortages are the main reason for limiting the cultivation of labor intensive crops.

-the attitude of farmers to their creation and participation in cooperatives and other network structures with the potential to shorten the chains for the sale of products and supplies.

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There is low support for the claim that there is an increase in the number of farmers aiming at producing better quality produce, not just to increase their quantity (average score of 2.88). Experts in the districts of Plovdiv and Haskovo scored the highest marks of 3.33, followed by Pazardzhik and Smolyan (with a score of 3), and it is not observed this trend in Smolyan and Kardzhali (grade 2).

The trend of increasing the number of agricultural holdings that diversify their activity with tourist activities is estimated by 2.75. The highest is the rating of experts in the region of Smolyan (4) and the lowest in Pazardzhik and Plovdiv (2.32).

The same support of 2.75 was received by the claim that farms applying agri-environment practices are growing. Here again, the assessments in the three districts with favorable agricultural conditions is higher, while the lower ones are for districts in which the semi-mountainous and mountainous municipalities predominate.

Although farmers in the South Central Region are among those active in setting up producer organizations and they continue to operate a significant number of cooperatives, experts claim that is difficult for farmers to associate or cooperate. The number of producer organizations established during the SAPARD program and continue to operate is small.

Table 7. Assessment of agricultural holdings development trends

Indicators	Max	Min	Average
The number of farms aiming at providing livelyhiid to the household has increased	4.5 Kar-dzhali	3 Has-kovo	3.47
The number of farms with non-agricultural activities increased	4.67 Plov-div	2 Kar-dzhali	3.13
The number of holdings making direct sales has increased	4.75 Plov-div	2 Kar-dzhali	3.5
The number of farms processing agricultural products increased	3.33 Has-kovo	1 Kar-dzhali	2.08

Source: Own study.

Particular attention should be paid to the expert opinion on the changing importance of farms that have diversified their activities with non-agricultural activities, direct sales and which carry out processing of agricultural products. The first two trends are highly appreciated in the Plovdiv district (Table 7). At the same time, the number of farms providing livelihoods to households in Kardzhali has increased. The lowest is the support of the claim that the number of farms processing agricultural products increased.

CONCLUSIONS

The following conclusions and summaries can be drawn from the made analysis:

-In the structure of agricultural holdings in the South Central Region of Bulgaria, family farms producing a large number of agricultural products dominate strongly. They use mainly family labour, and only part of the work processes are mechanized. They have many of the characteristics of the Southern European agricultural model [3].

-The specialization of production of the prevailing part of the agricultural holdings is not considered to be the most suitable for the area. The main reasons for not using all potential opportunities of the region are the limited number of labour force and the greatly reduced relative share of irrigated areas in the region.

-Evidence for the more favorable effects of the emerging model of agriculture on rural development compared to other regions in the country (especially the three northern ones) are the slower migration processes, lower unemployment rates in some municipalities and etc.

-Despite the ongoing processes of increasing production of high quality products, the construction of new short chains involving producers and consumers, the development of organic agriculture, the management of nature and landscape by farmers, the diversification, the expansion of agritourism, in the South Central region these trends are only observed in some of the districts. In addition, farm diversification and direct sales are observed in municipalities and regions close to large settlements (mainly near Plovdiv, Haskovo and Pazardzhik). There is a development of tourist activities in the mountain regions of Smolyan.

The findings strongly confirm the results of a number of authors on the differences and the gradual polarization of agriculture in two types of areas: (1) favorable agricultural areas in which farmers produce and trade with agricultural products which are competitive; and (2) areas with limited agricultural development conditions, which need to be supported by a number of subsidy programs in order to maintain the importance of agriculture [19], [10], [16].

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AGRICULTURAL COOPERATION AS A FORM OF ORGANIZATION OF RATIONAL LAND USE

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Abstract

It is established that the monopolization of means of production, in particular agricultural in rural areas, is one of the reasons for the decrease in the population of these regions, and also leads to a decrease in local budget revenues. Accordingly, maintaining one's own infrastructure at the proper level becomes less and less realistic. It was found that most United Territorial Communities (UTC) budgets in Ukraine are subsidized and their average subsidy from the government is about 45%. We found that 13 land users cultivate 68.5% of the agricultural land of the Kolomatska UTC. The community needs to increase its own budget revenues by 6.3% annually in order to compensate 60% of subventions and subsidies during 5 years. It is established that one of the ways to achieve this goal is to change the form of organization of agricultural production in the community from cultivation by single land users of large tracts of land they lease to the formation of agricultural cooperatives by landowners to ensure rational use of local resources and income distribution. Agricultural cooperatives are institutions of collective action that contribute to the rationalization of the use of natural resources. It is estimated that such a transition will double the income of landowners, and local budget revenues will increase by about 25%.

Key words**:** *agricultural cooperatives, institutions of collective action, local budget, forms of organization of agricultural production, local taxes*

INTRODUCTION

As part of the process of decentralization of power in Ukraine, which involves the formation of united territorial communities in rural areas, communities are developing strategies and projects for spatial development. On June 12, 2020, the government issued a resolution approving the administrative centers and territories of more than 1,470 communities, which will effectively complete the process of forming the UTCs [16]. It is important to note that the decentralization process involves giving broader powers to local communities to manage financial resources at the local level. However, their responsibilities are also growing significantly, as their task is to develop and maintain local technical and social infrastructure. It is worth noting that although local budgets have grown significantly in recent years, the expenditures of these budgets are growing very rapidly. Accordingly, a large number of communities, have been subsidized and remains subsidized. Nevertheless, the goal of the reform of decentralization and the formation of UTCs is the formation of self-sufficient communities. It is worth to mention that there are certain obstacles to community development:

-the population of rural areas in Ukraine is rapidly declining, but it should be noted that this is a global trend;

-monopolization of means of production, especially in agriculture, contributes to lower local budget revenues.

These problems make it difficult for communities to maintain and develop their own infrastructure. Aware of this problem, the Cabinet of Ministers of Ukraine determined by Resolution №200 of 16.03.2016 the procedure for providing subventions for UTCs for infrastructure development [1]. The government also provides medical, educational, and other subventions and grants to communities and funds local projects from the regional development fund. However, this situation has made many communities dependent on government subventions and grants. The share of subsidies an subventions in the budgets of the majority of UTCs in Ukraine is 15-65%, while the average value is about 45%, which is quite significant. According to calculations, most communities in Ukraine need a steady increase in their own budget revenues of 6.9-10% per year to compensate subsidies and subventions with own budget revenues for 5 years [3].

That is why communities need to develop strategies and projects for their own spatial development and create a precondition for their own economic development. One way to prevent the outflow of population and falling local budget revenues is to demonopolize agriculture by creating institutions of collective action, such as agricultural cooperatives.

The purpose of our study is to calculate revenues of local budgets and incomes of local residents depending on the organizational form of agricultural production, namely the cultivation of land by individual farmers or enterprises that lease most of the land and cooperatives formed by landowners. It is necessary to establish whether the use of agricultural cooperatives as institutions of collective action will contribute to increasing the welfare of landowners and increase revenues to local budgets.

Examining the existing experience, we **reviewed the literature** on planning strategies and projects for rural development, as well as institutions of collective action and analyzed the factors that contribute to sustainable development of territories.

Malik M. and Pulim V. (2009) examined rural development issues and concluded that local entrepreneurship and local self-government are key players in a local development strategy [10].

Elinor Ostrom (1990) examining the problems of common resources use, concludes that the institutions of collective action are the most effective in managing shared natural resources. According to her paper the state or individuals are less effective [12].

MATERIALS AND METHODS

Carrying out this research, we used the data of state statistical agency, materials of scientific works, provisions of laws and regulations. In particular, we have processed statistical data on revenues to local budgets published by the Ministry of Finance of Ukraine [11].

We also studied the simplified system of taxation of legal entities and individual entrepreneurs, as well as the sources of filling the local budget on the basis of the Tax Code of Ukraine [15].

The processed materials became the basis for our calculations, in which we determined the revenues to local budgets and earnings of landowners in various forms of organization of agricultural production.

It is first necessary to determine whether the concentration of agricultural land is a problem in the community, and whether the community depends on subsidies, in order to understand whether there is a need to change the form of organization of agricultural production.

The concentration of land in the community can be determined by the following formula:

$$C_{CI} = \frac{\sum_{i=1}\{S_i \mid S_i > CI\}}{S_t} * 100\%$$

where:

C – concentration of agricultural land in individual land holdings;

CI –concentration indicator, the area relative to which the concentration is calculated;

S_i – land use area;

S_t – total area of agricultural land on the territory of the united territorial community [9].

Determining the dependence of the community on subventions and subsidies is determined by the share of subventions and subsidies in the total budget revenues of the community. If this share exceeds 20%, it is already a threat to the long-term budget stability of the community. Accordingly, there is a need to compensate these funds with their own budget revenues. The required annual growth of own revenues to the local budget can be determined by the following formula:

$$i = \sqrt[n]{\frac{B'}{B}} - 1$$

where:
i - average annual growth of own budget revenues;
B' – desired amount of own revenues to the budget at the end of the period;
B – existing amount of budget revenues;
n – number of years [3].
As a next step, budget revenues and incomes of landowners and land users are calculated. Whether it is farmers, agricultural enterprises or cooperatives, they pay 5% of their annual income to the local budget [13]. To determine this amount, it is necessary to determine the typical crop rotation for the region on the basis of statistics to determine the cost per hectare per year for growing crops, then based on statistics that reflect the profitability of growing crops, determine the income of a farmer, enterprise or cooperative and deduct 5%, which to be paid as taxes.
Then the calculations are differentiated, because if it is a farmer or an enterprise, they lease land from landowners who receive rent and pay taxes.
Local tax paid by landowners can be calculated by the formula:

$$T_L = RxSx0.18x0.6$$

де:
T_L – local tax;
R – rent payment;
S – area.
Personal income tax in Ukraine is 18% [15], of which 60% is paid to the local budget [8]. In this case, the profit of a farmer or enterprise will be taxed income minus the cost of field cultivation and rent, and the income of landowners will be rent minus personal income tax and military tax, which is 1.5% [15].
In the case of a cooperative, its profits are distributed among its members, i.e. taxed income minus field cultivation costs will be paid to its members, who will pay 1.5% of the military tax and 18% of PIT, 60% of which will go to the local budget.

RESULTS AND DISCUSSIONS

Our study is performed on the territory of Kolomatska UTC of Kharkivska area. A total of 13 land users cultivate more than 200 hectares of land each. In total, they cultivate 15,094.4 ha [7], which is 68.5% of all agricultural land in the community. Accordingly, the concentration of agricultural land in the community is present, but not critical.
Analyzing the sources of revenues to the budget of Kolomatska UTC, we conclude that the community has a fairly significant level of dependence on subsidies and subventions, as they amount to 37.28 mln UAH (~€1.15 mln) or 43.80% of total budget revenues (Fig. 1), which is approximately the average value for Ukraine.

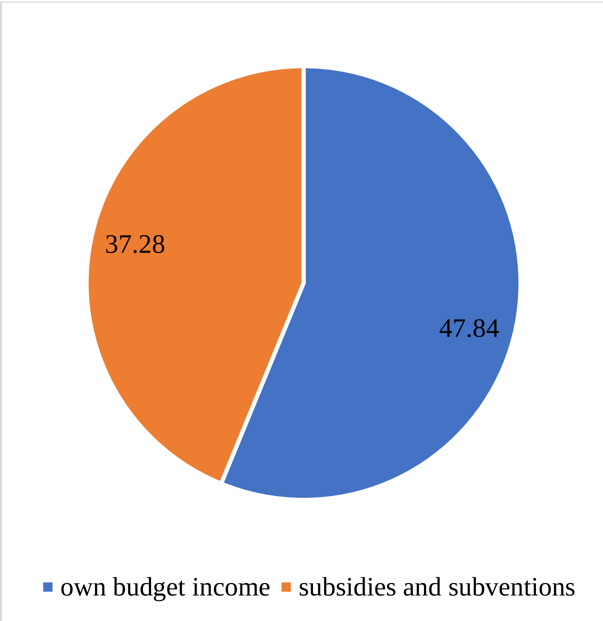

Fig.1. Sources of local budget income 2019, mln UAH
Source: Ministry of finance of Ukraine (stand 10.08.2020).

The next step is to determine the necessary growth of the local budget over five years in order to compensate subventions and subsidies with own revenues. However, it should be noted that not all subsidies and subventions will be reduced, some, such as education and healthcare subventions, will remain stable, so about 60% of subventions and subsidies should be compensated. Accordingly, we have calculated the required level of growth of own revenues to the budget to compensate 60, 80 and 100% of subventions and subsidies. At the same time, for calculation of the required growth of own budget revenues, the share of subventions and subsidies that shouldn't being compensated is added to own budget revenues for the calculations (Table 1).

According to our results, to fully replace subventions and subsidies with their own budget revenues, the community needs to increase them by 12.2% per year, which is a very difficult task, but setting a more rational goal to replace 60% of subventions and subsidies is achievable. To reach this goal an increase of 6.3% is needed, which is possible to realize through planning the strategy of spatial development and changing the organization form of agricultural production.

Table 1. Calculation of the required annual own budget revenues growth for Kolomatska UTC,%

<table>
<tr><th rowspan="2">Share of subventions and susidies to be replaced,%</th><th rowspan="2">Community budget, mln UAH.</th><th rowspan="2">Community budget per capita, thousand UAH</th><th colspan="2">Subventions and subsidies needed to be replaced</th><th colspan="2">Own revenues and the share of subventions and grants that will not be replaced</th><th rowspan="2">Budget without subsidies and subventions per capita, thousand UAH</th><th rowspan="2">Desirable annual growth of own budget revenues</th></tr>
<tr><th>mln UAH</th><th>%</th><th>mln UAH</th><th>%</th></tr>
<tr><td>60</td><td rowspan="3">85.12</td><td rowspan="3">12.33</td><td>22.37</td><td>26.28</td><td>62.75</td><td>73.72</td><td rowspan="3">6.93</td><td>6.3</td></tr>
<tr><td>80</td><td>29.82</td><td>35.03</td><td>55.3</td><td>64.97</td><td>9.0</td></tr>
<tr><td>100</td><td>37.28</td><td>43.80</td><td>47.84</td><td>56.20</td><td>12.2</td></tr>
</table>

Source: Ministry of finance of Ukraine (stand 10.08.2020) and calculations of authors.

The next step is to estimate the income of the farmer, enterprise or cooperative, the income of landowners and revenues to local budgets. An important difference is that an individual farmer or enterprise accumulates profits exclusively for itself and rents the land it cultivates, while a cooperative, as an institution of collective action, accumulates income for its founders, who are also landowners. We also differentiate production into organic and inorganic, because according to Ukrainian statistics, organic production is 20% more profitable than inorganic [5].

As for the parameters of the economy, we chose a land area of about 1,000 hectares in the northern part of the community. The average size of land plot in this part of the community is about 8 hectares. Accordingly, the study area includes about 125 land plots [14]. Growing of 9-year crop rotation typical for the natural zone of the Forest-Steppe is planned on the study area. The next crop rotation was chosen, which we have already designed for other farms and which has a deficit-free balance of humus. The order of crops in this crop rotation is as follows: Corn for the grain; Barley; Winter wheat; Perennial herbs; Sunflower; Perennial herbs; Winter wheat; Corn for silage; Soy [2].

Growing costs is approximately 12 mln UAH (~€0.37 mln) per year for sowing crops, field care, harvesting, wages and depreciation of production means (Table 2). The annual cost of growing our selected crops is from 9,000 UAH (~€280) to 15,000 UAH (~€460) per hectare, the average cost of growing all the selected crops is 12,000 UAH (~ €370). Accordingly, for a land area of 1,000 hectares, the costs will amount to 12 mln UAH (~€0.37 mln) per year. The average profitability of all crops of this crop rotation will be about 45%, and for organic production the profitability will be 65% [6].

The income received on the study area doesn't depend on the form of organization, but depends on the cultivation of organic or inorganic products by the farm. The income of inorganic farms/cooperatives will amount to 17.4 mln UAH (~€0.54 mln), and of organic farms/cooperatives – 19.8 mln UAH (~€0.61 mln). The local tax, which is 5% of the farm's/cooperative's income, will be 870 thousand UAH (~€26,900) or 990 thousand UAH (~€30,600), respectively. As for profits, here the differentiation also takes place according to the forms of organization of production, because cooperatives generate all profit for their members who own land cultivated by the cooperatives, and the farmer or enterprise is forced to lease land, the cost of leased land is deducted from farm income. The profit of a farm or enterprise growing inorganic products will amount to 1,012 mln UAH (~€31,300), and organic – 3,292 mln UAH (~€101,700). In the case of cooperatives, their profit will be 4.53 mln UAH (~€0.14 mln) and 6.81 mln UAH (~€0.21 mln), respectively.

Table 2. Calculation of incomes of farmer/cooperative and revenues to the budget of Kolomatska UTC for various forms of organization of agricultural production, thousand UAH

Form of organization of agricultural production	Costs	Earnings						Own revenues of the local budget		
		of cooperative/farmer			of landowners					
		Revenue	Local tax	Profit	Revenue (per land owner)	Local tax (per land owner)	Profit (per land owner)	Direct, from the payment of local taxes	Indirect, from spendings on local goods /services	Total
Cooperative	12,000	17,400	870	4,530	4,530 (36.2)	489.0 (3.9)	3,646.6 (29.1)	1,359.0	229.4	**1,588.4**
Cooperative (organic)	12,000	19,800	990	6,810	6,810 (54.5)	735.0 (5.9)	5,482.0 (43.9)	1,725.0	284.5	**2,009.5**
Farmer/ enterprise	12,000	17,400	870	1,012	3,518 (28.1)	380.0 (3.0)	2,832.0 (22.6)	1,250.0	210.0	**1,460.0**
Farmer/ enterprise (organic)	12,000	19,800	990	3,292	3,518 (28.1)	380.0 (3.0)	2,832.0 (22.6)	1,370.0	221.4	**1,591.4**

Source: Tax Code of Ukraine (Stand 12.08.2020), Agravery (Stand 12.08.2020) and calculations of authors.

If we talk about landowners, then in the case of land lease, the income of landowners will be the cost of leasing these plots provided to the farmer or enterprise for rent. The average cost of renting a land plot in Kharkivska oblast in 2019 was 3,518 UAH/ha (~€110) [4]. Accordingly, the total income of landowners will be 3,518 thousand UAH (~€110,000), which after paying taxes will be 2,832 thousand UAH (~€87,500). At the same time, revenues to the local budget will amount to 380 thousand UAH (~€11,800). If each plot has a different owner, the profit of each landowner will be 22.6 thousand UAH (~€700) per year.

Instead, in the case of a cooperative, their income will be equal to the cooperative's profit, the local tax paid by them will be 60% of 18% of their income and will amount to UAH 489 thousand UAH (~€15,100) for inorganic production and 735,000 thousand UAH (~€22,700) for organic. The profit will be 3,646.6 thousand UAH (~€112,700) and 5,482.0 thousand UAH (~€169,400), respectively. If each plot has a different owner, the profit of each landowner will be 29.1 thousand UAH (~€900) for inorganic production and 43.9 thousand UAH (~€1,400) for organic per year.

Our calculations reflect the lowest possible income of landowners, because we assume that all landowners are members of the cooperative and the cooperative is engaged in growing crops. Income will be higher if you grow fruits or berries. Also, it is very likely that some of the land plots cultivated by the cooperative will be leased and the total number of members will be lower, although the total profit of the cooperative will decrease due to the need to pay rent for the use of leased land plots, but each individual member of the cooperative will earn more.

Summarizing the revenues of the local budget from the payment of local tax, it should be noted that for different forms of organization of agricultural production these revenues will be different, inorganic agricultural cooperative will bring about 1,359 thousand UAH (~€42,000) per year, and organic – 1,725 thousand UAH (~€53,300). In this case, the farm or agricultural enterprise will bring 1,250 thousand UAH (~€38,600) or 1,370 thousand UAH (~€42,300), respectively.

It should be noted that the activities of either a farmer or an enterprise or cooperative will also lead to indirect revenues to the local budget, because in both cases we need employees who receive wages and pay taxes, and most importantly, landowners who receive income will spend money on local goods and services. These revenues are difficult to calculate clearly, we believe that they will amount to about 200-300 thousand UAH (~€6,200-9,300) per year. In the case of the formation of a cooperative, these indirect revenues will be higher, because landowners will receive more income and, accordingly, will be able to spend more on local goods and services.

In summary, we compare the earnings of the farmer/enterprise, landowners and revenues to the local budget for both forms of organization of agricultural production with organic agricultural products (Fig. 2).

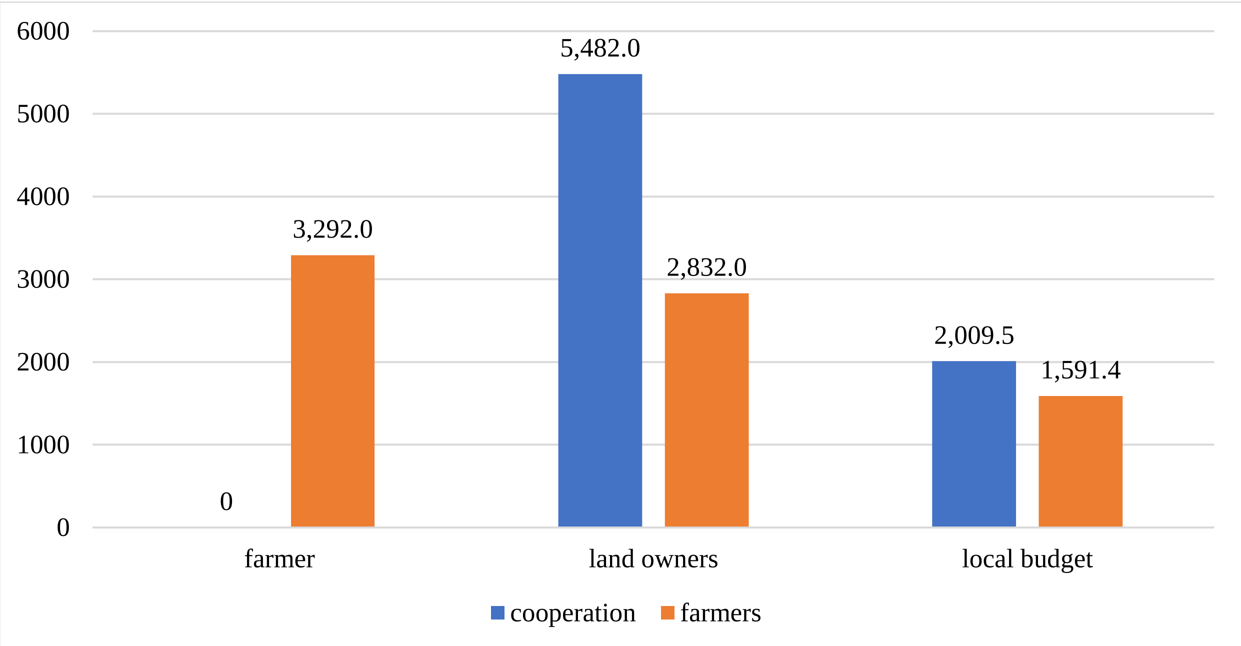

Fig.2. Distribution of income between different stakeholders, thousand UAH
Source: authors own calculations.

In the case of the formation of a cooperative, the cooperative will earn money for its members, respectively, it will not receive a profit. In the case of a farmer or enterprise, their profit will be 3,292 thousand UAH (~€101,700). So, an individual farmer or several farmers accumulate more profit than the owners of land they cultivate, because the profit of landowners will be UAH 2,832 thousand UAH (~€87,500). In the case of the organization of the cooperative, their profit will be almost twice as much and will amount to 5,482 thousand UAH (~€169,400).

As for receipts into the local budget, in case of a farm/enterprise they will be 1,591.4 thousand UAH (~€49,200), while the cooperative and its members will bring 2,009.5 thousand UAH (~€62,100) to the local budget.

CONCLUSIONS

As a result of our research, we have calculated the economic effect of various forms of organization of agricultural production and believe that institutions of collective action, in particular agricultural cooperatives are a more effective form of organization of agricultural production for both landowners and local budget revenues. In the case of transfer from land cultivation by individual farmers or enterprises to the formation of agricultural cooperatives, the income of landowners who form a cooperative will at least double, and revenues to the local budget will increase by approximately 25%. Further growth of landowners' wealth will promote the development of other local businesses.

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ESTIMATING THE ECONOMIC EFFICIENCY OF MEDICINAL CROPS

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Abstract

Medicinal plants have an important economic potential but which is not capitalized at fair value, so farmers choose certain crops that have reliable market. The paper analyzes from the point of view of economic efficiency, basil, thyme, lavender and hyssop crops. In this regard, the budget of revenues and expenditures for 2020 for these crops was estimated. For this study it was used the technical-economic analysis, determining the main economic indicators: value of production, total costs, variable costs, indirect costs, income, production cost, predictable domestic market price.

Key words**:** *basil, thyme, lavender, hyssop, economic efficiency*

INTRODUCTION

Since ancient times, natural therapy have been a form of medicine, used to treat various diseases. Medicinal plants are used in the pharmaceutical industry, and the knowledge gained has been passed down from generation to generation [7, 8]. Although medicine has evolved a lot over time, people still address to these forms of treatment, having an important role through the action of active substances and principles [2, 9]. Used both in spontaneous or cultivated flora, medicinal plants are used for both internal and external use. In recent times, consumers are interested in organic products, so that the areas cultivated in this way have expanded, both for plants used in the food industry, but also for those used in the pharmaceutical or cosmetics industry. Regarding the benefits of using medicinal plants to the disservice of medicines, it is counted that they are better received and tolerated by the body, and the side effects are fewer or do not manifest [3, 10, 11].
Due to the favorable climate and soil conditions, Romania has over 900 species of medicinal and aromatic plants with high pharmaceutical and food value. The active principles of medicinal plants change if they are exposed for a long time to high temperatures, and if harvesting, drying and storage are done in inappropriate conditions, a large part of the active principles is lost [1, 4, 6].

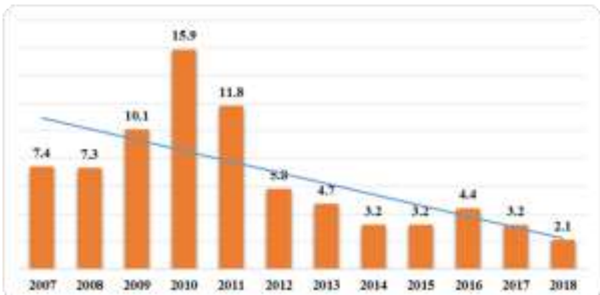

Fig. 1. Evolution of the area cultivated with medicinal and aromatic plants in Romania (thousand hectares)
Source: Ministry of Agriculture and Rural Development, Accessed on 23.05.2020 [5].

As can be seen in the chart number 1, the area cultivated with medicinal and aromatic plants in 2007 was about 7,400 hectares, reaching a maximum in 2010 with an area of 15,900 ha, double the area cultivated in 2007. If starting with 2007 the trend was an ascending one until 2010, after this period the evolution of the surface cultivated with medicinal and aromatic plants entered a decline, registering at the end of 2018, only 2,100 hectares.

Although the cultivation of medicinal and aromatic plants requires fewer resources consumed in the cultivation technology, the interest shown for these species has decreased significantly, most farmers turning to the cultivation of plant species easier to capitalize.

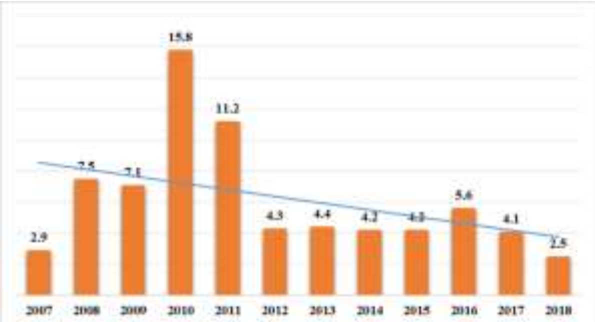

Fig. 2. Evolution of the total production of medicinal and aromatic plants in Romania (thousand tons)
Source: Ministry of Agriculture and Rural Development, Accessed on 23.05.2020 [5].

Regarding the total production of medicinal and aromatic plants (Fig.2), for the period 2007 - 2018, it had an oscillating trend, ranging from 2,500 tons in 2018 and a maximum of 15,800 tons in 2010, the productions being determined by the pedoclimatic conditions, surfaces, but also by the types of crops and the varieties used.

MATERIALS AND METHODS

The paper is part of the ADER sector project 25.1.2. "Research on the development and testing of technical equipment for harvesting medicinal and aromatic plants, used in small farms". In this paper was used the method of technical-economic analysis, determining the structure of the budget on culture, with detailed presentation of some main elements: Production value, Subsidies, Gross product, Intermediate consumption, Taxable income, Net income, Net income + subsidies, Taxable income rate, Net income rate + subsidies, Production cost, Predictable domestic market price

RESULTS AND DISCUSSIONS

At an average production estimated at 13,000 kg/ha, a production value of 160,160 lei/ha is achieved, and by adding to it the subsidy of 3,410.6 lei/ha, a gross product of 163,570.8 lei/ha is obtained (Table 1.).

Table 1. Revenue and expenditure budget for Thyme (conventionally grown in the field) - calculations per hectare - 2020 harvest (estimated production - 13 t)

No. Crt.	Indicators	U.M.	Value	
			Lei	Euro (exchange 4.8)
1	Production value	lei	160,160.30	33,366.7
2	Subsidies	lei	3,410.60	710.5
3	Gross product	lei	163,570.80	34,077.3
4	Total expenses	lei	128,128.20	26,693.4
5	Variable expenditure	lei	86,824.60	18,088.5
6	Fixed expenses	lei	41,303.60	8,604.9
7	Taxable income	lei	32,032.10	6,673.4
8	Net income + subsidies	lei	32,239.40	6,716.5
9	Rate is taxable	%	25	5.2
10	Net income rate + subsidies	%	25.2	5.3
11	Production cost	lei/t	9,856.00	2,053.3
12	Predictable internal market price	lei/t	12,320.00	2,566.7

Source: own calculations.

Variable expenses hold 67.8% of the total, being made up of 84% of value consumption with materials and materials. Holding a proportion of 32.2% of total expenditure, fixed expenditure is represented by 85.8% of value consumption with permanent labor (Table 1). By deducting the total expenses from the value of the production, a taxable income of 32,032 lei/ha results, finally obtaining a net income of 28,828.8 and an income rate of 25% (Table 1).

As a suggestive synthetic indicator for the degree of economic efficiency with which the thyme crop is obtained (conventional system), the production cost of 9,856 lei/ton is calculated by dividing the total costs by the estimated average production (Table 1).

Thyme cultivation becomes profitable by establishing a predictable market price of 12,320 lei/ton, calculated by multiplying the production cost by a coefficient of 1.25 (Table 1). The largest part of production costs is focused on materials and materials, so that for the estimate of the harvest for 2020, they represent 67% of total production costs, followed by manual labor costs with a share of 32%, and mechanical works have only 1% of total expenses (Fig. 3.).

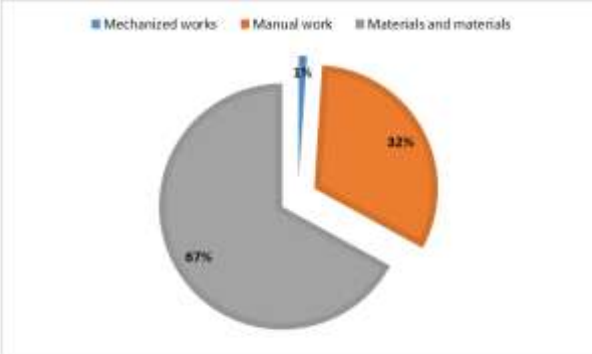

Fig. 3. Percentage distribution of the main expenditure incurred following the preparation of the framework estimate for Thyme cultivation (2020 harvest estimates)
Source: own calculations.

Table 2. Income and expenditure budget for Basil (cultivated in the field in a conventional system) - calculations per hectare - harvest 2020 (estimated production - 12 t)

No. Crt.	Indicators	U.M.	Value	
			Lei	Euro (exchange 4.8)
1	Production value	lei	140,346.40	29,238.83
2	Subsidies	lei	3,410.60	710.54
3	Gross product	lei	143,757.00	29,949.38
4	Total expenses	lei	112,277.20	23,391.08
5	Variable expenditure	lei	88,363.90	18,409.15
6	Fixed expenses	lei	23,913.30	4,981.94
7	Taxable income	lei	28,069.30	5,847.77
8	Net income + subsidies	lei	28,672.90	5,973.52
9	Rate is taxable	%	25	5.21
10	Net income rate + subsidies	%	25.5	5.31
11	Production cost	lei/t	9,356.40	1,949.25
12	Predictable internal market price	lei/t	11,695.50	2,436.56

Source: own calculations.

At an average production estimated at 12,000 kg/ha, a production value of 140,346 lei/ha is achieved, and by adding to it the subsidy of 3,410.6 lei/ha, a gross product of 143,757 lei/ha is obtained (Table 2.).

Variable expenses hold 78.7% of the total, being made up of 80% of value consumption with materials and materials. Holding a proportion of 21.3% of total expenditures, fixed expenditures are represented by 77.6% of value consumption with permanent labor (Table 2). By deducting the total expenses from the value of the production, a taxable income of 28,672.9 lei/ha results, finally obtaining a net income of 25,262.4 lei and an income rate of 22.5%. As a suggestive synthetic indicator for the degree of economic efficiency with which the basil crop is obtained (conventional system), the production cost of 9,356.4 lei/ton is calculated by dividing the total costs by the estimated average production (Table 2.).

Basil culture becomes profitable by establishing a predictable market price of 11,695 lei/t, calculated by multiplying the production cost by a coefficient of 1.25 (Table 2). The largest part of production costs is concentrated on materials and materials, so that for estimating the harvest for 2020 for the basil, they accounted for 80% of total production costs, followed by manual labor costs 19%, and mechanical works holding only 1% of total expenses (Fig. 4).

Table 3. Revenue and expenditure budget for Lavender (field cultivation in conventional system) - calculations per hectare - harvest 2020 (estimated production - 2 t)

No. Crt.	Indicators	U.M.	Value	
			Lei	Euro (exchange 4.8)
1	Production value	lei	21,642.40	4,508.83
2	Subsidies	lei	3,410.60	710.54
3	Gross product	lei	25,052.90	5,219.35
4	Total expenses	lei	17,313.90	3,607.06
5	Variable expenditure	lei	3,621.00	754.38
6	Fixed expenses	lei	11,297.10	2,353.56
7	Taxable income	lei	4,328.50	901.77
8	Net income + subsidies	lei	7,046.50	1,468.02
9	Rate is taxable	%	25	5.21
10	Net income rate + subsidies	%	40.7	8.48
11	Production cost	lei/t	8,656.90	1,803.52
12	Predictable internal market price	lei/t	10,821.20	2,254.42
13	Annual share of start-up costs (25 years of operation)	lei/ha	2,395.70	499.10

Source: own calculations.

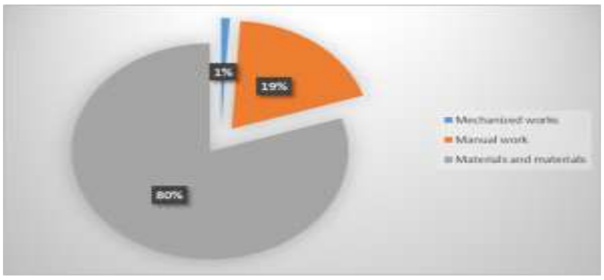

Fig. 4. Percentage distribution of the main expenditures incurred following the preparation of the framework estimate for the Basil crop (2020 harvest estimates)
Source: own calculations.

At an average production estimated at 2,000 kg/ha, a production value of 21,642 lei/ha is achieved, and by adding to it the subsidy of 3,410.6 lei/ha, a gross product of 25,052.9 lei/ha is obtained (Table 3).

Variable expenses hold 20.9% of the total, being made up of 77.5% of value consumption with materials and materials. Holding a proportion of 65.2% of the total expenses, the fixed expenses are represented in a percentage of 95% by the value consumptions with permanent labor, the rest of the expenses representing the annual quota related to the establishment expenses (25 years of operation), in amount of 2,395.7 lei/ha (Table 3).

By deducting the total expenses from the value of the production, a taxable income of 4,328.5 lei/ha results, finally obtaining a net income of 3,635.9 lei and an income rate of 21%.

As a suggestive synthetic indicator for the degree of economic efficiency with which the lavender crop is obtained - conventional system, the production cost of 8,656.94 lei/ton is calculated by dividing the total costs by the estimated average production (Table 3).

Obtaining the profitability of the lavender crop, becomes profitable by establishing a predictable market price of 10,821.2 lei/to, calculated by multiplying the production cost by a coefficient of 1.25 (Table 3).

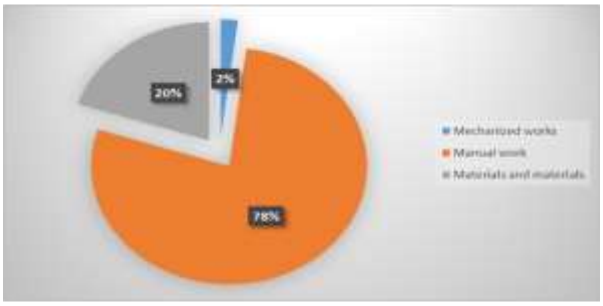

Fig. 5. Percentage distribution of the main expenses incurred following the preparation of the framework estimate for Lavender culture - 2020 harvest estimates
Source: own calculations.

The largest share of production costs is concentrated on manual work, so that for estimating the harvest of lavender crops for 2020, they accounted for 78% of total production costs, followed by expenditure on materials and materials, in percentage of 20%, and mechanized works holding only 2% of total expenditures (Figure 5).

At an average production estimated at 1,500 kg/ha, a production value of 20,467.5 lei/ha is achieved, and by adding to it the subsidy of 3,410.6 lei/ha, a gross product of 23,878.1 lei/ha is obtained (Table 4).

Variable expenditures hold 21.4% of the total, being made up of 77.1% of value consumption with materials and materials. Holding a proportion of 54% of the total expenses, the fixed expenses are represented in a percentage of 94,6% by the value consumptions with permanent labor force, the rest of the expenses representing the annual quota related to the establishment expenses (15 years of operation), in amount of 4,031.4 lei/ha (Table 4).

By deducting the total expenses from the value of the production, a taxable income of 4,093.5 lei/ha results, finally obtaining a net income of 3,438.5 lei and an income rate of 21%.

Table 4. Revenue and expenditure budget for Hyssop (conventional crop - calculations per hectare - harvest 2020 (estimated production - 1.5 t)

No. Crt.	Indicators	U.M.	Value	
			Lei	Euro (exchange 4.8)
1	Production value	lei	20,467.50	4,264.06
2	Subsidies	lei	3,410.60	710.54
3	Gross product	lei	23,878.10	4,974.60
4	Total expenses	lei	16,374.00	3,411.25
5	Variable expenditure	lei	3,503.10	729.81
6	Fixed expenses	lei	8,839.50	1,841.56
7	Taxable income	lei	4,093.50	852.81
8	Net income + subsidies	lei	6,849.10	1,426.90
9	Rate is taxable	%	25	5.21
10	Net income rate + subsidies	%	41.8	8.71
11	Production cost	lei/to	10,916.00	2,274.17
12	Predictable internal market price	lei/to	13,645.00	2,842.71
13	Annual share of start-up costs (25 years of operation)	lei/ha	4,031.40	839.88

Source: own calculations.

As a suggestive synthetic indicator for the degree of economic efficiency with which the hyssop culture is obtained - conventional system, the production cost of 10,916 lei/ton is calculated by dividing the total costs by the estimated average production (Table 4).
Obtaining the profitability of hyssop cultivation becomes profitable by establishing a predictable market price of 13,645 lei/ton, calculated by multiplying the production cost by a coefficient of 1.25 (Table 4).

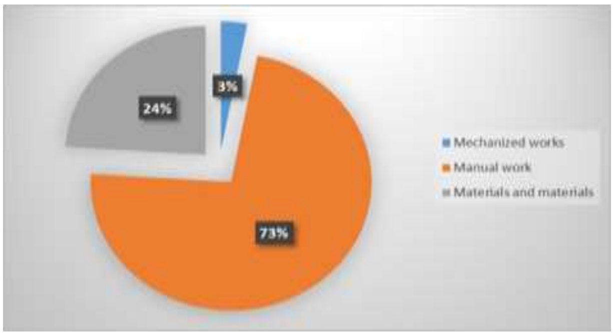

Fig. 6. Percentage distribution of the main expenditure incurred following the preparation of the framework estimate for Hyssop cultivation - 2020 harvest estimates
Source: own calculations.

The largest share of production costs is concentrated on manual work, so that for the estimate of the 2020 crop of hyssop, they accounted for 73% of total production costs, followed by material and material costs of 24%, and mechanized works holding only 3% of total expenses (Fig. 6).

CONCLUSIONS

In 2007 the cultivated area with medicinal plants was 7,400 hectares, reaching a maximum of the analyzed period in 2010, when the cultivated area was 15,900 hectares. After this period, the area cultivated with medicinal and aromatic plants decreased, due to the lack of processing units.
Regarding the yields obtained, they alternate depending on the species and variety grown, the area, but especially the soil and climatic conditions that can significantly influence the yields obtained.
Following the estimates of the budget of revenues and expenditures for the analyzed medicinal plant crops, it was possible to determine the following:

-At an average production of Thyme estimated at 13,000 kg/ha, a production value of 160,160 lei/ha is achieved. Thyme culture becomes profitable by establishing a predictable market price of 12,320 lei/ton.
-At an average production of Basil estimated at 12,000 kg/ha, a production value of 140,346 lei/ha is achieved. Basil culture becomes profitable by establishing a predictable market price of 11,695 lei/ton.
At an average production of Lavender estimated at 2,000 kg/ha, a production value of 21,642 lei/ha is achieved. The Levantica culture becomes profitable by establishing a predictable market price of 10,821.2 lei/ton.
At an average production of Hyssop estimated at 1,500 kg/ha, a production value of 20,467.5 lei/ha is achieved. Hyssop cultivation becomes profitable by establishing a predictable market price of 13,645 lei / ton.

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ASSESSMENT OF AGRICULTURAL SCIENTISTS' KNOWLEDGE OF GENETICALLY MODIFIED CROPS: IMPLICATIONS FOR FOOD SECURITY IN NIGERIA

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Abstract

One of the current challenges facing Nigeria is food insecurity. At the moment, Nigeria occupies 96th position in the Global Food Security Index Ranking (GFSIR). One striking feature of Nigerian agriculture is unpopularity of GMCs in the fight against food insecurity. However, scientists' knowledge of these GMCs is unknown in Nigeria, thus, making it difficult to ascertain farmers' readiness to adopt. This study therefore ascertained Agricultural Scientists' knowledge level in GMCs with a view to ascertaining their capability in disseminating GMCs to farmers in order to alleviate food insecurity challenge in Nigeria. Simple random sampling technique was used to select 240 Scientists from Universities, Research institutions and Extension Experts from ADP/Ministry of Agriculture and Natural Resources across the 6 geo-political zones in Nigeria with the use of structured questionnaire. Data were analyzed with use of F-test and described with frequency and percentage and Equal Interval Approach. It was observed that 59.2% of the Scientists had high knowledge of GMCs. However, there was a significant difference in the scientists' knowledge of GMCs across agricultural zones with the F-value of 15.2; p≤ 0.05. Further results of Duncan Range test revealed that North central zone (Mean = 154) zone had the highest knowledge compared to other zones. The high knowledge of GMCs recorded among scientists therefore, becomes an entry point in using GMCs to fight food insecurity challenge in Nigeria. Thus, farmer's readiness to adopt GMCs and cultural practices associated with their cultivation are highly depended on advice and recommendations from the Agricultural scientists in Nigeria.

Key words: *Genetically Modified Crops, knowledge, food security, scientists*

INTRODUCTION

Food insecurity is a global phenomenon and is more prevalent in the developing countries including Nigeria and this forms the reason why food security programmes are the target of every successive government in Nigeria since independence in 1960 [16]. This is because millions of Nigerians are vulnerable to food insecurity and malnourishment. Globally, the Food and Agriculture Organization [10] of the United Nations report showed that 868 million people were undernourished between 2010 and 2012 alone while an estimated 20.4 million of these people were still food insecure as at 2015 in Sub-Saharan Africa where farming is the predominant occupation of over 70% of the populace. However, over 70% of these food insecured persons are in Nigeria, Niger, Mali and Chad in African countries [30]. According to the world population records of 2016, there is a rapid population growth in Nigeria with total population of about 187,908,541 and with the growing estimated population rate of 80 million per year. It is also projected that by the year 2050, the population will double to two billion people [30]. Several projections also suggest that global food production may need to increase between 60 and 100 percent in 2050 because of the increasing demand and changing patterns of demand [5]. About 70% of these population lives on less than N370 (US$ 1.00) per day, suffering from hunger, malnutrition and poverty. Feeding its teeming population has become a big task for the Nigerian agricultural sector [7].

Nigeria as an agrarian community has both human and natural resources that should place us among the first 3 countries in the world in terms of food production. The nature and fertility of the Nigerian flag is captured in the National flag design with green colour

denoting the fertility of the Nigerian soil [18]. Unfortunately, the populace suffer amidst plenty based on the assertion of [11]. United State Agency for International Development [28] reported that about 14 million crop farmers are engaged in food production. The report further showed that farmers in Nigeria are characterized by old age, illiteracy, low income, cultivate less than 2 hectares of land, do not use productivity enhancing inputs, and lack knowledge of modern farming technology/practices. This is the basis for the growth of the country import at 11.0% per annum with negative consequences on the Gross Domestic Products (GDP) and the economy at large [4]. The dependent of Nigeria on other countries of the world for importation of food crops like rice, wheat and other agricultural produce despite the abundance of manpower and natural resources with favourable climate calls for interrogation.
Agriculture contributes over 41.8% to Nigeria Gross Domestic Product (GDP) in 2009 and 2010 and the sector employs about 70% of the workforce [21, 29]. Unfortunately, agriculture which in the past was the biggest sector now scored 23 percent in its contribution to Gross Domestic Product (GDP) in 2015. The GDP average Growth Rate was 1.47% from 2013 to 2015. It was 3.10% in the fourth quarter of 2015 compared with 9.19% in the previous third quarter and then came low to 11.57% in the first quarter of 2015 [6]. This decline in the performance of agricultural sector must have fueled the increase in food security programmes in the Nigeria.
Agricultural primarily concerns with the production of crops and rearing of animals. [9] report showed that crop yield in Nigeria is only 20 to 25% of that obtained in other developed nations of the world. This implies that crop production is not increasing as a rate to meet population growth. Also, utilization of improved seeds and seedlings are very low at 5% when compared with East Africa 25% and Asia 60%. About 90 percent of farmers in some Africa countries including Nigeria are smallholders who are poor and dependent on local varieties of crops for agricultural production as means of livelihood [9]. However, the use of local varieties of crops by farmers is no longer a solution to agricultural sector for any country that would meet the food requirements of its population.
One of the best strategies to increase food production is the adoption and utilization of Genetically Modified Crop (GMC) techniques. [12] opined that Scientists in Indonesia are more knowledgeable about GM foods and are more pre dispose to information and explanation to GM farmers, consumers and other end users. Fortunately, Nigeria agricultural sector with the aid of Agricultural Scientists has the potentials to help poor farmers out of their predicaments by their acceptance of GMCs use and the role they play in ensuring the success of the new Genetic Engineering (GE) techniques recently discovered. To eliminate micronutrient deficiencies, increasing yields and the nutritional value of crops is needed by genetically modification process. However, the knowledge of Nigerian agricultural scientists in GMC is largely unknown and this makes it very difficult to ascertain farmers' readiness to adopt. Hence, the need for this study.
The study was designed to assess scientists' knowledge and knowledge level of agricultural scientists in GMCs with a view to ascertaining their capability in disseminating GMCs to farmers in order to alleviate food insecurity challenge in Nigeria.

MATERIALS AND METHODS

This study was carried out in Nigeria. Nigeria has a land area of 923,769km^2 and a population of over 168.8 million people [20]. It is surrounded on the West by the Republic of Benin and the Republic of Niger; on the East by the Republic of Cameroon; on the North by Niger and Chad Republic's and on the South by the Gulf of Guinea. Nigeria is situated in the West African region and lies between longitude 3^o and 14^o and 4^o and 140^o (Fig. 3). The climate is equatorial and semi-equatorial. That is the wet and dry season and agriculture production mostly depends on natural rainfall. Temperatures across the country are relatively high with a very narrow variation in seasonal and diurnal ranges 22

=36^{0}C. (Nigeria Embassy, 2015). Nigeria has six Geo-political zones. They are North Central Zone, North-Eastern Zone, North-Western Zone, South-Eastern Zone, South-Southern Zone, and South-Western Zone. The target population was Agricultural Scientists across the six geopolitical zones in the country. Nigeria comprising of Agricultural Scientists from Agricultural Research Institutes, Universities and Government Agencies that are into crop activities.

A multi stage sampling technique was used to sample scientists across the six geopolitical zones across the country. At the first stage, a purposive sampling technique was used to sample three out of the six zones based on the population of scientists and the presence of research institutions where GMCs centers are located. At the second stage, stratified sampling technique was used to ensure that homogenous samples are obtained. At the third stage, simple purposive sampling technique was used to select prominent research institutions and universities in the three states selected based on their involvement in GMOs researches. At the forth and the last stage, proportionate sampling technique was used to sample Twenty (20) respondents each from FCT ADP, UNIABUJA and 80 respondents from NABDA/OFAB and NABMA to give a total of 120 were sampled in FCT Abuja. While twenty (20) respondents each from IITA, UI, and Oyo MANR/ADP making 60 respondents were sampled in Oyo state and twenty (20) respondents each from NRCRI, MOUAU, Abia MANR/ADP making 60 respondents were sampled in Abia state to give a total sample size of two hundred and forty (240) respondents in the study area. Data collected were described with frequency counts, frequencies, Equal Interval Approach and F-tests.

RESULTS AND DISCUSSIONS

Socio-economic characteristics of Scientists

Evidence in Table 1 show that about 64.6% of the respondents were male while only about 35.4% were female. The findings revealed that male dominated the population of scientists/researchers in Nigeria. This implies that male scientists in Nigeria will have more awareness of GMCs than their female counterparts since they dominate the population of scientists in most of the research stations where GMCs are developed. This may not be farfetched as gross inequality has been established between male and female in terms of access to education in Nigeria by extant literature such as [22, 17, 2] among others. In addition, [26] reported that the literacy rate for Nigerian girls and women stood at 47% while male was 53%,yet the female forms the larger proportion of the population. Some of these findings pointed to the fact that in Africa, the female social role has been traditionally linked to the home and it has always been assumed that they can only find happiness and fulfillment only as mothers and wives [2]. Therefore, there is likelihood of having more male scientists/researchers than the female based on the fact that male traditionally have better access to education.

The finding is in consonant with the report of [27] on gender and science which stated that less than 40% of world researchers are women. Obviously, it implies that a significant gender gap has persistently occurred throughout the years at all levels of science and technology not only in Nigeria but across all African countries. However, women have made tremendous efforts towards increasing their horizon in technology research and higher education with the achievement over the years in Science and Technology but the population of male scientists still outnumber that of the female. Consequently, this result agrees with the study of [23] which established that agricultural and biological sciences/domain is still dominated by male scientists/researchers, particular in Nigeria.

Based on age distribution in Table 1, it was revealed that the mean age was approximately 38 years. Specifically, the findings showed that about 45.8% were found between 31 and 40 years of age, 21.7% of the scientists/researchers fell with the age range of 41-50 years while very few (7.9%) of the scientists/researchers were between 51 years and above. The findings showed that scientists/researchers interviewed for this study were found in their youthful and active ages. The implication is that they are expected to have some youthful characteristics like innovation proneness, minimal risk aversion, faster reaction time, less fear of failure, less conservativeness, greater physical strength, greater knowlegde acqusition propensity, faster rate of learning, love for adventure and preference for boldness with high business oreintation [25]. The above characteristics if possessed may serve as a learage to promote their ability to developed GMCs that will assist in the fight against food security in Nigeria.

This result is in agreement with the findings of [23] that posited that more than half of the scientists/researchers whom perception was sought on GMCs across universities and research institutions in South Western Nigeria were less than 60 years. Similarly, [24] study supported the activeness of people whose age are within the age brackets of 31 and 40 years and stated that they are usually energetic, sensitive and productive. This means that respondents who fall within these age groups are in their prime age and can be efficient, effective and productive in delivering their research activities as expected.

Results in Table 1 further showed that about 78.4% of the respondents were married while 20.8% of the scientists were single and only very insignificant proportions (0.8%) were divorcees. Marital status in many African countries has been attached to responsibilities which has a strong correlation to job commitment and performance as opined by Adeoye *et al*. (2009). In addition, being married also would have encouraged them to be more committed towards their research activities. Marital status has been attributed to stability and stability will also enhance job performance based on the assertions of Adeoye *et al*. (2009) that reported that marital status was a significant variable that contributed to job performance of workers in an organization. The findings therefore showed that scientists/researchers interviewed for this study have the tendency to be committed since majority were married. The commitment is a function of stability that may invariably has significant influence on job performance. By this, it is expected that GMCs should be a common crops found in Nigeria if knowledge and acceptability are high.

With respect to religion, the results in Table 1 revealed that 79.2% of the total respondents in the study area were Christians when compared with Islam of barely 17.1% and African traditional religion 3.8%. This shows that Christianity is the dominant religion among the respondents. Although, both Christianity and Islam are the two dominant religious bodies in Nigeria and these have been found to influence certain farming practices. This result is in conformity with the assertions of [23] that posited that majority of the respondents were Christians. Moreover, this study is one of the specific studies that have showed the influence of religion on GMCs in Nigeria. For example, the study submitted that respondents' religion affiliation had significant effects on their perception towards genetically modified technology in Southwest, Nigeria and this was attributed to their different beliefs, norms, cultural values and taboos which are the basis doctrine of these religious organizations. Similarly, [31] asserted that religious beliefs could either promote or prohibit the adoption and utilization of GMCs in many parts of the world but the significance importance of GMCs in sustainable food production cannot be underestimated in developed countries of the world.

Results in Table 1 also showed that 34.6% of the scientists/researchers sampled were PhD holders, about 30.0% hold M.Sc degree while 29.2% and 6.2% were holders of First degree and HND certificate, respectively. The findings showed that respondents were well educated. This high level of education is expected to significantly influence their awareness and knowledge of GMCs. Also, education has been found to positively influence people disposition towards the acceptance of GMCs. [8 and 19] reported education as one of the factors identified as crucial to the adoption of genetically modified crops and animals. This means education has the potentials to increase scientist/researchers propensity to seek for more knowledge about GMCs especially in Nigeria as food insecurity is one of the target areas that researchers are encouraged to tailor their research interest toward in the 21st century with a view boosting agricultural productivity for a food secured nation.

Table 1. Distribution of respondents by their socio-economic characteristics

Socio-economic characteristic	Frequency	(%)	Mean	Std. Dev.
Sex of respondent				
Female	85	35.4		
Male	155	64.6		
Age (Years)				
<= 30	59	24.6		
31 – 40	110	45.8		
41 – 50	52	21.7		
51+	19	7.9	37.5	8.4
Marital Status				
Single	50	20.8		
Married	188	78.4		
Divorced	2	0.8		
Widowed/ Widower				
Religion				
Islam	41	17.1		
Christianity	190	79.2		
African traditional religion	9	3.8		
Educational Qualification				
HND	15	6.2		
B.Sc	70	29.2		
M.Sc	72	30		
Ph.D	83	34.6		
Occupation				
Research only	105	43.7		
Teaching only	19	7.9		
Research and teaching	69	28.8		
Extension service	47	19.6		

Source: Computed from Field Survey, 2018.

The finding conforms to the study of [23] that reported that about 45% of scientists sampled across Southwest universities in Nigeria on their perception towards genetically modified organisms were holders of M.Sc. the study further supported the fact that this high educational qualification will be an added advantage in enhancing respondents ability to conduct research owing to their strong analytical skills that must have risen from their educational experience over the years.

Furthermore, Table 1 revealed that about 43.7% indicated that they engaged solely in research activities, 7.9% indicated teaching as the only activity carried out by them while 19.6% were extension expert with the responsibility of information dissemination about GMCs and 28.8% combine teaching and research as their main occupation. This showed that diverse areas of concerns with regards to GMCs were involved in this study. Based on the above statistics, it can be deduced that over 70% of the sampled respondents carry out research and teaching activities. These activities are germane to acquisition of more knowledge about GMCs. The involvement of extension personnel is an indication of ensuring that research outputs will not be left fallow in research stations as their duties among others is to ensure that the research outcome gets to the final consumers [15]. This will enable to create more awareness about GMCs among the populace and an increased in awareness is expected to help in the fight against food insecurity.

Awareness of GMC by Respondents

The distribution of the respondents based on awareness of GMCs and the awareness level as shown in Table 2 and Figure 1. Evidence in Table 4 shows that about 87.1% of the respondents indicated their awareness of GMCs technology. This finding further confirmed the earlier report in Table 1 where respondents' awareness of the existence of GMCs were tested. In addition, about 87.1% of the respondents were aware that GMCs are products of genetic engineering and about 81.3% revealed their awareness that GMCs technology became popular in Nigeria in recent times. In addition, about 84.2% and 69.2% showed their awareness that GMCs have potential benefits for increasing food production and that Nigeria has not commenced commercialization of GMCs respectively. Furthermore, a little above average (57.1% and 55.0%) registered their awareness that GMCs technology is more expensive than the non-GMCs and USA multi-national agencies introduced GMCs to Nigeria, respectively. Nigeria institutions like NBMA, GON SHEDA and NABDA were set up to run the affairs of GM technology (60.4%), Nigeria government has signed GMCs Bill into law (56.7%), Nigeria government drafted biosafety laws and measures on GM technology (57.9%), GMCs have not been commercially grown (59.6%).

On the level of awareness of GMCs as measured in Chapter three, results in Figure 1 show that about 52.5% of the respondents were rated high in their awareness level. About 36.7% had moderate awareness while very few (10.8%) had low level of awareness. The findings showed that respondents had reasonable level of awareness of the GMC technologies, although they indicated that despite the fact that GMCs can be used to fight hunger, it's adoption and utilization has not been used to produce food at commercial scale.

The study agrees with the findings of [14] that pointed to the fact that Nigeria is not known among countries where GMOs have been used to fight hunger. The study listed countries like United States, Brazil, Argentina, India, Canada, China, Paraguay and South Africa as those that produce food using GMO technologies. This shows that only South Africa featred in the use of GMO technology at this period among the developing countries. However, [13] reported that in 2006, about 38% of food using GMOs were grown in the developing countries and GM crop production also reaches a significant level in Paraguay, South African, Uruguay and Australia

Table 2. Distribution of respondents based on their awareness of GMC

****Awareness of GMC**	**Frequency**	**Percentage**
Awareness of GMCs technology	209	87.1
GMCs are products of Genetic Engineering	209	87.1
GMCs technology became popular recently in Nigeria	195	81.3
GMCs has great potential benefits for increasing food production	202	84.2
Nigeria has not commenced commercialization of GMCs	166	69.2
GMCs technology is more expensive than non-GMCs	137	57.1
USA Multinational agencies introduced GMCs to Nigeria	132	55.0
Nigeria institutions like NBMA, GON SHEDA and NABDA were set up to run the affairs of GM technology	145	60.4
Nigeria government has signed GMCs Bill into law	136	56.7
Nigeria government drafted biosafety laws and measures on GM technology	139	57.9
GMCs have not been commercially grown	143	59.6

Source: Computed from Field Survey, 2018.
**Multiple Responses.

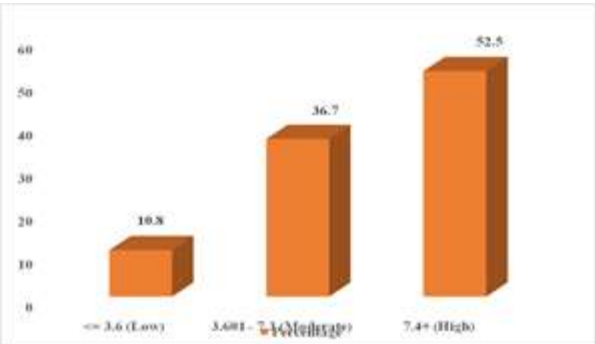

Fig. 1. Level of awareness of GMCs among respondents
Source: Computed from Field survey, 2018.
Maximum score = 11   Minimum score = 0   Range = 11

Knowledge level of GMCs Merits and Demerits by respondents

Results in Tables 3 and 4 show the respondents' knowledge of GMCs merits and demerits respectively. Table 3 indicated that respondents had high knowledge of GMCs merits in the study area with the mean value of 3 and above**.** This implies that respondents' exposure to GMCs research activities and teaching over the years has improved their knowledge. Respondents opined their high knowledge stating that GMCs has better yields with the highest mean value of 4.29. This is closely followed by the knowledge that GMCs has higher productivity (4.25) and better quality (4.23). Knowledge that GMCs reduced pesticide use as well as that it increases farmers' income had 4.15 respectively. GMCs has better resistant to disease had a mean of 4.14, followed by knowledge of greater resistance to pest (4.12), better nutritional value (4.09), higher flexibility in weed management (3.90) and that GMCs has a long shelf life (3.89).

Table 3. Kmowledge Level of G MCs Merits by Respondents

Merits Statements	Strongly Disagreed (1)	Disagreed (2)	Undecided (3)	Agreed (4)	Strongly Agreed (5)	Mean $\bar{X}$	Decision
Better quality	3 (1.3)	11 (4.6)	15 (6.3)	109 (45.4)	102 (42.5)	4.23	High
Better taste	6 (2.5)	56 (23.3)	86 (35.5)	55 (22.9)	37 (15.4)	3.25	High
Longer shelf life	5 (2.1)	22 (9.2)	45 (18.8)	90 (37.5)	78 (32.5)	3.89	High
Better resistant to disease	4 (1.7)	14 (5.8)	30 (12.5)	88 (36.7)	104 (43.3)	4.14	High
Better yields	1 (0.4)	9 (3.8)	19 (7.9)	102 (42.5)	109 (45.4)	4.29	High
Higher productivity	2 (0.8)	9 (3.8)	21 (8.8)	102 (42.5)	106 (44.2)	4.25	High
Better nutritional value	6 (2.5)	11 (4.6)	36 (15)	89 (37.1)	98 (40.8)	4.09	High
Better flavor	7 (2.9)	50 (20.8)	88 (36.7)	66 (27.5)	29 (12.1)	3.25	High
Better colour	4 (1.7)	46 (19.2)	78 (32.5)	65 (27.1)	47 (19.6)	3.44	High
Greater resistance to pest	2 (0.8)	14 (5.8)	27 (11.3)	106 (44.2)	91 (37.9)	4.12	High
Reduced pesticide use	5 (2.1)	15 (6.3)	31 (12.9)	76 (31.7)	113 (47.1)	4.15	High
Environment friendly	11 (4.6)	20 (8.3)	43 (17.9)	95 (39.6)	71 (29.6)	3.81	High
Higher flexibility in weed management	3 (1.3)	23 (9.6)	42 (17.5)	98 (40.8)	74 (30.8)	3.90	High
Higher farmers income	2 (0.8)	11 (4.6)	29 (12.1)	104 (43.3)	94 (39.2)	4.15	High

Note:
( ) = Percentage of total respondents
Critical Mean = 3.00
< 3.00 is low knowledge of GMCs merits
≥ 3.00 is high knowledge of GMCs merits
Source: Computed from Field Survey, 2018.

Those who agreed GMCs are environmental friendly had 3.81, GMCs has better color (3.44), has better taste than non GMCs and better flavor (3.25) respectively.

The study affirmed the fact that GMOs have been documented to have vast benefits to human endeavours, although its usage in Nigeria is still at the lowest level but respondents have wide knowledge of its merits through their experiences as researchers and scientists in their various fields of study.

The high knowledge recorded on the merits of GMCs may not be unconnected to numerous factors like experiences, conferences attendance and personal study of latest scientific discoveries among others while their inability to use GMO technology may be due to the unfavorable economic conditions such as lack of stable electricity, lack of well-equipped laboratories and reagents in most of our higher institutions and these are largely due to the government neglect.

The study of [3] confirmed this results that GM technology has such numerous benefits as attended to by the respondents. A similar report by [1] on awareness and utilization of genetically modified foods in Nigeria, also confirmed that the introduction of genetically modified foods (GMFs) raised hopes that the problem of food insecurity would be solved.

Table 4 further revealed the knowledge of the respondents on the perceived demerits of GMCs. The results showed that some respondents expressed their high fears about GMCs technology stating that they strongly agreed that GMCs alter human genetic make-up. This has highest mean value of 3.75. Other demerit as identified by respondents in the study area includes the fear that GMCs

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cause threat to environmental integrity (3.56), and that it eliminates biodiversity (3.49). Furthermore, they accept the fact that it destroys traditional farming practices (3.48) and increase production cost (3.36). Meanwhile, there is low agreement by respondents in the following; that GMCs increase input cost (2.98) and that farmers will depend on GMCs (2.83). The implication of this finding is that this attitude or mindset of fears would pose a lot of challenges to scientists and government of Nigeria which could have impede the implementation and utilization of this technology over the years.

Table 4. Knowledge Level of GMCs Disadvantages/Demerits by Respondents

Advantages/Merits Statements	**Strongly Disagreed (1)**	**Disagreed (2)**	**Undecided (3)**	**Agreed (4)**	**Strongly Agreed (5)**	**Mean $\bar{X}$**	**Decision**
Alter human genetic make-up	15 (6.3)	37 (15.4)	38 (15.8)	52 (21.7)	98 (40.8)	3.75	High
Make farmers depend on GMC companies for planting materials	36 (15.0)	66 (27.5)	62 (25.8)	55 (22.9)	21 (8.8)	2.83	Low
Increase input cost	29 (12.1)	55 (22.9)	66 (27.5)	72 (30.0)	18 (7.5)	2.98	Low
Increase production cost	24 (10.0)	51 (21.3)	34 (14.2)	77 (32.1)	54 (22.5)	3.36	High
Destroy traditional farming practices	24 (10.0)	37 (15.4)	35 (14.6)	87 (36.3)	57 (23.8)	3.48	High
Threat to environmental integrity	18 (7.5)	33 (13.8)	45 (18.8)	84 (35.0)	60 (25.0)	3.56	High
Eliminate biodiversity	20 (8.3)	41 (17.1)	36 (15.0)	88 (36.7)	55 (22.9)	3.49	High

Note: figures in parentheses represent percentages
Critical Mean = 3.00
< 3.00 is low knowledge of GMCs demerits
≥ 3.00 is high knowledge of GMCs demerit
Source: Computed from Field Survey, 2018.

The finding is in agreement with [1] assertion that Genetic Modified Foods (GMFs) do not usually deliver on any of their promised benefits but rather provide pain, difficulty and death. The high knowledge of its fear may be a serious threat to food security strategies as it will be difficult for the scientists to disseminate information that is at the detriment of the end users of the research findings.

Differences in the knowledge of GMCs across three selected zones

Results in Table 5 show that there was a significant different in the knowledge of GMCs among respondents across the three selected zones with North Central having the highest mean (154) based on the results of Duncan rage test with the F-value of 15.2; p≤ 0.05.

Table 5. Results of Analysis of Variance showing significant difference in the scientists knowledge of GMCs

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	4542.04	11	2728.15	15.2	0.05
Within Groups	12205.15	228	561.31		
Total	16747.19	239			

Source: Computed from Field Survey, 2018.

Table 6. Results of posthoc test using Duncan showing location of differences in the scientists' knowledge of GMCs

Zone	**Subset for alpha = .05**		
	1	2	3
Southwest	101.67		
Southeast	118.33	118.33	
North central			154.01

Source: Computed from Field Survey, 2018.

This implies that scientists in the North central zone of Nigeria had better knowledge of GMCs than those in the other zones. This may not be unconnected to the fact that they had more facilities to conduct research in GMOs than the other ones. This will make them to be more exposed to the GMCs technologies. Hence, their higher knowledge.

CONCLUSIONS

The study shows that there were more male scientists than the females and scientists awareness of GMC technology was rated high. Knowledge of the GMC technologies among scientists was also high but there was a significant difference in the knowledge of the technology among scientists in the north Central part of Nigeria than the other region. It was affirmed that there were more institutions with better facilities to conduct state of the earth researches in this part of the country than the other. This high knowledge of merits of GMCs may be a good entry point to solving the problem of food insecurity in the country. However, the high knowledge of demerit may equally serve as a serious threat to food security programme.

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COMPENSATING WAGES OF AGROCHEMICAL EXPOSURE RISKS OF COCOA FARMWORKERS

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Abstract

Occupational risk is a major factor reducing productivity of farm workers as it impairs their physical capacity and increase their vulnerability to ill health, diseases and injuries. Agrochemical exposure risk has been attributed to work demand and unhealthy work environment that these workers are subjected to which they are often not compensated. Consequently, this study estimated the compensating wages of life quality for agrochemical exposure risks of cocoa farm workers in Idanre Local Government Area, Ondo State, Nigeria. Multistage sampling technique was used to select 180 cocoa farm workers while data on factors affecting agrochemical exposure risks. Data were analyzed using descriptive statistics and linear hedonic regression. Linear hedonic regression revealed that temperature ($\beta = 5.02$), health index ($\beta = 9.65$) and participating in agrochemical spraying ($\beta = 44.71$) had positive and significant ($p<0.05$) influence on compensating wages while smoking ($\beta = -41.77$) and use of personal protective gadgets during spraying ($\beta = -31.67$) had negative and significant ($p<0.05$) influence. Cocoa farm workers received ₦75.00k per day as the compensation for incurring occupational risks. The study concluded that appropriate use of personal protective equipment minimizes agrochemical exposure risks. It was therefore recommended that educational programs that will enhance farmer's knowledge, skills and attitude to adopt safety measures in pesticide usage should be adequately planned.

Key words: *compensating wages, cocoa farm-workers, hedonic wage approach*

INTRODUCTION

Cocoa is the one of the main cash crop that contributed eminently to Nigeria's economy.

Though Nigeria foreign exchange earnings came from crude oil, yet cocoa remains the Nigeria's highest foreign exchange earning among all agricultural commodities, of which the country is the fifth largest exporter of Cocoa in the world [19].

Nigeria export earning on cocoa in the last 20 years has drastically reduced. Within the 60s Nigeria produced about 540,000 tonnes of cocoa annually and was the second largest producer of the crop in the world [26]. In the 70's cocoa output reached 308,000 tonnes [1]. However, cocoa output in recent years ranges between 185,000 and 215,000 tonnes [19].

Previous authors has stated that overdependence on crude petroleum as the Nigerian source of foreign exchange, small farm holdings, low yield, inconsistent production pattern, disease incidence, pest attack and climate change are the key factors decreasing cocoa production in Nigeria. [17,18].

In Nigeria cocoa is the most valuable cash crop among farmers in the major producing areas. About 20 million people depend directly on cocoa for their livelihood, 90% of the productions are exported in the form of beans or semi-manufactured coca products [25].

Compensating Wages is the extra income that a given worker must be offered in order to motivate them to accept given undesirable job, relative to other workers in other occupations [22]. Compensating wages is the difference in wages offered to offset the desirability or undesirability of a job. If the job is considered unwanted because of elements of risk, the differential is positive in the form of increased wages to offer incentives to the employee to take the job [11]. If the job is considered desirable, the differential is negative in the form of lower wages.

Occupational risk can be described as a condition surrounding a work environment or state of a work environment that increases the likelihood of death, illness or disability to a worker while hazard is defined as the native property of a substance or process that could cause injury or damage [30].

Farm can be source of life-threatening [14], farmers experience many fatal injuries happen to them when working with familiar equipment on the field. While doing tasks that they have been performing for years. Quick and chronic illness of farm workers and family members are caused by harmful agricultural materials like pesticides, herbicides, flammable liquids and other solvents and farm mechanization such as tractor, plough and other mechanized equipment make the farm works easier and increase the output of the farm. However, mechanization has contributed to severe injuries in agriculture significantly to the health risks [14].

In many countries, the use of agrochemical is highly regulated. Occupational risks are injuries that occur at the location of a person's employment which can include exposure to chemicals or other substances as well as accidents. Occupational accidents, work injury, work-related injury are other names for occupational injuries. The main cause of occupational injuries is the result of exposure to harmful agents usually toxins, gases, inhalants, etc. while working [5].

The World Health Organization (WHO) and the United Nations Environmental Programme (UNEP) estimated that one to five million cases of pesticide poisoning occur among agricultural workers each year with about 20 000 fatalities [30].

Agrochemical exposure risk can be measures by:

(i)Objective measure of risk is the measurement of the likelihood of fatal or non-fatal injury of the worker.

(ii)Subjective measure of risk this measure use of danger perception (occurrence of risk) dummy indicator that takes the value 1 if the worker believes that his job exposes him to harmful or unhealthy conditions and 0 otherwise). [27] Revealed that self-reported riskiness of one’s job is considerably and positively related to an individual’s wage. Subjective measures of risk were used for the study.

Main constraints of cocoa production are cocoa mass spraying programme, merged with a powerful increase in fertilizer use [28]. The cocoa sector continues to face problems such as occupational risks, inadequate storage facilities, pest and diseases, and child labour issues [15].

Occupational risk is a major factor reducing productivity of farm workers as it impairs their physical capacity and increase their vulnerability to ill health, diseases and injuries [16]. This study was carried out to estimate the expected compensating wages received by the workers incurring job related health risk and Identify factors causing agrochemical exposure.

MATERIALS AND METHODS

Study Area

The study was carried out in Ondo State, Nigeria. Ondo state is within the south-western part of Nigeria with its capital at Akure. The state lies entirely in the tropics, with the longitude of 4^0E and 6^0E of the Greenwich Meridian and latitude 5^0N and 8^0North of the Equator. Ondo state is bounded by Ekiti and Kogi State in the north; Edo State in the east; Ogun and Osun States in the west and the Atlantic Ocean in the south [24]. The state has an estimated population of 4,724,870 according to the Nigerian 2006 National Census [8] and covers an area of 14,793km^2.

The state made up of 18 Local Government Areas (LGAs).

Agriculture is the main source of income of the Ondo state and about 65% of the state labour force depends on agriculture as the main occupation [9]. Ondo State is the largest cocoa producing state in Nigeria; produce about 50% of Nigeria’s annual cocoa production [2]. Other cash crops like oil palm and rubber are produced in large scale in the state. Maize, yam and cassava and others food crops are also produced in large quantities. The state is also blessed with very rich forest resources where indigenous and exotic timber species in Nigeria abound. Idanre Local Government Area is Nigeria's largest cocoa producing area [4]. Idanre Local Government Area covers an area of 1,914km^2 and a projected population of 177,183 [8] the Local Government Area is bounded to the north-west by Ondo east and ile-oluji/oke-igbo local government, to the north-east by Ifedore, Akure South and Akure North local government areas.

Multistage sampling technique that guaranteed cocoa farmers who could provide desired information on the basis of the objectives of the study was adopted in selecting respondents. The first stage was the purposive selection of Idanre Local Government Area as the Nigeria's leading cocoa producing area.

The second stage is the random selection of 12 communities/villages namely Oke-idanre, Baale-ojumu, Owomofewa, omilifon, Apomu, Ala-Elefosan, Owena, Atosin, Arapa, Obatedo, Apefon and Iramuje were selected for the study from the selected LGA. The last stage is the random selection of 15 cocoa laborers working with cocoa farmers from each village. Making a total sample size of one hundred and eighty (180) respondents.

The use of primary data was employed for this study. Primary data was collected from cocoa farm workers through the use of structured interview schedule or guide, data collected was on socioeconomic

characteristics such as age, sex, marital status, level of education, Farming experience, etc. Pattern of payment questions was collected to estimate the compensating wage received by the respondents,

Data for this study was analysed with both descriptive and econometrics techniques, the descriptive techniques that was employed include; frequency counts, percentages, means and standard deviation, was used to analysed factors causes of agrochemical exposure, various human factors leads to the pesticides exposure risk and the parameters that was described are residue violation, illiteracy and ignorance, lack of awareness of personal protective equipment, smoking habit etc The econometric techniques was employed Ordinary Least Square(OLS) regression analysis to estimate expected compensating wages received by cocoa farm workers.

$$W_i = \alpha + \beta\, p_i + \Sigma_k\, \gamma_k\, X_{ki} + \varepsilon_i \quad \textbf{.............} \ (1)$$

[27] Specified that

where:

X = worker's personal characteristics variables (such as age, education, wearing of personal protective gadget and smoke) and job characteristics variables (such as temperature and agrochemical participation) for worker 'i',

pi = job (injury and or fatal) risk faced by worker 'i', and

ε_i = Disturbance or error term reflecting unmeasured factors influencing worker i's wage rate.

α = Constant term,

β and γk = parameters to be estimated using regression analysis,

This model follow [5] specification that **β** is a parameters to be estimated using regression analysis. Agrochemical exposure risk (fatal and non-fatal) is an objective measure of risk:

$W = \alpha + \beta_1$ Risk + β_2 Age + β_3 Education + β_4 Wearing of personal protective gadget + β_5 Smoke + β_6 Temperature + β_7 agrochemical participation + β_8 Body health mass index ... .(2)

where:

W = Daily wage rate (₦)

X_1 = Risk (1= workers expose to dangerous conditions or unhealthy, 0= otherwise)

Risk is a subjective measure of risk; it is a dummy variable indicate that worker believes that his job exposes him/her to dangerous or unhealthy conditions (such as sickness after pesticide spray operation)

X_2 = Age of the workers (Years)

X_3 = Level of education (Years)

X_4 = Wearing of personal protective gadget (1= Use of Personal Protective Equipment during spraying, 0= otherwise)

X_5 = Smoke (1= smoking during pesticide application, 0= otherwise)
X_6 = Temperature (atmospheric temperature ^{0}C during spraying period)
X_7 = agrochemical participation (1= participating in agrochemical spraying, 0 = otherwise)
X_8 = Body mass index = (Wt/Ht^2 x 100).
[6] Specified that

Compensating wage = coefficient of risks (β_1) ....…………… (3)

RESULTS AND DISCUSSIONS

Factors Causing Agrochemical Exposure are:

(a)Permissible residue violation
(b)Illiteracy and ignorance
(c)Lack of awareness of personal protective equipment
(d)Smoking Habit

Permissible residue violation

Table 1 shows majority of the respondent (57.8%) violated the residue prescriptions, while 42.2% did not violate the chemical residue. toxic nature of some pesticide, deposits residues on the plant and the residues are dangerous to the consumption of the farmer and his environment. Since cocoa serve as a major cash crop used in foreign exchange, non-compliance with the stated rule and regulations, overuse and too frequent applications of the chemical become potential source of danger, injury or harm to the applicator and the environments.

Good Agricultural Practice (GAP) revealed that Maximum Residue Levels are the maximum concentration of pesticide residue expressed as milligrammes of residue per kilogramme likely to occur in or on food and feeding stuffs after the use of pesticides. [7] highlighted that Residue may be violated when the pesticide applicator failed to apply agrochemical in line with the recommendation label on the product such as application rate, number of applications, formulation, timing and pre-harvest interval.

Table 1. Factors Causing Agrochemical Exposure

Variables	Frequency	Percentage
Residue Violation		
Yes	104	57.8
No	76	42.2
Total	180	100
Reading Instruction		
Yes	20	11.1
No	160	88.9
Total	180	100
Awareness of Protective Equipment		
Yes	63	35
No	117	65
Total	180	Total
Smoking Habit		
Yes	44	24.4
No	136	75.6
Total	180	100

Source: Field Survey, 2019.

Illiteracy and ignorance

Table 2 shows that majority of the farm workers were unable to read the instructions written on pesticides containers, because most of the farmers are illiterate. 11.11% of the respondents can always read instructions written on the containers while 88.9% report that they sometimes read the instruction and sometimes did not. This result supports the findings of [12], that pesticides bottle labels where helpful to the farmers;

This result corroborates with the findings of [3] and [23] that ignorance among cocoa farmers about the health risks caused by the usage of high dosage of agrochemical. In accordance with findings [13] that it's a difficult task for illiterate farmers to comprehend with written instructions on agrochemicals and unable to access other useful information or details unless it is imparted verbally or through some practical demonstration.

Lack of awareness of personal protective equipment

Majority of the cocoa farm workers (65%) in the study area not aware of PPE while 35% are using protective equipment. Respondent that are not compliance with wearing of protective gear can be easily expose to pesticide toxicity, the exposure can occur through the mouth(oral), inhalation (respiratory), skin(dermal), and eyes(visual). [5] highlighted that human exposure to agricultural pesticides may be through ingestion (oral), inhalation (respiratory), skin (dermal), and eyes (visual). The implication of this is that the cocoa farmers prone to experiencing health symptoms such as skin irritation, respiratory disorder and redness of eyes among others due to their exposures to pesticides. Respondents were asked about their use of Personal protective equipment (gloves and masks) and more than half did not use, while few always use PPE to protect themselves from direct pesticide exposure. Therefore, uneducated farmers may not serious with wearing of personal protective equipment (PPE). This conform the findings of [21] that compliance with usage of personal protective equipment during application of Actara26WG, Ridomil and Nordox75WP was very low among some field crop farmers.

Smoking Habit

The data in Table 1 indicate that 24.4% of the respondents smoke during pesticide application, while 75.6% answer that never smoke during pesticide application. The practice of smoking while spraying agrochemicals was also reported among cocoa farmers. This is quite risky because it increases the likelihood of direct oral ingestion of agrochemicals. [5] Highlighted that exposure of farm workers to agrochemicals increases when the basic recommendation of properly washing hands after spraying or before eating is not observed.

Protective Equipment Used by Cocoa Farm Workers

Majority of the respondents (65%) does not used hand glove, 35% of the respondents wear hand glove, nose guide (4.4%) and eye cover (6.7%) during application of agrochemicals. 54% of the respondents wear boot to farm while 44% of the workers did not wear farm boot. This is in line with the findings of [19] that 65% of farmers in Nigeria do not use Personal Protective Equipment (PPE) in their farming activities. The absence of nose guide, hand gloves and eye cover usage among farm workers may lead to high incidence of headache, severe fever, skin rashes/irritation, chemical inhalation and spillage on their bodies.

Table 2. uses of Personal Protective Equipment

Personal Protective Equipment	Frequency	Percentage
Foot protection	97	53.9
Eye cover	12	6.7
Hand glove	63	35
Nose cover	8	4.4
Total	180	100

Source: Field Survey, 2019.

Estimation of Compensating Wages Received by Farm Workers incurring job-related Health Risk

Compensating wages is the difference in wages offered to offset the desirability or undesirability of a job. If the job is considered unwanted because of elements of risk, the differential is positive in the form of increased wages to offer incentives to the employee to take the job. If the job is considered desirable, the differential is negative in the form of lower wages.

Multicollinearity was not a problem given the low value 1.04 of the computed Variance Inflation Factor (VIF) [29]. R- squared indicated that 50.1% variation in estimation of compensating wages was jointly explained by the significant explanatory variables. The probability of F showed that the variables in the model are fit to explain the estimation of compensating wages. The Ramsey Reset Test revealed that the null hypothesis of specification error was rejected; this implies that the model was rightly specified.

Table 3 shows the results of estimation of compensating wage, which revealed that Age is positive ($p<0.1$), Education is positive ($p<0.01$) this result supports the findings of [6] that the returns of workers with lesser education in agricultural job is higher than the returns for workers with higher education. This implied that workers with less education are more productive in the agriculture job than workers with more education, because the job options are rather low.

WEARING OF PPE is associated with a negative ($p<0.05$), indicating that workers with adequate care receive less wage compensation than workers without care. The implicit meaning is that usage of personal protective equipment ensures safe work environment and so less wage compensation.

The workers' personal habits variables Smoke having negative parameters ($p<0.05$). This means that the wages for workers with the habit of smoking are less than workers without the habit. The result shows that workers with smoking habits are risk lovers or risk takers so that they demand less or no compensation for occupational hazards. This is in line with the findings of [27], that smokers are more likely to take risks or get injured than non-smokers. Temperature variable is also associated with a positive coefficient ($p<0.05$). This implies that working under hot sun will pose workers into health risks. Such workers supposed to demand higher wages as per the expectation of the compensating differential theory.

Health index variable is associated with a positive coefficient but not significant indicating that healthy workers with high wages are more productive, but this result is not supported by t-value.

The variable of interest is RISK. It influences the wage rate positively ($p<0.01$), indicating that workers on jobs which they perceive as being dangerous (lead to sickness) earn an earnings premium ₦75 per day.

Table 3. Regression Estimation of Wage Equations

WAGE	Coeff	Std. Err.	t-value	p>t
Constant	902.6092***	332.5037	2.71	0.007
AGE	0.933146	1.019236	0.92	0.361
EDUCATION	1.045793**	0.402493	2.59	0.011
RISK	74.79754***	26.80494	2.8	0.006
TEMPERATURE	5.017797**	2.016404	2.5	0.013
HEALTH INDEX	9.208049	8.371428	1.10	0.273
WEARING PPE	-31.66634**	13.52674	-2.34	0.022
SMOKE	-41.78657**	20.90020	-2.00	0.045
R-squared	0.501			
F-value	4.30			
P>F	0.3412			
Mean VIF	1.04			
Ramsey Reset Test	0.413			

Source: Field Survey, 2019.
***, ** and * significant at 1%, 5% and 10% respectively

Estimation of Compensating wages Received by Farm Workers handles pesticide

Multicollinearity was not a problem given the low value 1.05 of the computed Variance Inflation Factor (VIF) [29]. R- squared indicated that 60.5% variation in estimation of compensating wages was jointly explained by the significant explanatory variables. The probability of F showed that the variables in the model are fit to explain the estimation of compensating wages. The Ramsey Reset Test revealed that the null hypothesis of specification error was rejected; this implies that the model was rightly specified.

Table 4 shows the estimation results of wage equation which additionally include Agrochemical participation variable, which is dummy indicator for whether worker participating in agrochemical spraying or not.

Age is positive statistically significant ($p<0.05$). This result support the findings of [10] that age of the farmers have to do with the longer history of agrochemical exposure and have a generally lower health status especially if they have suffered from sickness or illnesses caused by pesticide exposure.

Health Index variable is associated with a positive coefficient and statistically ($p<0.05$). The result Indicate that healthy workers are more productive and receive higher wages.

Education is positive ($p<0.1$).

The RISK variable is having a positive and significant ($p<0.05$) effect on wages. The results indicate that workers participating in agrochemical spraying receive an additional compensation of ₦86 per day for facing occupational hazard.

Agrochemical participation variable is positive and significant ($p<0.05$) these indicating that worker handling pesticides receive significantly higher wages than their counterparts who do not handle it.

Temperature variable is also associated with a positive coefficient and it is statistically significant ($p<0.05$). This implies that workers pose higher health risk while applying pesticides under hot sun demand higher wages than other workers on the cocoa farm. This is in accordance with the compensating differential theory.

Wearing of PPE is associated with a negative and significant coefficient ($p<0.05$), indicating that workers with personal protective equipment receive less wage compensation than workers without care. [21] Found that compliance with wearing of protective gear during application of chloroyrifo, thiamethoxam, and cyanazine was very low among some field crop farmers. This finding also corroborated with the finding of [18] that cocoa farmers in Nigeria are occupationally exposed to the toxic nature of insecticide application for mirid control in their cocoa plantations. The implicit meaning is that usage of PPE ensures safe work environment.

Table 3. Regression Estimation of Wage Equations by Farm Workers handles pesticide

WAGE	Coeff	Std. Err.	t-value	p>t
Constant	843.2508***	330.8206	2.55	0.012
RISK	85.95385**	40.02263	2.15	0.033
AGE	0.7059785**	0.356555	1.98	0.048
EDUCATION	0.5815242	3.966553	0.15	0.884
TEMPERATURE	4.207083**	1.752951	2.40	0.018
HEALTH INDEX	9.65034**	4.106527	2.35	0.020
WEARING PPE	-36.07781**	17.618269	-2.05	0.044
SMOKE	-33.6305	25.17818	-1.34	0.183
AGROCHEMICAL PARTICIPATION	44.71282**	22.02243	2.03	0.045
R-squared	0.605			
F-value	4.57			
P>F	0.1627			
Mean VIF	1.05			
Ramsey Reset Test	0.1075			

Source: Field Survey, 2019.
***, ** and * significant at 1%, 5% and 10% respectively

CONCLUSIONS

Based on the findings the study concluded that appropriate use of personal protective equipment minimizes agrochemical exposure risks. Application of agrochemical under higher temperature (above 25^0C) increases the chances of health damage and so workers demand higher wage for this risk [20].

Low usage of Personal Protective Equipment also exposes farmers to the risk of being exposed to agrochemicals. These constitute some serious health risk as a consequence of the toxicity contents of some chemical compounds that these agrochemicals contain. We find that the use of personal protective equipment minimizes the risk of health damage and less compensation for risk, which emphasizes the necessity for ensuring the use of protective equipment on the farm fields against the risk exposed due to pesticide application.

This study have reported higher risk level associated with more toxic chemicals contents and there is no differential wage rate for spraying chemicals of varying toxicity level. This is the contribution of the study which has estimated that farm workers receive ₦86 per day for the chemical dosage they handle as compensation wage for agrochemical exposure risk. It was therefore recommended that educational programs that will enhance farmer’s knowledge, skills and attitude to adopt safety measures in pesticide usage should be adequately planned. Appropriate use of personal protective equipment to reduce exposure to pesticides and the risks involved in the misuse and abuse of pesticides. In addition, training in Integrated Pest Management (IPM) methods, which are environment friendly and could reduce the potential exposures to pesticides. Receiving higher compensation wages by cocoa farm workers will act as an economic instrument to restrict the use of high toxic chemicals.

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THE ANALYSIS OF PRODUCTION FLUCTUATION, CARRIED OUT IN 2019, ON A GROUP OF VARIOUS ECONOMIC SIZED ENTITIES

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Abstract

The aspects related to the productions obtained by the agricultural entities highlight significant quantitative discrepancies and need a more detailed analysis of the causes that led to this state of fact. Our research is based on information obtained from the field, by interviewing farmers and recording the information obtained in the background notes of this work. The results obtained have led to the shaping of conclusions that highlighted legal and administrative issues related to the conventions or other agreements-type of collaboration, by which the use of lands is transferred, creating over-productions or decreased productions and thus, an artificial economic situation and, most of the time, the impossibility of correct reporting to APIA (Agricultural Payments and Interventions Agency). The conclusion of the research work and the one also shared by the farmers is to grant the subsidy only to those that actually produce and work the land.

Key words: *agriculture, grain production, subsidy*

INTRODUCTION

Our research begins from the analysis of the information obtained in practice, correlating it with the farmers' grievances related especially to the impossibility of certification by APIA of the exchanges between those who are in the temporary possession of lands, the lessees [4]. The purpose of these exchanges is to work the land on larger areas, as much as possible to eliminate unnecessary costs on small parcels and last but not least to gather increased economic efficiency.

MATERIALS AND METHODS

The methods used are specific to economic research, namely, the collection and selection of material, processing, comparison, observation and drawing conclusions. The material used is mostly the result of research and studies carried out by the authors.
Our research is based on information obtained from the field, by interviewing farmers and recording the information obtained in the background notes of this work.

RESULTS AND DISCUSSIONS

In our task, the object of research is a sample of six economic entities, of different sizes, located in geographical areas relatively close to Timiș County. The research was made for the agricultural year 2018-2019.
Entity I is an authorised natural person that carries out its activity within the Denta Commune. The worked area allows the farmer to carry out its activity without additional personnel costs.
The farmer's policy is to cultivate a heterogeneous production, trying to mitigate the risk of a poor harvest in the detriment of the homogeneous ones.
Entity II is a commercial company within the locality of Moravița. It cultivated 116 ha in 2020, choosing to decrease the risk by cultivating a heterogeneous production. It has one employee for the agricultural activity. The company adds to its income by carrying out activities in the rural area, namely retail trade of food and non-food products [7].
Entity III is an entity that carries out its activity within the Deta City. It is a very efficient company, replacing the *nil periods* from agriculture with the activity of support

services for agriculture, namely the trade of parts and accessories for agricultural equipment and repair and maintenance services for agricultural equipment. Thus, the rural economy contributes to the welfare of the citizens from the rural area [8].

Entity IV carries out its activity within the Jebel Commune. The labour force involved in the agriculture of this company is comprised only of its administrator and sometimes he calls upon the help of family.

Entity V carries out its activity within the Locality Valcani. The labour force involved in the agricultural activity is comprised of seven workers qualified in agricultural works.

Entity VI is an Individual Enterprise. It manages the largest area out of all the entities mentioned above. It works with qualified personnel. It adds to its income by carrying out agricultural works activities within another company that it owns, and in 2020, it started fruit-growing.

It is important to mention the fact that all the entities are led by persons qualified in agriculture, who also have higher education besides their acquired experience.

Table 1. Entity I

I	Sunflower	Wheat	Barley	Maize	Rape	Soy	Others	Total
Area	10.88	35.7	-	14.75	-	3.39	-	64.72
Total production	58.88	151.38	-	126.48	-	9.38	-	346.12
Production/ha	5.41	4.24	-	8.57	-	2.77	-	20.99

Sourse: Own calculation from the entity's accounting.

Table 2. Entity II

II	Sunflower	Wheat	Barley	Maize	Rape	Soy	Others	Total
Area	30.63	47.58	-	26.21	-	6	-	110.42
Total production	71.5	297.66	-	124.28	-	19	-	512.44
Production/ha	2.33	6.26	-	4.74	-	3.17	-	16.49

Source: Own calculation from the entity's accounting.

Table 3. Entity III

III	Sunflower	Wheat	Barley	Maize	Rape	Soy	Lucerne	Total
Area	38.94	84.58	10.81	8.14	8	6.76	1.67	158.9
Total production	182.18	555.86	161.44	32.56	35.49	13.59	7.5	988.62
Production/ha	4.68	6.57	14.93	4.00	4.44	2.01	4.49	41.12

Source: Own calculation from the entity's accounting.

Table 4. Entity IV

IV	Sunflower	Wheat	Barley	Maize	Rape	Soy	Lucerne	Total
Area	28.08	201.29	23.44	24.44	-	24.24	8.86	310.35
Total production	184.98	1113.51	191.98	85.54	-	32.06	7.2	1615.27
Production/ha	6.59	5.53	8.19	3.50	-	1.32	0.81	25.94

Source: Own calculation from the entity's accounting.

Table 5. Entity V

V	Sunflower	Wheat	Barley	Maize	Rape	Soy	Lucerne	Total
Area	110.4	186.44	40.86	10.02	-	-	38.88	386.6
Total production	321.76	580.34	140.74	80		-	166.38	1289.22
Production/ha	2.91	3.11	3.44	7.98	-	-	4.28	21.72

Source: Own calculation from the entity's accounting.

Table 6. Entity VI

VI	Sunflower	Wheat	Barley	Maize	Rape	Soy	Others	Total
Area	-	485.51	-	-	177.7	64.51	49.35	777.07
Production Total/tons	-	2588.94	-	-	863.8	306.88	178	3937.62
Production/ha	-	5.33	-	-	4.86	4.76	3.61	18.56

Source: Own calculation from the entity's accounting

Table 7. The average productions obtained by the entities

Farm	Sunflower	Wheat	Barley	Maize	Rape	Soy	Others
I	5.41	4.24		8.57		2.77	
II	2.33	6.26		4.74		3.17	
III	4.68	6.57	14.93	4.00	4.44	2.01	4.49
IV	6.59	5.53	8.19	3.5		1.32	0.81
V	2.91	3.11	3.44	7.98			4.28
VI		5.33			4.86	4.76	3.61

Source: Own calculation.

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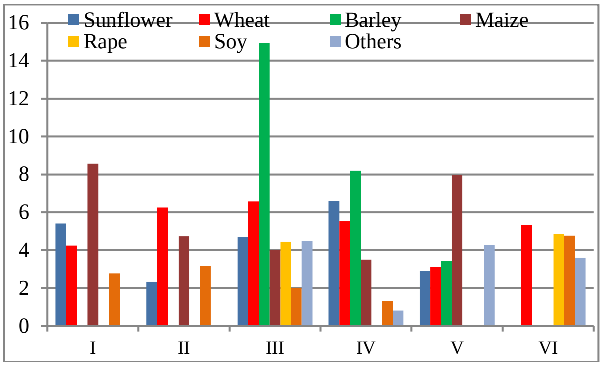

Fig. 1. Farmers ranking by productions in 2019
Source: Own determination.

From the observations made, we have found that entities who work large areas have the tendency to cultivate homogeneous productions unlike the ones up to 400 ha who choose a policy of heterogeneous harvests [1].
The reasons for choosing homogeneous harvests are the following:
- having compacted areas, it is easier for them to work the land and therefore the efficiency, productivity and yield/ha are increased;
- the large production quantity obtained per area unit allows the farmers either to negotiate better sales prices, or to store the production obtained until the market conditions are more favourable, with the purpose of obtaining better prices.
The study highlights poor results obtained by farm V that cultivates grain in 2019 on an area of 386.6 ha. The poorer productions are the consequence of the fact that the area in which it is located, Valcani, has a lower soil quality than the rest of the areas pertaining to the other entities included in the analysis [9].
Thus the analysis reveals aspects that need to be explained, considering the fact that with regard to the technology used, the inputs, the soil quality and the external weather factors, entities I-IV, except for entity V, are similar under all these aspects.
The production obtained by these entities that cultivate in the same geographical area with comparable production factors and different yields, raises some questions. To this purpose, we have carried out a mini investigation among the farmers, the mentioned aspects needing clarifications. Among the causes that result in such productivity fluctuations most of them are legal and administrative causes, such as:

➢ concluding an unofficial convention, the one where the owner of the land is the person who declares the area to APIA, thus he is the one that charges the subsidy, but in reality the land is cultivated by the entity. Hence, they get to have higher productions compared to the ones they declared.
➢ the farmer does not keep documents due to the lack of estate division, the inheritor not having a contract yet. The situation leads to anomalies, because no one collects the subsidy and the person who exploits the land pays rent from resources *only he knows about*. Again an artificial over-production is created, resulted from economic calculations, and this is also a consequence of reporting on a smaller area than the one declared.
➢ The exchanges between farmers can only be made from owner to owner and not between lessees. In this case, we have found other type of anomalies. The farmer has to declare the area cultivated by the person with whom he has made the exchange and vice-versa. It results in situations where the area is declared to APIA, he receives subsidy but he does not produce anything of what he declared.
➢ Another situation we found, which is frequently used, is the one where farmers, by means of the company they manage, sell the harvest obtained on their own lands, property of the natural person and not of the entity they own.
With regard to the exchanges, we have seen pretty elegant solutions in practice, escalation solutions and faithful and correct reporting of the areas that represent the object of the exchange and the production obtained.
Thus, company A has the harvest of company B on its land. In turn, company B has the harvest of company A on its land. Each of the companies declare to APIA their harvests on their lands, in the case, which in reality shall represent the object of a sales-purchase contract. It is an unconventional type of exchange, but it can be seen also as a superficies contract (planting on someone else's land) with the clause that at the end of the contract, the harvest shall be sold integrally. To sell to B and B sells to A, thus, the exchange becomes perfect and in

accordance with what the entities have cultivated in reality. Therefore, the sole purpose of this exchange was the one of cultivating with maximum efficiency on joined, neighbouring lands.
Schematically, the situation of this *exchange* looks like this:

Table 8. The exchanges between farmers

	Land A	Land B
Step 1	A cultivates barley	B cultivates wheat
Step 2	A collects subsidy for barley	B collects subsidy for wheat
Step 3	A sells the entire harvest to B	B sells the entire harvest to A
Step 4	A purchases Wheat and sells Barley harvest	B purchases barley and sells Wheat harvest

Source: Own calculation.

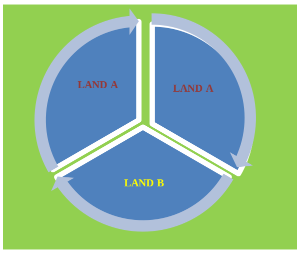

Fig. 2. Wheat harvest A

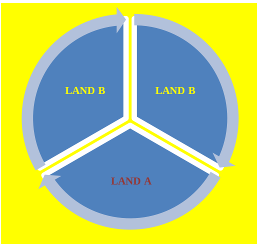

Fig. 3. Barley harvest B

Source: Own calculation.

We have highlighted some of the anomalies resulted from the absence of lands ownership documents, the non-conformity of the laws and the lack of solutions for certain conventions between the land workers and certain situation that farmers use in the name and for the sole purpose of making the activity more efficient.
Regarding taxes, the current taxation is very good and does not discourage, on the contrary it only brings benefits to those who *register through the company* the entire production obtained, as well as to the State Budget.
Benefits for microenterprises, with a Turnover of up to EUR 1 million.

- the income tax for microenterprises (on sale) is only 1% if the entity has only 1 employee and 3% if the entity has no employees [6];
- increases the entity's profit and turnover, an essential criterion for accessing credit, leasing or other financing means;
- the entire activity is taxed within and outside the entity;
- The VAT by means of reverse taxation is a very good instrument for declaring all income;
- A decreased taxation leads to positive microeconomic and macroeconomic effects;
- For the entities that are organised individually or in association, such as PFA (Authorised Natural Person), Individual Enterprise, Family Enterprise, the tax is set per area and is due in fixed amount, regardless of the income level [3]. Consequently, the income level does not influence the size of the tax.

CONCLUSIONS

The negative aspects of these methods of working the land without the conclusion of a convention or the non-fulfilment of all the legal requirements in order to become a written document also recognised by APIA, usually lead to the loss of subsidy by not collecting it [2]. We think that the purpose of granting a subsidy is to support the farmer, i.e. the person who exploits the land and not the person who owns it and thus, we consider the reconsideration ex nunc of its granting only to those that are actually producing, ipso facto, the ones that work the land. The purpose of the convention is to help the farmer, through the support received, to eliminate the upstream advanced costs for the harvest, [5] costs that include fuel and inputs, a considerable part in the final costs of the production/harvest. Therefore, we suggest that the subsidy is granted according to the quantity sold and not according to the cultivated area, thus, the purpose of the subsidy would serve the ones for whom the letter and spirit of the regulation is expressed by the normative act, i.e. the ones that cultivate and produce, who carry out agricultural activities [4].

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IMPACT OF THE FOURTH INDUSTRIAL REVOLUTION ON THE DEVELOPMENT OF SCIENTIFIC RESEARCH IN THE FIELD OF AGRICULTURAL ENGINEERING IN EGYPT AND ARAB WORLD

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Abstract

The fourth industrial revolution that the world is witnessing in the field of technology casts a shadow over all aspects of life, which results in new types of distinct and advanced jobs and skills. The successful adoption of these new technologies can boost global productivity to the same extent that personal computers and the Internet achieved during the late 1990s. For investors, the fourth revolution offers opportunities for profit similar to the ones that preceded the ones that preceded it. Indeed, the owners of technology in this early stage of the industrial revolution are asking for very large prices for their technology, and because there are many oryx Data that can not artificial intelligence and robots being able to perform; leaving us an open society of the human element, in order to cope with the rapid changes has to be the transfer of knowledge and enhance leadership skills, creativity, and value judgments and the ability to adapt; to remain the most valuable skill through education, training and professional development. This creates many areas of work related to modern technologies that are rapidly invented by the Fourth Industrial Revolution, so cooperation between academic institutions and economic sectors must be developed to develop human resources capable of keeping pace with the digital transformation resulting from artificial intelligence, which also requires us to be a mirror of societal values and a reflection of them; thus It makes us entrusted with verifying the ethics and legitimacy of artificial intelligence in a way that serves security and occupational safety and serves social and economic goals. the training and education is the primary focus of any future strategy, education has had the greatest impact on the Fourth Industrial Revolution and influencing it, this digital transformation of the industry needs different teaching mechanisms and high-level professional skills; in order to keep pace with the nutrition of robotics systems and the complexities of artificial intelligence and also the future need for interaction skills Digital and communication skills with what's new. The knowledge revolution resulted in a society with special features called the knowledge society, which imposed a set of roles and responsibilities, and thus the transformation of universities in developed countries into investment universities, which made them required to change their structural, financial and administrative policy to change their outputs, which led to increased restrictions on universities, and also imposed competition between Universities in the production of knowledge so that the pressure on universities increased and they need to provide more knowledge because they are the only ones that provide human elements at the highest level to lead the community.

Key words**:** *agricultural, engineering, fourth industrial revolution, training and education, scientific research*

INTRODUCTION

Agricultural engineering as part of this broad system is also affected by this industrial revolution, and the spread of digital technology and artificial intelligence leads to a change in many areas such as automation of agricultural equipment, and agricultural equipment automation must face the need to develop modern approaches as auxiliary sciences for agricultural engineering to understand the operation Equipment; from courses for automatic control and electronic circuits, as well as the spread of digital technology in the field of satellite image analysis by adding courses such as digital image analysis and digital sound analysis and creating courses that help Understanding of information technology and processing; to create digital work platforms and self (software design); which will develop the skills and creates value through the use of technology in achieving interdependence between human beings and the equipment and the surrounding environment.

Research problem: The world is moving rapidly towards a new era that differs in its features and characteristics from what we have learned. When the world changes around us, it is necessary to change our lifestyles, teach and learn, and the basic skill of radical change and adaptation to new conditions becomes the ability to learn and access knowledge, then re-learn until Our old habits do not become a reason for our delay, by applying the principle of lifelong learning. The digital age has revolutionized education, whereby the tools of this era have enabled researchers to become more active and more independent in their learning. The Internet has allowed the creation of gatherings with new knowledge structures in which researchers can collaborate and learn from one another, and has allowed them to take responsibility for learning through exploration Expression and experience.

In 2003, National Planning Institute [7] made a study which aimed to determine the priorities of scientific research and investment in the agricultural sector, and found a deficit in the agricultural trade balance with the outside world as a result of the limited natural agricultural resources in agricultural production and coupled with an increased presence of demand for agricultural products. The research aims to increase agricultural production, reduce poverty, increase employment and improve Agricultural entry level. This, in turn, imposes the need to prioritize investment in such agricultural development programs. Increasing agricultural production by increasing the area of agricultural area and devising new crops through cooperation between the fields of scientific research and agricultural extension.

In 2016, [4] outlined the problems that Egyptian universities are facing. Based on the reality of previous studies and personal interviews with members of the teaching staff and support bodies and some of the university leaders represented in the research sample, there were pointed out the following aspects: - Delay in the improvement processes and rigid templates within which teaching and support staff are working; - The repulsive environment and the lack of encouragement for innovation and creativity; - The absence of a policy of cooperation within the university through its various colleges and departments, and between the university and other universities inside and outside Egypt; - Bureaucratic practices and red tape are the main obstacle to any innovation and creativity; - There is no effective link or cooperation between the university and the various industrial sectors within the community; - The problem of financing research that is characterized by innovation and creativity; - The problem of the lack of external missions and the lack of training courses, especially for the personnel of the support staff. It is clear from the previous narration of the problems that hinder the achievement of our goal and is to achieve excellence in university performance, the researcher mentioned that the problems can be divided into three main axes:

The first axis relates to the problems of knowledge transfer inside and outside the university. These are the problems that relate to knowledge transfer processes between the university and industry, and among the members of the teaching staff and their auxiliary bodies and between students and researchers.

The second axis is related to the delay in the processes of development and development of the performance of faculty members and supportive bodies. These are problems that relate to the stagnation of the processes of developing the performance of faculty members, aid bodies and rigid templates within which they work. [6] made a study aiming to clarify the effects of the Fourth Industrial Revolution and artificial intelligence and the resulting inventions and their clear effects on companies, employment and all aspects of life. These positive effects will lead to the existence of networked organizations via the Internet in addition to global competition between companies and benefit from the inventions that dependence on artificial intelligence will provide, and offer extensive opportunities to use new innovations to improve products and services.

[1] developed a research which in its first part there were presented the different concepts of the knowledge economy, and explained the difference between the new growth theory based on the knowledge economy and the

modern classic theory. He presented the amount of investment in the field of knowledge in some countries, and also summarized the most prominent features of the knowledge economy. Then, he then presented to the basic pillars of the knowledge economy, and pointed out four methods and models used to measure the knowledge economy. He also mentioned the experiences of Ireland, Finland, Korea and Singapore in applying the knowledge economy. In the second part of his study, the author was focused on the case study of Egypt, and presented the method of knowledge assessment in which the World Bank works to study the case of Egypt. The steps taken by Egypt in the direction of the knowledge economy were presented, then Egypt's indicators were studied in the pillars that make up the knowledge economy. A comparison has been made regarding the values of the various indicators of Egypt with the different groups to which they belong: the Middle East and North Africa Group, the Africa Group, the Group of Minimum Middle Income Countries and the Group of Countries with an Average Human Development Index. Also, a comparison between the different indicators for Egypt in two different time periods, and a study of the changes that occurred in Egypt with respect to the different indicators in the two time periods under study have been presented as well. In the end, the most important measures that were required to enter Egypt in the knowledge economy were presented through the recommendations of the study. [3] studied the use of artificial intelligence in all aspects of life, presenting a brief philosophy of artificial intelligence, its classification destined to highlight what we have in reality and what we might expect from future developments, and also the study provided information on attempts to organize artificial intelligence from a legal perspective, and discussed how the legal approach is a guarantor of the balance between the development of artificial intelligence and human control over it.

[8] aimed to monitor the impact of integrating scientific research and technological development on knowledge-based development as one of the main pillars of the knowledge economy, as well as to measure the impact of indicators of knowledge and technological progress on the gross domestic product. Through an analysis of the reality of the state's economic and social plans during the study period, the researcher concluded that the successive economic and social plans of the country did not integrate scientific and technological research effectively and comprehensively in the development process and its effects on the development process in Egypt were not reflected, which means that scientific research and technological development did not contribute In the positive development of the national economy, thus, research and development did not play a major role in the field of development.

[2] aimed to clarify the progress in artificial intelligence and robotics and may lead to a new industrial revolution. The study provided an analysis model for the effects of inequality and marginalization, and a set of variables that reflect how to automate the labor market was analyzed, and the results of the study confirmed that automation is a good thing for economic growth and bad from the point of view justice and equality, real wages decrease in the short term and ultimately rise.

[5] highlighted the penetration of artificial intelligence systems for many organizational processes, which led to a growing fear that smart devices and their solutions to humans will also dominate decision-making processes, and thanks to the computing capacity of computer information processing and its analytical approach helped broaden human perceptions when dealing with complex matters, while humans can understand the axioms and use a more comprehensive approach when dealing with decisions.

The research importance:

(1) The research coincides with the nature of the current era and its rapid developments, and the imposed new forms in the field of scientific research.

(2) It is hoped that the results of the research will benefit decision-makers and those concerned with higher education and scientific research, by examining the reality of scientific research and keeping pace with the

times and identifying obstacles and challenges.

(3)The current research may help those involved in higher education to review the scientific programs provided to researchers in the field of agricultural engineering.

(4) It is hoped that the results of the research will benefit the owners of factories and projects in benefiting from and activating the research topics presented.

The research aims: This fourth industrial revolution should be matched by a change in education, and not merely a development or change, as its vocabulary imposes the qualification of the teacher technologically, and his technical empowerment, as he prepares the "trump card" in the digital future, to build generations that keep pace with the requirements of that revolution. Hence the importance of linking between the Fourth Industrial Revolution, as a civilized phenomenon that represents a major breakthrough towards the future and the education system in general, and to build that relationship, it is required to define the intellectual pattern required to establish in order to build a system of education that is different from what is now prevailing, so that this heterogeneous educational system establishes a new mindset capable of participation in the construction and development of the fourth industrial revolution. In addition to the current trend towards non-space-related education, lifelong learning, education based on the current need, self-education, effective education, and in order to achieve this union and integration between the principles of the Fourth Industrial Revolution in the fields of education; we must enhance the level of teaching of applied sciences and advanced technologies and modernity and focus on the level of professionalism in educational institutions and the transformation of these educational institutions into research centers, in addition to informing learners of global experiences and all of this will open broader horizons and continuous accompaniment to the results and applications of this revolution and to become the goal of education Lq industry healthy, safe and more diverse world.

MATERIALS AND METHODS

Research Methodology

The current research used the descriptive survey method, through analysing research, whether in the master's or doctorate level or promotion studies in the field of agricultural engineering at The Arab world in the last five years, and identifying the research that benefited from the ideas of the fourth industrial revolution and the results of these research that are compatible with the ideas of this revolution.

Terminology of study

Agricultural engineering: It is a science and art that studies the science that relates to humans, land and plants and farm equipment

Agricultural engineering is engineering applications in the fields of agriculture and is part of the engineering sciences and branches into several areas, including agricultural production, including natural resource management. (The Author)

The Fourth Industrial Revolution:

The Fourth Industrial Revolution or “The Fourth Industrial Revolution”, Globalization 4.0 is the name given by the World Economic Forum in Davos, Switzerland, in 2016, to the last episode of the series of industrial revolutions, which is under Starting now, it refers to "the process of integrating physical or physical sciences with digital and biological systems into manufacturing processes via electronically controlled machines and smart machines connected to the Internet such as Internet of Things and three-dimensional printing, artificial intelligence and robotics and computing, biotechnology, energy storage and others in the form of Implementation they have interfered in all areas of life and work.

RESULTS AND DISCUSSIONS

The requirements and needs imposed on us by the current era, which make e-learning and distance education - as one of the technological innovations - the strategic option that is not irreplaceable, and from these needs, the need for continuous education, the need for flexible education, and the need to communicate and open up to Others, in addition to the current trend towards non-space-related education, life-long education, education based on the current need, self-education, effective education, and in order to achieve this union and integration between the principles of the fourth industrial revolution in the fields of education; we must strengthen the level of The Head of Applied Sciences, advanced and modern technologies, focusing on the level of professionalism and professionalism in educational institutions and transforming these educational institutions into research centers, in addition to informing learners about global experiences, all of which will open a broader horizon and continuous accompaniment to the results and applications of this revolution and to become the goal of education related to the manufacture of a healthy, safe and more diverse world.

International statistics show that spending on scientific research is low in the Arab world in general (Fig. 1).

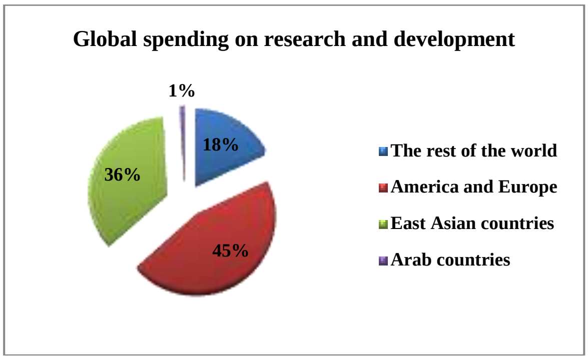

Fig. 1. Global spending on research and development
The rest of the world 19%, America and Europe 48%, East Asian countries 38% and Arab countries 1%
Source: United Nations Science, Culture and UNESCO 2013 [9].

Higher levels of research spending

According to UNESCO Science Report: towards 2030, the Arabic edition of which was presented to more than 100 high-level officials and journalists on 24 January 2019.

Egypt is one of several Arab countries which have raised their level of domestic spending on R&D in recent years. Egypt invested 0.71% of GDP in R&D in 2016, up from 0.43% in 2010. This places Egypt on a par with Morocco for this indicator.

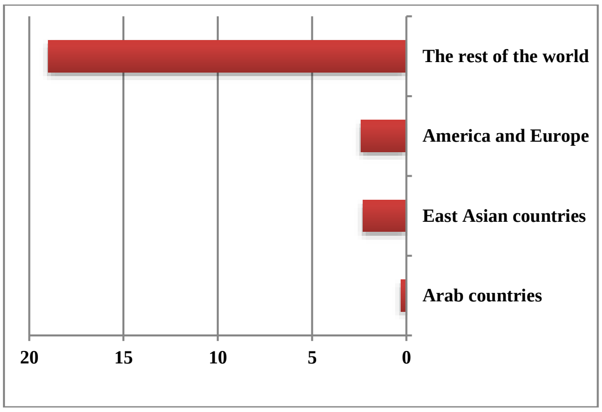

Fig.2 Spending as a share of GDP
The rest of the world 19%, America and Europe 2.40%, Arab countries 0.30%, East Asian countries a 2.30%
Source: United Nations Science, Culture and UNESCO 2013 [9].

Only a handful of Arab countries have covered more ground in such a short space of time. Saudi Arabia devoted 0.82% of GDP to R&D in 2013, a considerable improvement on the 0.05% of GDP invested five years earlier. The United Arab Emirates flirted with the symbolic threshold of 1% of GDP in 2016 (0.99% of GDP), after doubling its level of commitment to R&D since 2011.

A number of Arab countries have announced plans to hoist their ratio of research spending to 1% of GDP – or more – over the next few years. The 1% target has even been inscribed in the Egyptian Constitution since 2014. This is an important goal, as the Arab world still boxes beneath its weight: in 2013, the region contributed 6% of global GDP but just 1% of global research spending, according to the UNESCO Science Report.

Of course, some countries' research systems have been decimated by years of conflict. Once a leader for science in the Arab world, Iraq could only muster a research intensity of 0.04% of GDP in 2016.The great majority of Arab countries hover around the 0.3-0.5% mark, including Jordan, Kuwait and Qatar. Jordan, however, has invested heavily in the construction of the region's first particle accelerator, the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME), which was inaugurated by H.M. King Abdulla II in 2017. The UNESCO Science Report stresses the need for more champions of science in the region. Currently, the two Muslim countries with the greatest research intensity are Malaysia (1.30% of GDP in 2015) and Turkey (1.01% in 2014). Both countries have doubled their research intensity since 2004 and Malaysia is even planning to devote 2% of GDP to R&D by 2020. The world average in 2013 was 1.70% of GDP.

The number of researchers in the Arab region is growing. There were 391 researchers (in full-time equivalents) per million inhabitants in 2009 and 417 per million four years later, even though some countries in the throes of political turmoil have seen their pool of researchers shrink.

The greater human and financial investment in the Arab world is translating into greater scientific output. The volume of scientific publications from the region grew more rapidly (+109.6%) between 2005 and 2014 than in any other part of the world, according to the report, pushing up the region's modest share from 1.4% to 2.4% of the global total (Thomson Reuters' Web of Science, Science Citation Index Expanded).

CONCLUSIONS

From previous studies, we find that:

•Automation of equipment is good for economic growth;

•The use of artificial intelligence systems in many decision-making processes, and thanks to the capacity of information processing, it helped expand human perceptions when dealing with complex matters;

•The integration of scientific research and technological development has an impact on knowledge-based development;

The effects of the Fourth Industrial Revolution, artificial intelligence and the resulting inventions will lead to the existence of interconnected organizations, and provide ample opportunities to use new innovations to improve products and services.

The problems facing Egyptian universities are:

-Delay in improvement processes and stereotypes within which faculty members and the support staff work

-The lack of a policy of cooperation between the university and other universities

- There is no effective link and cooperation between the university and various industrial sectors and the problem of research funding

It was noticed through the monitoring of research in the field of agricultural engineering in Egypt and Arab world, the start clear slightly increase in scientific research that directly benefited from the applications of the Fourth Industrial Revolution; through the technological availability provided by the university to researchers, and even that appeared in the outputs of this scientific research what we can say It is a support and enrichment of this industrial revolution, and this is what we will explain through this scientific research that monitors this clear change in the field of research, whether at the master's or doctorate level or the promotion research at Egypt and Arab world.

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MONITORING WHITE MOLD *SCLEROTIA PERORATES* TO REDUCE THE RISKS IMPACT ON IMPORTED SOYBEAN SEEDS

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Abstract

The dissimilarity in the engineering characteristics of white mold which leads a difficulty in soybean seeds separating , this difference in the engineering characteristics of the white mold constructions differ according to the degree of infection and the period of storage, which results in irregularly from wide range in shaped white mold constructions which leads to the separation efficiency decreases and repetition of the separation processes. The aim of the study is to decide the engineering properties of American soybean seeds and white mold (Sclerotinia sclerotiorum) imported from the USA to Egypt. The experimental work was carried out until 2018 in the Agricultural Engineering Department, Faculty of Agriculture, Tanta University, Egypt. The engineering properties can be used in the design and development of handling, transportation, storage and separation equipment. Seed dimensions were tested at moisture levels between 8.85 and 12.30% (wet basis). The results showed that by changing the moisture content the average dimensions of the soybean seeds were changed, respectively, from 5.39 mm to 5.96 mm, and the width from 4.76 mm to 5.16 mm. Thickness changes from 3.98mm to 4.38mm. The size is 55.8 to 71.93mm3, the average geometric diameter is from 4.66 to 5.05mm. Arithmetic average diameter from 4.7 to 5.10 mm. Sphericity decreased from 86.94 to 85.10%. Also, the surface area changed from 68.29 to 80.17 mm 2. On the other hand, the dimensions of the hardening of the white mold ranged according to the place imported, with the length ranging from 5.85 to 20.31 mm, the width from 1.32 to 4.39 mm, the thickness from 0.88 to 3.07 mm, and the size from 9.75 to 75.19 mm3, the mean geometric diameter from 2.64 to 5.22 mm, the arithmetic mean of diameter from 3.02 to 8.07 mm and spherical diameter from 15.98 to 58.81%. Also, the surface ranged from 22 to 85.85 mm 2. These results showed that the difference between the physical properties of soybeans and white rot is not strong in terms of length, width and thickness in this case, which impedes the separation processes.

Key words: *soybean, physical and chemical properties, white mold, sclerotia, moisture content*

INTRODUCTION

Egypt imported about 3,045,469.31 tons from USA according to Minstry of agriculture statics in 2018. Soybean white mold named because the fungal disease produces a white fluffy cottony growth in the outside of the stem and on the poods. *Sclerotinia sclerotiorum* lives in the soil as sclerotia, which were hard, black structures, it is the major soybean disease in the Upper Midwest region of the United States and southern Canada which causes loss in soybean yield by reducing weight and seed number during the reproductive growth stage. It can be observed in harvested grain which affected in seed quality and seed production.

Soybean is one of the most important member from the Fabaceae family. The total production of soybean in the world is 352.6 million tonnes. On the other hand, Egypt production of soybean in 2017 was 45,000 tons according to FAO (2017) Soybean (*glycin max*) has a relatively high protein content (35–42%) and oil (16–27%). This makes the soybean be the most valuable and commonly cultivated crop [5].

The physical, mechanical and aerodynamic properties of agricultural products must be determined to use in design of the different component of machines and equipment for cleaning processes, handling, transporting and storage [1], [4], [9] and [11].

The moisture content of soybean seeds ranging from 6.92 to 21.19 % d.b. to evaluate the effect of moisture content on some physical properties. As the moisture content increased from 6.92% to 21.19% d.b. where the bulk density and true density were found to decrease from 650.95 to 625.36 kg/m^3 and from 1,147.86 to 1,126.43 kg/m^3 respectively, while the porosity was found to increase from 43.29% to 44.48% [8].

The physical properties of soybean at various moisture levels. The geometric mean diameter increased from 5.44 to 5.57 mm and the sphericity varied between 0.83 and 0.84 as moisture content increased from 7.37% to 15.80% (db), respectively. At moisture content of 7.37% (dry basis) the average of length were 6.55 mm, width were 5.56 mm, thickness were 4.53 mm and thousand mass, were 103.57 g, [10].

The seed dimension, geometric mean diameter, individual seed weight, sphericity, thousand seed, weight, bulk and true density, porosity angle of repose and static coefficient were effected by moisture content. Moisture contents of soybean seeds were determined as 7.95, 13.68 and 19.14% (dry basis) [7].

One of the greatest problems faced the development of soybean diseases because this can trigger significant losses in relation to yields and increased production costs of the grain and seeds, mainly due to the utilization of agrichemicals in crop fields. However, in order to occur epidemics caused by such a pathogen it is necessary that the climatic conditions, mainly air temperature and relative humidity be favorable to the occurrence and development of the disease [2].

Sclerotinia sclerotiorum is a necrotrophic and polyphagous pathogen possessing a vast spectrum of hosts, roughly 408 agricultural crops, of which the most important in terms of economic are soybean, common beans and cotton. Moreover, the fungus in question has a natural ability to form resistance structures, named sclerotium, which can survive in the soil for a period of time, varying from 3 to 8 years, even under adverse environmental conditions [3].

The soybean grains geometric mean diameter increased from 4.83 to 5.27 mm and the sphericity increased from 0.8627 to 0.8512 with the increase in moisture content from 10% to 16% (wb). The length, width and thickness change as moisture content ranged from 10 to 16% (wb), the grains length increased from 5.81 to 6.57 mm, width and thickness change from 4.91 to 5.69 mm and 4.11 to 5.53 mm respectively [6].

Separating and cleaning facing a lot of problems because the difference in the engineering characteristics of white mold, therefore machine must adjusted to remove all sclerotia of white mold fungi.

The main objective of this research to determine the differences between the physical properties of soybean and white mold Sclerotia to find the important information properties which can be used in prepare and adjust of separating equipment.

MATERIALS AND METHODS

Experiment was carried out through 2018 at the Department of Agriculture Engineering, Faculty of Agriculture, Tanta University, Egypt, to investigate physical, properties of the American soybeans seeds imported to Egypt. The soybean seeds and white mold dimensions tested under four different moisture content 8.85, 10.80, 11.60, and 12.30%.

Materials- Soybean crops

American soybean seeds were used in this study (Fig.1), and also (*Sclerotinia sclerotiorum*) fungus as shown in Fig. 2.

Fig. 1. American Soybean seeds Source: Author's own illustration.

Fig. 2. White mold Sclerotia Source: Author's own illustration.

Measurements and determinations

Physical properties

The three axial dimensions of seed are namely length "L, in mm" (longest intercept), width "W, in mm" (equatorial width perpendicular to L) and thickness "T, in mm" (breadth perpendicular to L and W), measured by a digital Vernier-caliper with accuracy of 0.01 mm for randomly selected 100 seeds. Mean dimensions of soybean seeds, the arithmetic mean diameter (D_a), mm, geometric mean diameter (D_g), mm, surface area (A_s), mm^2, volume (V), mm^3 and sphericity (φ), % of grains were calculated as:

-***Arithmetic mean diameter*** (D_a), mm:

$$D_a = \frac{(x+y+z)}{3} \ldots\ldots\ldots\ldots(1)$$

-***Geometric mean diameter*** (D_g), mm:

$$D_g = (x.\ y.\ z)^{1/3} \ldots\ldots\ldots\ldots(2)$$

-***Surface area*** (A_s), mm^2:

$$A_s = \pi.,D_g^2 \ldots\ldots\ldots\ldots (3)$$

-***Volume*** (V), mm^3:

$$V = \frac{\pi}{6}(x.\ y.\ z) \ldots\ldots\ldots\ldots (4)$$

-***Sphericity*** (φ), %:

$$\varphi = \frac{(x.y.z)^{1/3}}{x} = \frac{D_g}{x} \ldots\ldots\ldots (5)$$

where: x: length of grains (mm),
y: width of grains (mm) and
z: thickness of grains (mm)

-***Density:***

$$\rho = m/v\ (gm./cm^3) \ldots\ldots\ldots\ldots(6)$$

where: m= Mass of sample,(gm.)
v = Volume occupied by the sample, (cm^3).

-***Surface area*:**

$$S_a = \Pi\ (D_g)^2 \ldots\ldots\ldots\ldots(7)$$

- ***Moisture content*** of soybean seeds was determined as dried in an oven of 103°C for 24h. All moisture percentages were determined on wet basis as it is showed in the equations below:

$$M_w = (W_2-W_1)/W_2\ x100 \ldots\ldots\ldots\ldots (8)$$

where: M_w: Moisture content of soybean seeds sample on wet basis, (%),
W_1: Final mass of soybean seeds sample after drying, (g) and
W_2: Initial mass of soybean seeds sample before drying, (g).

-***Terminal velocity***, drag force and drag coefficient:

An apparatus was designed according to Dilmac et al, (2016) to determine the terminal velocity (Vt) of grains. The drag force (Fd) and drag coefficient (Cd) could be calculated according to Mohsenin, (1986) as follows:

$$Fd = 0.5\times Vt2\times \rho a\times As\times Cd \ldots\ldots\ldots(9)$$

$$Cd = \frac{2mg(\rho_s-\rho_a)}{\rho_s\ \rho_a A_s V_t^2} \ldots\ldots\ldots\ldots (10)$$

where: m: The mass of the grain (kg),
g: The gravitational acceleration ($m.s^{-2}$),
ρa: The air density (1.191 $kg.m^{-3}$),
ρs: The grains density (true density), ($kg.m^{-3}$),
As: The grain surface area (m^2) and
Vt: The terminal velocity ($m.s^{-1}$).

-***Angle of repose*** was calculated according to Mohsenin, (1986):

$$\theta = \tan\text{-}1\ (2h/d) \ldots\ldots\ldots\ldots (11)$$

where: θ: Angle of repose, degree,
h: height of pile and d is the diameter of cone, mm
d: Cone diameter, mm.

-***Angle of static friction***

The angle of static friction coefficient (θ) on galvanized metal for wheat grains was calculated according to Mohsenin, (1986):

$$\theta = \tan^{-1}(SFC)\ . \ldots\ldots\ldots\ldots (12)$$

where: θ: Angle of static friction, (degree) and
SFC: Coefficient of static friction.

-Bulk density

The bulk estimated according to Mohsenin, (1986). The bulk density is the ratio of the mass of the sample to its container volume. It was measured by weighing a filled measuring cylinder with known volume and calculated as:

$$\rho_b = \frac{m}{V_{total}} \quad \text{.......................} \quad (13)$$

where: ρ_b: Bulk density (kg.m^{-3}),
m: Mass (kg) of the sample and
V_{total}: Volume of the sample (m^3).

RESULTS AND DISCUSSIONS

Effect of different moisture content on physical properties of soybean seeds.

In (Fig.3) Linear relationship was obtained between moisture content (Mc) and seed length:

$y = 0.206x + 5.195 \quad R^2 = 0.928 \quad (14)$

The seed length linearly increased from 5.39 to 5.96 mm with increase moisture content from 8.85 to 12.3% (wb).

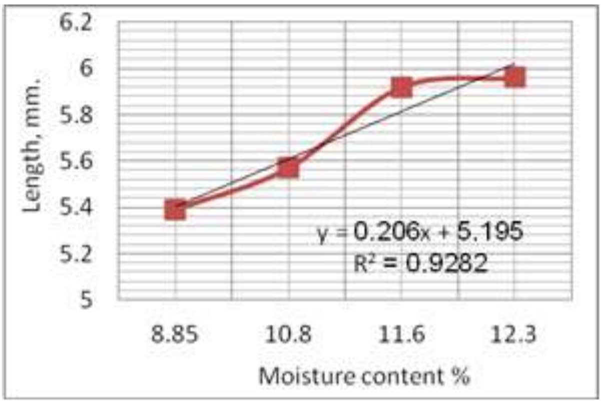

Fig. 3. Relationship between moisture content and seed lenght.
Source: Author determination.

In (Fig. 4). Linear relationship was obtained between moisture content (Mc) and seed width:

$y = 0.134x + 4.65 \quad R^2 = 0.972 \quad (15)$

The seed width linearly increased from 4.76 to 5.17mm with increase moisture content from 8.85 to 12.3% (wb).

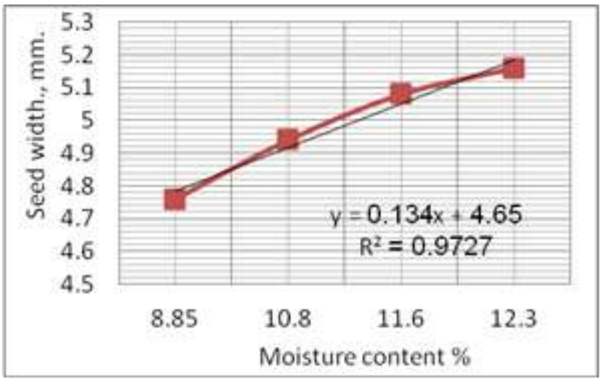

Fig. 4. Relationship between moisture content and seed width.
Source: Author determination.

In (Fig. 5) Linear relationship was obtained between moisture content and seed thickness:

$y = 0.131x + 3.865 \quad R^2 = 0.99 \quad (16)$

The values of seed thickness linearly increased from 3.98 to 4.38 mm with increase moisture content from 8.85 to 12.3% (wb).

Similar increasing for seed length, width and thickness trends have been reported for soybean seed [3].

The positive linear relationships of seed width and moisture content were also reported by [6] for soybean.

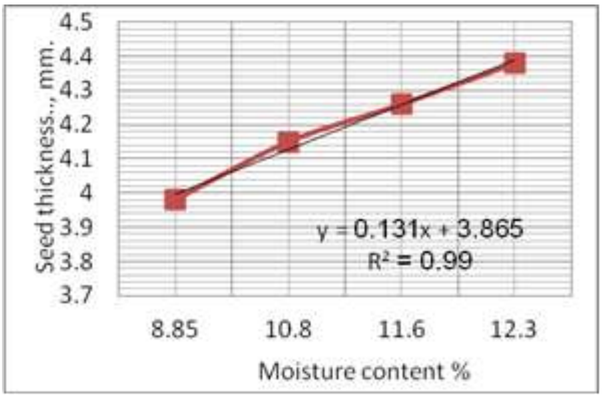

Fig. 5. Relationship between moisture content and seed thickness.
Source: Author determination.

In (Fig. 6). Linear relationship was obtained between moisture content and seed volume:

$y = 5.792x + 50.35 \quad R^2 = 0.931 \quad (17)$

Volume of seed showed linearly increase from 55.89 to 71.93 mm^3 with increase moisture content from 8.85 to 12.3% (wb).

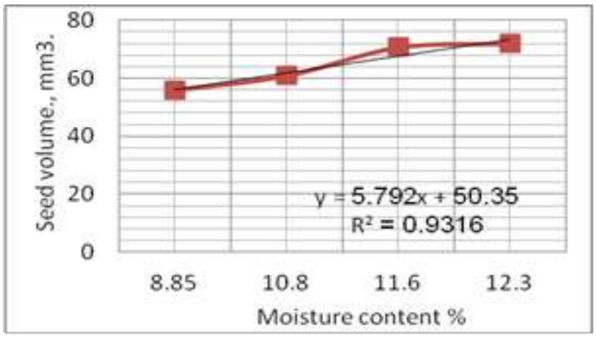

Fig. 6. Relationship between moisture content and seed volume.
Source: Author determination.

In Fig.7. Linear relationship was obtained between moisture content and seed arithmetic diameter:

$y = 0.149x + 4.560 \quad R^2 = 0.904$ (18)

Seed arithmetic diameter ranged from 4.7 to 5.105 mm when moisture content increased from 8.85 to 12.3%.

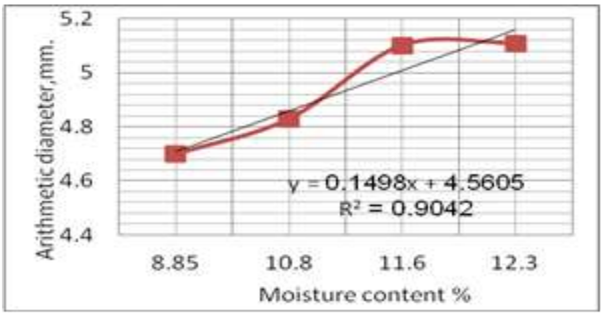

Fig. 7. Relationship between moisture content and seed arithmetic diameter.
Source: Author determination.

In Fig. 8, it is presented seed geometric diameter which ranged from 4.66 to 5.05 mm when moisture content increased from 8.85 to 12.3%. Linear relationship was obtained between moisture content and seed arithmetic diameter:

$y = 0.143x + 4.525 \quad R^2 = 0.905$ (19)

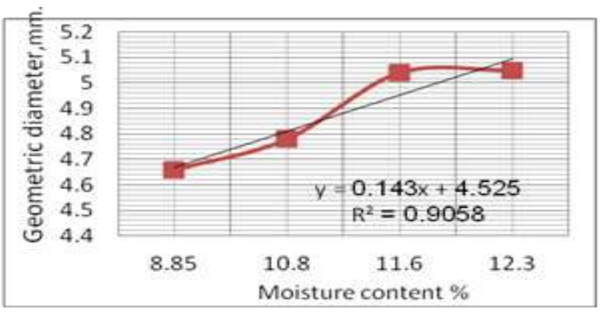

Fig. 8. Relationship between moisture content and seed geometric diameter.
Source: Author determination.

In Fig. 9 it is shown the seed sphirecity which ranged from 86.94 to 85.1% when moisture content increased from 8.85 to 12.3%.

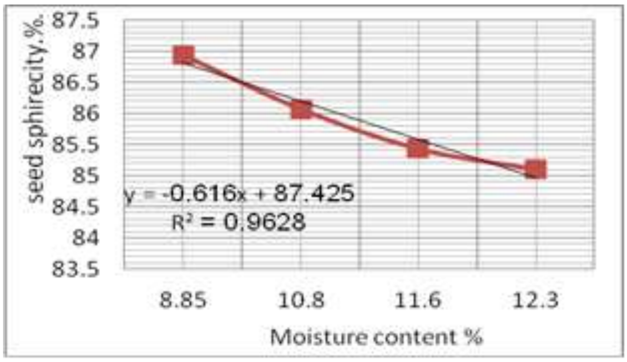

Fig. 9. Relationship between moisture content and seed sphirecity.
Source: Author determination.

Linear relationship was obtained between moisture content and seed sphericity:

$y = -0.616x + 87.42 \quad R^2 = 0.962$ (20)

The result in Fig. 10 indicates that the soybeans surface area increased with 68.29, 71.64, 79.7 and 80.17mm^2 when moisture content increased by 8.85, 10.8, 11.6, and 12.3%. The relationship of surface area and moisture content can be expressed using regression equation:

$y = 4.37x + 64.02 \quad R^2 = 0.908$ (21)

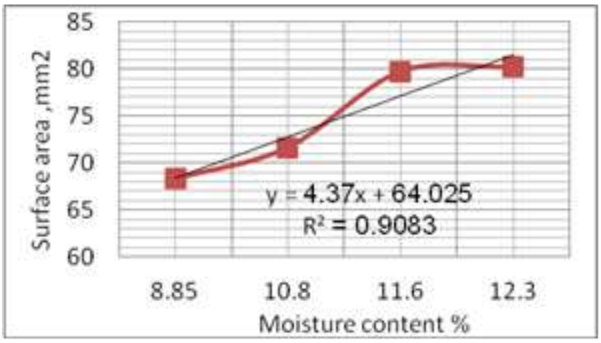

Fig. 10. Relationship between moisture content and seed surface area
Source: Author determination.

Effect of different moisture content on chemical properties of soybean seeds

The chemical analysis of the American soybean seeds affected moisture content. The increasing of moisture content from 8.85% to

12.3 % percentage lead to decrease of the other components of the seed.

Table 1. Chemical properties of soybean seeds

Items	Moisture content%			
	8.85	10.8	11.6	12.3
Oil content%	19.80	19.1	19.7	19.2
Protein%	35.6	34.1	33.2	32.9
Fiber %	5.1	4.97	4.3	4
Colored bean%	0.26	0. 07	0.82	0.89
Foreign matter%	1.2	1.1	0.9	0.7
Total damage %	1.3	1.4	1.5	1.58
Green beans%	0.36	0.12	0.21	0.33
Splits %	6.8	6.68	6.62	6.54
F.F.A	0.42	0.49	0.53	0.61

Source: Own results.

Table 1 shows that oil content was decreased from 19.8 to 19.2 %, protein also was decreased from 35.6 to 32.9%, fibre was decreased from 5.1 to 4 %, foreign matter was decreased from 1.2 to 0.7%, total damage from 1.3 to 1.58, green beans from 0.36 to 0.33, splits 6.8 to 6.54, F.F.A from 0.42 to 0.61.

Physical properties of white mold seeds

The average length, width and thickness of white mold sclerotia ranged from 5.85 to 20.31mm, 1.32 to 4.39mm, 0.88 to 3.07 mm and also volume ranged from 9.75 to 75.19 mm^3 as maximum and minimum value respectively.

The arithmetic diameter ranged from 2.64 to 5.22 mm and geometric mean diameter increased from 3.2 to 8.07 mm. The surface increased from 22 to 85.8 mm^2 and the sphericity increased from 15.98 to 58.18% with maximum and minimum value respectively as shown in Table 2.

Table 2. Some physical properties of white mold (*sclerotina scleriotiorum*)

Parameter	average	Max	Min
Length, mm	10.64	20.31	5.85
Width, mm	2.82	4.39	1.32
Thickness, mm	1.99	3.07	0.88
Volume, mm^3	31.3	75.19	9.75
Arithmetic diameter, mm	5.15	8.07	3.2
Geometric diameter, mm	3.28	5.2	2.64
Sphericity %	38.18	58.18	15.98
Surface, mm^2	46.94	85.85	22.02

Source: Own results.

The differences between the physical properties of white mold sclerotia and soybean seeds.

The average length, width and thickness of white mold sclerotia were ranged from 5.85 to 20.31 mm, and 1.32 to 4.39 mm, thickness from 0.88 to 3.07 mm, geometric mean diameter from 2.64 to 5.22 mm, the arithmetic mean diameter from 3.02 to 8.07 mm and soybean alternated length from 5.39 to 5.96 mm, width from 4.76 to 5.16 mm. Thickness changed from 3.98 to 4.38 mm and geometric mean diameter fluctuated from 4.66 to 5.05 mm. The arithmetic mean diameter from 4.7 to 5.109 mm with maximum and minimum value respectively. At a constant moisture content, 12.3 % (Fig. 11).

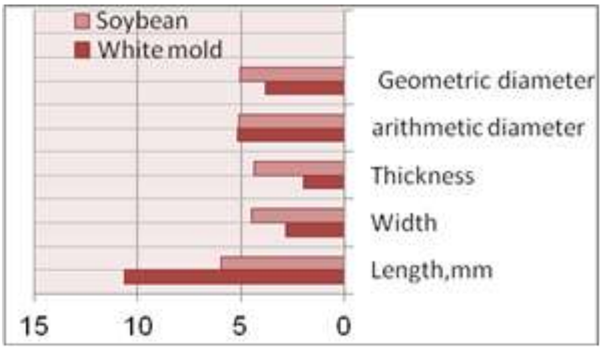

Fig. 11. The differences between some physical properties of white mold sclerotia and soybean seeds
Source: Author determination.

The mechanical properties of soybean.

Terminal velocity ranged from 11.2 - 12 (m/s), Repose angle 29^o, Modulus of elasticity £ (μ_{pa})126, Viscosity 0.0406$Pa_{s,}$ Static coefficient of fraction - concert wood float finish 0.52- wood Douglas fire grain par 0.35 - Galvanized sheet metal 0.22, 1,000 grains mass 165 g, bulk density 821.5 kg/m^3 (Table 3).

Table 3. Some mechanical properties soybean seeds

Items	Value
Terminal velocity (m/s)	11.2 - 12
Repose angle (^{o})	29
Modulus of elasticity £ (μ_{pa})	126
Viscosity(Pa_s)	0.0406
Static co efficient of fraction - concert wood float finish - wood Douglas fire grain par - Galvanized sheet metal	 0.52 0.35 0.22
1,000 grain mass (g)	156
bulk density (kg/m^3)	821.5

Source: Own results.

CONCLUSIONS

The average length, width and thickness of soybean grains ranged from 5.39 to 5.96 mm, 4.76 to 5.16 mm and 3.98 to 4.38 mm as the moisture content increased from 8.85% to 12.3% (wb), respectively. The geometric mean diameter increased from 4.66 to 5.05 mm. and the sphericity decreased from 86.94 to 85.1%. with the increase in moisture content from 8.85% to 12.3% (wb). The average of white mold sclerotia length ranged from 5.85 to 20.31 mm, width from 1.32 to 4.39 mm, thicknesses from 0.88 to 3.07 mm, volume from 9.75 to 75.19 mm^3, geometric mean diameter from 2.64 to 5.22 mm, the arithmetic mean diameter from 3.02 to 8.07 mm, and sphericity from 15.98 to 58.81%. Also surface ranged from 22 to 85.85 mm^2**.**

By determining the physical properties for white mold sclerotia and soybean seeds, the wide range of white mold sclerotia shape changed by moisture content can be monitored to allow chose multiple use of sieves with holes suitable for complete separation. This action lead to reduces the risk of mixing the white mold with soybeans during oil extract production.

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OPTIMAL RESOURCE ALLOCATION IN YAM-BASED CROPPING SYSTEMS IN YORRO LOCAL GOVERNMENT AREA OF TARABA STATE NIGERIA

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Abstract

Rising rural population densities in Nigeria are profoundly affecting farming systems with localized land pressures being experienced by many rural farmers. This study was conducted to examine optimal resource allocation in Yam-based cropping systems among farmers in Yorro Local Government Area of Taraba State, Nigeria. Primary data used for the study were collected from 142 farmers using structured interview schedule. Data were analysed using descriptive statistics and linear programming model. Results revealed that respondents were small-scale farmers characterized by large family size and were well experienced in farming with a mean farming experience of 23 years. Respondents adopted mixed cropping as a result of scarcity of land and to avoid crop failure. Profitability analysis revealed that yam based cropping systems were profitable where Yam/Cowpea/Sorghum had the highest gross margin of ₦372,500.00 followed by Yam/Maize/Groundnut/Cowpea (₦362,990.00) respectively. Linear programming model recommended yam/cowpea/sorghum and yam/maize/groundnut/cowpea out of the five enterprises. For yam/cowpea/sorghum, the existing plan allocated 2.36 ha while the optimal plan obtained from the programming recommended 4.37ha. For yam/maize/groundnut/cowpea, the existing plan allocated 2.08ha while the optimal plan recommended 1.11ha. The optimal farm plan recommends that yam-based farmers should allocate resources in such a way that the two crop enterprises are produced according to this hectarage allocation to maximize Total Gross Margin of ₦2,031,084.08/ha.

Key words**:** *optimal plan, profitability, linear programming, yam- based, Yorro, Nigeria*

INTRODUCTION

Root and tuber crops are important in food security and income for 2.2 billion people in developing countries and crops comprise crop covering several genera. They are staple food crops, being the source of daily carbohydrate intake for the large populace of the world. Root and tuber crops refer to any growing plant storing edible materials in subterranean root, corm or tuber and yam is a member of this important class of food [1].Yam is an important food crop especially in the yam zones of West Africa, comprising, Nigeria, Cameroon, Benin, Togo, Ghana and Cote d'Ivoire. This zone produces more than 90% of the total world production which is estimated at about 20 – 25 million tonnes per year [13]. The biggest yam harvest, globally was in 2008 when world produced 54 million metric tonnes of yam, with Nigeria producing an annual average of 35.017 metric tonnes [4]. Nigeria is the main producer of yam in the world with 70% of the world output followed by Ghana, Cote d'Ivoire, Benin and Togo [8]. The crop yield depends on how and where the setts are planted, sizes of mounds, interplant spacing, provision of stakes for the resultant plants, yam species, and tuber sizes desired at harvest. Small-scale farmers in West and Central Africa often intercrop yams with cereals and vegetables. Yam based crop mixture (YBCM) is a common crop mixture system practised in farming communities of Nigeria. Yam, the based crop of YBCM, is an important food crop in Nigeria [4]. The crops in YBCM are arable crops which are food crops planted and harvested at maturity within one production cycle or season. However, crop mixture is a viable strategy for spreading the risks of crop failure and labour demands for critical operations of sowing, weeding and harvesting [3]. Yam-based cropping system is a system in which yam production is the predominant rural activity among several other crops, livestock or off-farm production

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activities. The practice of intercropping is popular because of its advantages over sole cropping which include yield stability, security and higher profitability due to higher combined returns per unit area of land. The practice of inter cropping controls erosion and weeds and allows a more even distribution of farm labour than sole cropping and serves as enterprise combination which is a security against crop failure. The cropping combination is also agriculturally compatible. In 2010, the world harvested 48.7 million tonnes of yam, 95 percent of which was produced in Africa. Rising rural population densities in Nigeria are profoundly affecting farming systems and indeed the overall trajectory of economic systems in ways that are underappreciated in current discourse. Population pressure is linked in one way or another to the shrinking size of most smallholder farms over time; more continuous cultivation of fields, contributing to land degradation and unsustainable forms of agricultural intensification; the rise of land rental and purchase markets and changes in land allocation institutions, all of which are rapidly altering farm structure; and the challenges that Nigeria is currently experiencing in achieving broad-based and inclusive forms of farm income growth. The extent, distribution and exploitation of land are factors that have long been identified as fundamental influences on agricultural development paths and poverty reduction [9]. Nigeria is typically characterized as land abundant, with the implication that land endowments pose no serious constraint for agricultural development, but our starting point for studying the impacts of population density is the recognition of Nigeria's spatially heterogeneous distributions of rural populations, giving rise to acute localized land pressures being experienced by many rural farmers.

Linear Programming (LP)is a mathematical model which seeks to maximize profit or minimize cost as an objective function and with objective function constraints which are expressed as linear mathematical statement and decision variables having continuous or discrete values. The word "Programming" is concerned with the optimal allocation of limited resources to various competing demands. It is a mathematical method of optimizing problems towards achieving the best outcome as solutions. It was developed by Charnes and Coopers in 1961 and has been widely used in Agriculture and Management Sciences.

Ibrahim [5] examined optimal maize-based enterprise in Soba Local Government Area of Kaduna State, Nigeria using linear Progamming analysis. The result indicated that a gross margin of ₦56,920.30 was obtained in the planned farm as against ₦26,282.00 per hectare of maize/cowpea in unplanned farm. Ibrahim and Omotesho [6] examined an optimal enterprise combination for vegetable production under Fadama in North central Nigeria. The result of optimal plan obtained achieved 88 percent of the goals considered. Igwe *et al.* [7] applied a linear programming model (LP) model and determined the optimum enterprise combination in Abia State in Nigeria. The result showed that out of the twelve production activities made up of ten cropping activities and two fish enterprise, only two were recommended by the model for farmers to achieve a gross income of ₦342,763.30. Maurice [10] examined optimal production plan and Resource Allocation in food crop production in Adamawa State, Nigeria using linear programming. The result showed that out of the eleven basic activities included in the LP model, only three activities entered the programme namely sole groundnut (0.28ha), maize/sorghum (0.26ha) and maize/sorghum/cowpea (1.88ha). He further reported that food crop farmers should allocate their resources in such a way that three crop enterprises could be produced according to the hectares allocated.

Despite wider application of linear programming in many studies, its application in yam based cropping system in particular is scanty. The broad objective of the study is to analyze enterprise combination in a Yam-based cropping systems in Yorro Local Government Area of Taraba State, Nigeria. The specific objectives were to describe the socio-economic characteristics of yam farmers; identify the various crops in the yam-based cropping systems; examine resource allocation pattern and estimate cost and returns among respondents in the study area.

MATERIALS AND METHODS

The Study Area. The study was conducted in Yorro Local Government Area of Taraba State, Nigeria. The Local Government Area lies between latitude 8.17˚N and 9.7˚N and longitude 11˚ 66˚E and 11˚ 46˚E of Greenwich meridian. The Local Government Area lies to the North-Eastern part of Taraba State, bordered by Zing Local Government Area to east, Lau Local Government Area to the North, Jalingo and Ardo-Kola Local Government Areas to the West and Bali Local Government Area to the South. The Local Government Area has a land area of 21,200 km^2 with a projected population of 60,894 people. The Local Government Area has tropical climate marked by dry and rainy seasons. The rainy season starts in April and ends in October. The wettest months are August and September. The mean annual rainfall ranges from 800 mm to 1,000 mm and the mean daily temperature ranges between 18.8˚ C and 34.4˚C. The dominant soil types in the Local Government Area are ferruginous sandy loamy soil. The main vegetation cover of the Local Government Area is made up of scattered trees, while the topography is essentially marked with mountainous land traversed by small streams between them [14].

Source of Data. Primary data were used for the study and were collected using structured interview schedule administered to the respondents to collect the desired information from the 2017/2018 production season.

Sampling Size/Sampling Technique: The population for this study comprised of yam farmers in Yorro Local Government Area of Taraba State. A sample size of two hundred and fifty (250) yam farmers was considered from the eight (8) farming villages, where one hundred and fifty (150) farmers were selected using proportionate and random sampling technique. Out of this number, 142 interview schedules were retrieved and used for the study.

Method of Data Analysis

Descriptive statistics and inferential statistics were used to analyse the data collected. The descriptive statistics was used to achieve objectives i and ii while linear programming was used to achieve objective iii (resource allocation pattern) among respondents. The gross margin analysis was used to estimate costs and returns associated with yam based cropping systems among respondents(objective iv).

The model is specified as follows:

$$GM = TR - TVC \text{ .... } (1)$$

where: GM = Gross Margin TR = Total Revenue and TVC = Total variable Cost .

The linear programming model used is expressed as:

$$MaxGM=128{,}132.50X_1+372{,}500X_2+54976X_3+201990X_4+362990X_5+106{,}313X_6 \leq 330{,}450.70 \text{ ....} (2)$$

Subject to:

$$Land = 690.80X_1+ 154.12X_2+ 565.98X_3+ 295.16X_4+ 227.94X_5+386.2X_6 \leq 2320.2 \text{...................} (3)$$

$$Fertilizer = 487.50X_1+167.63X_2+150.37X_3+314.25X_4+ 226.62 X_5+268.8X_6 \leq 1615.17 \text{.................} (4)$$

$$Herbicide = 225X_1+52.50X_2+99.25X_3+61.90X_4+99.75X_5+ 107.2X_6 \leq 646.35 \text{......................................} (5)$$

$$Seeds = 33X_1+46.50X_2+20.25 X_3+65.25X_4+61.87X_5 +45X_6 \leq 271.87 \text{..} (6)$$

$$Family\ labour = 115.5X_1+74.25X_2+58.25X_3+189.38X_4+ 46.50X_5 +96X_6 \leq 580.28 \text{.............................} (7)$$

$$Hired\ labour = 42X_1+210.65X_2+273X_3+232.31X_4+130.80 X_5+177.40X_6 \leq 1066.16 \text{.............................} (8)$$

The parameters were estimated using Tora Optimization system (TOS), version 2.00, 2006.

RESULTS AND DISCUSSIONS

Respondents' Socio-economic Characteristics

Summary statistics of respondent's socio-economic variables as contained in Table 1 revealed that the minimum age of respondents was 18 years with a maximum of 78 while the mean age was 46 years with variations in the ages of respondents as revealed by standard deviation. Farmers were relatively older and may portend danger to food production in the study area. The finding is in line with the works of Migap and Audu [11] and Donye *et al.* [2] that yam production was carried out by the elderly farmers. Government should intensify efforts in the provision of infrastructure in rural areas to attract young people and encourage food production. Furthermore, yam- based cropping systems was small scale enterprise as evidenced by a mean farm size of 2.7 hectares. Respondents have large family sizes with a mean family size of 9 people which could be used a source of labour for production activities. Also, respondents were experienced with minimum, maximum and mean experience of 12, 47 and 23 years respectively. With years of experience, it is expected that respondents will be efficient in managerial decision and the choice of enterprise and adoption of improved farm practices. Studies have shown that experienced farmers are better off than inexperienced ones.

Table 1. Summary statistics of selected socio-economic variables of Respondents

Variable	Minimum	Maximum	Mean	Standard deviation
Age	18	78	46	13.928
Farm experience	12	47	23	13.771
Farm size	0.5	6	2.7	1.301
Family size	1	22	9	4.801

Source: Field survey 2019.

Respondents' Cropping pattern and Reasons for Intercropping

Yam- based cropping systems have been found to be agriculturally compatible and economically feasible in many farming communities in Nigeria. Analysis in Table 2 showed the various cropping combinations. The purpose of mixed cropping is to generate beneficial biological interaction between the crops, which can also increase yield and stability, more efficient use of the available resources and reduces weeds pressure. Reddy *et al.* [12] stated that mixing species in cropping system may lead to a range of benefits that are expressed on various space and time scales, from short-term increase, in crop yield and quality, to longer term agro-ecosystem sustainability, up to societal and ecological benefits.

From this result, where maize or sorghum is used, the farmers may use fewer stakes while legumes in the cropping combination improves soil fertility through nitrogen fixation ability inherent in the legumes.

Table 2. Cropping Combination and Reasons for Mixed Cropping (N= 142)

Cropping combination	Total hectarage	Frequency	Percentage
Yam / Maize /Groundnut	53.15	80	63.49
Yam/Cowpea / Sorghum	73.08	110	87.30
Yam / Millet /Groundnut	69.76	105	83.33
Yam / Maize /Cowpea	79.72	120	95.24
Yam / Maize / Groundnut / Cowpea	64.45	97	76.98
Sole Yam	43.24	16	

Source: Field Survey 2016.

Reasons for yam- based cropping system may not be farfetched; diversification and scarcity of land due to rising population as well as conversion of arable land for construction.

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Table 3 showed that 50.79% of respondents mixed up their crops because of land scarcity, 42.06% of the respondents mixed up their crops because of fear of failure while 7.14% of multiple yield advantages. The study area falls in quite a mountainous area which is a hindrance to the acquisition of more agricultural land. This cropping system is used to maximize production and diversify crops from a parcel of land either in time or space than would be obtained by one crop. Studies have established that many intercropping systems may give higher and more stable yields than their component crops grown as sole crop, this may give rise to the efficient use of the available resources.

Table 3. Reasons for Mixed Cropping (N= 126)

Reason For cropping combination	Frequency	Percentage
Crop Failure	53	42.06
Scarcity of land	64	50.79
Multiple crop yield advantage	9	7.14

Source: Field Survey 2019.

Resource Allocation Pattern of Respondents

Linear programming was used in the optimization of resources and achieving efficiency in yam-based production planning. The optimal farm generated for maximizing total gross margin (TGM) was predicated on the premise /assumption that profit maximization is the basis guiding the farmers in their resource use and allocation decisions. Out of the six activities included in the model, two entered the model (Table 4).

The recommended enterprises were Yam/Cowpea/Sorghum and Yam/ Maize/Groundnut/Cowpea. For Yam/Cowpea/Sorghum, the existing plan allocated 2.36 ha while the optimal plan obtained from the programming recommended 4.37 ha.

Table 4. Linear Programming Result

Enterprise	Solution	MOC
1. Yam / Maize /Groundnut	0.00	40840.68
2. Yam / Cowpea / Sorghum	4.37	0.00
3. Yam / Millet /Groundnut	0.00	268082.90
4. Yam / Maize /Compea	0.00	264562.15
5.Yam / Maize /Groundnut /Cowpea	1.11	0.00
6. Sole Yam	0.00	230696.85
Max. objective		2,031084.08

Source: Field Survey 2019.

For Yam/Maize/Groundnut/Cowpea, the existing plan allocated 2.08ha while the optimal plan recommended 1.11ha. The optimal farm plan recommends that yam farmers should allocate resources in such a way that the two crop enterprises are produced according to this hectarage allocation to maximize TGM of ₦2,031084.08/ha**.**

The non basic activities (Table 5) includes Yam/maize/groundnut,Yam/millet/Groundnut and Yam/Maize/Cowpea. The marginal opportunity cost (MOC) shows by how much the programme value will decrease if any of the non-basic activities is forced into the programme. For instance, if one hectare of the non-basic activities is forced into the plan, the optimal cost of production will increase by a margin equal to MOC, indicating either gain or loss. Enterprise 3 (Yam/Millet /Groundnut) has the highest penalty if forced into the plan with MOC of ₦268,082.90.

Table 5 is the resource utilization pattern and shows that only fertilizer and hired labour out of the resource constraints were fully utilized i n arriving at the optimal solution. Their dual p rices indicate amount by which the objective f unction will increase if these inputs are increa sed by one unit. TGM will increase by 1,074.7 5 and 913.08 for one kilogramme of fertilizer and one man day of hired labour. The non-full y utilized resources are land, herbicides, seeds and family labour indicating that these resour ces are inefficiently utilized by yam farmers i n Yorro. This result is consistent with that of Maurice [10] who found out that land, agroch emicals; seeds were not fully utilized by farm ers in Adamawa State.

Table 5. Resources allocation and use pattern

Resource Constraint	User Status	Slack	Dual price
Land	Not fully utilized	18.88	0.00
Fertilizer	Fully utilized	0.00	1074.75
Herbicides	Not fully utilized	424.84	0.00
Seeds	Not fully utilized	21.56	0.00
Family labour	Not fully utilized	33.53	0.00
Hired labour	Fully utilized	0.00	913.08

Source: Field Survey 2019.

Costs and Return Analysis of Yam- based Cropping Systems

Analysis in Tables 6A and 6B showed that land preparation, planting and weeding in a yam based cropping systems were the dominant cost of production in the study area. All the enterprise combinations were profitable. Yam/cowpea/sorghum had the highest gross margin of ₦372,500.00 followed by Yam/maize/Groundnut/Cowpea (₦362,990.00), Yam/Maize/Cowpea (₦201,990.00) while the least was Yam/Millet/Groundnut with a gross margin ₦54,976.00 respectively.

Table 6A. Profitability analysis /hectare of enterprise combination of Respondents

Enterprise	Cost Item	Value	Percentage of Total Cost
Yam /Maize /Groundnut	Land preparation	₦ 27737.22	28.44
	Planting	₦ 16070.46	16.47
	Weeding	₦ 16197.59	16.61
	Agrochemicals	₦ 8081.49	8.28
	Application of agrochemicals	₦ 9413.14	9.65
	Harvesting operation	₦ 4389.23	4.5
	Transportation	₦ 10437.69	10.7
	Other farm operation	₦ 5218.68	5.35
	TVC	₦ 97545.5	
	TR	₦ 225,678	
	GM Yam	₦53,338.54	
	GM Maize	₦29,307.35	
	GM Groundnut	₦45,436.61	
	GM(TR-TVC)	₦128,132.50	
Yam / Cowpea / Sorghum	Land preparation	₦ 35358.85	28.21
	Planting	₦ 20936.51	16.71
	Weeding	₦ 19529.76	15.58
	Agrochemicals	₦ 11670.22	9.31
	Application of agrochemicals	₦ 12096.42	9.65
	Harvesting operation	₦ 7210.523	5.75
	Transportation	₦ 11842.90	8.65
	Other farm operation	₦ 5706.31	6.14
	TVC	₦ 125351.50	
	TR	₦497,851.50	
	GM Yam	₦186,129.19	
	GM Cowpea	₦81,130.51	
	GM Sorghum	₦45,436.61	
	GM(TR-TVC)	₦372,500.00	
Yam / Millet /Groundnut	Land preparation	₦ 13868.07	35.06
	Planting	₦ 3938.75	9.95
	Weeding	₦ 8177.45	20.67
	Agrochemicals	₦ 1691.42	4.28
	Application of agrochemicals	₦ 3826.23	9.67
	Harvesting operation	₦ 1507.08	3.81
	Transportation	₦ 4429.73	11.20
	Other farm operation	₦ 2121.27	5.36
	TVC	₦ 39560	
	TR	₦ 95,536.00	
	GM Yam	₦28,325.33	
	GM Millet	₦6450.30	
	GM Groundnut	₦20,2 00.37	
	GM(TR-TVC)	₦ 54,976.00	

Source: Field survey 2019.

Table 6B. Profitability analysis /hectare of enterprise combination of Respondents

Enterprise	Cost item	Value	Percentage of Total Cost
Yam / Maize /Cowpea	Land preparation	₦ 31874.16	29.24
	Planting	₦ 18073.25	16.58
	Weeding	₦ 14980.64	13.75
	Agrochemicals	₦ 12146.97	11.15
	Application of agrochemicals	₦ 10517.54	9.65
	Harvesting operation	₦ 6138.85	5.63
	Transportation	₦ 7427.64	6.81
	Other farm operation	₦ 7830.97	7.19
	TVC	₦ 108990	
	TR	₦ 309,990.00	
	GM Yam	₦84,309.25	
	GM Maize	₦60,315.10	
	GM Cowpea	₦57,365.65	
	GM(TR-TVC)	₦ 201,990.00	
Yam / Maize / Groundnut / Cowpea	Land preparation	₦ 21017.17	27.41
	Planting	₦ 14418.48	18.8
	Weeding	₦ 12946.28	16.88
	Agrochemicals	₦ 6138.69	8.01
	Application of agrochemicals	₦ 8399.33	10.96
	Harvesting operation	₦ 3022.34	3.94
	Transportation	₦ 7632.50	9.95
	Other farm operation	₦ 3102.21	4.05
	TVC	₦ 76677	
	TR	₦ 439,667.00	
	GM Yam	₦136,121.25	
	GM Maize	₦45,373.75	
	GM Groundnut	₦110,747.50	
	GM Cowpea	₦70,450.19	
	GM(TR-TVC)	₦ 362,990.00	
Sole Yam	Land preparation	₦ 28,653.02	30.62
	Planting	₦ 13378.25	14.29
	Weeding	₦ 15581.32	16.65
	Agrochemicals	₦ 7713.23	8.24
	Application of agrochemicals	₦ 8031.44	8.58
	Harvesting operation	₦ 7130.15	7.62
	Transportation	₦ 9095.54	9.72
	Other farm operation	₦ 4007.07	4.28
	TVC	₦ 93590.00	
	TR	₦ 199,903.00	
	GM(TR-TVC)	₦ 106,313.00	

Source: Field survey 2019.

CONCLUSIONS

The study revealed that yam – based cropping systems was predominantly by relatively older farmers with large family sizes and is a small -scale business which was profitable. Yam/cowpea/sorghum and Yam/ Maize/Groundnut/Cowpea out of the six enterprises were recommended. For Yam/Cowpea/Sorghum, the existing plan allocated 2.36 ha while the optimal plan obtained from the programming recommended4.37ha. ForYam/Maize/Groundnut/Cowpea, the existing plan allocated 2.08ha while the optimal plan recommended 1.11ha. The optimal farm plan recommends that yam farmers should allocate resources in such a way that the two crop enterprises are produced according to maximize Total Gross Margin of ₦2,031,084.08/ha. Government should intensify efforts in the provision of infrastructure in rural areas to attract young people and to encourage food production.

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PLACE AND ROLE OF AGENCY FOR FINANCING RURAL INVESTMENTS - AFIR IN ABSORBING EUROPEAN FUNDS

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Abstract

This paper analyses the activity of the Agency for Financing Rural Investments (Agenția pentru Finanțarea Investițiilor Rurale - AFIR) in order to ensure the process of informing and implementing on how to access European funds granted through the National Rural Development Plan (NRDP) for the period of 2014-2020, following the types of measures and submeasures, the amounts granted and the advantages obtained through their accession by the applicants as a result of the agreements existent between the European Community and Romania. The actions of AFIR, through its central, regional and county representatives, are aimed at informing and communicating, according to the Regulation on Organization and Functioning of the Agency for Financing Rural Investments and the Manual of Procedures for Public Relations, for knowledge transfer in view of increasing the competiveness and diversification in agriculture, and for the need to modernize the agricultural sector by processing and marketing of agricultural products and by market development, ensuring a wide range of products and services together with the use of renewable energy in order to protect the environment. The methodology used consists in studying the references, collecting, processing, analysing and interpreting the data provided by the databases of AFIR and the Ministry of Agriculture and Rural Development (MARD), as well as formulating conclusions on the situation of the submitted projects, allocated amounts, achieved targets and measures to be further taken in support of rural areas.

Key words: *AFIR, projects, programmes, measures, submeasures, rural development, non-repayable European funds for agriculture, common agricultural policy*

INTRODUCTION

The accession of the Eastern European states to the European Union was an important event but also a great achievement in terms of accession to the **Common Agricultural Policy (CAP)**, whereby various agricultural models were implemented, the number of consumers has increased and the rural community has developed.

The European agricultural models are the following:

- The German model;
- One model focusing the support of small farmers;
- One model combining large and small farmers who can compensate or supplement industrial production with small quantities of products, but of high quality;

Article 39 of the Treaty on the Functioning of the European Union establishes the specific objectives of the common agricultural policy:

1. Increase agricultural productivity;
2. Ensure a fair standard of living for the farm population;
3. Stabilise markets;
4. Ensure the availability of supplies;
5. Ensure that supplies reach consumers at reasonable prices.

CAP has two pillars:

a) Common organisation of the markets establishing the activity of agricultural product markets;
b) Rural development with essential measures contributing to the development of rural regions.

CAP has extended based on the principles of the single market:

a) Free movement of agricultural goods within the EU;

b) Protection of consumption of goods produced in the European Union;
c) Common budget financing the projects.

Along with the accession to the European Union, Romania accepts the principles of the Common Agricultural Policy (CAP) in the field of agriculture and rural development, rules and measures targeting the productivity growth, ensuring a developed standard of living for the farm population, equalizing the markets, ensuring he security of supplies, guaranteeing reasonable prices of supplies for the consumers [7].

Council Regulation (CE) No 1290/2005 on the financing of the common agricultural policy has created two European agricultural funds:

-**EAGF** means the European Agricultural Guarantee Fund aiming the measures to regulate and support the agricultural markets and direct payments to the farmers within the context of the common agricultural policy

-**EAFRD** means the European Agricultural Fund for Rural Development and finances rural development programmes.

The European Agricultural Fund for Rural Development has started to be accessed in March 2008, after the approval of **the National Rural Development Plan (NRDP) with the National Strategic Plan 2007-2013** and followed by **the National Rural Development Programme 2014-2020** whereby four priority guidelines (axes) for the financing through the European Agricultural Fund for Rural Development (EAFRD) have been outlined

The first axis was the first important guideline for the development of rural area *by* ***increasing the competitiveness of agricultural and forestry sector*** and it was aimed at the reorganisation and development of agricultural and forestry production, together with the development of related processing industries in order to be more competitive and to contribute to the economic growth and the concentration of incomes in rural area, together with securing the standard of living and protecting the environment in these areas.

The second axis **has improved the rural environment and areas** by preserving and improving the quality of the environment in rural areas of Romania, maintaining the biodiversity, preserving nature and developing the forest, maintaining a balance between the agricultural and forest lands.

Investments have been made in the development of infrastructure and rural services, economic multi-functionalities have been created in rural areas, by emphasizing the cultural and architectural heritage.

The third axis takes into consideration ***the improvement of quality of life in rural areas and diversification of rural economy*** and is aimed at managing and supporting the labour force reconversion from the agricultural sector to other sectors that may ensure them a more prosperous life, both socially and economic.

The fourth guideline, the fourth axis, named **LEADER** is aimed at implementing several local development plans in order to improve the management of rural administrative units [1].

The **Financial Instrument (FI)** is defined according to the provision of Article 38 of Regulation no. 1303/2013, with the subsequent completions and modifications, and represents any financial instrument, including, but not limited to loans, leasing, guaranties and counter-guaranties, equity and quasi-equity investments or mezzanine-type investments for the benefit of final recipients.

Through FI, the following are made available:

The financial instrument (FI) consists in two parts:

- Credits to be used as guaranties for private co-financing, according to the projects granted through NRDP (a mixture of FI + grant)
- Other stand-alone credits related to the investments made in farms, in processing of agricultural produce and to the investments made in non-agricultural activities performed in the rural area.

The advantages of applying the financial instrument to the NRDP beneficiaries are materialized in accessing more funds applied by the beneficiaries, in case that the funds allocated to the grants are exhausted; the credits are more adapted to the requested necessities, a guarantee does not need to be requested, and the interest is low [9].

The means of implementing the EU cohesion policies consists in a mixture of grants and financial instruments (micro-financing, loans, guaranties, equity and risk capital) authorized through the ESI funds, at the national or European level [4].

According to Article 2(p) of the Financial Regulation, "financial instruments" are the measures taken by the European Union for the financial support based on the budget. These instruments are equity or quasi-equity investments, loans, guaranties or other instruments and may be combined, if necessary, with grants.

According to the rules, there are four options to be used by the final beneficiaries in order to apply:

The first option is to combine "a financial instrument with a grant from the same programme related to the ESI funds or from another programme (FI ESI F + G ESI F)";

The second option is to combine "the financial instrument from the ESI fund with another financial instrument from the same programme or another programme, according to the ESI funds";

The third option is when "a financial instrument from a programme related to ESI funds can be combined with a grant supported by the Union (FI ESI F + G non-ESI F); and the last option is when a financial instrument from a programme related to ESI funds can be associated with another financial instrument supported by the Union (FI ESI F + FI non-ESI F)" [5].

The Agency for Financing Rural Investment (AFIR) was established by the Emergency Government Ordinance No 41/18 June 2014, by reorganizing the Paying Agency for Rural Development and Fisheries (Agenţia de Plăți pentru Dezvoltare Rurală și Pescuit - APDRP) in order to develop and improve the institution, in order to easily award and access the National Programme for Rural Development 2014-2020, together with the completion of the current programme (NRDP 2007-2013).

The accreditation document for the Agency for Financing Rural Investments, as an agency governing EAFRD, was approved and signed by the Minister of Agriculture and Rural Development on 15 December 2007.

The Agency for Financing Rural Investments aims to attract European funds for agriculture and to increase, with the help of NRDP 2014-2020, the level of improvement regarding the technical and financial implementation means, by constantly updating the Guide for Applicants.

Another important stage whereby the steps of crowding-in are performed is receiving the financing and payment requests, followed by the evaluation of procurements files, that have to be as easily as possible to accomplish.

The third stage refers to the payments that have to be made proper and according to the law, in view of protecting the financial interests of the EU and of the state budget.

Romania as a member state of the European Union and with an agriculture that has certain peculiarities related to the fact that a large part of the population is in rural areas carrying out agricultural activities, often being below the subsistence level, has benefited and benefits from of funds [6].

MATERIALS AND METHODS

The paper is based on a large documentation of the legislation in force, the published reports and articles on the topic.

The methodology used consists in studying the literature, collecting, processing, analysing and interpreting the data provided by the databases of AFIR and the Ministry of Agriculture and Rural Development (MARD).

Finally, the conclusions on the situation of the submitted projects, allocated amounts, achieved targets and measures to be further taken in support of rural areas have been drawn.

RESULTS AND DISCUSSIONS

The National Rural Development Programme 2014-2020 (NRDP 2020) is the programme whereby non-repayable funds from the European Union and the Government of Romania are granted, for the economic and social development of the Romanian rural area. The implementation of the technical and financial solution is supported by the Agency for Financing Rural Investments (AFIR). The performance of investments in Romanian agriculture, to the level of the European standards, was supported by non-repayable funds to the amount of EUR 9 billions, distributed to farmers and institutions.

The main rural development priorities for the financial period 2014-2020

•Expand farms, modernize machineries, open markets and develop agricultural produce processing;

•Support young farmers and stimulate their settlement;

•The progress of rural area was accomplished by the extension and modernization of basic rural infrastructure (roads, education, administration, utilities etc.) in order to attract new investments in these areas;

•Attract non-agricultural SMEs by promoting the variation of rural economy;

•Promote the fruit and animal growing sector with a dedicated sub-programme;

•LEADER programme promotes the local development through the improvement of competitiveness and quality of life and the fight against poverty.

In order to access the investment projects related to NRDP, the financing applications shall be submitted online, according to the Regulation on Organization and Functioning (ROF) of the selection and complaint solving process, regarding the projects related to the measures of the National Rural Development Programme (NRDP) 2014-2020, approved by the Order of the Minister of Agriculture and Rural Development. The online submission is made through the AFIR portal, up to the limit of the allocated funds, during the period of the session opened to the receipt of financing applications.

The ceiling for submitting the projects is established according to the provisions of the Order of the Minister of Agriculture and Rural Development No 30 of 16 February 2017, according to Article 5, and is aimed at saving an amount of 10% of the value of the allocation increased by over-contracting in order to provide for the financing of projects to be financed by NRDP 2020, following the admission of complaints whereby it was established that the financing requirements have been fulfilled by the respective projects.

European legislation

Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005; Regulation (EU) No 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) No 352/78, (EC) No 165/94, (EC) No 2799/98, (EC) No 814/2000, (EC) No 1290/2005 and (EC) No 485/2008;

Commission Implementing Regulation (EU) No 808/2014 of 17 July 2014 laying down rules for the application of Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD);

Commission Implementing Regulation (EU) No 908/2014 of 6 August 2014 laying down rules for the application of Regulation (EU) No 1306/2013 of the European Parliament and of the Council with regard to paying agencies and other bodies, financial management, clearance of accounts, rules on checks, securities and transparency.

National legislation

Government Emergency Order No 41 of 18 July 2014 on the establishment, organisation and functioning of AFIR.

Decision No 226 of 2 April 2015 on the establishment of the general framework for implementing the measures of the National Rural Development Programme co-financed from the European Agricultural Fund for Rural Development and the state budget

Order No 400 of 12 June 2015 for the approval of the Code for the internal/management control in public entities.

Measure - means whereby the project co-financing is allowed. A financial contribution from the European Union and Romania and a set of specific tasks are assigned to a certain measure;

Submeasure - component of a measure. It establishes a certain type of investments with specific objectives that belong to the activity field specific to a measure (general objectives).

Sessions for submitting projects within National Rural Development Programme

From the beginning of the programming period to June 2020, within NRDP 2014-2020, the following sessions for submitting projects have been started and the following amounts assigned:

Measure 1 - Knowledge transfer actions and information actions, with a total value of EUR 27.6 millions:

- *Submeasure 1.1.* Support for vocational training and skill acquisition, with a value of EUR 22.2 millions;
- *Submeasure 1.2.* Information actions for farmers, with a value of EUR 5.4 millions.

Measure 2 - Advisory services, farm management services and replacement services inside the farm with a total value of EUR 11.1 millions:

- *Submeasure 2.1.* Advisory actions for farmers, with a value of EUR 11.1 millions.

Measure 3 - Quality systems for the agricultural produce and foodstuff, with a total value of EUR 6 millions:

- *Submeasure 3.1.* Support for the first time participation in the quality schemes, with a value of EUR 2 millions;
- *Submeasure 3.2.* Support for information and promoting activities performed by the groups of producers within the internal market, with a value of EUR 4 millions.

Measure 4 - Investments in physical assets, with a total allocation of EUR 2,401.4 millions:

- *Submeasure 4.1.* Investments in farms, with a value of EUR 844.7 millions;
- *Submeasure 4.1. ITI* Investments in farms, with a value of EUR 33 millions;
- *Submeasure 4.1a.* Investments in fruit-growing farms, with a value of EUR 296.7 millions;
- *Submeasure 4.1a.* ITI Investments in fruit-growing farms, with a value of EUR 5 millions;
- *Submeasure 4.2.* Investment support for agricultural produce processing/marketing, with a value of EUR 382.8 millions*;*
- *Submeasure 4.2a.* Investment support for processing/marketing of fruit products within the fruit-growing sector, with a value of EUR 34.6 millions;
- *Submeasure 4.2.* GBER Investment support for agricultural produce processing/marketing in view of obtaining non-agricultural products, with a value of EUR 112.5 millions;
- *Submeasure 4.2.* MINIMIS Investment support for agricultural produce processing/marketing in view of obtaining non-agricultural products, with a value of EUR 5.5 millions;
- *Submeasure 4.2.* ITI Investment support for agricultural produce processing/marketing in view of obtaining non-agricultural products, with a value of EUR 10.6 millions;
- *Submeasure 4.2a.* ITI Investment support for processing/marketing of fruit products within the fruit-growing sector, with a value of EUR 0.8 millions;
- *Submeasure 4.3.* Investments for the development, modernization or adapting the agricultural and forestry infrastructure - irrigation with a value of EUR 433.98 million;
- *Submeasure 4.3.* Investments for the development, modernization or adapting the agricultural or forestry infrastructure - irrigation - ITI Danube Delta with a value of EUR 7 million;
- *Submeasure 4.3.* Investments for the development, modernization or adapting the agricultural or forestry infrastructure - agricultural access infrastructure with a value of EUR 130.3 million;
- *Submeasure 4.3.* Investments for the development, modernization or adapting the agricultural or forestry infrastructure - agricultural access infrastructure - ITI Danube Delta with a value of EUR 3 million;
- *Submeasure 4.3.* Investments for the development, modernization or adapting the agricultural or forestry infrastructure - forestry infrastructure with a value of EUR 99.3 million;
- *Submeasure 4.3.* Investments for the development, modernization and adapting the agricultural and forestry infrastructure -

forestry infrastructure - ITI Danube Delta with a value of EUR 1.7 million.

Measure 5 - Restoring agriculture production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions with a total value of EUR 28.5 millions:

- *Submeasure 5.1.* Investment support for preventive actions aimed at diminishing the effects of natural disasters, with a value of EUR 24.8 millions;
- *Submeasure 5.2.* Investment support for restoring the agricultural lands and the production potential affected by the natural disasters, with a value of EUR 3.7 millions.

Measure 6 - Farm and business development, with a total value of EUR 1,016.4 millions:

- *Submeasure 6.1.* Support for setting-up of young farmers, with a value of EUR 466.8 millions;
- *Submeasure 6.1.* ITI Support for setting-up of young farmers, with a value of EUR 10 millions;
- *Submeasure 6.2a.* Support for setting-up of non-agricultural activities, with a value of EUR 106.6 millions;
- *Submeasure 6.2b.* ITI Support for setting-up of non-agricultural activities, with a value of EUR 5 millions;
- *Submeasure 6.3.* Support for the development of small farms, with a value of EUR 246.5 millions;
- *Submeasure 6.3.* ITI Support for the development of small farms, with a value of EUR 5 millions;
- *Submeasure 6.4.* Investments in creation and development of non-agricultural activities, with a value of EUR 166.5 millions;
- *Submeasure 6.4.* ITI Investments in creation and development of non-agricultural activities, with a value of EUR 10 millions;
- *Submeasure 6.5.* Small farmers scheme, with a value of EUR 0.01 millions.

Measure 7 - Basic services and village renewal in rural areas, with a total allocation of EUR 1,319.7 millions:

- *Submeasure 7.2.* Investments in creation and modernization of basic infrastructure, on a small scale, with a value of EUR 1,060.3 millions;
- *Submeasure 7.2.* ITI Investments in creation and modernization of basic infrastructure, on a small scale, with a value of EUR 48.6 millions;
- *Submeasure 7.4.* Investment support in creation, improvement or extension of basic local services for rural population, including recreational and cultural services and of the related infrastructure, with a value of EUR 13.8 millions;
- *Submeasure 7.6.* Investments related to the protection of cultural heritage, with a value of EUR 188 millions;
- *Submeasure 7.6.* ITI Investments related to the protection of cultural heritage, with a value of EUR 9 millions;

Measure 8 - Support for the first afforestation and creation of afforested lands, with a total value of EUR 106.8 millions:

- *Submeasure 8.1.* Afforestation and creation of afforested lands, with a value of EUR 106.8 millions;

Measure 9 - Setting up of agricultural producer groups and organisations, with a value of EUR 20 millions:

- *Submeasure 9.1.* Setting up of producer groups, with a value of EUR 16.8 millions;

Submeasure 9.1a. Setting up of producer groups in the field of fruit growing, with a value of EUR 3.2 millions;

Measure 10 - Agro-environment and climate, with a value of EUR 835.2 millions

Measure 11 - Organic farming, with a value of EUR 246.9 millions

Measure 13 - Payments for area facing natural constraints or other specific constraints with a value of EUR 1,522.7 millions

Measure 14 - Animal welfare, with a value of EUR 794.4 millions

Measure 15 - Forest-environmental and climate services, forest conservation with a value of EUR 90.1 millions.

Measure 16 - Cooperation, with a value of EUR 31.4 millions:

- *Submeasure 16.1.* Support for establishment and functioning of operational groups (OG), for developing pilot projects, new products -

Stage I and II - calls for expression of interest, with a value of EUR 6.7 millions;

-*Submeasure 16.1a.* Support for establishment and functioning of operational groups (OG), for developing pilot projects, new products - Stage I and II - calls for expression of interest, with a value of EUR 5.8 millions;

- *Submeasure 16.4.* Support for horizontal and vertical cooperation between the actors of the supply chain, with a value of EUR 12,4 millions;

- *Submeasure 16.4a.* Support for horizontal and vertical cooperation between the actors of the supply chain - fruit growing, with a value of EUR 6,5 millions.

Measure 17 - Risk management, with a value of EUR 42.8 millions:

- *Submeasure 17.1.* Insurance premiums for crops, livestock and plants, with a value of EUR 42.8 millions.

Measure 19 - LEADER, with a value of EUR 637.6 millions:

- *Submeasure 19.1.* Preparatory support for drawing up local development strategies, with a value of EUR 2 millions;

- *Submeasure 19.2.* Support for implementing actions within the frame of local development strategy, with a value of EUR 495.6 millions;

-*Submeasure 19.3.* Preparing and implementing cooperation activities of the Local Action Groups, with a value of EUR 17 millions;

- *Submeasure 19.4.* Support for operating and animation charges, with a value of EUR 123 millions.

Measure 20 - Technical assistance, with a value of EUR 209.1 millions.

Financial instruments

The amount paid represents 50% of the value of the agreement concluded with the European Investment Fund on 28 November 2017, regarding the granting of financial instruments within the framework of submeasures 4.1, 4.1a, 4.2, 4.2a and 6.4. with an amount of EUR 93.8 millions [2], [8].

The total allocated amounts for the measures related to the project submission session until 18 June 2020 within the frame of NRDP 2014- 2020 are in amount of EUR 9,441.5 millions.

From January 2020 to July 2020 projects in amount of Lei 110.49 millions have been submitted for submeasures 4.2 GBER MINIMIS, 4.3, 5.1, 5.2, 6.1, and 17.1 and funds in amount of Lei 113.81 have been remained available for submeasures 4.2, 4.2 GBER MINIMIS, 5.1, 6.1 and 17.1. Details regarding the situations can be found in the attached Table 1 [3].

Table 1. Funds allocated within NRDP 2020 for the active sessions with online submission

Submeasure	Ceiling for project submission m. EUR	Value of submitted projects m EUR	Number of submitted projects	Available funds m EUR
4.2	19.40	0	0	19.40
4.2 GBER MINIMIS	6.00	0.54	31	5.46
4.3	65.55	92.78	95	Exhausted funds
5.1	19.56	12.40	183	7.16
5.2	5.52	0.19	1	5.33
6.1	64.53	0.35	14	64.18
17.1	16.50	4.21	2271	12.29

Source: https ://online.afir.info/ contorintegration

By analysing the state of project submission and implementation, it is found that there are still obstacles in the interpretation of national legislation because the normative acts are overlaying, they are changed very often and the Guides of Applicants are too complex and differ a lot from the European legislation. From an administrative point of view, it is found that:

-The documents related to the financing applications are very difficult to fill in, their evaluation takes a long time, the on-site controls take place over an extended period and can negatively affect the project implementation, the procurement process after the approval of the file is very complex and long, and the technical and economic procedures are difficult and confusing. These obstacles do nothing but delay the development of agriculture and rural areas and result in loss of important amounts.

-The situation of projects, allocated and paid amounts can be found below:

Situation regarding the number of projects submitted, selected and contracted from the beginning of the programme to the end of 2019.

- Number of submitted projects - 65,552;
- Number of selected projects - 38,801;
- Number of contracted projects - 37,409;
- Completed projects - 13,989;
- Terminated projects - 247.

Situation regarding the number of projects submitted, selected and contracted from the beginning of the programme to 18 June 2020.

- Number of submitted projects - 67,346;
- Number of selected projects - 41,585;
- Number of contracted projects - 40,537;
- Completed projects - 18,088;
- Terminated projects - 289.

Situation regarding the number of projects submitted, selected and contracted from the beginning of the programme to the end of 2019.

- Value of submitted projects is EUR 9,503.1 millions;
- Value of selected projects is EUR 5,250.6 millions;
- Value of contracted projects is EUR 4,589.3 millions.
- Value of completed projects is EUR 977 millions
- Value of terminated projects is EUR 53.1 millions.

Situation regarding value of projects submitted, selected and contracted from the beginning of the programme to 18 June 2020.

- Value of submitted projects is EUR 9,571.7 millions;
- Value of selected projects is EUR 5,347.2 millions;
- Value of contracted projects is EUR 5,021.5 millions;
- Value of completed projects is EUR 1,285 millions;
- Value of terminated projects is EUR 67.3 millions

Payment stage

Situation of payments made from the beginning of the programme to the end of 2019 - EUR 4,460.6 millions.

Situation of payments made from the beginning of the programme to 18 June 2020 - EUR 5,022.5 millions.

13.42% of the projects submitted within the period 2014-2020 are finalized, which is still not a good percent, and the period from submitting the projects to their completion is still very long.

The highest funds allocation is for the following submeasures:

-*Submeasure 4.1,* Investments in farms, with 4,048 submitted projects, a value of EUR 2,218.3 millions and 1,224 completed projects in value of EUR 353.1 millions represents only 30.24% of the total of projects submitted for this section*;*

-*Submeasure 4.3,* Investments for the development, modernization or adapting the agricultural or forestry infrastructure - irrigations, with 530 submitted projects, a value of EUR 525.3 millions and 28 completed projects, a value of EUR 26.2 millions represents only 5.28 % of the total of projects submitted for this section;

-*Submeasure 6.1,* Support for setting-up of young farmers, with 14,149 submitted projects, a value of EUR 581.9 millions and 7,719 completed projects in value of EUR 317.6 millions represents only 54.56 % of the total of projects submitted for this section. In accessing these funds, a higher involvement is noted.

-*Submeasure 7.2,* Investments in creation and modernization of basic infrastructure, on a small scale - road infrastructure of local interest, with 972 submitted projects, a value of EUR 1,003 millions and 76 completed projects in value of EUR 4.2 millions represents only 7.8 % of the total of projects submitted for this section.

CONCLUSIONS

The lowest involvement is noted in granting the funds within the frame of Submeasure 6.5, named Small farmers scheme, where the number of submitted projects is 21, with a value of EUR 61,813 and 3 contracted projects, with a value of EUR 4,496. Until now, none of these projects has been completed.

The goals to be achieved by attracting financing from non-reimbursable funds in agriculture through submeasures prepared for Romanian farmers and processors with the help of specialists from AFIR is to support several needs and projects:

(1)Vocational training and skill acquisition for farmers and small processors in the agri-food field, with the help of vocational training courses;

(2)Support for the farmers, with the help of quality schemes, in view of increasing production and marketing of agricultural produce and foodstuff;

(3)Increase the capacities of fruit-growing farms or development of processing companies;

(4)Direct marketing of products obtained and marketing development;

(5)Increase the quality of agricultural products and services;

(6)The supply chain for raw materials is shortened, with a positive influence on the agricultural produce processing enterprises;

(7)Diminish the production expenses by using renewable energy and reducing energy consumption;

(8)Investments in tangible and intangible assets that led to the restructuring and modernization of farms and improvement of economic performance;

(9)Diminish the effects of natural disasters and adverse climatic events on crop yield;

(10)Encourage young farmers and their families to settle in rural areas, being stimulated to become competitive, to enter in associations, resulting in a positive effect on the national economy in general;

(11)Create new activities in the non-agricultural sector through production activities, tourist services and craft activities resulting in the diversification of rural economy and the creation of new jobs;

(12)Create and develop the educational infrastructure, aimed at the study of natural resources but also the environmental protection, and vocational schools in the agricultural field;

(13)Establish partnerships with non-governmental organizations and public authorities, in order to prepare and implement a local development process of an area.

The achieved objectives were in line with the initial goals and added value to the final beneficiaries, farmers and entrepreneurs in rural areas, private institutions or public institutions with the following achievements:

-Endowment with competitive machinery and equipment, and also investments in farm modernization (especially small and medium farms);

-Increase the competitiveness of agricultural activity, diversification of agricultural production and quality of products obtained;

-Converse the small and medium size farms in commercial holdings;

-Observe the Community standards for all the investment grades;

-Process the products within the farm and their direct sale in integrated food supply chain.

-Establish and/or modernization of processing and marketing companies;

-Develop new products and processes;

-Implement new measures for environmental protection, diminishing the energy consumption and GHG emissions;

-Develop the fruit growing sector;

-Improve the internal quality control;

-Obtain new or higher quality non-agricultural products;

-Increase the number of jobs in rural area;

-Modernize and adapt the access roads;

-Ensure a better supply, simpler access to the consumers and sales markets;

-Develop education in rural areas through the modernization of school infrastructure, the establishment of teaching positions and the establishment or modernization of libraries.

-Afforestation of deforested areas and conservation of forests.

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SELECTION OF ECONOMIC INDICATORS FOR MEASURING SUSTAINABLE RURAL DEVELOPMENT

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Abstract

Sustainable rural development consists of three components: economic, ecological, and social. The paper paid to the economic component through selection of the most relevant economic indicators for measuring sustainable rural development at NUTS 3 level. Objectives of the research were: a) to identify the most appropriate economic indicators for measuring sustainable rural development, either used so far or proposed in the literature, b) to select five most relevant indicators according to the experts' estimate. The analysis of previous research has outlined and explained 15 economic indicators. After the first phase of selection, an additional selection of indicators by expert evaluation was carried out. Based on the expert evaluation, five most relevant economic indicators were identified, namely according to the average grade: unemployment rate (4.49), accessibility of agricultural infrastructure (4.47), gross domestic product per capita (4.45), education level as a prerequisite for the use of innovation (4.26) and productivity of agricultural production (4.21). Looking at separate assessments of each of the expert groups, it is evident that their selection of the five most relevant indicators only coincides in two of them: unemployment rate and availability of agricultural infrastructure.

Key words: *economic indicators, experts' evaluation, sustainable rural development*

INTRODUCTION

One of the biggest challenges most of the countries in the world are facing with is the mitigation of rural population migrations to cities, which is, inter alia, reached by ensuring equable development of a country's rural and urban areas. Rural development is the implementation of political, economic and social projects that are in harmony with the common vision of rural regions' future [44]. The concept of sustainable development consists in three pillars: ecological, economic and social, which in ideal conditions equally contribute to the objective. Therefore, Smith and McDonald [41] say that ecological sustainability means that development is in harmony with maintenance of ecological processes, economic sustainability means that it is economically feasible and social sustainability means that it is socially acceptable. Considering that nothing is ideal in the real word, accomplishing the goals within one pillar can harm, or even disable accomplishing goals stemming from other pillars'. When this happens, the concept of sustainability points to the need for finding real balance between the three pillars of sustainability, taking into account that when achieving a goal in one pillar, minimal standards in other two pillars have to be respected [9]. Golusin and Munitlak Ivanovic [22] say that in its first stage, economic development assigns the need of depletion of ecological resources. Kordej-De Villa et al. [30] point out that the environment starts to recover when people achieve a certain level of income. Since the level of income in Croatia is lower than satisfactory. According to the EUROSTAT data [18] GDP per capita in Croatia in 2018 was € 12,620, while the EU 28 average was € 30,980. Only Romania and Bulgaria have a lower GDP than Croatia.

As evidenced by numerous migrations to more developed EU countries, it could be said that the economic component is the most important and it will remain as such until an appropriate level of income per capita is accomplished, alongside a grown environmental consciousness. Subsequently, this paper pays attention to the economic pillar through the selection of the most appropriate economic indicators for measuring sustainable rural development.

Sustainable rural development can be observed at different levels, from local to international. Reed et al. [40] pointed out that the majority of hitherto proposed indicators is based on the top-down definition of sustainability and is using data that are available at state level, which can result in disregard of critical sustainability issues at the local level and a postponement of factors that are important to the people at the local level. To avoid that, selection of the most appropriate economic indicators is adjusted to the NUTS 3 level. Sustainable development at the local level implies that local economic development supports life and strength in the community by using talents and resources of local people. Economic development benefits must be equally distributed within the community and available to all community groups in the long-term [25].

The need to construct a system measurable rural development indicators results from the effort to objectively, by using scientific and specialised tools, quantify the level of accomplished rural space sustainability. According to Abolina and Zilans [1] indicators are pieces of information that point out what is going on in a large system. They are little windows that give us a view of the bigger picture. Indicators inform us how a system functions, whether it is a machine, a human being, an ecosystem or a country. They help us define goals, connect them and evaluate the progress in their accomplishing [39]. In this paper selection of economic indicators is described along with the argumentation of their role in the overall assessment of economic sustainability of the rural space.

The first objective of the paper is to identify the most appropriate economic indicators for measuring sustainable rural development already used or proposed in literature. The second objective is to choose the five most appropriate indicators according to experts' assessment.

MATERIALS AND METHODS

The first step of the research was a literature review with the objective of defining theoretical-methodological determinants of the paper and identifying a broader set of economic indicators of rural development used in different works of research, as well as the ones only proposed by competent institutions. Those are the indicators that certain institutions (e.g. the European Commission) proposed in their templates for assessing rural space sustainability, but examples of their use in specific works of researchers have not been found. The second step was the experts' assessment of identified indicators with the objective of a narrower selection. On a scale from one to five, the experts determined the relevance of each indicator for the assessment of sustainable development. The experts could also suggest other indicators that they consider important, and were not on the list of offered indicators. The expert assessment was conducted face to face and via e-mail, among 47 expert representatives of scientific institutions connected with rural development, sociology and economy, representatives of counties connected with rural development and agriculture, representatives of various relevant agencies and associations and leaders of Local Action Groups (LAG) operating in Croatia. The expert assessment included 20 representatives of scientific institutions, 20 representatives of LAGs and associations and seven representatives of local and state bodies (counties, ministries and agencies). The research was conducted in the period from July to August 2016.

The data was processed in the SPSS Statistic 17.0 program, that calculated the average for each indicator and performed a Chi-square test for the experts' workplace dependence with grades assigned to each indicator.

RESULTS AND DISCUSSIONS

Proposed economic indicators for measuring sustainable rural development with results

After analysing previous works of research on the subject of sustainable rural development, especially its economic component, 15 economic indicators were singled out and described below. Table 1 lists previously mentioned indicators and authors that used/proposed them in respective works of research.

Table 1. List of proposed economic indicators with specified authors that used/proposed them

Economic indicator	Authors using/proposing the indicator
Budget revenues of local or regional self-government units per capita	Khalifa and Connelly (2009) [29]
Number of beds in rural tourism in relation to the total population	EC (2001); Boggia et al. (2014); (EC, 2013a). [13, 3, 15]
Diversification of sources of income on the farm (additional activities on the farms)	EC (2001); Dantsis et al. (2010); (EC, 2013a) [13, 10, 15]
Diversification of economic activities in the rural area (GVA of individual activities, number of employees in individual sectors)	EC (2001); EC (2013); Niggemann (2009) [13, 15, 14, 34]
Number of EU-level protected products in each county in relation to the total number of such products in the country	EC (2001); Boggia (2014) [13, 3]
Unemployment rate	Ferrarini et al. (2001); EC (2001); Niggemann (2009); Khalifa and Connelly (2009); Golusin and Munitlak Ivanović (2009); Ramos (2009); Boggia and Cortina (2010); EC (2013); [19, 13, 34, 29, 22, 38, 4, 15]
GDP per capita	EC (2001); UN (2007); Ramos (2009); Khalifa and Connelly (2009); Golusin and Munitlak Ivanović (2009); EC (2013) [13, 42, 38, 29, 22, 15]
Productivity of agricultural production (GVA / agricultural land area)	EC (2001); EC (2013) [13, 15, 14]
Number of entrepreneurs in agricultural and non-agricultural activities in rural areas	EC (2013) [15, 14]
Education as a prerequisite for using innovation	Niggemann (2009); Dantsis et al. (2010) [34, 10]
Number of cars per household	Niggemann (2009) [34]
Internet access – number of connections / number of inhabitants or households	EC (2001); UN (2007); (NN 30/2009); Golusin and Munitlak Ivanović (2009); EC (2013a) [13, 42, 35, 22, 15]
Availability of infrastructure facilities connected to agriculture	Bosshaq et al. (2012) [5]
Economic vitality – the number of blocked vs. the number of newly established companies	Niggemann (2009) [34]
Land fragmentation — average farmland size in ARKOD	-

Source: Authors' synthesis based on literature.

Budget revenues of local or regional self-government units per capita is one of the indicators used to calculate the Development Index. In addition to it, these are also used: (1) unemployment rate, (2) per capita income, (3) general population movements and (4) education rate [36]. According to the Regulation on the Development Index [36], the budget revenues of local or regional self-government units per capita are calculated as the ratio of realized revenues of local or regional self-government units, minus revenues: from domestic and foreign aid and donations, from special contracts: co-financing of citizens for local self-government, realized on the basis of additional shares in income tax and equalization assistance for financing decentralized functions and from surtax on income tax, and number of inhabitants in the area of local or regional self-government unit. This indicator indicates the strength of the economy of regional or local self-government units.

Number of beds in rural tourism in relation to the total population. The tourist supply on agricultural holdings indicates the multifunctionality of agriculture, represents additional sources of income for agricultural holdings, facilitates the placement of products at higher prices, generates jobs in rural areas and contributes to a higher number of young people keeping to live in the countryside. In this paper, not only agritourism will be observed, but rural tourism as a whole. Hjalager [24] states that the economic benefits of rural tourism for rural areas are multiple: (1) diversification of local industry, (2) higher employment rate, (3) higher income, (4) higher tax base, and (5) business income growth. EC [13] proposes this indicator as a form of additional source of income for farmers. Boggia et al. [3] measure this indicator by the number of beds in agritourism per square kilometre. The indicator needs to be measured in relation to the number of inhabitants and not to the size of the area because of the significantly different population density in rural areas. Rural tourism should also be included in the measurement as it would be unfair to exclude

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other entities engaged in rural tourism, seeing as they generate income and provide jobs for the local population.

Diversification of sources of income on the farm (additional activities on the farms). Given the low profitability of agriculture, price volatility, uncertainty of purchase and payment, and its seasonal character, an additional source of income is important for economic stability and sustainability of agricultural economy. The indicator is proposed by the EC [13] stating that, among other factors, diversification of sources of income in the economy is important for the economic dimension of sustainable rural development. It has also been used in research by Dantsis et al. [10] as well as in a report on rural development in the EU [15]. This indicator is measured by the number of holdings in an area with registered additional activities in relation to the total number of agricultural holdings.

Diversification of economic activities in the rural area (GVA of individual activities, number of employees in individual sectors). Greater economic diversification is assumed to lead towards greater economic stability in a given region. If only a few activities predominate in the region, the region is more vulnerable when undergoing structural changes. Another advantage of business diversification is the wider supply of jobs that makes the region more attractive [34]. The EC [13] proposes an indicator that compares the number of enterprises registered in rural areas engaged in non-agricultural activities in relation to the total number of enterprises. Ramos [38] proposes the company structure indicator. The EC (2013) in its report on rural development in the EU uses two indicators that can be linked to this, namely: the structure of employment and economy in rural areas. This report monitors the share of the primary, secondary and tertiary sectors in rural, rural-urban and predominantly urban areas. The economic diversification indicator is also used by Niggemann [34] investigating the difference in the number of employees in each of the ten industries according to the classification of activities in Sweden. The municipality with a difference higher than 10% is attributed the least points, while an even distribution of all activities is attributed the most points. This indicator is calculated according to the number of employees in the activities that monitored by the national statistics according to the National Classification of Activities (NCA). NUTS 3 units are ranked according to the index of specialization (diversity) which is calculated according to the formula $I = 10{,}000/\sum u^2$, where u is the share of each activity in the total employment of NUTS 3 units. An index closer to one means greater specialization.

Number of EU-level protected products in each county in relation to the total number of such products in the country. The Ministry of Agriculture [32] states that indigenous agricultural and food products are protected due to: higher price category, creation of identity and recognisability, direct connection of products with a certain geographical area which gives additional value and recognisability to that area and contributes to rural development and the establishment of interest associations, that is, the joint promotion of a food product. Given the higher added value, the price of these products is also higher, which is reflected in the income of the farm as well as in the entire rural economy. The indicator is also suggested by the EC [13] as a number, sales or market share of products with a local designation, designation of origin or designation of origin in a particular area. This indicator is also used by Boggia [3] in measuring the number of these products in a particular municipality compared to the number in the entire region of Umbria. The evaluation takes into account the number of protected products in a given NUTS 3 unit in relation to the total number of these products in the country.

Unemployment rate. Unemployment is a major problem in Croatia in general, and in rural areas in particular, where unemployment rates are higher than in the urban parts of the country. People looking for jobs are moving from these areas to larger towns and cities, and villages are dying out due to depopulation. Finding a job in a rural area is a particular problem for more educated people, due to the limited number of jobs for which a

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university degree is required. The unemployment rate is defined as the share of unemployed people in the total labour force, i.e. the total population. The unemployment rate indicator is used by Ferrarini et al. [19]. Niggemann [34] used it by relating the number of unemployed persons between 16 and 64 years of age and the total number of persons of that age. A lower unemployment rate was attributed a higher number of points. Khalifa and Connelly [29] use this indicator to monitor sustainable development in rural areas of Egypt, while Golusin and Munitlak Ivanović [22] use it to measure sustainable development in the countries of Southeast Europe. Boggia and Cortina [4] use it to measure the sustainable development of municipalities in Italy, and the EC [14] used it in a report on rural development in the EU. It is also proposed by the EC [13] in its Framework for Indicators for the Economic and Social Dimension of Sustainable Agriculture and Rural Development as well as Ramos [38] to measure sustainable development in the Algarve region of Portugal. The indicator is used in the Community Sustainability Assessment manual [21].

GDP per capita. Regional GDP is an indicator of a region's output and can therefore be used to measure and compare the degree of economic activity of different regions [7]. GDP is an important indicator from a policy point of view as it serves to determine the extent to which each EU Member State should contribute to the EU budget and therefore the three-year average GDP is used to identify regions eligible for the EU Structural Funds [16]. Although it shows the economic strength of a particular rural area, it should not be relied upon only on in political debates because other characteristics of an area, such as environmental sustainability or social inclusion, are not taken into account. The indicator is proposed by the EC [13] in the Framework for Indicators for the Economic and Social Dimension of Sustainable Agriculture and Rural Development, the UN [42] and Ramos [38]. It was used by Khalifa and Connelly [29] to monitor sustainable development in rural Egypt, by Golusin and Munitlak Ivanović [22] to measure sustainable development in Southeast European countries as well as by the EC [14] in a report on rural development in the EU. They observed the differences in GDP in rural, rural-urban and predominantly urban areas of the EU. Economic development is usually expressed in terms of GDP, which in a regional context can be used to measure macroeconomic activity and growth and to provide a basis for comparisons between regions [16].

Productivity of agricultural production (GVA/agricultural land area). Productivity is defined as the quantity or value ratio of production and the amount of expended labour. A higher value of the productivity indicator indicates either a better use of labour input, less labour required to produce an effect, or a higher value of production with equal labour consumption [33]. Labour productivity in agriculture is calculated by the ratio of Gross Value Added (GVA) and Annual Work Units (AWU). Gross Value Added is equal to the difference between agricultural production in base prices and intermediate consumption in purchase prices [23]. The indicator is proposed by the EC (2001) in the Framework for Indicators for the Economic and Social Dimension of Sustainable Agriculture and Rural Development, that used it in 2013 in preparing a report on rural development in the EU. If calculations of agricultural production productivity at NUTS 3 level are not available in official statistics, the indicator must be adjusted to the available data. Thus, for example, instead of annual units of work, the number of agricultural holdings in NUTS 3 units can be used.

Number of entrepreneurs in agricultural and non-agricultural activities in rural areas. This indicator is proposed to show the economic activity of the rural area. A higher number of entrepreneurs in agricultural and non-agricultural activities indicates a more economically active area. In order to make the indicator as transparent as possible, the number of entrepreneurs is expressed in relation to the number of inhabitants in a certain area. The non-agricultural economic

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development indicator was used by the EC [14] in a report on rural development in the EU. They monitored differences in rural, rural-urban and predominantly urban areas. An area with more entrepreneurs per 1,000 inhabitants is more economically active.

Education as a prerequisite for using innovation. According to the OECD [37], the level of education of farmers and effective farm management as well as the timely adoption of environmentally sound management practices are positively correlated [10]. Effective governance is key to a positive economic performance, which is why this indicator is proposed in the group of economic indicators. Innovations are assumed to be more easily accepted by more educated farmers because, as Niggemann [34] posits, people can reach their full potential and additionally improve their quality of life through the learning process. She also states that education is positively related to economic growth. The importance of innovation in agriculture is also emphasized by Dwyer et al. [12] stating that they are a key element in helping agriculture achieve long-term sustainability and adaptability in meeting global challenges. In terms of sustainability and the CAP, innovation is seen as key to stimulating a greater degree of acceptance of the more significant challenges of the future, including climate change, water conservation, and biodiversity protection [12]. The Strategy for Sustainable Development of the Republic of Croatia [35] states that an increase in GDP can occur if the education of the population increases, whereupon the population will be able to use new technologies and more complex production processes. The economic consequences of population aging can also be seen through this indicator because of the assumption that younger people in general, and especially in rural areas, will find it easier to accept innovations and apply them than older people, who generally have lower education [26]. Dantsis et al. [10] measure the level of education in the years of education of farmers while Niggemann [34] observes the progress in the farmers' education level in a given period. The indicator is measured as the level of farmers' completed education.

Number of cars per household. Niggemann [34] divides the mobility indicator into two sub-indicators: (1) car ownership and (2) internet access. Here, these two sub-indicators are listed separately. Car ownership is very important if we take into account the fact that public transport in rural areas is mostly underdeveloped. People often travel to work outside their place of residence and are dependent on a car. In addition to the benefits of owning a car, it is important to emphasize the negative consequences that arise from it, such as environmental pollution, noise, traffic jams, traffic accidents etc. In evaluating this indicator, only the advantages are taken into account, and this indicator is evaluated as the number of cars per household. Niggemann [34] believes that every household should have at least one car, because owning a car is crucial for rural development, and this is taken as a reference value for comparing the NUTS 3 units.

Internet access – number of connections / number of inhabitants or households. The development of the information society is considered key to meeting the needs of the EU society and economy [17]. The official statistics on the Internet usage in Croatia is based on a survey commissioned by the CBS and done by Ipsos plus d.o.o. on a sample of 5,975 persons [8]. Niggemann [34] states that the use of IT technologies is widespread in Sweden and that good results (70%) are correlated with the overall development in Sweden. The indicator is proposed by the EC [13] in the Framework for Indicators for the Economic and Social Dimension of Sustainable Agriculture and Rural Development, the UN [42], whereas the importance of access to modern technologies is also emphasized by Dolata [11]. The indicator was also proposed in the Strategy for Sustainable Development of the Republic of Croatia [35], and was used in the research by Golusin and Munitlak Ivanović [22] and in the EU report on rural development [15]. In the evaluation, the NUTS 3 units are compared with the national average.

Availability of infrastructure facilities connected to agriculture. The description of this indicator refers mainly to the economic infrastructure which, according to Franić and Ljubaj [20], includes transport (in the broadest sense), energy, telecommunications and utilities, as well as all other activities directly related to the production processes (storage, warehousing, cooling, confectioning, product packaging). When evaluating this indicator, warehouses and mills for cereals, cold stores and packing plants for fruits and vegetables, slaughterhouses, mini dairies, wholesale markets and markets are taken into account. The existence of these facilities arguably allows the storage of primary agricultural products and the option of waiting for a favourable moment to enter the market, which increases the economic profit. Certain infrastructure also allows the processing of primary agricultural products into value-added products, which facilitates sales and improves the financial performance of agricultural holdings. Markets and wholesale markets provide easier access for customers to farmers' products. The evaluation of infrastructural availability includes the analysis of agricultural production in the observed NUTS 3 unit, which is compared with the existing agricultural infrastructure. This indicator was used by Bosshaq et al. [5] to measure factors affecting sustainable agricultural development in rural areas in Ravansar Province, Iran. The indicator is evaluated on convenient scales because it is not possible to set exact unified parameters applicable to all counties due to the differing structure of agricultural production, and thus differing needs for the type and capacity of infrastructure facilities. A higher coverage of agricultural production with storage and processing capacities and accompanying non-economic infrastructure carries a higher rating.

Economic vitality – the number of blocked vs. the number of newly established companies. Niggemann [34] states that the number of newly established companies versus the number of blocked ones is a very important indicator for assessing the economy of a particular area. Small businesses contribute to local economies by bringing growth and innovation to the community in which the company is founded. Small businesses also help in stimulating the economic growth by providing employment opportunities to people who are not employable in larger corporations [6]. On the other hand, the number of blocked companies indicates a decline in economic growth and a decline in employment. The ratio of newly established and blocked companies is put in relation to the population in order to reach comparable data. The indicator is evaluated by the number of newly established companies, and the number of blocked companies per 1,000 inhabitants.

Land fragmentation — average farmland size in ARKOD (Croatian land parcel identification system). The Agricultural Land Agency [2] states that the advantages of land consolidation are: (1) creation of larger and more regular plots/holdings for a more economical use and creation of more favourable conditions for agricultural production development, (2) increase of farmers' competitiveness by creating more favourable production conditions, (3) improvement of physical conditions of each plot – levelling of the soil surface and implementation of measures for soil improvement, (4) improvement of the rural environment and (5) creation of basic conditions for irrigation. The abovementioned advantages of land consolidation show the shortcomings of the current state of land fragmentation, which greatly affect the economic viability of agricultural production. For the evaluation of this indicator, the reference condition is the one listed in the ARKOD system, since it represents the actual size of the analysed particles. The larger the average size of an ARKOD parcel in a NUTS 3 unit, the higher the grade, because it is considered that in this way less investment is needed for the same yields and lower logistics costs are required.

Ranking of the economic indicators of sustainable rural development according to experts' assessment

As stated in the Methods chapter, experts of different profiles evaluated the relevance of the described indicators in the overall assessment of the economic viability of the rural area. Based on the obtained results, the five most relevant indicators with regard to the level of the average grade were selected. The best rated indicators with the corresponding grades are shown in Table 2.

Table 2. List of the most relevant economic indicators according to the expert opinion

Indicator	Average grade of the experts
Unemployment rate	4.49
Accessibility of agricultural infrastructure	4.47
Gross domestic product per capita	4.45
Education as a prerequisite for using innovations	4.26
Productivity of agricultural production	4.21

Source: Own results.

Respondents were able to suggest indicators that they considered to be very important and were not offered in the survey. Only five respondents (three representatives of scientific and educational institutions and two from associations and LAGs) availed this opportunity and their suggestions are: unemployment rate in agriculture, number of associations/cooperatives of agricultural producers, size of agricultural households, number of family households in the observed area and family household revenues compared to the total income of the area. It can be seen that these indicators are mostly related to agriculture because it is still the most common activity in rural areas and therefore its development is linked to the development of the whole area.

Below is Table 3 with selected five indicators and their average grades assigned to them by representatives of individual groups that participated in the research.

The results show that there are differences in the choice of indicators depending on which group the respondents belong to (scientific and educational institutions, LAGs, state and local authorities), which indicates that different life experiences shape different judgments about the importance of individual indicators. It is possible that these differences are a consequence of the place of work, respectively life, because the respondents from the LAGs are mostly residents of rural areas, while the representatives of scientific and educational institutions are mostly from larger cities. Keseru et al. [28] in their study, that also involved several stakeholder groups, concluded that there is a large heterogeneity in their responses. Although different five indicators according to the workplace of the experts were selected the Chi-square test found that the relationship between the evaluation of indicators and the group of experts exists only for the GDP per capita indicator ($p <= 0.05$).

Table 3. Economic indicators with the highest average grades according to the opinion of different groups of experts

Scientific and educational institutions	LAG's and associations	State institutions
Unemployment rate (4.65)	Gross domestic product per capita (4.45)	Education as a prerequisite for using innovations (4.86)
Gross domestic product per capita (4.60)	Accessibility of agricultural infrastructure (4.45)	Accessibility of agricultural infrastructure (4.57)
Education as a prerequisite for using innovations (4.45)	Unemployment rate (4.35)	Unemployment rate (4.43)
Accessibility of agricultural infrastructure (4.45)	Diversification of sources of income on the farm (4.30)	Fragmentation of agricultural land (4.43)
Productivity of agricultural production (4.40)	Diversification of economic activities in the rural area (4.15)	Internet access (4.29)

Source: Own results.

The most relevant indicators in the paper are selected based on the average score of all respondents, but it is interesting to consider the opinions of individual expert groups, each of which participating in rural development a different capacity. The coincidence in the selection of the five most relevant economic indicators in all three expert groups is visible in the case of two indicators: unemployment rate and availability of agricultural infrastructure. The importance of the unemployment rate as an indicator of economic development is also emphasized by Živić and Pokos [45]. The importance of this indicator is reflected in the fact that employed residents will find it easier to decide to stay in rural areas while sacrificing some other things (cultural content, distance from key government services and institutions, lack of a good public transport system, etc.). If the unemployment rate is high, dissatisfaction is high and people leave rural areas in search of work, which negatively affects the sustainability of these areas. The importance of this indicator was also emphasized in the measurement of the county development index, in which the unemployment rate participates in the final assessment with 30% [36]. The results show that the ranking of counties according to the unemployment rate is equal to the overall ranking of counties, which indicates a correlation between these variables. Observing all Croatian counties, it can be seen that in all counties where population growth was recorded, except in Zagreb, the unemployment rate is below the Croatian average. In Zagreb County, the unemployment rate is only one percent higher than the Croatian average.

Another indicator selected by all three expert groups is availability of agricultural infrastructure. It is very important for the development of agriculture because its function is to directly reduce production losses, increase the market value of agriculture and improve primary agricultural production [27]. The choice of this indicator is most likely a consequence of understanding its importance, as well as its lack in the whole country, which is evident in the research of Krapina-Zagorje County in the study by Jež Rogelj et al. [27] where representatives of cities and counties state that there is not enough public agricultural infrastructure, in which they concur with farmers in the area.

This review of indicators selected by different groups of respondents intended to point out the importance of involving different stakeholders in sustainable rural development in the whole process because everyone has their own opinion and perception of the meaning of the term "sustainable rural development" and how it should be achieved. Apart from involving different stakeholders, a heterogeneous group of respondents was selected to reduce the subjectivity of judgments as much as possible because each group has its own priorities determined by the level of education, area of scientific interest, attitudes, background etc. The importance of group heterogeneity in the research containing sensitive topics (environment, sustainable development and socially responsible business) is also emphasized by Mardle et al. [31] and Von Solms [43]. The disadvantage of the conducted research is the fact that the respondents from all groups did not respond to the research in equal numbers, and as a result, the opinion of the representatives of scientific and educational institutions, who are mostly from large cities, as mentioned earlier, prevails.

CONCLUSIONS

The paper proposed 15 economic indicators that have been used in similar research or suggested in professional literature for the purpose of measuring sustainable rural development. Based on the expert assessment on a scale of one to five, the five most relevant indicators were selected with regard to the obtained average assessment: unemployment rate (4.49), availability of agricultural infrastructure (4.47), gross domestic product per capita (4.45), education as prerequisite for using innovation (4.26) and productivity of agricultural production (4.21). Looking at the assessments of each of the expert groups separately, it can be seen that in their selection of the five most relevant indicators, only two match: unemployment rate and availability of agricultural infrastructure.

However, no significant difference was found between the assessments of experts from different groups. The only exception is the GDP/capita indicator by the Chi-square test, for which a statistically significant difference ($p \leq 0.05$) was determined in the assigned assessment, depending on which expert group the experts belong to.

Although not statistically significant, there is a difference in the choice of indicators and it is due to the heterogeneity of expert groups as well as individuals because everyone has their own priorities according to education level, area of scientific interest, attitudes, background and so on.

Because of the above, it is very important to involve as many stakeholders of different profiles as possible in order to make the results as credible as possible.

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STUDY ON CULTIVATED AREAS AND PRODUCTIONS IN ROMANIA IN THE MAIN CROPS IN AN EUROPEAN CONTEXT

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Abstract

Romanian land resources are immense, but certain land-ownership laws have caused a fragmentation of agricultural areas. Romania suffers from fragmentation of agricultural properties. Compared to other Member States of the European Union, Romania has an average farm size similar to that of Malta or Cyprus, island countries with much less agricultural land than Romania. Almost 75% of farms in Romania have less than 20 ha, and the share of farms under 10 ha represents about 98% of the total number and 38% of the total agricultural area used. In this paper, the authors analyse the situation of cultivated areas and productions in the main crops in Romania under the current conditions. Romania is one of the European countries with the most favourable soil and climate conditions for agriculture. Romania's natural conditions indicate that more than 60% of the total area of our country can be used for agriculture. The role of agriculture is an extremely important one for today's society because it can provide the necessary production of food for the population, raw materials for different industries, as well as production for export. Agriculture is one of the sectors where the Member States of the European Union have agreed to share both public funding and responsibilities. Studies carried out for this paper show that Romania is one of the main agricultural producers at European level and that it ranks among the countries of the European Union in terms of the area under cultivation and production of the main agricultural crops. The authors of the paper conclude that Romania is also one of the top ten exporters of wheat and maize in the world. Analyses show that agriculture is one of the few branches of the economy that have ranked Romania in the European top of the first places in the production of cereals and oilseeds obtained each year.

Key words: *crops, areas, production, Romania, Europe*

INTRODUCTION

The agricultural sector plays an important role in Romania, with about 30% of the total population engaged in different agricultural activities, compared to only 3%-14% of the population occupied in agriculture in other European countries [2], [1]. There is a major difference between rural and urban areas, residents living in rural areas are marked by a significantly higher level of poverty and by a lower standard of living compared to residents living in urban areas. Most Romanian farmers suffer from a lack of a clearly defined professional status, which has negative or ambiguous implications for the tax plan and social and health insurance. It is also reflected in the fact that the majority of those involved in agriculture in Romania do not have the necessary professional training to provide them with an adequate level of knowledge and skills suitable for the competitive agricultural sector [5], [6]. Therefore, most Romanian farmers rely solely on their practical experience and only 7% of farmers have agricultural training. Although this is not uncommon in the EU, the lack of agricultural education is more severe in Romania.

Agriculture in Romania is one of the few branches of the economy that has put Romania at the forefront of the European tops. For example, in 2016, Romania ranked first in the European Union's sunflower production tops and second in wheat and maize production, after France, according to data from the National Statistics Institute (NSI) [11]. At the national level, agriculture is one of the important branches of the Romanian economy. Thus, the contribution of agriculture, forestry and fish farming to the building up of the Gross Domestic Product (GDP) is around 6% in Romania, while, in the European Member States, the contribution to GDP from agriculture is around 1.7% [9]. However, Romania's agriculture cannot reach its full potential because of the massive fragmentation of agricultural areas, of the lack of technology and of efficient irrigation systems. These are some aspects for which Romania has fluctuating production per ha in the main crops, compared to the other Member States of the European Union [3]. Agriculture has become one of the sectors most vulnerable to climate change and the forecasts say that this trend will increase [4]. The current irrigation system continues to face problems caused by the location and poor technical condition of the irrigation infrastructure, resulting in a high cost of water, which only large farmers can afford to pay. This is the main reason influencing the production of small and medium-sized farmers in terms of the climate conditions of the year. In the years of drought, the farms often record low yields per ha [7].

MATERIALS AND METHODS

Following the study, the authors present the current situation of the cultivated areas and productions recorded in the main cultivated agricultural crops in Romania.
The data used shall come from the official databases of the NSI and Eurostat and are related to the crop production in the main agricultural crops and the areas cultivated with each type of crop.
The area under cultivation is the total area cultivated annually with each crop and is expressed in thousands of ha. Total production is the amount of agricultural produce in each crop for the year analysed and is expressed in thousands tons.
As a working methodology, the technique of indirect research, that of documentation and collection of information from databases and literature has been used.

RESULTS AND DISCUSSIONS

Occupation and land use are closely interdependent with the relief units present on the territory of the country. Romania enjoys a very varied relief (28% mountains, 42% hills and plateaus, and 30% plains), which leads to a variety of land use possibilities. The geographical distribution of the relief is reflected in an unequal territorial distribution of land types.

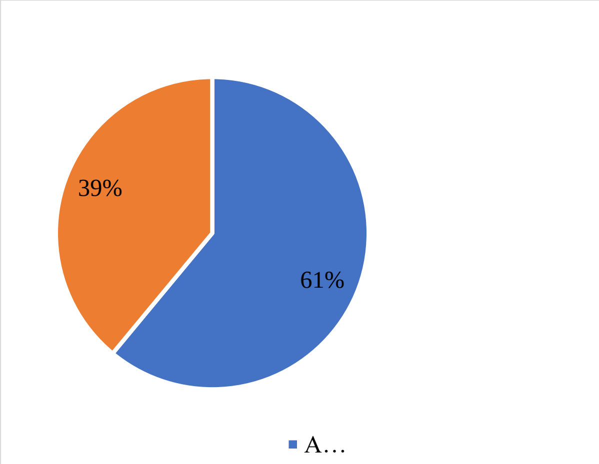

Fig. 1. Share of agricultural area of total area of Romania
Source: Data processed after the Ministry of Regional Development and Public Administration [9].

The area of Romania is 23,839,071 ha, of which 61% is agricultural land (Fig. 1). The largest agricultural areas are arable areas (64% of agricultural land), followed by pastures and meadows (33% of agricultural land). Forests cover an area of 6,800,872 ha, representing 29% of the country's territory, with 0.32 ha of forested land per capita.
In 2019, compared to 2018, agricultural crop production increased in grain legumes and decreases in grain cereals, oil plants, sugar beet, fodder beet, tobacco, potatoes – total, vegetables – total, green fodder from arable land, orchards on fruit and vineyards on fruit.
Grain crops with significant shares of cereal production in 2019 were grain maize (56.9%), wheat (33.9%), barley and two-row barley (6.5%) (Fig. 2).
The main grain-growing counties, which have important shares of the total production, are Timiş (8.8%), Călărași (6.4%), Dolj (5.7%), Constanța (5.2%), and Teleorman (5.1%) (Fig. 3).

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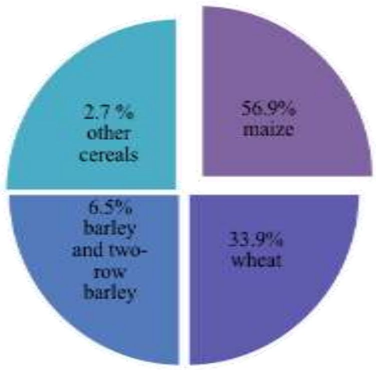

Fig. 2. Areas cultivated with the main grain cereals, 2019
Source: Own calculation.

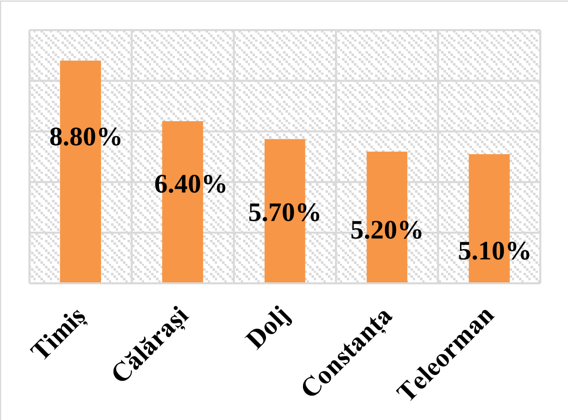

Fig.3. Main grain-cereal growing counties
Source: Own calculation.

Counties with a higher share of the total sunflower production were Dolj (9.4%), Timiş (7.8%), Brăila (7.5%), Teleorman (6.6%), and Constanța (6.5%) (Fig. 4).

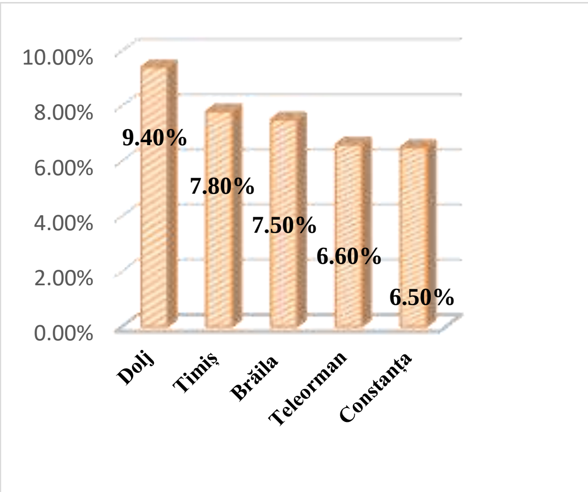

Fig. 4 Main sunflower growing counties, 2019
Source: Own calculation.

Production of oil plants decreased because of the decrease in both yield per ha and the area under cultivation.
More significant rape productions were obtained by the counties of Călărași (11.9%), Arad (8.8%), Teleorman (7.2%), Giurgiu (7.2%), and Constanța (6.6%) (Fig. 5).

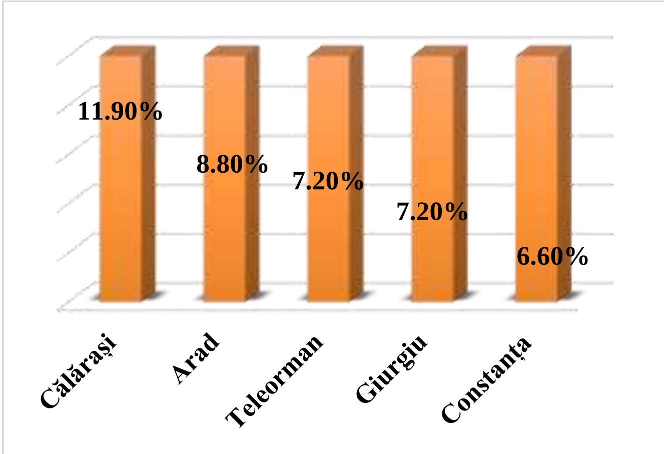

Fig. 5. Main counties with the largest share of rape production, 2019
Source: Own calculation.

The counties with a higher share of the total soybean production are Călărași (16.5%), Timiş (14.8%), Brăila (14.4%), Botoşani (10.4%), and Satu-Mare (6.0%) (Fig. 6).

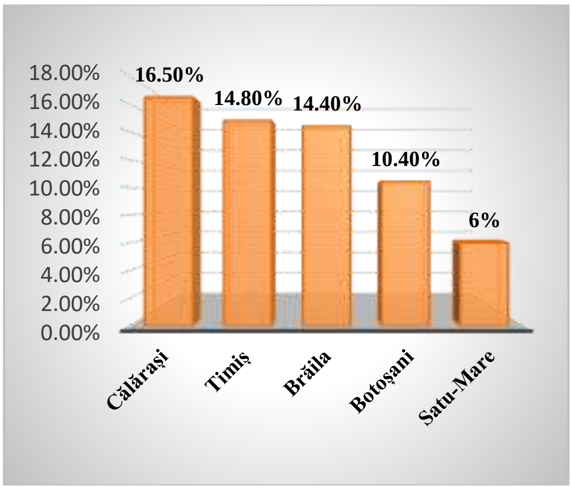

Fig.6.The main counties with the highest share of the grain soybeans, 2019
Source: Own calculation.

At European Union level, the most important crops in arable land are cereals, the most widespread being, of the total area under cereal cultivation, wheat (46.7%), barley (22.1%), and maize (16.0%) (Fig. 7).

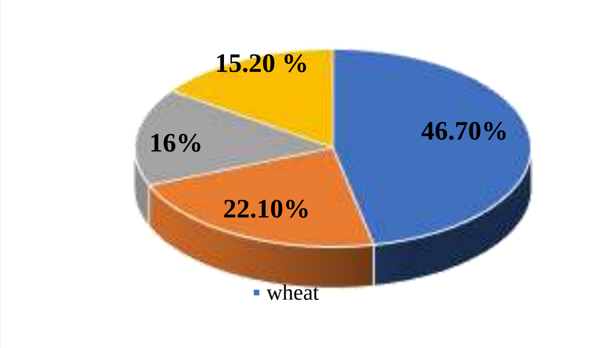

Fig. 7. Share of the main cereal crops in the EU, 2019
Source: Data processed after NIS [10].

However, crops can vary significantly from country to country because of different climate conditions, production and consumption practices, and tradition.
In terms of wheat cultivation, Romania ranked fourth (8.2%) after France, Germany and Poland, and the share of the European Union's total wheat-cultivated area decreased by 0.1% compared to the previous year (Fig. 8).

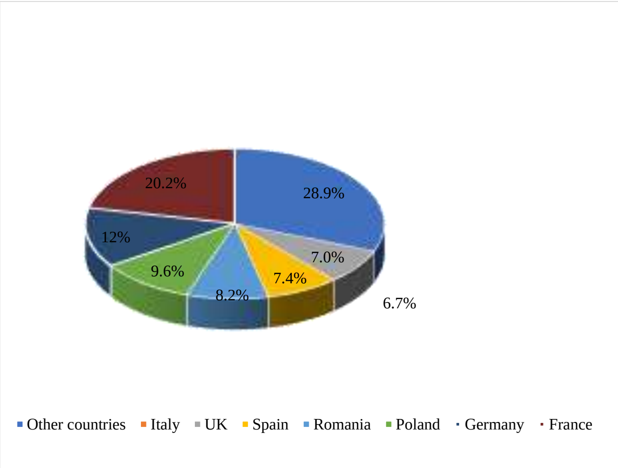

Fig. 8. Areas cultivated with wheat in the EU, 2019
Source: Data processed after Eurostat [4].

Romania, the largest grain maize grower in 2018 and 2019 in the European Union (more than one-fourth) (Fig. 9 and 10).
In 2018, its share in the EU cultivated area with maize was 29% and in 2019 it increased at 29.7%.
In 2018, Romania was followed by France whise share in the EU-28 cultivated area accounted for 17%, and Italy with 16% (Fig. 9). In 2019, Romania was followed by Bulgaria which kept 18.6% and Spain with 16.3% (Fig. 10).

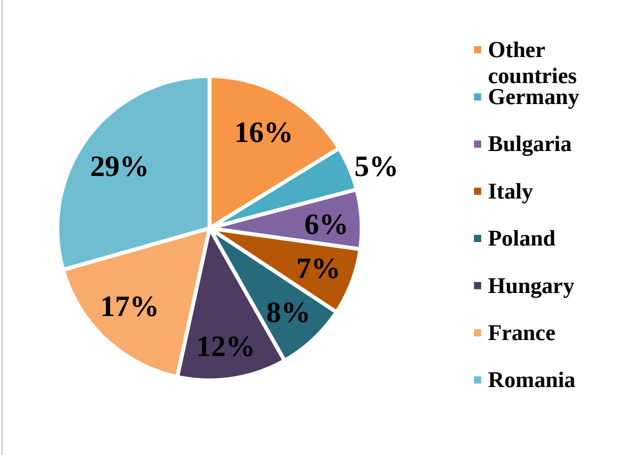

Fig. 9. Areas cultivated with grain maize in the EU, 2018
Source: Data processed after Eurostat [4].

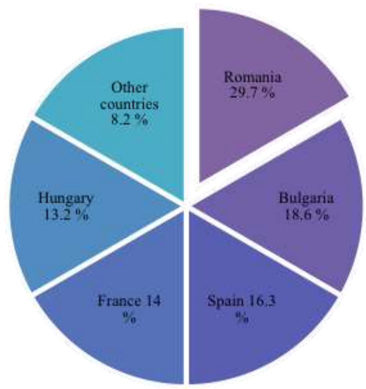

Fig. 10. Areas cultivated with grain maize in the EU, 2019
Source: Data processed after Eurostat [4].

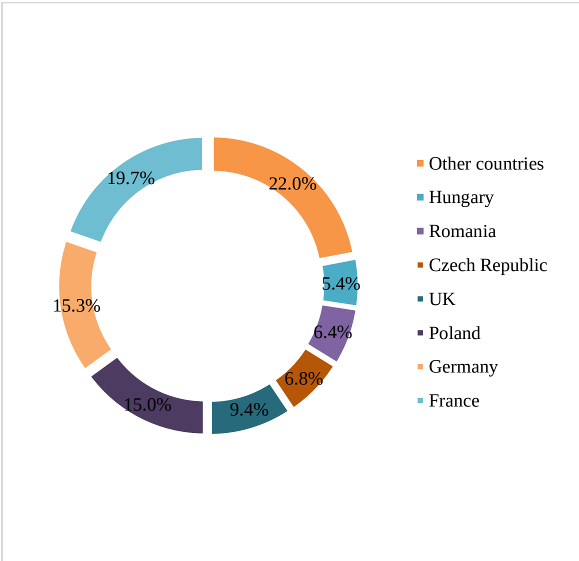

Fig.11. Areas cultivated with rape in the EU, 2019
Source: Data processed after Eurostat [4].

For the rape cultivated area, Romania was ranked the sixth among the Member States in 2019.
Its share in the total rape-cultivated area of the European Union decreased by 2.7% compared to the previous year (Fig.11).
Romania ranked third, after Italy and France, in areas cultivated with soybeans in 2019. The area cultivated with soybeans in the European Union decreased by 6.9% in 2019 compared to the previous year (Fig. 12).

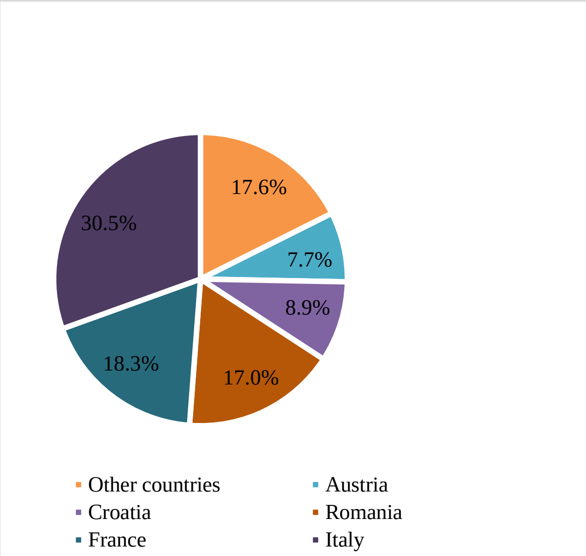

Fig. 12. Areas cultivated with soybean in the EU, 2019
Source: Data processed after Eurostat [4].

In Romania, 6.5% of the total wheat production of the European Union was obtained in 2019, with our country ranking fifth among Member States, after countries such as France, Germany, the United Kingdom, and Poland.
In 2019, Romania cultivated the largest area with grain maize in the European Union and also obtained the largest production.
As regards sunflower production, Romania ranked first among Member States, followed by Bulgaria, Hungary, France, and Spain.
Rape production placed Romania in the top seven Member States.
In 2019, the largest rape producer in the European Union was France, which, together with Germany, the second largest producer, produced 37.3% of total Community production.
In 2019, Italy produced 38.0% of soybean production, followed by France (15.7%), Romania (14.6%), Croatia (8.5%), Austria (7.9%), and other Member States (15.3%).
Romania also maintained potato production among the first seven Member States, after Germany, France, the Netherlands, Poland, the United Kingdom, and Belgium [8].

CONCLUSIONS

The production performance in Romania's reflect the potential of agriculture for maize, sunflower, soybean, wheat, rape and potato, for which the country occupy the 1st position (maize, sunflower), the 3rd position (soybean) the 6th position (rape) and the 7th position (potato) among the top EU agricultural producing countries.
But, the performance is given especially by the extend of the cultivated areas than yields, which makes the difference between Romania and the other EU country with a high developed agriculture.
The present data show that the enhancement of the performance of Romanian agriculture can resize Romania’s image as a cereal force on the European market and beyond.
Increased trade in agricultural products can contribute decisively to the growth of Romania’s economy.

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SUSTAINING RURAL LIVELIHOOD THROUGH ENTREPRENEURSHIP AND CREATIVE VILLAGE DEVELOPMENT: MALAYSIA AND INDONESIA EXPERIENCE

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Abstract

Rural development in various countries in Asia has experienced tremendous change and transformation. Countries like Malaysia and Indonesia have experienced growing interest in utilising information and communication technologies (ICTs) for rural development. ICT and society could create a new pathway for the rural area and its society should progress in future. Evidently, technologies will continue to evolve and used to improve productivity. However, in the long run, this might jeopardise any effort for creating and sustaining employment/job and wealth creations for locals and for rural economic sectors. This is because current jobs including in rural small and medium enterprises (SMEs) could be replaced by technologies, hence might reduce industry dependency on local workforce. There are cases whereby the ICTs and other emerging technologies which have been introduced in rural areas, as shown in "creative kampung" communities, have not deter locals from being employed in rural economic sectors (and SMEs) instead sustaining jobs and improve SMEs operations and productivities. Creative kampung emphasises on sustaining economic activities based on human creativity and/or creative industry that cannot be replaced by machines or any other means of modern technologies. However, it is a norm for local entrepreneurs to incorporate some elements of technologies to improve productivity and quality of products and services, while maintaining the authenticity of their products. The paper presents some key findings based on comparative study of two creative kampungs in Sayong, Kuala Kangsar, Malaysia and Gemawang Village at Semarang District, Central Java Indonesia. It is expected that the findings might have values particularly in improving the understanding on the concept of creative kampung from different localities, internal and external key drivers for transformation of creative kampung and entrepreneurship development.

Key words**:** *Creative village (kampung), ICT, rural, transformation, enterprises*

INTRODUCTION

Finding the right balance between urban and rural development in many developing countries often generating pertinent impacts on rural transformation process, especially to shifting from old paradigm to adaptation of new thinking of development. Migration to the cities, as stated by many social scientists and demographers has eroded the vitality of rural communities [3]. Traditional economic systems especially in farming and forest-related activities, are falling into disuse and the income and employment opportunities in rural communities are decreasing [3] [2] [5]. In this light, there is an urgent push for rural communities and their administrators to explore new development strategies in sustaining positive socioeconomic growth and increasing the peoples' livelihood.

Traditional economic sectors driven by natural resources exploitation for instance mining and forestry were urged to undergone appropriate adjustment. This is because at the same time, many parts of rural regions have been penetrated by information and communication technologies (ICTs), making the communities becoming more connected with outside world. Furthermore, the emergence of knowledge-driven economy and widespread of ICTs also resulted as to respond to sustainable development agenda for rural areas [13]. This new movement had shifted the rural development paradigms and thinking, as well as alerting rural planners and local communities to adequate themselves with new and innovative approaches in development of rural areas.

Creative Village Concept and Rural Entrepreneurship

The search for innovative rural development approach has bring in the evolving concept of "creative kampung" (creative village) into the limelight. However, there was no agreement on the official definition of creative village [13] simply because researchers viewed a community as a group of people with thinking (and creativity) that constantly evolves due to interaction with surrounding environment and exposure to technologies. There is no doubt that the role of ICTs has open wider opportunity for information sharing and enhance learning process among rural people. As a result, there cannot be a one-size-fits-all definitions.

In the context of this paper, authors are more inclined to define the concept of creative village as an extension from the existing concept of creative city [13] [7] and creative economy [9] [11], which emphasis on creative way to utilization of assets which potentially generate economic growth and development (Figure 1). UNCTAD [11] highlighted the potential of creative economy with inclusion of fostering income generation, job creation and export earnings while promoting social inclusion, cultural diversity and uplifting people's livelihood. The vehicle for creative economy would be, among others, are the creative *kampung* (*village*) which embraced creative rural industries (mostly SMEs) and entrepreneurships.

Modern technologies in many ways have improved performance many small and medium enterprises (SMEs) in rural areas through mechanization process and more efficient marketing and business networking activities. On the other hand, modernisation shrank local job prospects by taking job from local people including in traditional businesses. A small scale, family or village owned and operated and utilizing local knowledge in rural areas could suffer the most if they fail to innovate and adopt new manoeuvring steps in facing these emerging challenges.

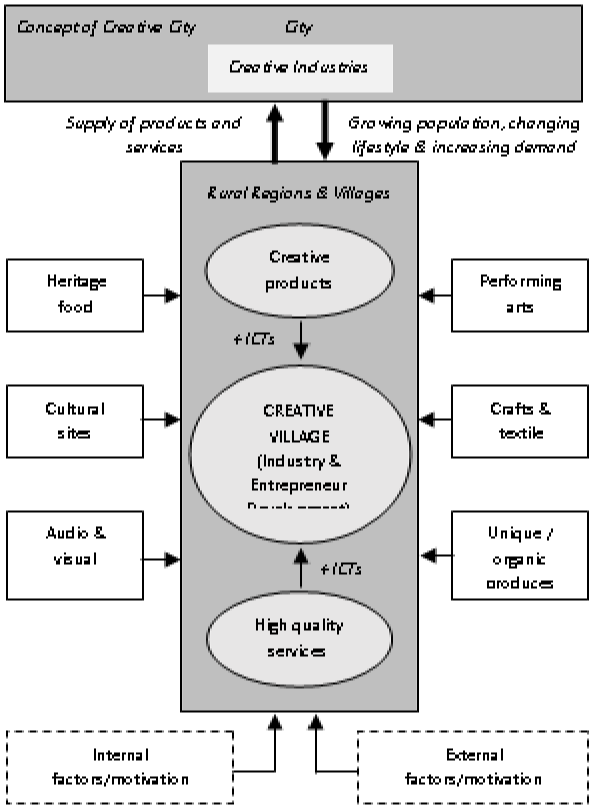

Fig.1. Creative village concept and its main classification as an extension of creative city agenda.
Source: Adopted from [3] [11] [13].

As shown in Fig. 1, the growing interest for creative village industries and entrepreneurial development might influence by growing demands of the urban population and lifestyle changes due to a better socioeconomic condition. Organic farming produces by rural farmers for their own consumption or for selling to local markets are consider as common practice. Similar examples for the using and small-scale trading of medicinal plants and foods. These products however, could have huge demand from people living in the cities. With greater purchasing power and concern for consuming organic and natural products regardless of the higher prices, this scenario could enhance the new and niche market for certain rural produces and services. Similar observation also occurred for other rural economic activity driven by utilising traditional knowledge and skills and creativity which be enhanced by modern inputs and ICTs including rural tourism, handicrafts making, music and cultural performances, textile (particularly batik) and traditional food which might be able to rejuvenate rural development [3] [11].

Review of literature also enable authors to identify three crucial components that underpinned the idea of creative village namely; (1) elements; (2) requirements and; (3) indicators. The detail sub-components under each main component is explained in Fig. 2.

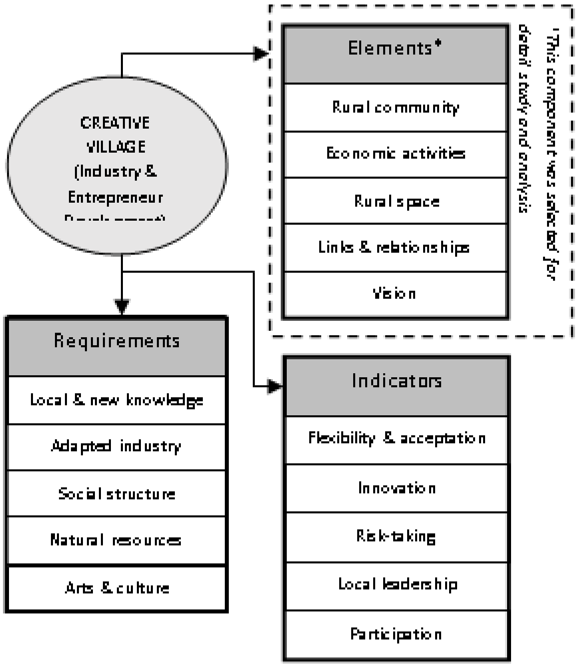

Fig.2. The structure of the key factors of the creative village.
Source: Adopted from [8].

It is worth mentioned that due to research limitation (i.e. financial barrier to fund movement and to conduct frequent visits for comparative study), this paper will be presenting key findings from component (1) i.e. “elements” consist of five sub-components namely; rural community, economic activity, rural space, links and relationship and vision. Results from comparative study involving two case study of creative *kampung* in Kuala Kangsar, Malaysia and Gemawang Village in Semarang Regency, Central Java Indonesia. It is expected that the findings might have values particularly in improving the understanding on the concept of creative *kampung* from different localities, internal and external key drivers for transformation of creative kampung and entrepreneurship development.

MATERIALS AND METHODS

Study Approach

This study adopted a qualitative approach for data capture and analysis, the use of single case study for each country (yet will allow for a more in-depth and detail analysis and discussions), survey of local small and medium enterprises (SMEs) including crafts makers and tourism-based operators, limited field observation and photography. The adoption of all these methods can be best explained in two main stages namely: (1) Field study and data collection, and; (2) Data analysis and synthesis. Details for each stage of field study and data collection are presented in Table 1.

Table 1. Description of research methodology

Stage 1: Field study and data collection a) **Interview of respondents (local entrepreneurs)**	
Type of data: • Profile of respondent • Respondents’ key motivational factors & reasons for respondents to venture into OVOP • Respondents’ main issues/challenges in OVOP	Methodology: • Interview session was conducted in respondents’ workshop / souvenir shops • Take photos of workshop/souvenir shop condition and economic activities of operators • Informal interview with head of the village, committee and local representatives
b) Cyberspace survey	
Type of data: • ICT media that currently being used by entrepreneurs • How local people benefited from the usage of ICT media	Methodology: • Search and observe all websites and content with name of villages as a keyword
Stage 2: Data Analysis a) Synthesis of findings	
• Production of field survey report	• Descriptive and comparative analysis based on Creative Kampung “element” (Fig. 2) (findings were presented in simple table form)

Source: Research fieldwork [1] [10].

Study Areas

Sayong village is identified as one of creative village (kampung) that actively involved in the making of pottery which started for more than 100 years ago. Their distinctive and

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popular pottery product known as "Labu Sayong" and located in Kuala Kangsar district in Perak state, Malaysia. The selection of Sayong village in particular made after reviewing all relevant information on ODOI (One District One Industry) producers in Malaysia from the ministry of Rural and Regional Development and Malaysia Craft Agency (commonly known as *Kraftangan Malaysia*) [4]. Based on report from *Kraftangan Malaysia*, there are at least 35 active pottery makers and entrepreneurs in Kuala Kangsar and many of them concentrating in Sayong area since clay from Sayong is considered the best quality for Labu Sayong pottery [10] (Fig. 3).

Fig.3. Location of study area at Sayong village, Kuala Kangsar district, Malaysia.
Source: Google Map.

Majority of respondents participated in this study are the pottery makers. They are diversifying their craft/pottery business by integrating workshop (production area) and sales gallery (or souvenir shop) for tourism purposes. In every visit, visitors will be presented with live demonstration by the pottery craftsmen on moulding process (i.e. how to press liquid clay into moulds of various shapes and sizes) and then using the spinning machine for pottery decoration before drying process of end products. Every visitor/tourist can participate in these processes via interactive "learning by doing" activity (Photo 1 and 2). Moreover, they can purchase and bring home their own hand craft pottery after the activity. Many of tourist are school children which on their school trip and also some tourists from abroad [10].

Photo 1 and 2. Pottery making process in Sayong village, Kuala Kangsar
Source: Research fieldwork [10].

With advancement of manufacturing and ICT technologies, the pottery making process in Sayong had undergone significant changes. For many entrepreneurs, manual works of shaping the clay vast has gradually been replaced with the use of mould press. This is to ensure uniformity and standardization of end products. Although for some clients and/or tourists, the usage of modern method including mould press might affect the authenticity of Labu Sayong (because each vast is too perfectly shaped!), from the entrepreneurs' point of view, using some technologies would allow less experience workers to be employed to carry out the job [10].

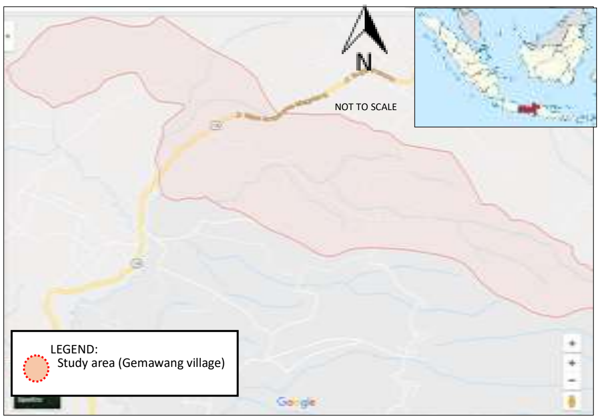

Fig.4. Location of study area at Gemawang village, Semarang Regency, Central Java, Indonesia.
Source: Google Map.

Almost all Labu Sayong entrepreneurs leveraging on ICTs particularly social media platforms and website to promote their products, interact with potential clients and for handling online booking activity.
The second case study is Genawang creative village which located in the south of Semarang District, directly adjacent to

Temanggung and Magelang regencies, with population of 3,456 people. The village of Gemawang was chosen as one of test site under "Vocational Village project" by the Centre for Non-Formal and Informal Development (P2PNFI) (now P2PAUDNI) Regional II in 2004 [1]. At that time, there are three business groups which actively involved in batik and food-based SMEs. All three businesses were selected for detail study prior to their utilisation of local resources in production of batik and food (Photo 3 and 4). Information from P2PNFI indicated that the vocational village program has improved vocational skills among local entrepreneurs and craftsman, hence strengthening business group development in facing future challenges. In addition, majority of program participants are now enjoyed economic improvement, better social status, mindset changes, increase literacy and ability to plan for their own future [6].

Photo 3 and 4. Batik production and development of Gemawang as tourism village in Semarang Regency.
Source: Research fieldwork [1].

Prior to Gemawang's success story in implementing P2PNFI vocational program, local businesses reap most of the benefits including increased visitation from tourists and district and local government officials who wanted to learn about vocational village and rural entrepreneurial development in batik making business. Interactions with outsiders and expansion of business networks has allowed Gemawang village to evolve into tourism village. The development of tourism village has led to the provision of accommodation facilities or homestay for tourists to stay, as well as the development of other attractions and tourism-related businesses. Management of homestay is carried out by certified local homestay managers which already undergone intensive training [1]. Local business groups then formed a voluntary based organization with focus on enhancing tourism awareness among locals and persuade greater participation among locals into tourism activities in Gemawang. This organization is named *Pokdarwis* who take care of tourism activities in the village. Other than tourism-related businesses, people of Gemawang village have actively involved in craft making, traditional food making and hosted few international events. In 2010, Gemawang hosted the International Literacy Day celebration with the support of 35 regencies all over Central Java [1].

RESULTS AND DISCUSSIONS

ICT and Creative Village

Since the early establishment of vocational villages in Gemawang, Indonesia and creative village under ODOI initiative in Sayong, Malaysia, local entrepreneurs become increasingly aware of the necessity of using ICT particularly smartphones, email/SMS (short massages) and social media platforms for promotional activities and widening their business networks. ICT personnel also appointed by the local business community to create and manage blogs and websites for each unit of activity. Based on random website survey process, many of these blogs however, did not show recent activity (some blogs only been updated in 2012 and up to 2016). It is also worth mentioned that appointment of one or few IT personnel for website or blogs maintenance might not effective to promote local business.

Recently, many local entrepreneurs shifted towards fully utilised social media platforms including WhatsApp and Facebook to engage with potential clients from local and abroad [9] [10]. However, new issue had emerged i.e. the displays of content in social media often not related to their business interests. This issue urged local business group in Gemawang to develop human resources in ICT and provide appropriate training program. ICT media about Gemawang and Sayong also leveraging on online internet videos particularly YouTube and Marketplace [4] [12].

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Comparative Analysis on Elements of Creative Village

Table 2 discusses the findings from fieldwork activities carry out in Sayong village, Malaysia and Gemawang village, Indonesia.

Table 2. Comparative analysis between Gemawang village and Sayong village in relation to the concept of creative village

Creative village elements*	Case study of Gemawang village, Indonesia	Case study of Sayong village, Malaysia
1. Rural Community	All villages in Jambu District are categorised as rural areas according to Semarang Development Plan. The area is covered by vast agriculture land (785.96 hectare) consist of 27.93 hectare of rice field and 629.53 hectare for food crops (cassava) and plantation crops (coffee and rubber). Gemawang village is located near the main road between Semarang and Yogyakarta. Majority of its population are farmers.	Sayong village is maintains its rural setting i.e. surrounded by orchards and small-scale rubber and palm oi plantations but located near to the town of Kuala Kangsar (less than 5km). The village connected by main road and two main bridges make it highly accessibility for locals and visitors. The majority of its population are Malays which also synonym with the image of Kuala Kangsar as the Royal Town of Perak state.
2. Economic Activities	Main economic activities in Gemawang are agriculture and farming-related industries including producing agriculture products such as honey, coffee, spices, cassava chips. Other agro and small-scale industries are handicraft production such as batik, shoes and wooden craft toys. Hence, Gemawang becomes a creative village under the vocational village scheme supported by tourism and small-scale industry activities.	Main economic activities in Sayong and nearby areas are agriculture-based including working in small-scale rubber and palm oil plantations. Other supporting yet important economic activities are including pottery/Labu Sayong industry and selling traditional delicacies including grill fish and *laksa* Kuala Kangsar – since Kuala Kangsar town located strategically between Gerik and Ipoh which make it famous among travellers to stop by.
3. Rural Space	Gemawang is a rural with highland area setting. The centre for all communal activities taken place in *balai* (meeting hall), mosque and *lapangan* (big green open space functioned as gathering place).	Sayong village is showing a typical characteristic of a rural village i.e. dominated by vast agriculture land. The centre for activity is the *padang* (green open spaces / football field) and mosque.
4. Link and Relationship	Gemawang village involves in social cohesion and relationships where the individuals with facilitation and group work skills are the valuable guides in the development of teamwork, strategy and synergetic optimisation within their community. Gemawang village society, like Javanese society in general, has strong community attachment. The Javanese people have "Gotong Royong" tradition in which people will help each other immediately if needed by their neighbours. High social cohesion and strong relationship also supported by existing kinship among the community. The economic activities in Gemawang indicate that the established business networks include suppliers of raw materials (in batik groups), shops/stalls (within the group), outside business centres (in wooden toys groups), and village organisations. These groups share common values and norms; values of openness, mutual assistance, and an agreed division of labours. Trust among members are achieved through openness with others by building commitment to quality, and clear information about the product. Information related to business improvement is achieved through learning from experience, informal learning, and mass media. (Tohani, 2015)	Based on the interview, the business ecosystem involving pottery makers in Kuala Kangsar occurred in a symbiotic manner. Young craftsmen are employed and nurture their skills in pottery making process. These workers are allowed to quit and establishing their own pottery workshop in future. For local entrepreneurs, nurturing future entrepreneurs and young craftsman to continue Labu Sayong production is far more important than monopolise the business itself (stressed on sustainability and continuity of local knowledge and skills in making the pottery). There is a business competition but they tend to explore and expand market for their products. For small scale pottery makers with limited capital, they are more focusing on marketing their product for local demand. On contrary, a bigger scale entrepreneur with bigger capital and production volume, are expanding their market to nearby states, to Kuala Lumpur and into international markets (some have exported to Dubai, etc.). Relationship between entrepreneurs and government agencies particularly the Rural and Regional Development Ministry, Ministry of Tourism and Kraftangan Malaysia is rather good. All active pottery makers often been invited to participate in any craft exhibitions either at national or international level. Necessary support and assistance shall be given to those who are committed to join the exhibition.
5. Vision	In Gemawang, vision will visible on action where the community is increasingly trusting and engaging in vocational group activities. The level of tourism in Gemawang supported by voluntary based organisation known as Pokdarwis which aims to drive Gemawang communities to tourism awareness in their village. After the administrator develops a concept of sustainability for the organisation, they will introduce and communicate to the community about vision of Pokdarwis. The concept should be economically and realistic for the community [1]. After the community accepted the vision or the concept, many new businesses emerges and they became part of the vocational group of various agriculture products and small-scale industry even though they were not involved in the vocational group from the beginning.	All respondents acknowledge the importance of SDSI (One Village One Industry) status in fostering the development of creative village for Sayong. With status as SDSI site, local entrepreneurs are given better opportunity to interact with Kraftangan Malaysia office in Kuala Kangar where the agency is responsible for providing training to entrepreneurs and nurturing young pottery and in giving prospect for Labu Sayong products. Since Kraftangan Malaysia established district/regional offices in various parts of this country, given better opportunity for promotion and marketing of Labu Sayong produced by makers from Sayong area. Initially there was a local cooperation established in Sayong to take care of development of Labu Sayong. However, the cooperation did not success in enhancing the project, hence faded due to lack of leadership and inability to evolve and to respond to current market needs and rapid changes.

Authors' creation based on literature presented in Fig.2.
Source: Research fieldwork [1] [10].

It is worth mentioned that both cases leveraging on local culture and knowledge to strengthening local product development and services. In the case of Sayong, distinctive local pottery product popularly known as “Labu Sayong” was promoted as the unique product of Kuala Kangsar. The production of Labu Sayong has utilizing local materials while maintaining local knowledge and expertise in pottery making. As for Gemawang village, the important project is related to Batik making and village tourism. The business also employs many local craftsman including youths and the poor households. Good rapport between local stakeholders and business groups with government agencies and investors, have created positive business ecosystem that not only enhancing production and marketing, but in creating many tourism-related activities in the area. With the role of ICT becoming more and more important, almost all entrepreneurs adopting the technology for marketing and business transactions.

CONCLUSIONS

This paper presented some key findings based on comparative study of two creative *kampungs* (*villages*) in Kuala Kangsar, Malaysia and Gemawang Village at Semarang Regency, Central Java Indonesia. The key findings are:

(1)The symbiotic relationships between the communities such as kinship and cooperation could empower the creativity of economic activities in the village.

(2)The vision for village development should be in parallel with the integration of actions by various stakeholders especially the communities.

(3)Local culture, knowledge and leadership could strengthen and sustain the local product development.

It is expected that the findings might have values particularly in improving the understanding on the concept of creative kampung from different localities, internal and external key drivers for transformation of creative kampung and the utilisation of ICT into entrepreneurship development.

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PERSPECTIVES OF HAY-MAKING PRODUCTION ON SLOPES WITH SOUTH AND NORTH ORIENTATION ON EXAMPLE OF CHERNOZEM PODZOLIZED IN UKRAINE

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Abstract

The aim of this work was to compare the results of biogeocenotic perspectives estimation for vegetation cover on slopes of different orientations (north and south) on an example of chernozem podzolized, situated in Forest Steppe of Ukraine. Geocenotic characteristics included nitrogen, phosphorus, and potassium content in the soil, so as soil organic matter (humus) and the reaction of the soil solution (pH)– determined for the basic genetic horizons of soil profiles. Biocenotic characteristics included analysis of the plants species composition and yield of grasses on each slope, according to the moisture regime differences and changes in humus content and reaction of the soil solution. The article presents the botanical composition of natural herbage on both slopes of different exposure and presents the humus content and soil pH data by comparing the data of 1987 and 2017 years. The percentage of prevailing herbs families of hillside area and the number of hay-making production are also presented.

Key words: *biogeocenosis, slope lands, orientation, adaptation, botanical composition*

INTRODUCTION

Meadow grasslands, especially on hillsides, have multicomponent and important soil and plant (biogeocenotic) structure. They are the major energy storage and organic matter producers. Creating a thick vegetation cover, they reliably protect the soil from water and wind erosion and serve as an important source of high-quality cheap forage at the same time [4, 6]. The most favorable conditions for plant growth and development are provided by black soils (in Ukraine - *chernozems*) due to the combination of their optimal physical, chemical and agrophysical properties. The reproduction of highly productive and erosion-resistant natural grasslands on hillsides has an economic and environmental profit. Biogeocenoses heterogeneity of plants is such an important feature of vegetation agglomeration that plays an important role in the plant adaptation processes to seasonal and varied changes in ecological conditions and require necessary phytogenesis resources [2].

The assessment of hillside exposure (slope orientation) during the comparison of their biogeocenotic functions is important because it allows us to take into account the difference between their microclimatic indices and to find the difference in the quantitative and qualitative composition of the expected biomass.

The uneven distribution of rainfall and varied utilization of water due to the different intensity of transpiration and evaporation processes on the slopes of different exposure are important for the qualitative and quantitative composition of plants. The maximal intensity of these processes is on the slopes of the southern exposure that receive the largest amount of solar energy [13].

In Ukraine, the crucial moisture deficiency has an impact on vegetation mostly in spring and early summer, when short rainfalls occur. Vegetation on the eastern, southern and western slopes suffers the most, while at foothills additional humidity can be observed [14]. Therefore, the task of assessing biogeocenotic features in order to optimize the functioning of natural forage lands on the hillsides and to preserve their species diversity due to changes in soil fertility over time is a necessary and relevant objective.

MATERIALS AND METHODS

Investigation of biogeocenotic features of hillside lands due to soil fertility parameters and characteristics of botanical composition along with grass yields were conducted in the conditions of *chernozem podzolized on loess*, located in the middle part of slopes with different exposure (north and south) within "Balanchivska" ravine, near village Momotovo in Kharkiv region.

Additionally, comparisons of similarly obtained results were made for both slopes with different exposures [8]. Geographic coordinates of the hillsides location for the north exposure - N = 36.44890, E = 50.06030; for the south - N = 36.44890, E = 50.06100. Mapping of the study area, hillside shapes and their locations with geographic coordinates are presented below (Fig.1). A comparison of results for the study area obtained by similar methods for soil parameters (the total humus content and the reaction of the soil solution) included relation to the metrics obtained 30 years ago. In addition, laboratory research methods in present days also included the horizon-wise determination of the ammonium nitrogen content (NH_4), flexile phosphorus (P_2O_5) and potassium (K_2O) content [5]. The observation, accounting, and production of yield data for terrestrial plant biomass were performed according to generally accepted methods. Biomass analysis of mowed grass was carried out with a working tool – compact mower at a cutting height of 5-6 cm. Also, we determined the yield of green and air-dry biomass, botanical analysis of herbage on dried samples (selected for drying to determine hay yield over the past several years).

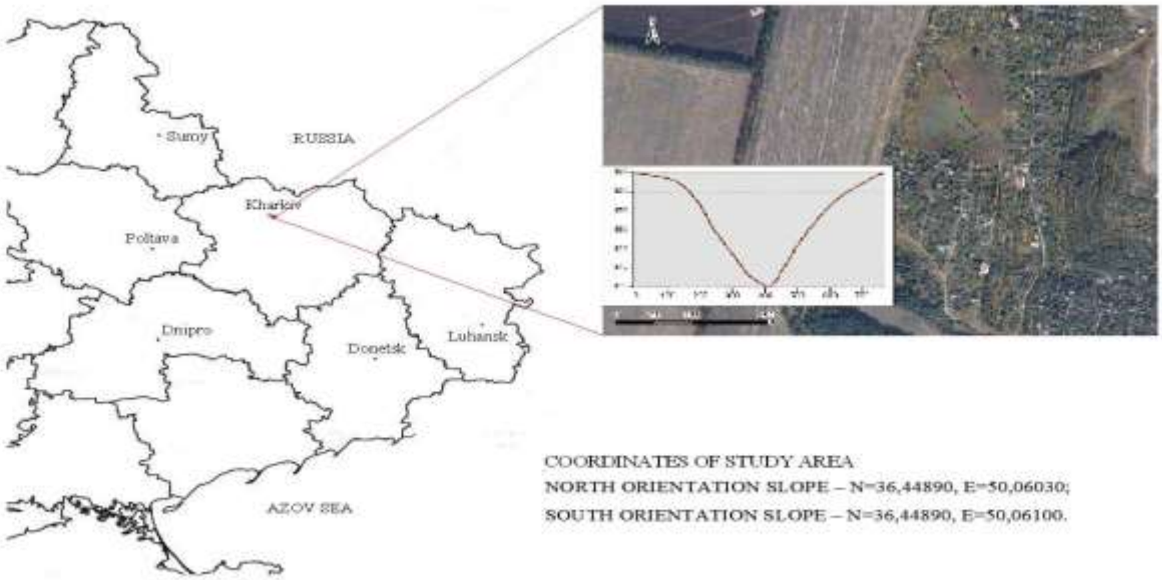

Fig.1. Map of study area (v. Momotove, Kharkiv region, Ukraine, 2017).
Source: Google and Bing Satellite Imagery [12]

RESULTS AND DISCUSSIONS

The study area with appropriate slopes has been chosen among many others in north-eastern direction from Harkiv town, Kharkiv region, Ukraine.

The soil, located on the slopes of the "Balanchivka" ravine of the Forest Steppe Left Bank, is presented by *chernozem* *podzolized* on loess parent material and has the following morphometric description of the south (S) and north (N) slopes horizons [11].

First horizon Hd 0-16 cm (S); 0-20 cm (N) – arable, porous, dust-lumpy, has a dark gray color with inclusions of plant roots, there are noticeable signs of SiO_2 along the entire profile length, the transition to next layer is unmarked. Next horizon He 16-45 cm (S); 20-60 cm (N) – humified, slightly eluted, more compacted with structure in comparison with the previous horizon, moist, heavy-loamy, with a slightly marked transition. Horizon Hi 45-80 (S); 60-90 cm (N) - slightly illuvial, less humified, moist, compacted, dark gray with the noticeable transition. Horizon Hp 80-106 cm (S); 90-130 cm (N) – upper transitional, less humified, compacted with some marks of colloidal traces along the edges of structural elements, dark gray color, transition noticeable. Horizon Ph 106-138 cm (S); 130-170 cm (N) - lower transitional, partly humified, dark gray color, with more thick structure, some marks of colloidal traces along the edges of structural elements, noticeable transition to the next horizon. Last one horizon P 138 cm (S); 170 cm – is a parent material, a light brownish color, slightly humified, gley loess.

This type is considered a high-fertile soil situated on the Left-Bank Forest Steppe and is most commonly observed within the right banks of rivers. It is suitable for growing all kinds of agriculture crops, but because of the location on high gradient slopes (10-15 degrees) is widely used as hayfields and pastures with limited grazing. For the analysis of soil, samples were taken in the middle of the slopes of different exposure (north and south), located opposite to each other.

The main differences between *chernozem podzolized* types on different slopes included deeper soil profile length on north slope with approximately the same thickness of the soil horizons.

The laboratory analyses result of soil samples horizons-wise given in Table 1.

In 1987 the humus content for the north exposition slope were for horizons (%): Hd – 6.80; He – 5.45; Hi – 4.10; Hp – 2.66; Ph – 1.55. Same values for south orientation soil horizons were lower (%): Hd – 3.55; He – 2.66; Hi – 1.80; Hp – 1.30; Ph – 0.60.

Table 1. Soil fertility parameters for horizons of *chernozem podzolized*, v. Momotove, 2017

Soil horizons	**Humus content, %**	**Soil fertility content**			**pH**
		NH_4 mg/100g	**P_2O_5** mg/100g	**K_2O** mg/100g	
North exposure slope					
Hd	6.46	45.49	2.44	78.33	5.85
He	6.24	37.42	2.00	66.28	5.81
Hi	5.61	31.91	1.53	69.29	5.90
Hp	4.97	30.66	1.22	72.30	5.85
Ph	2.43	29.07	0.84	93.39	5.85
South exposure slope					
Hd	4.76	43.51	1.42	84.35	6.12
He	4.13	35.50	1.33	90.37	6.20
Hi	3.49	26.31	0.94	90.37	6.23
Hp	2.96	27.80	0.81	90.37	6.33
Ph	2.01	27.26	0.50	66.40	6.43

Source: authors analyzation and calculations.

The soil aqueous solution reaction values were distributed somewhat differently. Thus, for the slope of the north exposition along the horizons in 1987 they were: Hd – 5.95; He – 6.0; Hi – 6.1; Hp – 6.0; Ph – 6.15. Same pH-values for south orientation soil horizons were higher: Hd – 6.15; He – 6.30; Hi – 6.40; Hp – 6.40; Ph – 6.62.

According to this such soil type has an average soil fertility level and is typical for conditions of Left Bank Forest-Steppe of Ukraine.

After taking into account the humus values and the reaction of the soil aqueous solution, the corresponding comparative diagrams of their values have been plotted over the horizons.

The soil data obtained from the analysis indicates a slight humus content decrease in the arable layer on the north faced slopes, while the humus content is increasing along other horizons and along the entire soil profile. The difference in humus content between the north and south exposure slopes fluctuates by several percents at the top of the horizon.

Due to changes in the reaction of the soil solution, a slight decrease in the soil solution response rate was observed in all horizons. Thus, the pH of the north slope was lower than that of the south slope, and in the context

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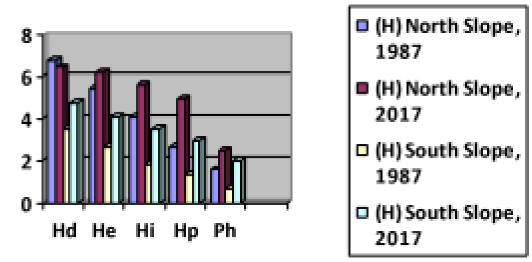
of 30 years period, there is a well-defined tendency to increase of the actual acidity in the soil.

Diagrams of parameters are presented below. (Fig.2)



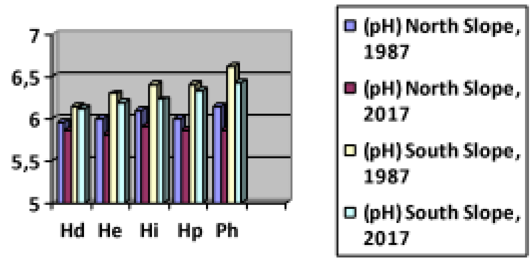


Fig. 2. Comparison of humus content (h) and the reaction of the soil solution (pH) values in 1987 and 2017 years.
Source: authors calculations and archival data [9].

The humus indicator reflects the content of nutrients for plant agglomerations on the hillside. The changing of the soil solution reaction towards acidification indicates increased assimilation of anions, which deteriorate the conditions of mineral nutrition. This also hinders the intake of calcium into plants, slows down the synthesis of proteins and sugars.

The study of issues regarding the improvement and preservation of natural forage considers the principles of ecology and biogeocenology - fullness of phytocenoses, economical and ecological complementarity of species, their different reaction to the influence of factors, etc [1, 3, 10]. In order to formulate a general idea about quantitative and qualitative aspects of the botanical composition present in grasses covering the slopes, we have systematized species belonging to certain genus and families. A survey of hillsides with various exposition of “Balanchivska” ravine indicates that the number of herbaceous plants included more than 70 species belonging to 13 orders, 21 families and 56 genera.

The largest number of them are of the legume family (Leguminósae) - 15 species. They also had the largest number of genera, which is the evidence of their high taxonomic and genetic diversity.

The second place was occupied by asters (Asteraceae) – 11 species, the third – grass cereals (Poaceae) – 9 species, the fourth – lip-flowers (Lamiales) – 7 species, the fifth-sixth – rose family (Rosaceae) and figwort family (Scrophulariaceae) – 4 species, the seventh-nine – buttercup (Ranunculaceae), umbrella (Umbellíferae) and forget-me-not (Boraginaceae) family – 2 species, tenth-eleventh – milkweed (Euphorbiaceae) and violets (Violaceae) – two species, but in each of two families.

Thus, legumes accounted for 21.5% of the botanical composition, asters – 15.7, grass cereals – 12.9, lip-flowers – 10.0, roses and figworts – 11.4, umbrellas and forget-me-nots milkweed and violets – 14.5 and the last ten families accounted for 14% of the total families.

During the years of experiments, among the grass cereals the most spread were such species as meadow bluegrass – Poa pratensis, couch grass – Agropyrum repens L., hungarian brome grass – Bromopsis inermis (Leys.), koeleria (or junegrass) – Koeleria delavignei Czern. et Domin, meadow fescue – Festuca pratensis Huds., volga fescue – Festuca sulcata Hack. та інші. Legumes were presented with alfalfa medica – Medicago romanica Prod., birds-foot trefoil – Lotus ucrainicus Klok., esparcet (Arenaria) – Onobrychis arenaria (Kit.), sweet clover – Melilotus officinalis (L.) pall, yellow alfalfa – Medicago falcata L., purple-globe clover – Trifolium alpestre L., mountain trefoil – Trifolium montanum L та іншими видами. Among the motley grass are common yarrow – Achillea millefolium, meadow sage – Salvia pratensis L., sagebrush wormwood – Artemisia campestris L., narrowleaf plantain – Plantago lanceolata, St John's-wort perforate – Hypericum perforatum L., leafy spurge – Euphorbia virgata Waldst. et Kit., brown knapweed – Centaurea-jacea L., white cinquefoil Potentilla alba L., sickleweed (longleaf) – Falcaria vulgaris Bernh., dwarf everlast – Helichrysum arenarium (L.) DC, clustered bellflower – Campanula glomerata L., common dandelion – Tarahacum officinale Webbex Wigg., mouse-ear hawkweed – Hieracium pilosella L., wild thyme -Thymus serpyllum L., viper's bugloss - Echium vulgare L., common gypsyweed – Veronica officinalis L., sour weed – Rumex acetosella L., fern-leaf dropwort – Filipendula vulgaris Moench., austrian wormwood – Artemisia austriaca Jacq., bird's-eye speedwell – Veronica chamaedrys L., common chicory – Cichorium intybus L. and others [7]. The next part of the study was the selection of typical vegetation clusters in relation to the regime of humidity and temperature on the example of cereals, legumes and herbs. After that, the differences between the characteristics of these phytocenoses on the slopes of different exposures were refined by clarifying the botanical composition of the natural herbage and hay crop by mowing.

It should be noted that among the plants with higher fodder value, the following species of cereal species were identified: meadow bluegrass, couch grass, hungarian brome grass, koeleria (junegrass), volga fesque and meadow fesque. Legumes were presented by yellow alfalfa, birds-foot trefoil, purple-globe clover and mountain trefoil and other species. Most species were of low-grade quality for foraging. The results of the ecological analysis confirmed that the main part of the species - mesophytes.

It also should be noted that during the botanical composition survey in 1987-1989, for an average of two years in the south exposition cereal grass species composed 52.9%, legumes - 8.9, and motley grass - 38.3%, and north respectively 54.1; 6.8 and 39.1%. In 2017 and 2019, we also determined the botanical composition of the herbage in both the south and north slope exposition (Table 2). Analysis of studies shows that, after a long period of time, compared to previously obtained results, the average number of cereals in the south exposition decreased by 3.1%, compared to the previously obtained results for the period 2017-2019, by 2.2% in the north 3.1%, however, the share of legumes, by contrast, increased by 2.2 and 3.1% respectively. The number of motley herbs increased slightly and was the same in both exposures (39.4%).

Table 2. Botanical composition of natural grass on slopes of different exposure, %

Production valuable groups of herbs	Years of study		Average for two years
	2017	2019	
South orientation slope			
Cereal grass	51.2	48.4	49.8
Legumes	9.4	11.2	10.3
Motley grass	39.4	40.4	39.9
North orientation slope			
Cereal grass	52.2	51. 6	51.9
Legumes	8.4	10.2	8.9
Motley grass	39.4	38.2	38.8

Source: authors analysation and calculations.

It should be noted that in determining the species composition of herbage in 2017-2019, we noted its slight changes compared to the previous survey. The number of herbs present in certain phytocenoses and some species increased slightly, namely there is an additional presence of such mezophites as false hellebore – Adonis vernalis L., erect cinquefoil – Potentilla erecta (L) Raeusch and comnion burnet – Poterium sanguisorba.

After a period of research in 2017 and 2019, we also determined the hay yield, which in the south exposition was higher than the average in 1987 at 0.08 t/ha more and equaled 1.77 t/ha, and in the north by 0.11 t/ha and equaled 2.09 t/ha. The distribution of grass yields by slopes was chosen as an indicator to characterize the productive properties of grasses. It allowed us to have a clue about the capacity of plant mass during the growing season, which is extremely important for planning the process of supplying livestock with green mass and the proper organization of work during hay harvesting. In our studies, the soil and climatic conditions contributed to two times haymaking activity instead of a single one (Table 3).

In our experiments, the first haymaking is usually obtained in the first decade of June and the second in late summer, or in the first decade of September. In the experiments conducted in 1987-1989, for an average of six years, in the south exposition, the first haymaking contributed 77.9%, and in the north 77.1% of the total hay harvest for the season, the rest accounted for the second haymaking (22.1-22.9%).

Table 3. Hay yield on slopes of different orientation, t/ha

Hay yields on slopes after two hay-makings					
2017		**2019**		**Average for two years**	
First hay-making	Second hay-making	First hay-making	Second hay-making	First hay-making	Second hay-making
South orientation slope					
1.38	0.34	1.40	0.42	1.39	0.38
North orientation slope					
1.60	0.42	1.64	0.52	1.62	0.47

Source: authors analysation and calculations.

In assessing the yield of natural hayfields in 2017-2019, it was also confirmed that the main part of it was the first haymaking, namely at the south exposure of 1.39 t/ha (78.5%) and at the north - 1.62 t/ha (77.5%). It should also be noted that the average hay yield for 2 haymaking at the north exposure was higher by 0.31 t/ha (18.1%) over the 2017-2019 average.

CONCLUSIONS

It was determined for *chernozem podzolized* what for a slope with north exposure the higher percentage of humus along all soil horizons, except for the upper one, indicates a higher potential yield than on the south exposure slope, that is confirmed by the yield data for all slopes of 2017 and 2019. Among the plant communities that prevailed on both slopes, the first place is occupied by grass cereals, the second place – by motley grass, and the last - by legumes. Appearance in 2017 of some new herbs belonging to mesophytes that are adapted neither to a particularly wet nor a particularly dry environment indicates on potentially appropriate biogeocenotic conditions.

Our research clearly shows the possibility of involving such slope areas of *chernozem podzolized* in hay-making production within a soil-protective land use strategy.

In spite of low-grade herbs quality for foraging, there is a stable profit of two hay-makings during a season and creation of stable vegetation cover to prevent erosion processes on hillslides.

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ECONOMIC MODELING OF SUSTAINABLE RURAL DEVELOPMENT UNDER THE CONDITIONS OF DECENTRALIZATION: A CASE STUDY OF UKRAINE

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Abstract

The content of rural territories development as a socio-economic-ecological system has been determined. It has been also proved that the study of rural development is of crucial importance because of the necessity to solve some socio-economic problems such as preservation of local customs, historical and ethnic characteristics. We have identified the decentralization as one of the vital components of democratic reformation, contributing to the transparency of the authorities' activity. The impact of decentralization processes on the indicators of sustainable rural development in Ukraine has been revealed. It manifests itself in the growth of employment and income of rural population, provision of medical and educational institutions, enhancements of road transport infrastructure, creation of conditions for business development and further diversification of economic activity in rural areas, environmental protection. The analysis of sustainable development of rural territories in the conditions of decentralization based on the application of the proposed methodology has been done. Integral indices of sustainable development of rural territories of Ukraine have been calculated using the determination of partial indices of social sphere development, economic and ecological situation. The results of modelling rural territories sustainable development in the context of decentralization can be used to make management decisions for the development and implementation of economic instruments with the aim of achieving such strategic prospects as reformation of local self-governments and territorial organization of central government in Ukraine. To analyze the impact of decentralization on achieving sustainable rural development prospects, the benefits and risks of this process have been identified.

Key words: *rural territories, decentralization, territorial community, sustainable development, social–economic sphere*

INTRODUCTION

One of the consequences of the crisis, which is characteristic of the development of the economy of Ukraine and its regions at the present stage, is the aggravation of the problems of rural improvement. Now rural territory occupies almost 90% of the total area of the country, where a third of the total population lives [7, 8, 29]. High unemployment rate, unfavorable demographic situation, migration processes, low availability of infrastructure and other negative trends require the development and implementation of effective mechanisms to ensure the competitiveness of rural areas and to improve the quality of life of rural population.

The current processes of creation and development of united territorial communities, which are taking place during the implementation of the decentralization reform in Ukraine and the Association Agreement with the EU, open up new prospects for enhancing the competitive advantages of rural territories and help to increase the efficiency of utilization of both available and potential rural development opportunities.

Theoretic-methodological and applied provisions on the essence of rural areas and ensuring their sustainable economic development in the context of decentralization are the subject of research by many scientists, including: Akimova L. [1], Boiar A. [2], Dziamulych M. [7, 8], Kravtsiv V. [12], Kitsyuk I. [15], Tsymbaliuk I. [16, 36, 37], Popescu A. [20, 21, 22, 23, 24, 25, 26, 27], Sodoma R . [31], Tofan I. [33], Yakubiv V. [38], Zhurakovska I. [39] and others.

Generalization of scientific approaches to ensuring the sustainable development of rural territories gives grounds to claim that there is currently no single conceptual approach to the concept of decentralization.

We reckon, rural development should be seen as a dynamic process that leads to structural changes in social, economic, financial, natural-environmental, institutional objects and phenomena occurring in a multicomponent spatial system formed on the territories outside cities [10].

Sustainable development is an enhancement that makes it possible to «meet the needs of the present generation without sacrificing the ability of future generations to meet their own needs» [15] Taking this into account, the sustainable development of rural territories is a socio-ecological-economic process of extended reproduction of rural territories development, which ensures the harmonious growth of economic, social, demographic, ethnic and environmental spheres.

In April 2014, the Government of Ukraine approved the Concept of Reforming Local Self-Government and Territorial Organization of Power in Ukraine. Issues related to administrative, budgetary, financial and land decentralization as well as the development of rural territories on which integrated territorial communities have been formed are often discussed on the pages of scientific journals, at scientific conferences and in political circles [11]. Issues concerning the development of recommendations for sustainable development of rural territories in the context of decentralization are currently relevant in Ukraine.

Theoretical, methodological and applied provisions concerning the nature of rural territories and ensuring their sustainable development in the conditions of decentralization have been revealed in many scientific works [15, 16, 2, 29]. In particular, Borshchevskyy V. V. considers the theoretical and applied aspects of functioning the mechanisms which increase the socio-economic potential of rural territories. Among the priority tasks in the context of ensuring the efficient functioning of the institutional mechanism for enhancing their socio-economic potential, the scientist emphasizes the decentralization of power and the increase of the institutional capacity of local governments [4]. Borschevskyy V., Zalutskyy I. outline the causes and consequences of stagnation in the process of improving the socio-economic status of rural territories in the context of decentralization of power and argue for the priority of taking into consideration territorial factors for ensuring sustainable development of rural territories and self-sufficiency of the united territorial communities [5].

Prytula Kh. reveals the nature and features of rural territories in the context of the implementation of national regional policy, generalizes approaches to the identification and classification of these territories. The scientist defines models of rural territories development and their application for ensuring their effective management [28].

Pavlov O. in the works [17, 18] defines the essence of rural territories as complex natural and socio-spatial formations, determines the factors of spatial development of rural territories, substantiates the strategic priorities of their development taking into account the levels, types and varieties of these territories. Pavlov O. reveals the shortcomings of the existing model of rural development on the basis of territorial communities [19], substantiates the positive effects of the integration of rural communities around urban territorial communities for the modern development of Ukraine.

Klyuchnik A. classified the rural areas by such features as production and economic orientation, natural potential, recreational and tourist activity, marketing potential, etc. [9].

Borodina O., Prokopa I. reveal the essence of inclusive rural development [3]. In his turn, Lupenko U. believes that in order to ensure sustainable development, villagers should be given the opportunity to implement their own entrepreneurial initiative, especially in agriculture [13].

Dax T., Copus A. believe that the main interest in rural territories development should be in focusing on pursuing policies that seek effective ways of nurturing local and regional assets across a range of policy areas in order to improve well-being and promote eco-friendly developments in European rural areas [6].

Siudek T., Czarnecki E., and Vashchyk M. assess the sustainability of rural development in all countries of the European Union. The study was conducted using economic, environmental and social indicators. As a result of the analysis, scientists find that there is a great deal of diversification of the economic, environmental and social development of rural areas among EU Member States. The authors believe that sustainable (rural) development exists only theoretically. In practice, this development somewhat deviates from equilibrium. In addition, rural development is a dynamic effect as it is constantly changing over time [30]. Tryhuba, A., Pavlikha, N., Rudynets reveal features of dairy development in rural communities [34, 35].

Scientists and practitioners state that the processes of decentralization reform have an impact on rural development. The results of the analysis of preconditions for sustainable development of rural territories in the context of decentralization will allow to make a conclusion on positive and negative sides of this influence.

The purpose of the article is to analyze the social, economic, environmental preconditions and to model the sustainable development of rural territories under decentralization to make managerial decisions in order to develop and implement the guidelines for achieving strategic perspectives for reforming local self-government and territorial organization of government in Ukraine.

MATERIALS AND METHODS

In the study we calculated the normalized indicators of the development of the social sphere of the Ukrainian rural territories and calculated the partial index of development of the social sphere of rural territories in Ukraine ($\mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}}$) by the formula:

$$\mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}} = \frac{1}{21}\left(\sum_{j=1}^{21} \mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}}\right),$$

The calculation of the partial index of development of economic situation in rural territories in Ukraine ($\mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}}$) is calculated by the formula:

$$\mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}} = \frac{1}{18}\left(\sum_{j=1}^{18} \mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}}\right),$$

We calculated the partial index of the development of the ecological situation in rural territories in Ukraine ($\mathrm{I}_{\mathrm{rur}}^{\mathrm{eccol}}$) by the formula:

$$\mathrm{I}_{\mathrm{rur}}^{\mathrm{ecol}} = \frac{1}{9}\left(\sum_{j=1}^{9} \mathrm{I}_{\mathrm{rur}}^{\mathrm{ecol}}\right)$$

We calculated the integrated index of sustainable rural development ($\mathrm{I}_{\mathrm{rur}}$) by the formula:

$$\mathrm{I}_{\mathrm{rur}} = \frac{1}{48}\left(\sum_{j=1}^{21} \mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}} + \sum_{j=1}^{18} \mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}} + \sum_{j=1}^{9} \mathrm{I}_{\mathrm{rur}}^{\mathrm{ecol}}\right),$$

A regression model of the dependence of the index of sustainable development of rural territories in Ukraine on partial indices of social, environmental and economic systems has been built according to the following formula:

$$\mathrm{I}_{\mathrm{rur}} = a_0 + a_1\mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}} + a_2\mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}} + a_3\mathrm{I}_{\mathrm{rur}}^{\mathrm{ecol}},$$

where:

a_0, a_1, a_2, a_3-parameters of model,

$\mathrm{I}_{\mathrm{rur}}$ – integral index;

$\mathrm{I}_{\mathrm{rur}}^{\mathrm{soc}}$ – index of social sphere development;

$\mathrm{I}_{\mathrm{rur}}^{\mathrm{econ}}$ – index of economic situation;

$\mathrm{I}_{\mathrm{rur}}^{\mathrm{ecol}}$ – index of ecological situation.

Modeling was conducted to make management decisions on the development and implementation of directions for achieving sustainable development of rural areas in Ukraine. It includes the construction of a multiple regression model using the methods of correlation and regression analysis.

RESULTS AND DISCUSSIONS

The subject of our study is the development of rural areas, which are part of urban, township and rural united territorial communities. The relationship between the concepts of «rural area» and «urban united territorial community» is schematically shown in Fig. 1. The relationship between the concepts of «rural area» and «settlement united territorial community» is schematically shown in Fig. 2. The relationship between the concepts of «rural area» and «rural united territorial community» is schematically shown in Fig. 3.

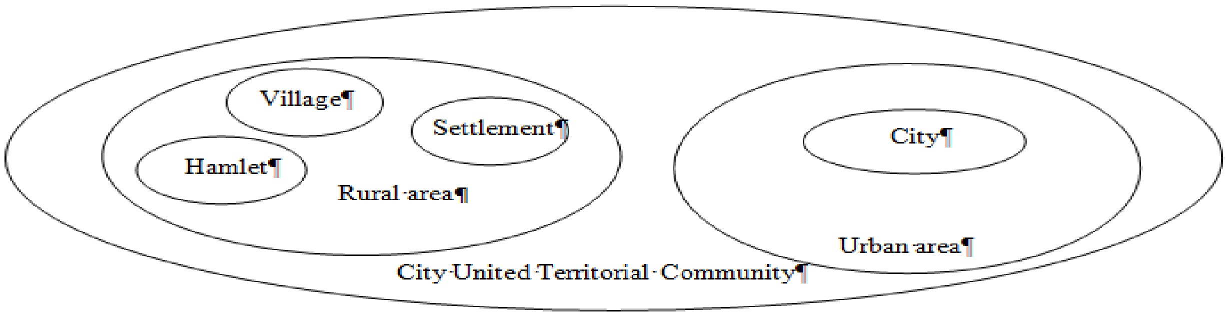

Fig. 1. Correlation of the concepts «rural territory» and «urban united territorial community»
Source: built by the authors.

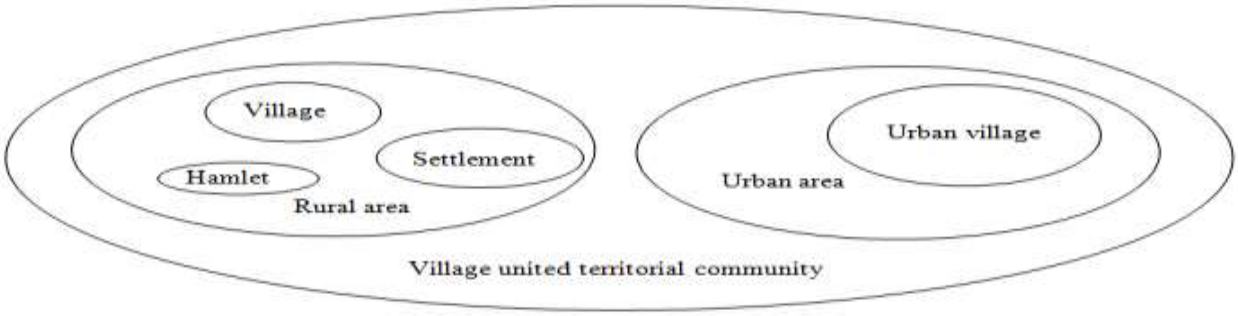

Fig. 2. The relationship between the concepts of «rural area» and «settlement united territorial community»
Source: built by the authors.

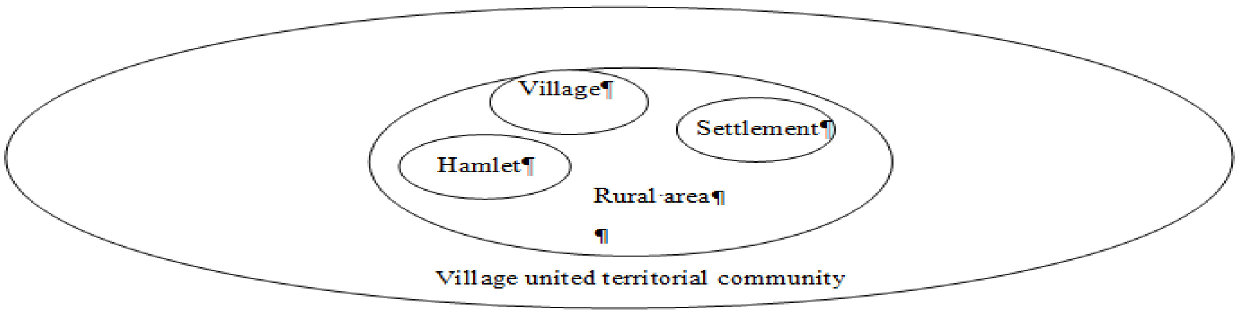

Fig. 3. The relationship between the concepts of «rural area» and «rural united territorial community»
Source: built by the authors.

According to our reckoning, a rural united territorial community is an administrative unit which, as a result of voluntary association of several villages, settlements and hamlets, is able to provide an appropriate level of service provision (educational, cultural, health care) independently or through relevant local governments, taking into account the relevant resources for the development of the infrastructure of this unit.

Rural communities formed as a result of decentralization contribute to rural development, which depends primarily on the villagers and the extent to which rural communities can maintain local infrastructure at the appropriate level, have access to a wide range of services, and work to intensify business and economic opportunities. .

As of November 1, 2019, 28,377 rural settlements were registered in Ukraine, which is 468 less than in 1991. Most of these villages disappeared in Kyiv, Kharkiv, Poltava, and Zhytomyr oblasts. Along with the decrease in the number of rural settlements, there is a decrease in the total number of rural population. During 1990–2018, the rural population decreased by 3.8 million people (from 32.4% to 30.7% of the total population). The dynamics of the rural population number and the share of rural population in the total population of Ukraine is shown in Fig. 4.

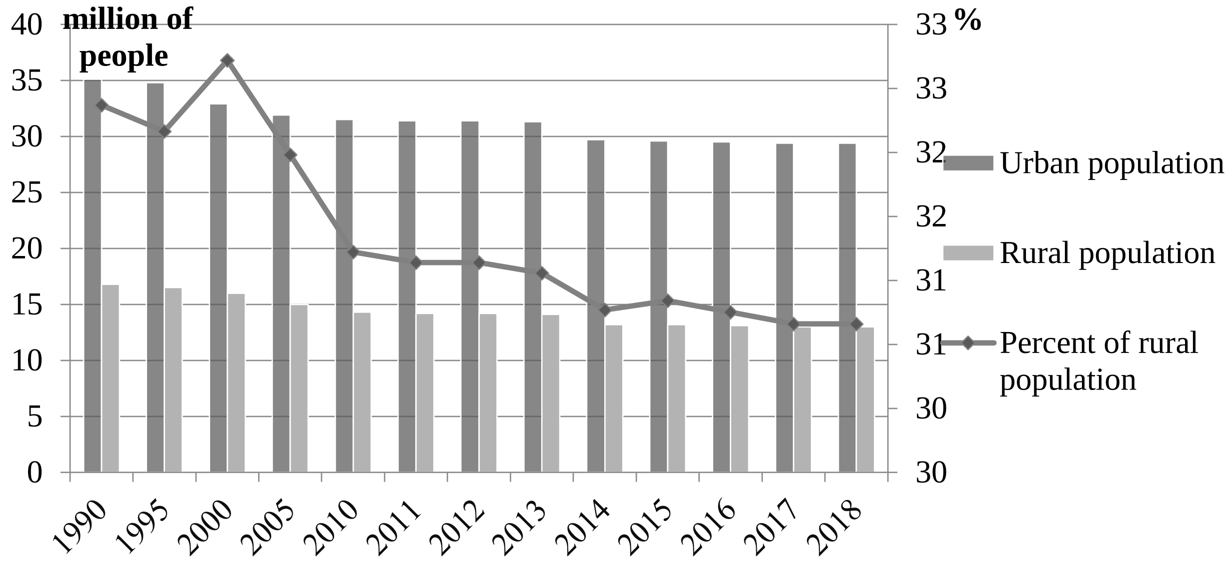

Fig. 4. Dynamics of the number of rural and urban population and the share of rural population in the total population of Ukraine, 1990 – 2018
Source: based on data [32, p. 29].

In 2018, the largest number of rural population per rural settlement was observed in Zakarpattia (1,368 persons), Chernivtsi (1,291 persons) and Ivano-Frankivsk (1,002 persons) regions.

An important social parameter of rural development is the general increase (decrease) of the rural population. In 2018, there was a total reduction of the rural population in Ukraine by 118.9 thousand people due to natural (108.2 thousand people) and migration (10.7 thousand people) reduction. The problem of migration outside territorial communities for all their types (urban, settlement, rural) is extremely relevant. The problem of population migration is especially acute for territorial communities that are located far from large cities and important highways.

The decrease in the number of rural residents is also due to a natural reduction, i.e. a reduction in the number of people of working age.

The main problem of rural residents' life is that their financial situation is more difficult than that of the urban population. The low standard of living of rural residents of Ukraine is evidenced by such an indicator as the share of the population with per capita equivalent cash income per month below the statutory subsistence level: in 2018 it was 4.3% nationwide, while in rural areas – 7.1 %. In 2018 the share of the population with per capita equivalent cash income per month below the actual subsistence level for Ukraine as a whole was 38.6%, and in rural areas – 48.4%. As of January 1, 2019, 4,465 thousand pensioners lived in rural areas, i.e. 38.9% of the number of all those registered at the Pension Fund of Ukraine, which is 775 thousand more pensioners than in 2017.

In rural areas, there is a rapid decline in the employment of active population, especially in the share of the employees working at agricultural enterprises. The decline in employment at agricultural enterprises is not offset by the expansion of rural population employment in other areas, as well as self-employment.

An important prerequisite for sustainable development of rural areas is the improvement of living conditions of peasants (because in addition to agriculture, rural development covers other areas, such as education, health, environment, infrastructure etc.). In general, only 41% of rural children of the corresponding age are covered by preschool education in Ukraine. There is not only a decrease in the number of preschool institutions and treatment and prevention facilities, but also in the number of libraries and clubs. The dynamics of reducing the number of commissioned residential premises in rural areas is observed.

We calculated the integrated index of sustainable development of rural territories I_{rur} . We determined the indicators of development of the social sphere, economic situation and ecological situation.

The indicators of the development of the social sphere of rural territories in Ukraine and their dynamics in 2014–2018 are revealed in Table 1.

Table 1. The indicators of the development of the social sphere of rural territories in Ukraine in 2014–2018

Indicator	2014	2015	2016	2017	2018
Share of rural population, %	30.88	30.81	30.77	30.71	30.59
Number of rural population per rural settlement, persons on average	467	464	462	459	454
Provision of living space, sq. m for 1 person	28.51	28.94	29.30	29.61	30.07
Share of apartments in residential buildings and non-residential buildings in rural areas, equipped with % running water	28.9	29.8	30.6	31.5	32.3
hot water supply	16.9	17.5	18.1	19.1	19.5
sewerage	25.2	26.1	26.9	27.7	28.5
central heating	1	1.1	1.2	1.2	1.3
heating from individual installations	48.1	48.8	48.9	49.5	49.9
stove heating	44.2	44.2	44	44.2	44
natural gas	53.2	53.5	53.7	53.8	54.1
Total increase, decrease (-) in the rural population, per 1,000 people	-75.9	-80.6	-73.3	-86.8	-118.9
Economically active population aged 15-70, thousand people	5,850.6	5,667.5	5,648.7	5,602.2	5,604.7
Economically inactive population aged 15-70, thousand people	3,615.9	3,647.7	3,633.7	3,674.1	3,644.9
Rate of economic activity, %	61.8	60.8	60.9	60.4	60.6
Employment rate, %	55.9	55.1	54.9	54.4	55
Unemployment rate, %	9.5	9.4	9.7	9.9	9.2
Coverage of children by preschool educational institutions, % to the number of children of the appropriate age	40	40	41	41	41
Number of rural settlements with 1 library	2.10	2.07	2.10	2.12	2.13
Number of rural settlements that have one club-type cultural institution	1.86	1.82	1.83	1.83	1.84
Provision of the population with hospital beds, thousand people per 1 bed	3.92	4.21	4.73	4.76	4.73
Share of households with access to the Internet at home, %	15.6	27.2	30.6	38.6	40.6

Source: formed on the basis of data from the State Statistics Service of Ukraine.

*Excluding the temporarily occupied territories of the Autonomous Republic of Crimea, Donetsk and Luhansk regions.

We calculated the normalized indicators of the development of the social sphere of rural territories in Ukraine in 2014–2018 and the partial index of the development of the social sphere of rural areas in Ukraine I_{rur}^{soc} (Table 2).

Table 2. Partial index of development of the social sphere of rural territories in Ukraine, 2014 – 2018

Year	2014	2015	Increase to the previous year,%	2016	Increase to the previous year,%	2017	Increase to the previous year,%	2018	Increase to the previous year,%
I_{rur}^{soc}	0.2817	0.2817	0	0.2812	-0.1910	0.2830	0.6690	0.2855	0.8580

Source: calculated by the authors.

At present, the agricultural sector is the foundation of a sustainable economy, filling budgets and space for attracting investment. The territory of Ukraine consists of 95% of lowlands and hills, 5% of it is mountainous, which is extremely favorable for the development of agricultural production. Ukraine ranks first in Europe in terms of agricultural land and arable land.

The area of agricultural lands of Ukraine as of January 1, 2019 amounted to 41,329 thousand hectares or 68.5% of the total land fund, of which arable land accounted for 32,544.3 thousand hectares or 78.74%.

The area of the plowed land in Ukraine is almost the largest in the world and is equal to 53.9%. High percentage of the plowed land is threatening, because it is the reason for the reduction of the natural potential of rural areas.

Agricultural development of Ukraine in 2018 was 71.3%, and the share of arable land in the total area of agricultural land was 78.7%.

For comparison - in the countries of the European Union plowing of agricultural lands is 25.6%, and in highly developed countries worldwide – 11.8% [14, p. 82].

A significant aggravation of the economic crisis can be seen in the sphere of agriculture - the main productive sphere of rural areas. Large agricultural holdings are mainly engaged in the cultivation of grain and industrial crops using advanced technologies, which virtually monopolizes arable farming. The largest area of agricultural land (3,977.6 thousand hectares) is concentrated in enterprises that owned and used more than 10,000 hectares.

As a result, enterprises practically monopolized the processing of agricultural raw materials and sales of marketable products.

Monopolization of land leads to the decline of small and medium-sized businesses in rural areas, farming.

The most important branch of the food sector in rural areas in Ukraine is grain production. This is due to favorable soil and climatic conditions, which are suitable for growing almost all types of cereals. Grain production plays an important role not only in the socio-economic and political development of the economy, but also in ensuring food security of the state. Ukraine ranks seventh in the world rating of grain producers.

Ukraine has been a world leader in the production and export of sunflower oil for several years in a row. At the same time, exports of seeds and fruits of oilcrops increased by +525 million US dollars (where rapeseed and soybeans hold key positions), and grain exports – by +428 million US dollars (mainly due to corn). The main market for Ukrainian agricultural products remains the Asian market, which slightly reduced its share in the structure of Ukrainian exports in 2017 to 45%, from 48% in 2016.

In order to calculate the integrated index of sustainable development of rural areas, the main indicators of economic development in rural areas in Ukraine and their dynamics in 2014-2018 have been identified, which is presented in Table 3.

Table 3. **T**he main indicators of the economic situation in rural areas in Ukraine in 2014 – 2018

Indicator	2014	2015	2016	2017	2018
GRP for 1 person, UAH	33.473	36.904	46.413	55.899	70.233
Level of agricultural land development, %	71.66	71.66	71.65	71.62	71.34
The level of plowing of the territory, %	56.16	56.18	56.18	56.18	56.18
The level of plowing of agricultural land, %	78.37	78.4	78.41	78.44	78.74
Provision of agricultural land per hectare per rural inhabitant	3.13	3.15	3.17	3.19	3.22
Number of business entities in agriculture, forestry and fisheries, thousand items	75.8	79.3	74.6	76.6	76.3
Share of economic entities in agriculture, forestry and fisheries in total, %	3.92	4.02	4.00	4.24	4.15
The level of profitability of agricultural, forestry and fisheries enterprises, %	42.30	41.70	32.40	22.40	17.90
Share of agricultural, forestry and fisheries enterprises that suffered losses, %	11.3	11.5	12.2	13.8	13.8
Share of the population employed in agriculture, forestry and fisheries, %	17.10	17.46	17.61	17.71	17.96
Average monthly nominal salary of full-time employees in agriculture, UAH	2,476	3,140	3,916	5,761	7,166
Production of agricultural products, UAH million	371.189	544.206	637.791	707.792	847.587
Volumes of capital investments in agriculture, UAH million	18.388	29.310	49.660	63.401	65.059
Share of capital investments in agriculture to total volumes, %	8.38	10.73	13.82	14.14	11.24
The share of transported products of agriculture, forestry and fisheries in the structure of all the goods transported by motor transport enterprises	12.93	13.51	12.78	13.94	12.42
Total resources of households in rural areas, on average per month per household	4.455	5.238	6.258	8.065	9.455
Income from the sale of agricultural activities	409.86	497.61	506.93	661.31	680.77
The cost of consumed products obtained from personal farms	494.51	639.04	725.97	798.42	907.70

Source: formed on the basis of data from the State Statistics Service of Ukraine.
*Excluding the temporarily occupied territories of the Autonomous Republic of Crimea, Donetsk and Luhansk regions of Ukraine.

The results of calculations of the partial index of economic development in rural areas in Ukraine I_{rur}^{econ} are presented in Table 4.

Table 4. Partial index of economic situation development in rural areas in Ukraine, 2014 – 2018

Year	2014	2015	Increase to the previous year, %	2016	Increase to the previous year, %	2017	Increase to the previous year, %	2018	Increase to the previous year, %
I_{rur}^{econ}	0.1201	0.1202	0.0463	0.1202	0	0.1214	0.9379	0.1210	-0.2975

Source: calculated by the authors.

In order to calculate the integrated index of sustainable development of rural areas, the main indicators of the development of the ecological situation in rural areas in Ukraine and their dynamics in 2014 – 2018 are highlighted (Table 5).

Table 5. The main indicators of the development of the ecological situation in rural areas in Ukraine in 2014–2018

Indicator	2014	2015	2016	2017	2018
Emissions of pollutants into the atmosphere from stationary sources of pollution of agriculture, forestry and fisheries, thousand tons. Their share in the overall structure of emissions, %	2.4	2.7	2.7	3.1	3.1
Emissions of carbon dioxide into the atmosphere from stationary sources of pollution of agriculture, forestry and fisheries, thousand tons. Their share in the total structure of emissions, %	0.5	0.8	0.6	0.9	0.9
The share of fresh water intake by agricultural enterprises from the total intake, %	36.08	32.81	33.84	37.01	43.89
The share of the area fertilized with mineral fertilizers, %	82	81	87	89	91
The share of the area fertilized with organic fertilizers, %	2	3	3	3	4
Share of generated waste from agriculture, forestry and fisheries in total, %	2.38	2.80	2.95	1.69	1.69
Share of forest reproduction areas to deforestation areas, %	15.16	15.13	16.36	15.44	11.56
Share of capital investments in environmental protection from agriculture in the volume of total capital investments, %	0.29	0.24	0.31	0.44	0.06
Share of current investments in environmental protection from agriculture in the volume of total capital investments, %	1.07	1.03	0.40	0.38	0.29

Source: formed on the basis of data from the State Statistics Service of Ukraine.

We presented the results of the calculations of the partial index of the development of the ecological situation in rural territories in Ukraine I_{rur}^{eccol} in Table 6.

Table 6. Partial index of ecological situation development in rural territiries in Ukraine, 2014 – 2018

Year	2014	2015	Increase to the previous year,%	2016	Increase to the previous year,%	2017	Increase to the previous year,%	2018	Increase to the previous year,%
I_{rur}^{ecol}	0.4162	0.4209	1.1132	0.4222	0.3089	0.4166	-1.3134	0.4053	-2.7150

Source: calculated by the authors.

The results of the calculations of the integrated index of sustainable development of rural areas (I_{rur}) are presented in Table 7.

Table 7. Integrated index of rural development in Ukraine, 2014 – 2018

Year	2014	2015	Increase to the previous year, %	2016	Increase to the previous year, %	2017	Increase to the previous year, %	2018	Increase to the previous year, %
I_{rur}	0.2727	0.2743	0.5868	0.2745	0.0972	0.2737	-0.3157	0.2706	-1.1206

Source: calculated by the authors.

The basis for making management decisions on the development and implementation of the guidelines for achieving strategic prospects for sustainable development of rural areas in Ukraine are the results of our modeling.

The initial data for the correlation-regression analysis of the relationship between the integrated indicator of rural development I_{rur} and partial indices of social development I_{rur}^{soc}, economic I_{rur}^{econ} and environmental I_{rur}^{ecol} situation in rural areas are presented in Table 8.

Table 8. Initial data for the construction of a correlation-regression model of rural development in Ukraine, 2014 – 2018

Year	Integral index	Index of social sphere development	Index of economic situation development	Index of ecological situation development
	Y	X_1	X_2	X_3
2014	0.2727	0.2817	0.1201	0.4162
2015	0.2743	0.2817	0.1202	0.4209
2016	0.2745	0.2812	0.1202	0.4222
2017	0.2737	0.2830	0.1214	0.4166
2018	0.2706	0.2855	0.1210	0.4053

Source: calculated by the authors.

The existence of a correlation between the features X_1 I_{rur}^{soc}, X_2 I_{rur}^{econ}, X_3 I_{rur}^{ecol} and Y I_{rur} is checked by the graphical method and the method of analytical grouping, which is presented in Fig. 5, Fig. 6, Fig. 7.

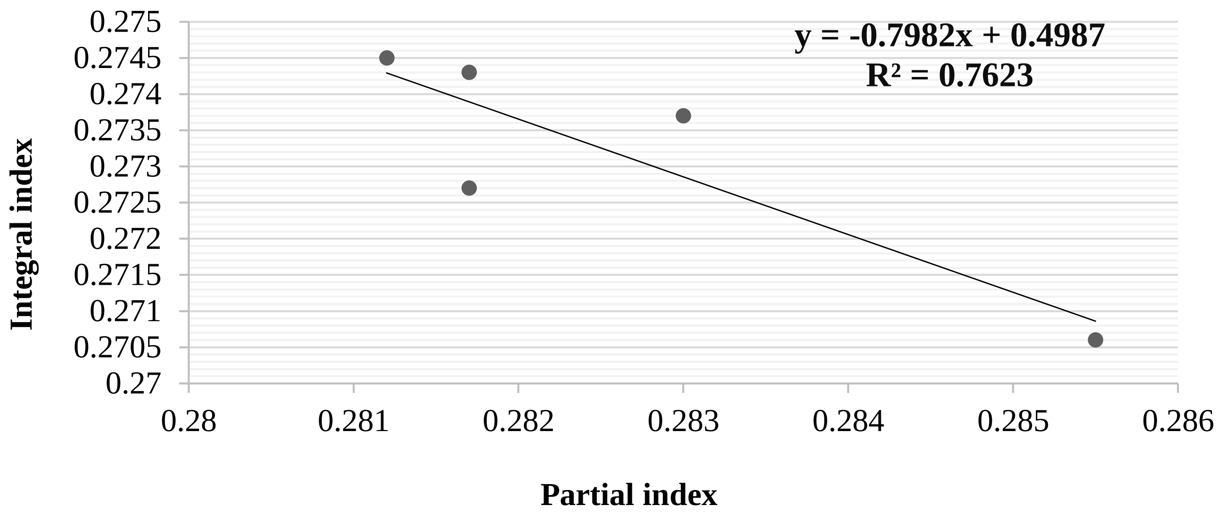

Fig. 5. Correlation field of dependence between the partial index of development of the social sphere and the integrated index of sustainable development of rural areas in Ukraine
Source: built by the authors.

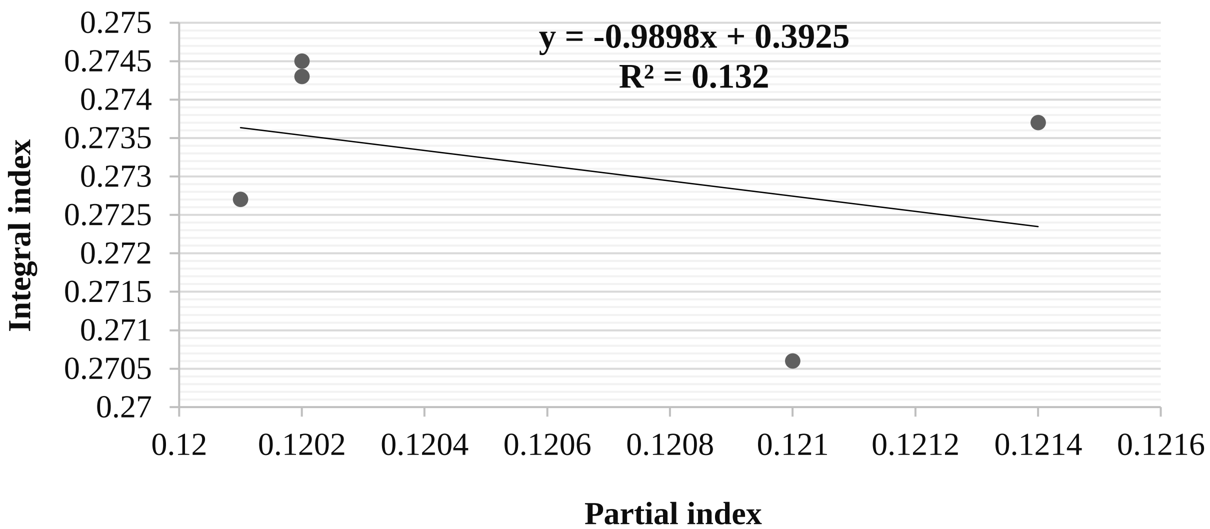

Fig.6. Correlation field of dependence between the partial index of economic situation development and the integrated index of sustainable development of rural areas in Ukraine
Source: built by the authors.

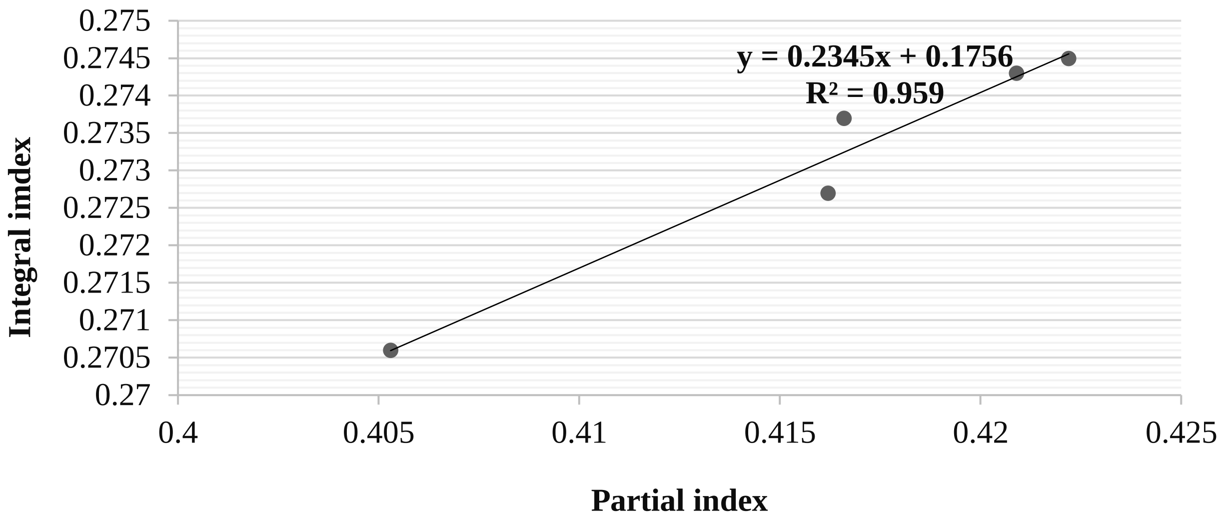

Fig. 7. Correlation field of dependence between the partial index of ecological situation development and the integrated index of sustainable development of rural areas in Ukraine
Source: built by the authors.

We can see the highest level of dependence between the index of environmental development and the integrated index of sustainable development of rural territories.

In the case of the index of development of ecological situation, we can say about the direct nature of the relationship according to the location of points from the lower left to the upper right corner, and the inverse relationship in the case of the index of social and economic development. Thus, the determining factor for the sustainable development of rural areas is the development of the environmental sphere. That is, in the formation and development of economic potential and actions aimed at improving the social situation in rural areas, it is necessary to take into account what impact such actions will have on the environmental situation. In addition, the issue of the existing impact of the economic sphere on the environmental situation is important. On the other hand, this trend is explained by the traditionally insignificant negative impact on the environmental situation as compared to cities, where industrial production is usually concentrated. In addition, the population density factor is important, which allows rural areas to be in closer contact with the natural environment.

Based on the constructed graphs, to determine the correlation between the features X_1 I_{rur}^{soc}, X_2 I_{rur}^{econ}, X_3 I_{rur}^{ecol} and Y I_{rur} we obtained the regression dependence equation for each partial and integral index in pairs (Table 9).

Table 9. Correlation relationship based on integrated analysis data

Contents of the relationship	Regression dependence	Components of equation
The impact of the social sphere on the sustainable development of rural areas	y = -0.7982x + 0.4987; R^2 = 0.7623	y – integral index of rural territories sustainable development (I_{rur}); x – index of social sphere development of rural territories (I_{rur}^{soc})
The impact of the economic situation on the sustainable development of rural areas	y = -0.9898x + 0.3925; R^2 = 0.132	y – integral index of rural territories sustainable development (I_{rur}); x – index of economic situation of rural territories (I_{rur}^{econ})
The impact of the environmental situation on the sustainable development of rural areas	y = 0.2345x + 0.1756; R^2 = 0.959	y – integral index of rural territories sustainable development (I_{rur}); x – index of ecological situation of rural territories (I_{rur}^{ecol})

Source: Built by the authors.

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However, the analysis of data using the method of constructing correlation fields of dependence between factor features is a preliminary stage of modeling and demonstrates the relationship between only two features.

That is, the reliability of the obtained data can be considered to some extent only partial, but not erroneous. To obtain a more reliable picture and determine the level of interdependence between integral and partial indicators, we should build a multiple regression model.

A matrix of pairwise correlation coefficients has been constructed in order to detect the absence of the phenomenon of multicollinearity between traits (Table 10).

Table 10. Matrix of paired correlation coefficients

	Y	**X_1**	**X_2**	**X_3**
Y	1	-0.8731	-0.3633	0.9793
X_1	-0.8731	1	0.6996	0.9506
X_2	-0.3633	0.6996	1	0.5343
X_3	0.9793	-0.9506	-0.5343	1

Source: Built by the authors.

As we can see, all partial indices of the level of sustainable development of rural areas significantly affect the integrated index and there is no autocorrelation between them (Table 11 and Table 12).

Table 11. Regression statistics

Multiple R	**0.9999**
R-square	0.9997
Normalized R-square	0.9989
Standard error	0.0001
Observation	5

Source: built by the authors.

Table 12. Analysis of variance

Components of equation	**Coefficient**	**Standard deviation**	**t-statistics**	**P-value**	**Lower 95%**	**Upper 95 %**	**Lower 95%**	**Upper 95 %**
Y	0.007	0.021	0.3430	0.7896	-0.2653	0.2800	-0.2653	0.2800
X_1	0.302	0.073	4.1401	0.1509	-0.6242	1.2276	-0.6242	1.2276
X_2	0.369	0.080	4.6208	0.1357	-0.6451	1.3824	-0.6451	1.3824
X_3	0.327	0.016	20.2615	0.0314	0.1219	0.5320	0.1219	0.5320

Source: built by the authors.

We built a multiple regression model of sustainable development of rural territories in Ukraine in 2018:

$$I_{rur} = 0.007+0.302I_{rur}^{soc}+0.369I_{rur}^{econ}+0.327I_{rur}^{ecol} .$$

According to the model, it can be argued that the predominant impact of the economic situation on the process of ensuring sustainable development of rural areas is obvious. At the same time, the significant impact of the environmental situation and the least significant impact of the social sphere development is confirmed.

The validity of the proposed model was verified by constructing its graphical interpretation on the basis of the integrated index of sustainable development of rural areas calculated on its data (Fig. 8).

The coefficient of determination serves as a precaution as to how well the regression describes this system of observations. To analyze the overall quality of the linear multifactor regression equation the multiple coefficient of determination R2 is used. The coefficient of determination R2 takes values in the range from zero to one: $0 \leq R2 \leq 1$. The larger R2, the greater part of the variance of the performance trait (Y) is explained by the regression equation, and the better the regression equation describes the original data. In the absence of a relationship between (Y) and (X), the coefficient of determination R2 will be close to zero.

According to the results of calculations it is obtained: R2 = 0.9997.

This indicates that 99.9% of the model parameters explain the dependence and change of the resulting factor Y. The obtained result indicates high quality of the proposed model and the accuracy of the regression equation selection.

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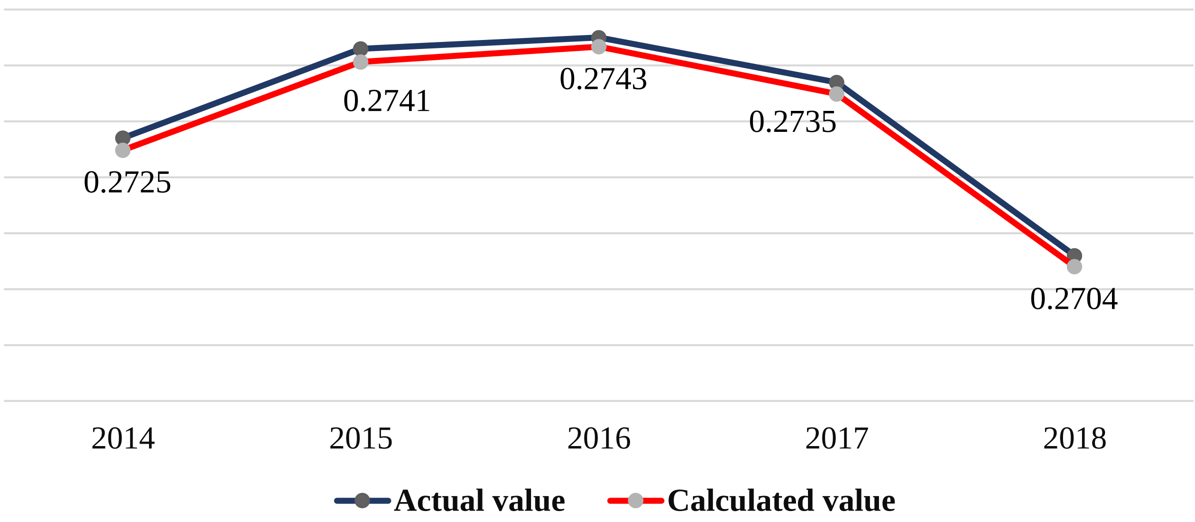

Fig. 8. Comparison of actual and calculated values of the integrated index of sustainable development of rural areas in Ukraine, 2014 – 2018
Source: built by the authors.

The significance of the regression equation was checked on the basis of the calculation of Fisher's F-test, which is used to assess the quality of the regression model as a whole, as well as its parameters.

According to the results of calculations for the proposed model Ftable = 590.85, while Fact significantly exceeds its tabular value. Based on this, we can conclude about the statistical significance of the selected factors and the reliability of the constructed regression model.

With the number of objects of analysis up to 30 units, it is necessary to check the significance of each regression coefficient. At the same time, they find out to what extent the calculated parameters are characteristic of the display of a set of conditions: whether the obtained values of the parameters are the results of random causes or not. The significance of the coefficients of simple linear regression (for sets in which $n < 30$) is determined using Student's t-test. The actual values of the t-test for the parameters of the equation are calculated.

The calculated values for the variable factors X_1, X_2, X_3 significantly exceed the one given in the table. On this basis, it can be stated that the relationship between variables and the results of the regression equation is not accidental.

CONCLUSIONS

The results of the analysis of rural territories development in the conditions of decentralization, obtained by us using economic and mathematical methods, show that the existing strategies of rural development in Ukraine are not effective enough. They do not take into account the full range of problems that are characteristic of the current state of rural development under the influence of local government reform. The problems which need to be addressed include the reduction of rural population and its ageing; external and internal labor migration; low incomes of rural residents; high unemployment rate; insufficient level of competitiveness of agricultural products; reduction of the efficiency of agricultural production; underdeveloped infrastructure; deterioration of the ecological situation in the countryside.

Decentralization is the process of bringing management decisions closer to the public, expanding the rights and powers of local governments. This facilitates the development and implementation of strategies, programs, rural development projects and the provision of services in accordance with the needs of the united territorial communities and the priorities of sustainable growth.

The advantages of decentralization in terms of its impact on rural development are:

-rational decision-making procedure for the development of the rural community;
-transparency of management decisions and quick response to problems to solve them;
-independence of the rural community in the formation of budget revenues and expenditures, based on the available financial and natural resources;
-the opportunity for each villager to participate in the discussion of current issues, which contributes to the formation of public consciousness;
-accessibility of rural residents to qualitative administrative, social and other services;
-promotion of regional development;
-transfer of the budgets of united communities to direct inter-budgetary relations with the State budget;
-transfer of the state-owned agricultural land plots to communal ownership of the united territorial communities;
-increase of tax payments receipts to the budgets of territorial communities;
-growing interest in the diversification of forms of management in the rural community;
-the possibility of receiving grants for rural development.

Analyzing the risks of decentralization that negatively affect or may affect rural development we can mention the following ones:
-strengthening the uneven development of rural areas, including local communities;
-increasing risks of making incorrect management decisions regarding the activities of the rural community due to inadequate qualifications of officials;
-promoting the strengthening of local nationalism and causing interethnic conflicts, especially in border regions;
-creation of too large territorial communities;
-the growth of corruption at the local level through the expansion of the powers of local governments;
-unwillingness of the richer, already established communities to associate with poorer territorial communities;
-loss of state control.

Thus, in the context of the implementation of modern decentralization reform, the main role in managing the sustainable development of rural areas belongs to local authorities. They coordinate the activities of all economic structures, participate in the development and implementation of strategies, programs, projects, decide on their financing.

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STRATEGIC PRIORITIES OF FINANCIAL SUPPORT FOR SUSTAINABLE SOIL MANAGEMENT IN UKRAINE

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Abstract

The aim of this paper is to justify the strategic priorities of financial provisions for sustainable soil management in agriculture of Ukraine. In conditions of limited financial resources, there is a need to identify the top priorities of sustainable soil management. The study found that the most important priority of financial support for sustainable soil management is to suspend the decrease of the content of humus and achieve its deficit-free balance (global priority – 0.556); the second position is occupied by the protection of soils from erosion (priority – 0.274); third place – enrichment of soils with nutrients substances (priority – 0.101); fourth place – amelioration of acid and solonets soils (priority – 0.069). In the context of identification of priorities of financial support for practical implementation of the proposed conception of sustainable soil management this paper also addresses the empirical expert evaluation of the relative importance (significance) of the principles of sustainable soil management, as well as the level of adherence (compliance) of these principles in agricultural enterprises of Ukraine. The obtained results demonstrate the state of compliance with the principles of sustainable soil management in agricultural enterprises, the availability of opportunities and reserves for improving the situation for their implementation, and as well due to which this should be carried out. Thus, 77.8 % of the principles were implemented at a low level, the rest (22.2 %) – at a very low level, so there are significant reserves to improve the situation.

Key words*: *soil organic carbon, climate change, low-carbon land use, Ukraine

INTRODUCTION

The problem of financial support for the agriculture has always been and remains relevant. The results of the analysis of recent publications indicate a significant scientific interest of researchers in the problem of financial support for the agricultural sector of the economy (Kirieieva et al. [8]; Mazur [13]; Kolotukha et al. [9]; Pronko et al. [14] Sakhno et al. [18]; Soliwoda [19]; Wieliczko [24]; Zakaria et al. [26]). The problem of the sustainable soil management is among the most topical scientific and practical issues (Adeyolanu and Ogunkunle [1]; Ansong Omari et al. [2]; Baritz et al. [5]; Helming et al. [6]; Rojas and Caon [15]; Vargas et al. [23]). However, in Ukraine this issue is at the initial stage of research [3]. Ukrainian researchers mainly focus their attention on other issues [20; 21]. Our monograph is a first attempt to close the research gap in the literature and to promote research on the sustainable soil management in Ukraine [12]. In the context of scarcity of financial resources, it is very important to identify strategic priorities that require priority funding. This will make it possible to organize their effective use in order to achieve sustainable competitiveness of land use of agricultural enterprises.

To achieve the strategic goals of the development of agriculture in terms of sustainable soil management in Ukraine, while preventing their degradation along with restoring soil fertility, a whole package of measures has to be implemented; these measures are put forward as strategic state priorities for financial support, taking into account the current state of soil cover and dynamics of its positive renovation suspending of the decrease of the content of humus and achievement its deficit- free balance; enriching the soils with nutrient substances; protection of soils from erosion; amelioration (reclamation) of acidic and solonets soils [4]. Therefore, the aim of our study is to justify the strategic priorities of financial provisions for sustainable soil management in agriculture of Ukraine.

MATERIALS AND METHODS

The materials of an expert survey conducted in Ukraine are an empirical basis. The study used the following methods: monographic (depth analysis of the issue under study); expert assessments (determination of the main priorities of financial support for sustainable soil management); abstract-and-logical, analysis and synthesis (formulation of conclusions).

In conditions of limited financial resources, there is a need to identify the top priorities of sustainable soil management. For this purpose, we first proposed using a matrix data analysis (or matrix of priorities), which is part of the method of Analytical Hierarchy Process (AHP), developed by the American scientist T. Saaty. For a quantitative expert assessment of the relative importance (priority) of objects, we used the T. Saaty scale (Table 1).

Table 1. Scales of relative importance (priority) according to Saaty

Numerical score	Definition (Verbal judgements of preferences)
1	Equal importance
3	A slight advantage of the importance of one element over another
5	A significant advantage of one element over another
7	Strong advantage of one element over another
9	Absolute advantage of one element over another
2, 4, 6, 8	Intermediate values between neighboring

Source: Saaty, 2008; Khirkh-Ialan, 2013 [16; 7].

RESULTS AND DISCUSSIONS

Expert evaluation of the strategic priorities of financial support for sustainable soil management in Ukrainian agriculture

As a result of the study, we constructed a matrix of pairwise comparisons of the priorities of financial support for sustainable soil management in Ukraine (Table 2). The developed matrix can be used as a mathematical tool for managerial decisions regarding the protection and rational use of soil resources.

Table 2. Matrix of pairwise comparisons of the priorities of financial support for sustainable soil management, determined on the basis of expert assessments

Priorities of financial support for sustainable soil management	Suspending the humus-content decrease and achievement its deficit-free balance	Enriching the soils with nutrient substances	Protection of soils from erosion	Amelioration of acidic and solonets soils	Global priorities
Suspending the humus- content decrease and achievement its deficit- free balance	1.000	5.000	3.000	6.000	0.556
Enriching the soils with nutrient substances	0.200	1.000	0.250	2.000	0.101
Protection of soils from erosion	0.333	4.000	1.000	4.000	0.274
Amelioration of acid and solonets soils	0.167	0.500	0.250	1.000	0.069

Source: author's calculations.

Local priorities (A_i) are calculated by the formula [22; 25]:

$$A_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \ , \qquad ....(1)$$

where Π – mathematical symbol of the product;

n – number of criteria;

α_{ij} – i-th element of the j-th column of the matrix of pairwise comparisons of criteria.

For example, in our study we obtained the following results:

$$A_1 = \sqrt[4]{1 \cdot 5 \cdot 3 \cdot 6} = 3.080$$

$$A_2 = \sqrt[4]{0{,}200 \cdot 1 \cdot 0{,}250 \cdot 2} = 0.562$$

$$A_3 = \sqrt[4]{0{,}333 \cdot 4 \cdot 1 \cdot 4} = 1.519$$

$$A_4 = \sqrt[4]{0.167 \cdot 0.500 \cdot 0.250 \cdot 1} = 0.381$$

$$\sum A_i = A_1 + A_2 + A_3 + A_4 = 5.542$$

Global priorities (B_i) are calculated by the formula [22; 25]:

$$B_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \qquad \text{.........................(2)}$$

Appropriate calculations for our example:
$B_1 = A_1 : A = 0.556$
$B_2 = A_2 : A = 0.101$
$B_3 = A_3 : A = 0.274$
$B_4 = A_4 : A = 0.069$

So, on the basis of the study, it was found that the most important priority of financial support for sustainable soil management is to suspend the decrease of the humus content and achieve its deficit-free balance (global priority – 0.556). The second place is occupied by the protection of soils from erosion (priority – 0.274); third position – enrichment of soils with nutrients substances (priority – 0.101); fourth place – amelioration of acid and solonets soils (priority – 0.069). Such a distribution of priorities confirms our assumption and is quite logical, given the current state of soil resources in Ukraine.

At the final stage, we evaluated the consistency of the results. The maximum eigenvalue of the inverse-symmetric matrix of pairwise comparisons (λ_{max}) was determined by the formula [25]:

$$\lambda_{\max} = \sum_{j=1}^{n} A_j \left(\sum_{i=1}^{n} a_{ij} \right) \qquad \text{........................ (3)}$$

where A_j – the value of the j-th column of the matrix of pairwise comparisons of criteria.

In view of the above we have obtained the following results:

$$\sum_{i=1}^{4} a_{i1} = 1 + 0.200 + 0.333 + 0.167 = 1.7$$

$$\sum_{i=1}^{4} a_{i2} = 5 + 1 + 4 + 0.500 = 10.5$$

$$\sum_{i=1}^{4} a_{i3} = 3 + 0.250 + 1 + 0.250 = 4.5$$

$$\sum_{i=1}^{4} a_{i4} = 6 + 2 + 4 + 1 = 13.0$$

$$\lambda_{\max} = 0.556 \cdot 1.7 + 0.101 \cdot 10.5 + 0.274 \cdot 4.5 + \\ + 0.069 \cdot 13.0 = 4.14$$

Estimates of the relative importance of the comparative priorities must be consistent, so we calculated the consistency index (*SI*) and the consistency ratio (*CR*), using the appropriate formulas [25]:

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{4.14 - 4}{4 - 1} = 0.047$$

$$CR = \frac{CI}{RCI} = \frac{0.047}{0.89} = 0.053,$$

where *RCI* – the value of the random consistency index (Table 3).

Table 3. Reference values of a random consistency index depending on the number of compared objects

Number of objects (*n*)	1	2	3	4	5	6	7	8	9	10
Average random consistency	0.0	0.0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Source: Saaty, 2008 [17].

Therefore, the results of the study are quite consistent, since the actual value of the consistency index (5.3 %) is much smaller than its limit value (10.0 %). A comparison of the relative importance showed that in modern realities, among the priorities considered, the optimization of the content of organic matter in the soil requires priority attention and appropriate measures and their financial support. This issue becomes particularly relevant in the context of climate change [10]. Therefore, the development of low carbon agricultural land use is a strategic priority for financial support [11].

Expert evaluation of the level of adherence (compliance) of the principles of sustainable soil management in agricultural enterprises of Ukraine

In the context of financial support for practical implementation of the proposed conception of sustainable soil management, we conducted an empirical expert evaluation of the relative importance (significance) of the principles of sustainable soil management, as well as the level of adherence (compliance) of these principles in agricultural enterprises of Ukraine. The formed system of special principles for sustainable soil management is accepted as a basis for the development of methodology of expert evaluation (Fig. 1) and situational analysis of the degree of observance of these principles in agriculture, which it is assumed to be applied along with others for the substantiation of decision-making and actions.

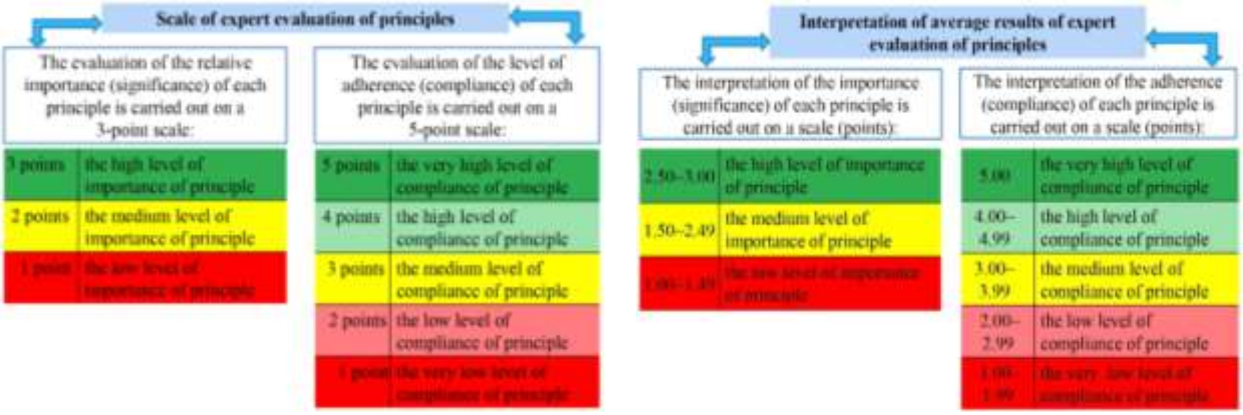

Fig. 1. Methodological framework for expert evaluation of the relative importance (significance) of the principles of sustainable soil management, as well as the level of adherence (compliance) of these principles in agricultural enterprises of Ukraine
Source: built by the author according to the analysis and synthesis of the literature.

A generalization of the obtained results (Table 4) made it possible to group and rank the principles under consideration according to the level of importance:
(i) the high level of importance – enhance soil organic matter content (2.833 points); combination of actions market mechanism and government regulation (2.778 points); combination of economic incentives and responsibility (2.722 points); systematic consideration of a complex of factors (2.611 points); continuous development and implementation of advanced technologies for the reproduction of soil fertility (2.611 points); minimize soil erosion (2.611 points); improve soil water management (2.611 points); focusing on the future, responsibility before the next generations (2.556 points); principle of differentiation (2.556 points); foster soil nutrient balance and cycles (2.556 points);
(ii) the medium level of importance – solidarity responsibility for the preservation and improvement of soil fertility (2.444 points); principle of monitoring and information feedback (2.444 points); priority of social and environmental tasks (2.444 points); principle of harmonious combination of tactical and strategic goals (2.444 points); the unity of economic and natural laws (2.389 points); prevent and minimize soil contamination (2.389 points); prevent and mitigate soil compaction (2.333 points); prevent, minimize and mitigate soil salinization and alkalinization (2.333 points); preserve and enhance soil biodiversity (2.278 points); principle of complexity and synergy (2.222 points); principle of dynamism and adaptability (2.222 points); principle of parametrization (2.222 points); principle of relativity (2.167 points); recognition of land by capital (2.056 points); principle of decomposition (2.000 points); prevent and minimize soil acidification (1.944 points); minimize soil sealing (1.611 points).
None of the principles fell into the low-level group of significance. Thus, the results of the empirical study confirmed the logic of choice and the importance of theoretically sound principles of sustainable soil management.
The generalized average expert level of importance in the context of the three groups of principles of sustainable soil management is: guidelines principles for sustainable soil management – 2.350 points; principles of system management of soil fertility – 2.285 points; principles of organizational-and-economic regulation of soil fertility reproduction – 2.512 points.

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Table 4. Results of expert evaluation of the relative importance (significance) of principles of sustainable soil management in Ukraine

No.	Principles	Average rank	Sum of ranks	Average value	Standard deviation
1	Minimize soil erosion	16.639	299.5	2.611	0.502
2	Enhance soil organic matter content	18.917	340.5	2.833	0.383
3	Foster soil nutrient balance and cycles	15.500	279.0	2.556	0.511
4	Prevent, minimize and mitigate soil salinization and alkalinization	12.972	233.5	2.333	0.485
5	Prevent and minimize soil contamination	13.278	239.0	2.389	0.502
6	Prevent and minimize soil acidification	9.000	162.0	1.944	0.639
7	Preserve and enhance soil biodiversity	12.500	225.0	2.278	0.669
8	Minimize soil sealing	6.583	118.5	1.611	0.698
9	Prevent and mitigate soil compaction	13.611	245.0	2.333	0.686
10	Improve soil water management	16.250	292.5	2.611	0.502
11	Principle of differentiation	15.639	281.5	2.556	0.511
12	Principle of monitoring and information feedback	14.833	267.0	2.444	0.705
13	Principle of harmonious combination of tactical and strategic goals	14.722	265.0	2.444	0.705
14	Principle of dynamism and adaptability	11.778	212.0	2.222	0.647
15	Principle of decomposition	9.222	166.0	2.000	0.594
16	Principle of parametrization	11.194	201.5	2.222	0.428
17	Principle of relativity	11.028	198.5	2.167	0.618
18	Principle of complexity and synergy	12.472	224.5	2.222	0.808
19	Combination of actions market mechanism and government regulation	18.750	337.5	2.778	0.548
20	Solidarity responsibility for the preservation and improvement of soil fertility	15.194	273.5	2.444	0.784
21	Priority of social and environmental tasks	14.722	265.0	2.444	0.616
22	Recognition of land by capital	10.500	189.0	2.056	0.725
23	Combination of economic incentives and responsibility	17.889	322.0	2.722	0.575
24	The unity of economic and natural laws	14.556	262.0	2.389	0.778
25	Focusing on the future, responsibility before the next generations	16.667	300.0	2.556	0.784
26	Continuous development and implementation of advanced technologies for the reproduction of soil fertility	16.750	301.5	2.611	0.608
27	Systematic consideration of a complex of factors	16.833	303.0	2.611	0.698

Source: author's calculations on the results of the survey of experts (n = 18).

Summarizing the results of the study (Table 5) showed a low and medium level of compliance of the principles of sustainable soil management in agricultural enterprises of Ukraine. So, the average level of completion guidelines principles for sustainable soil management amounted to only 49.3 %, including by principles: prevent, minimize and mitigate soil salinization and alkalinization – 56.7 %; prevent and minimize soil acidification – 54.4 %; foster soil nutrient balance and cycles – 53.3 %; prevent and minimize soil contamination – 51.1 %; improve soil water management – 50.0 %; minimize soil erosion – 48.9 %; minimize soil sealing – 47.8 %; preserve and enhance soil biodiversity – 47.8 %; prevent and mitigate soil compaction – 43.3 %; enhance soil organic matter content – 40.0 %. So, all the guidelines principles of this group adhere on low level, however, only five out of 10 principles are fulfilled by 50.0 % or more, the rest is less than half, so there are substantial reserves to improve the situation.

Quantitative assessment of the quality of compliance of the principles of system management of soil fertility showed that in this group, one principle (12.5 %) performed at a very low level, namely the principle of harmonious combination of tactical and strategic goals – 37.8 %, the rest (87.5 %) of the principles – at a low level. So, the quality of compliance principle of relativity met the necessary requirements by 55.6 %; principle of dynamism and adaptability – 53.3 %; principle of parametrization – 51.1 %, decomposition – 47.8 %; differentiation – 46.7 %; monitoring and information feedback – 46.7 %; complexity and synergy – 45.6 %. The total average assessment of the quality of compliance of the principles of system management of soil fertility, by the conclusions of experts, amounted to 2.403 points, that is, the necessary requirements were met only by 48.1 %.

The worst situation formed is in compliance the principles of organizational-and-economic regulation of soil fertility reproduction.

The results of the calculations show that on average these principles were compliance in agricultural enterprises of Ukraine only by 39.5 %, that is, most of the principles are kept at a very low level, in other words, almost not implemented. Very low compliance (very significant deviations, non-compliance) characteristic of the following principles: combination of economic incentives and responsibility – 32.2 %; solidarity responsibility for the preservation and improvement of soil fertility – 34.4 %; systematic consideration of a complex of factors – 35.6 %; focusing on the future, responsibility before the next generations – 38.9 %; priority of social and environmental tasks – 38.9 %. The low level compliance (significant deviations) inherent in such principles: continuous development and implementation of advanced technologies for the reproduction of soil fertility – 41.1 %; recognition of land by capital – 43.3 %; the unity of economic and natural laws – 44.4 %; combination of actions market mechanism and government regulation – 46.7 %.

Table 5. Results of expert evaluation of the level of adherence (compliance) of the principles of sustainable soil management in agricultural enterprises of Ukraine

No.	Principles	Average rank	Sum of ranks	Average value	Standard deviation
1	Minimize soil erosion	15.222	274.0	2.444	0.705
2	Enhance soil organic matter content	10.972	197.5	2.000	0.594
3	Foster soil nutrient balance and cycles	18.083	325.5	2.667	0.686
4	Prevent, minimize and mitigate soil salinization and alkalinization	19.028	342.5	2.833	0.707
5	Prevent and minimize soil contamination	16.722	301.0	2.556	0.705
6	Prevent and minimize soil acidification	17.778	320.0	2.722	0.669
7	Preserve and enhance soil biodiversity	15.167	273.0	2.389	0.698
8	Minimize soil sealing	15.194	273.5	2.389	0.850
9	Prevent and mitigate soil compaction	12.972	233.5	2.167	0.618
10	Improve soil water management	16.194	291.5	2.500	0.707
11	Principle of differentiation	14.556	262.0	2.333	0.767
12	Principle of monitoring and information feedback	13.444	242.0	2.333	0.840
13	Principle of harmonious combination of tactical and strategic goals	10.389	187.0	1.889	0.758
14	Principle of dynamism and adaptability	17.583	316.5	2.667	0.686
15	Principle of decomposition	15.139	272.5	2.389	0.979
16	Principle of parametrization	16.889	304.0	2.556	0.784
17	Principle of relativity	19.278	347.0	2.778	0.548
18	Principle of complexity and synergy	13.861	249.5	2.278	0.752
19	Combination of actions market mechanism and government regulation	14.417	259.5	2.333	0.907
20	Solidarity responsibility for the preservation and improvement of soil fertility	8.250	148.5	1.722	0.461
21	Priority of social and environmental tasks	10.611	191.0	1.944	0.639
22	Recognition of land by capital	13.306	239.5	2.167	0.707
23	Combination of economic incentives and responsibility	7.500	135.0	1.611	0.698
24	The unity of economic and natural laws	13.917	250.5	2.222	0.878
25	Focusing on the future, responsibility before the next generations	10.944	197.0	1.944	0.725
26	Continuous development and implementation of advanced technologies for the reproduction of soil fertility	11.250	202.5	2.056	0.725
27	Systematic consideration of a complex of factors	9.333	168.0	1.778	0.878

Source: author’s calculations on the results of the survey of experts (n = 18).

Therefore, in this group, 44.4 % of the principles adhere to on low level; the rest (55.6 %) is at a very low level, so there are significant reserves to improve the situation.

Summarizing the calculation results shows that, on average, the principles of sustainable soil management in agricultural enterprises of Ukraine were observed only 45.7 %. The clearly of results are presented in Fig. 2.

The obtained results demonstrate the state of compliance with the principles of sustainable soil management in agricultural enterprises, the availability of opportunities and reserves for improving the situation for their implementation, and as well due to which this should be carried out. Thus, 77.8 % of the principles were implemented at a low level, the rest (22.2 %) – at a very low level, so there are significant reserves to improve the situation.

For the convenience of situational analysis and management decision-making on financial support, we can use our proposed matrix (Table 6). Depending on the obtained values, there are a possible 15 different cases when the result of the evaluation falls into one or another quadrant.

The higher the level of importance and the lower the degree of adherence to the principle, the priority and faster should be the adoption of measures to improve the situation.

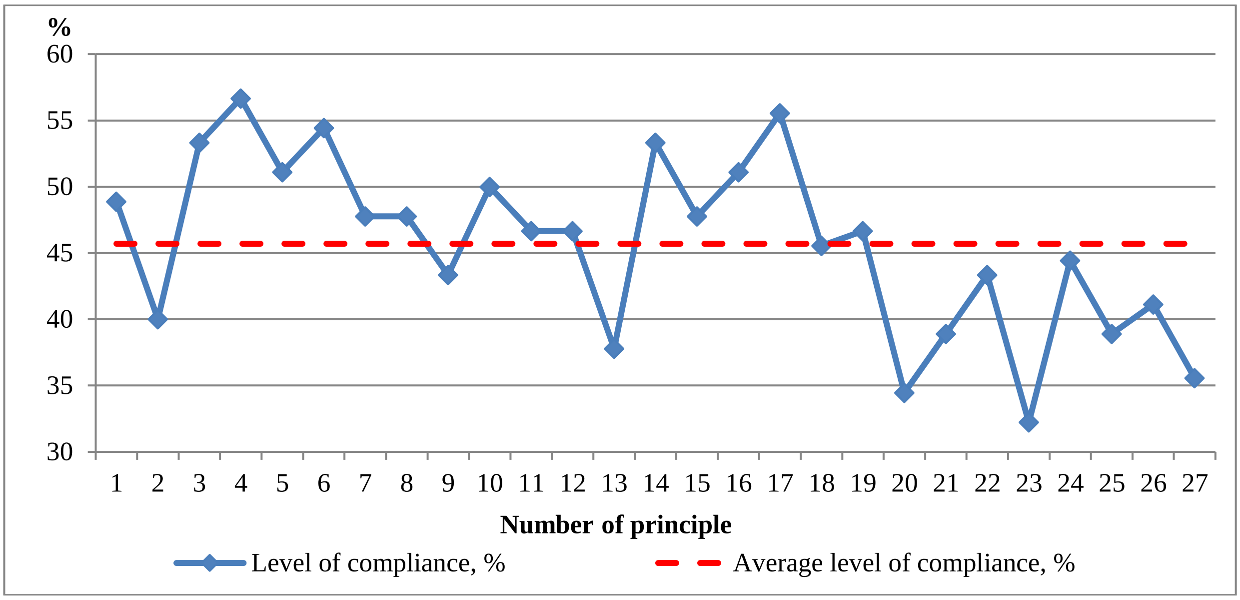

Fig. 2. The average level of compliance of the principles of sustainable soil management in agricultural enterprises of Ukraine, %

Source: developed by the author on the results of the survey of experts.

And vice versa: ceteris paribus, the lower the level of importance and the higher the degree of adherence to the principle, the less attention it requires. The general mechanism of the sequence of managerial decision making can be:

(i) priority decisions about the principles that fell into quadrants No. 1, 2, 3, 6, 7;
(ii) secondary decisions about principles that fall into quadrants No. 5, 10, 15, 13, 14;
(iii) thirdly decisions about principles that fall into quadrants No. 4, 8, 9, 11, 12.

Table 6. Matrix of priorities of financial support based on decisions about «the degree of importance of the principle of sustainable soil management – the degree of its compliance»

Degree of importance (significance) of principle	Level of adherence (compliance) of principles				
	Very low	Low	Average	High	Very high
High	1 *23, 25, 27*	2 *1, 2, 3, 10, 11, 19, 26*	3	4	5
Average	6 *13, 20, 21*	7 *4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 17, 18, 22, 24*	8	9	10
Low	11	12	13	14	15

Note. Italics indicate the order number of the principles being evaluated.

Source: developed by the author.

CONCLUSIONS

Based on this study we can conclude that the most important priority of financial support for sustainable soil management in Ukraine is to suspend the decrease of the humus content and achieve deficit-free balance of soil organic matter (global priority – 0.556); the second place is occupied by the protection of soils from erosion (priority – 0.274); third position – enrichment of soils with nutrients substances (priority – 0.101); fourth place – amelioration of acid and solonets soils (priority – 0.069). The financial mechanism for restoring soil fertility should be focused on the implementation of these priorities, which requires a review and development of a new holistic economic system that can effectively solve the problem of maintaining and restoring soil fertility in the context of implementing a sustainable development strategy; because many currently active financial-economic and legal instruments are based only on outdated methodological and regulatory framework.

In the context of identification of priorities of financial support for practical implementation of the proposed conception of sustainable soil management this paper also addresses the empirical expert evaluation of the relative importance (significance) of the principles of sustainable soil management, as well as the level of adherence (compliance) of these principles in agricultural enterprises of Ukraine. For the convenience of situational analysis and management decision-making on financial support, for the first time, we proposed the matrix approach. Depending on the obtained values, there are a possible 15 different cases when the result of the evaluation falls into one or another quadrant. The higher the level of importance and the lower the degree of adherence to the principle, the priority and faster should be the adoption of measures to improve the situation.

Development of specific financial-economical levers to sustainable soil management in agriculture would open new prospects for further research. In conclusion, we argue that suspension of humus content reduction and achievement of enhance soil organic matter content is a strategic (global) priority of financial support. Therefore, the next our research is devoted to conceptualization of sustainable management of soil organic carbon in the context of climate change.

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OPPORTUNITIES AND BARRIERS ON THE WAY OF INTRODUCING INNOVATIONS IN AGRICULTURAL ENTERPRISES

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Abstract

This paper studied the opportunities and barriers on the way of introducing of innovations and innovative projects in the area of land use in agricultural enterprises in the context of agribusiness 4.0 in Ukraine. For ease of analysis and political and managerial decision making, all of identified barriers were conventionally grouped into five groups (ranked in order of importance based on average expert estimates): (i) insufficient financing of innovation activity (average assessment – 3.502); (ii) lack of competence of the subjects of innovation activity (3.412); (iii) imperfection of innovative management (3.400); (iv) imperfection of the normative-legal base of innovation activity (3.261); (v) lack of effective innovation infrastructure (3.256). In general, among the 31 analyzed barriers, the TOP-5 most important, according to experts, include the following: lack of established contacts of scientists in the business environment (average assessment – 4.100); insufficient stimulation of subjects of innovative activity, in particular, authors of developments (3.900); low level of scientific and technical base of scientific organizations (3.850); the vast majority of researchers have not realized the importance of commercialization and are not able to commercialize the results of their research (3.850); there is no state support of innovation business (3.737). Obviously, overcoming these barriers forms key opportunities for introducing innovations in Ukrainian agricultural enterprises.

Key words*: *barriers, innovations, innovative projects, expert assessments, agriculture, Ukraine

INTRODUCTION

A lot of studies have been carried out on main barriers in a way of innovations development in various industries and countries. For example, Chesbrough, Laukkanen and Patala examine the issues related to opportunities and barriers to sustainable business model innovation [2; 15]. Various studies and scholars have evaluated barriers, drivers, factors and opportunities for implementation of innovations in different industries [4; 5; 17; 24], and barriers hindering innovations in small and medium enterprises [6; 10]. An important contribution to the development of these issues in agriculture of different countries has been done by Kudová, Chládková, Latushko, Radko, Tomich et al., Wigboldus et al. [13; 14; 19; 22]. Björklund, like Sivertsson and Tell, [1; 18] identified three main types of barriers to sustainable business model innovation in Swedish agriculture: external, internal, and contextual. They believe that cognitive abilities affect intentions, behaviors and actions; some barriers are caused by human factors (individuals' attitudes, social norms, and traditions; some barriers relate to a particular industry or enterprises; other barriers, such as government regulations, and weather, are more abstract [1; 18]. The paper by Harizanova-Bartos and Dimitrova concludes that the barriers to barriers in the implementation of innovations in Bulgarian agriculture are the cost of investment for innovation and the lack of information on possible innovations, as well as the traditional way thinking of the Bulgarian farmer [8]. Simultaneously, «the factors influencing the acceptance of innovation the most are the size of the farm, the willingness of the farmer to take risks, and the financing by bank and non-bank institutions» [8]. Ukrainian researchers have studied main barriers on the way of innovations development and commercialization of research results in economy of Ukraine [7; 9; 16; 20; 21; 23], and problematic aspects of innovative development of agriculture [3; 11; 12; 25]. However, none of these studies examine the barriers to introducing innovations in Ukrainian agriculture. Based on this, it is important to determine the critical barriers in the implementation of innovations in the agriculture of each country, taking into account national specificities. This study aims to determine the opportunities and barriers on the way of introducing of innovations and innovative projects in the area of land use in agricultural enterprises in the context of agribusiness 4.0 in Ukraine.

MATERIALS AND METHODS

Relatively high scientific potential, on the one hand, and relatively low innovation activity of agricultural enterprises – on the other hand, testifies to the existence of barriers between science and production. Therefore, identifying these barriers and establishing their rating is an urgent task, on which the decision was directed our work. The barriers that prevent the transformation of research results into innovative products have different nature-economic, legal, and organizational, etc. Therefore, the causal relationships between the barriers are so complex that they cannot be determined mathematically. In addition, the data necessary for extrapolation are absent. With this in mind, we have chosen an expert evaluation method for research, namely the simplified Delphi method [21]. In this study, we used the methodological approach of Tsybulov and Korsun [20; 21] as a starting point that allowed us to examine the on the way of introducing innovations and innovative projects in agricultural enterprises.

At the first stage of the study we, taking into acount the research of Tsybulov and Korsun [21], formed a list of barriers that hinder the commercial transfer of innovations in the field of land use in agricultural production in the context of agribusiness 4.0 in Ukraine. This list includes 31 barriers. At the second stage, experts were invited to carry out an independent expert assessment of the weight of each barrier on a five-point scale. If the barrier is the most important, it is estimated at 5 points, if the barrier is insignificant then 1 point. In addition, experts were invited to supplement these barriers, answering the question: «Which, in your opinion, are there barriers between the results of scientific research and innovative products that is what prevents commercialization of scientific research results in the field of land use?». Specialists were selected as the experts who have experience and knowledge in the field of innovation activity and represent different scientific areas: economics, agricultural chemistry, soil science, law, and management. Mostly they were PhDs and Doctors of Sciences, their number – 18 people. In the third stage, the data received from experts were processed by methods of mathematical statistics and an analysis of the obtained results was carried out.

RESULTS AND DISCUSSIONS

As a result of statistical processing of the obtained expert assessments the rating of barriers hindering the commercialization of scientific research in the field of land use in agricultural production was determined (Table 1). According to the obtained data, the most significant were the following barriers: lack of established contacts of scientists in the business environment (average assessment – 4.100); insufficient stimulation of subjects of innovative activity, in particular, authors of developments (3.900); low level of scientific and technical base of scientific organizations (3.850); the vast majority of researchers have not realized the importance of commercialization and are not able to commercialize the results of their research (3.850); there is no state support of innovation business (3.737) and others. The identified barriers are difficult to compare with each other, because they are different in nature and belong to different spheres: economic, legal, administrative, etc. For ease of analysis, all these barriers were conventionally grouped into five groups:

- insufficient financing of innovation activity;
- lack of competence of the subjects of innovation activity;
- imperfection of innovative management;
- imperfection of the normative-legal base of innovation activity;
- lack of effective innovation infrastructure.

Table 1. The rating of barriers hindering the commercialization of the results of scientific research in the field of land use in the context of agribusiness 4.0 in Ukraine

No	The content of the barrier	Average assessment	
		point	%
1	Lack of established contacts of scientists in the business environment	4.100	82.0
2	Insufficient stimulation subjects of innovative activity, in particular, authors of developments	3.900	78.0
3	Low level of scientific and technical base of scientific organizations	3.850	77.0
4	The vast majority of researchers have not realized the importance of commercialization and are not able to commercialize the results of their research	3.850	77.0
5	There is no state support innovation business	3.737	74.7
6	The state does not sufficiently stimulate innovation activity both in financial and organizational terms	3.700	74.0
7	Low motivation of scientists	3.650	73.0
8	Lack in the domestic market demand for innovative products	3.632	72.6
9	Insufficient distribution of state financing of innovation projects by volume and irrational in directions	3.579	71.6
10	Scientists, as a rule, first get the results of the research, then look for ways to use them, and not vice versa	3.550	71.0
11	Scientists are not market oriented	3.526	70.5
12	Incomprehension of a determining role of intellectual property in the development of the economy by the first persons (government officials, heads of scientific organizations and agricultural and agro-industrial enterprises)	3.500	70.0
13	The vast majority of executed work ends with the writing of reports that are not suitable for further development	3.500	70.0
14	Lack of interest of public officials in the implementation of innovation policies	3.450	69.0
15	Most academic institutions have the status of a non-profit organization, which significantly reduces the possibility of their establishment of innovative enterprises	3.450	69.0
16	National Academy of Agrarian Sciences of Ukraine is planning directions of scientific research, not focusing on the market	3.333	66.7
17	Lack of state innovation policy and strategic programs of development for the branches of the economy	3.300	66.0
18	Not favorable production area for innovation	3.300	66.0
19	Low effectiveness of competitions for funding research works	3.250	65.0
20	More than half of the scientists focused on fundamental research	3.250	65.0
21	Overly complex mechanism of creation of technoparks	3.222	64.4
22	Insignificant contribution of foreign capital to the innovation sphere of Ukraine	3.211	64.2
23	The lack of readiness of small and medium enterprises to perceive innovations	3.200	64.0
24	Laws in the field of innovation provide some preferences to technoparks that are not actually implemented and practically do not provide preferences to small innovative enterprises	3.200	64.0
25	A large number of talented scientists was redirected to the orders of foreign scientific centers and companies	3.111	62.2
26	Scientists do not have sufficient knowledge and skills to design and implement innovative projects	3.050	61.0
27	Simplified access to Western technology, therefore it is often more profitable to buy a new technology abroad than to develop it on its own	3.000	60.0
28	Inconsistency of the legislative and normative base, which regulates legal relations in the field of innovation activity	2.842	56.8
29	The reluctance of civil servants to take risks by taking managerial decisions in the field of innovation activity	2.789	55.8
30	National Academy of Agrarian Sciences of Ukraine has insufficient funds for the legal protection of the results of scientific research	2.737	54.7
31	There are contradictions between the relatively long period of implementation of the innovation project (several years) and the short term of government officials in power (one year)	2.737	54.7

Source: list of barriers compiled by the author based on the source [20], estimates formed by the author based on a survey of experts.

Let`s consider these groups of barriers in more detail (Table 2–6). As we expected by rating the first place had a group of barriers (Table 2), which characterizes insufficient financing of innovation activity (average assessment – 3.502). It should be noted that this group of barriers is decisive, since without overcoming them other barriers cannot be eliminated for effective commercialization of innovations in the field of land use in the context of agribusiness 4.0.

Table 2. The rating of barriers characterizing insufficient financing of innovation activity

No	The content of the barrier	Average assessment	
		point	%
1	Insufficient stimulation subjects of innovative activity, in particular, authors of developments	3.900	78.0
2	Low level of scientific and technical base of scientific organizations	3.850	77.0
3	There is no state support innovation business	3.737	74.7
4	Insufficient distribution of state financing of innovation projects by volume and irrational in directions	3.579	71.6
5	Insignificant contribution of foreign capital to the innovation sphere of Ukraine	3.211	64.2
6	National Academy of Agrarian Sciences of Ukraine has insufficient funds for the legal protection of the results of scientific research	2.737	54.7
Average assessment		3.502	70.0

Source: formed by the author based on a survey of experts.

With regard to this barrier group, we have already noted in the previous works of scarcity of funds, which allocate to the financing of scientific and scientific-technical works from the state budget, which is usually not enough to ensure the effective start of innovation [12]. But even these financial resources, in the opinion of Tsybulov and Korsun, are used not in the best way. So, the distribution of funding between fundamental, applied research and development is 25 : 19 : 56 %, that is, the ratio between the amount of financing for science and development is 1.27, when in the world – 1 : 10 [21]. Deformed, in their opinion, is the ratio between the amount of funding for fundamental and applied sciences 1.32 : 1.0, although the cost of applied research is usually larger than the fundamental one. World experience shows that correlation financing of the stages of the life cycle of innovative products – research and development work: development: production is equal 1 : 10 : 100 [20].

In second place on rating a group of barriers came (Table 3), which characterizes the lack of competence of the subjects of innovation activity (average assessment – 3.412).

Table 3. The rating of barriers characterizing the lack of competence of the subjects of innovation activity

No	The content of the barrier	Average assessment	
		point	%
1	The vast majority of researchers have not realized the importance of commercialization and are not able to commercialize the results of their research	3.850	77.0
2	Scientists, as a rule, first get the results of the research, then look for ways to use them, and not vice versa	3.550	71.0
3	Incomprehension of a determining role of intellectual property in the development of the economy by the first persons (government officials, heads of scientific organizations and agricultural and agro-industrial enterprises)	3.500	70.0
4	A large number of talented scientists was redirected to the orders of foreign scientific centers and companies	3.111	62.2
5	Scientists do not have sufficient knowledge and skills to design and implement innovative projects	3.050	61.0
Average assessment		3.412	68.2

Source: formed by the author based on a survey of experts.

It should be noted, that according to the provisions of the institutional theory, this group of barriers is reflected in the socio-cultural psychotype of the subject of innovation activity, so one should agree with the fact that, which is a fundamental prerequisite overcoming all barriers is a rethinking of the place and role of intellectual property and innovations in the development of the economy by the first persons (government officials, heads of scientific organizations and agricultural and agro-industrial enterprises), increase of competence and psychological readiness of subjects of innovative activity before commercialization of research results, an important role in what motivation plays in particular, material incentives.

The next group of barriers is closely linked to the previous one (Table 4), characterizing the imperfection of innovation management (average assessment – 3.400).

Table 4. The rating of barriers characterizing the imperfection of innovative management

No	The content of the barrier	Average assessment	
		point	%
1	Lack of established contacts of scientists in the business environment	4.100	82.0
2	Low motivation of scientists	3.650	73.0
3	Scientists are not market oriented	3.526	70.5
4	The vast majority of executed work ends with the writing of reports that are not suitable for further development	3.500	70.0
5	Lack of interest of public officials in the implementation of innovation policies	3.450	69.0
6	National Academy of Agrarian Sciences of Ukraine is planning directions of scientific research, not focusing on the market	3.333	66.7
7	Low effectiveness of competitions for funding research works	3.250	65.0
8	Simplified access to Western technology, therefore it is often more profitable to buy a new technology abroad than to develop it on its own	3.000	60.0
9	The reluctance of civil servants to take risks by taking managerial decisions in the field of innovation activity	2.789	55.8
Average assessment		3.400	68.0

Source: formed by the author based on a survey of experts.

In this group of barriers, the first priority is the lack of established contacts between scientists in the business environment (4.100), low motivation of scientists (3.650), scientists are not market oriented (3.526), which to some extent confirms the preliminary conclusions. Thus, the improvement of innovation management is closely linked with the increase of the competence of the subjects of innovation activity and the improvement of their motivation and reorientation to the market.

Obviously, effective innovation management is difficult in the conditions of the imperfect regulatory framework of innovation activity, therefore, of course, the next ranking is a group of barriers (Table 5), which characterizes the imperfection of the regulatory framework of innovation activity (average assessment – 3.261). Among the significant barriers are: the state does not sufficiently stimulate innovation activity both in financial and organizational terms (3.700), lack of state innovation policy and strategic development programs for the branches of the economy (3.300), laws in the field of innovation provide some preferences to technoparks, which are actually not implemented, and practically do not give preferences to small innovative enterprises (3.200).

Table 5. The rating of barriers characterizing the imperfection of the normative-legal base of innovation activity

No	The content of the barrier	Average assessment	
		point	%
1	The state does not sufficiently stimulate innovation activity both in financial and organizational terms	3.700	74.0
2	Lack of state innovation policy and strategic programs of development for the branches of the economy	3.300	66.0
3	Laws in the field of innovation provide some preferences to technoparks that are not actually implemented and practically do not provide preferences to small innovative enterprises	3.200	64.0
4	Inconsistency of the legislative and normative base, which regulates legal relations in the field of innovation activity	2.842	56.8
Average assessment		3.261	65.2

Source: formed by the author based on a survey of experts.

Overcoming these barriers is in the legal plane, which falls within the competence of the legislative and executive authorities.

Describing this group of barriers, we note that, according to studies of Tsybulov and Korsun, the innovation activity in Ukraine is regulated by more than 80 laws and resolutions of the Cabinet of Ministers of Ukraine. Particularly important among them are the laws of Ukraine: «On Innovation Activity», «On Priority Areas of Innovation Activity in Ukraine»; «On the special regime of innovation activity of technological parks», «On investment activity». An analysis of these laws shows that in some cases they not only do not promote innovation activity, but even create additional barriers to the commercialization of research results. So, the Law of Ukraine «On Innovation» provides for an overly complicated procedure for approving and financing innovative projects, monopolizes this procedure. In order to register an innovation project for the technopark, it is necessary to obtain from the ministries 17 conclusions and this does not guarantee the receipt of financing of the project. The Law of Ukraine «On Priority Areas of Innovation Activity in Ukraine» is oriented to maintain and development III and IV technological way instead of V and VI, that is orientated on yesterday. It is believed that technoparks in Ukraine are most adapted for commercialization of scientific research results. At the same time, the mechanism for creating such parks is extremely complicated «On the special regime of innovation activity of technological parks», that is, decisions are taken at the level of the Verkhovna Rada of Ukraine, which is a rather complex and long-lasting procedure. Innovative projects require investment. At the same time, according to the Law of Ukraine «On Investment Activity», the investor is required to obtain numerous permits and approvals, positive a comprehensive conclusion state expertise of regarding compliance in investment programs and projects current norms. This law only declares, and does not provide real guarantees on the protection of investments that deter potential investors [20].

As known, the strategic direction of economic development of Ukraine is the transition from the doctrine of «development to the fore» to the doctrine of «development to advance», the basis of which should be laid the innovative technological model, based on the maximum use of powerful human potential [25]. In implementing the strategy of transition to the model of «development to advance» should be borne in mind that the key factor VI technological way (chronological limits 2010–2050) is nano and cellular technology, its nucleus is nanoelectronics, molecular and nanophotonics, nanomaterials and coatings, nanobiotechnology, nanosystem technology, the main advantages are a sharp decrease in the material and energy intensity of production, creation of materials and organisms with predetermined properties [16].

Consequently, we are deeply convinced that if we apply in practice an innovative forward-looking model of a qualitatively new development of agro-industrial production, then one of the strategic directions of scientific research in the field of land use should be nano- and nanobiotechnologies, digital and climate-smart technologies and practices for reproduction of soil fertility and increase of land productivity.

The final ranking has been a group of barriers (Table 6), which characterize the lack of effective innovation infrastructure (average assessment – 3.256).

In this group, the defining and primary barrier, in our opinion, is the lack of demand for innovative products on the domestic market (3.632). If this barrier had been overcome, then, in our opinion, it would be possible to significantly improve the situation with the transfer of innovations in the field of land use.

One of the ways of creating such demand is to stimulate agricultural enterprises to the use of innovations through the creation of a real incentive mechanism for lending and taxation for the implementation of innovation projects by these entities.

With the specified barrier two more directly linked: the unfavorable production sector to innovation (3.300) and the unpreparedness of small and medium enterprises to perceive innovations (3.200).

Table 6. The rating of barriers characterizing the lack of effective innovation infrastructure

No	The content of the barrier	Average assessment	
		point	%
1	Lack in the domestic market demand for innovative products	3.632	72.6
2	Most academic institutions have the status of a non-profit organization, which significantly reduces the possibility of their establishment of innovative enterprises	3.450	69.0
3	Not favorable production area for innovation	3.300	66.0
4	More than half of the scientists focused on fundamental research	3.250	65.0
5	Overly complex mechanism of creation of technoparks	3.222	64.4
6	The lack of readiness of small and medium enterprises to perceive innovations	3.200	64.0
7	There are contradictions between the relatively long period of implementation of the innovation project (several years) and the short term of government officials in power (one year)	2.737	54.7
Average assessment		3.256	65.1

Source: formed by the author based on a survey of experts.

Another problem is that most academic institutions have the status of a non-profit organization, which significantly reduces the possibility of their establishment of innovative enterprises. Maybe this issue in legal aspects will be resolved after the full implementation of the new Law of Ukraine «On scientific and scientific-and-technical activities», however, there remain a lot of financial-economic, organizational aspects and geopolitical problems that need to be resolved to attract relevant investments.

Summarizing the results of the study, we give an integrated rating of groups of barriers that interfere with commercialization of the results of scientific research in the field of land use in the context of agribusiness 4.0 (Fig. 1).

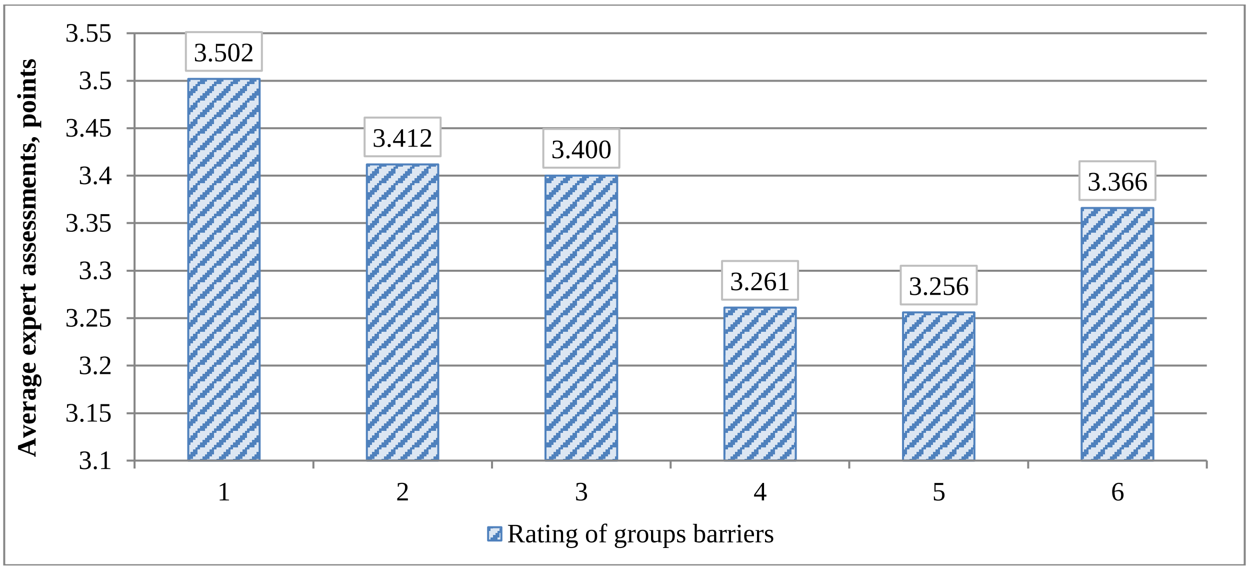

Fig. 1. Rating of groups barriers, which interfere to commercialization results of scientific research in the sphere of land use in the context of agribusiness 4.0

Note. 1 – insufficient financing of innovation activity; 2 – lack of competence of the subjects of innovation activity; 3 – imperfection of innovative management; 4 – imperfection of the normative-legal base of innovation activity; 5 – lack of effective innovation infrastructure; 6 – average assessment.

Source: built by the author based on a survey of experts.

In a separate group there are the barriers that were added by the experts to the ones proposed for evaluation, namely: progressive increase in non-scientific tasks; uncertainty about the position of employers in paying royalties and their amount (Law of Ukraine «On Copyright and Related Rights») given the opportunity to record it in separate civil law contracts); ignoring the possibility of paying royalties and paying additional wages both authors and other specialists who create documents for the commercialization of scientific research; underfunding of the sector as a whole; the lack of targeted budget financing for preparation of innovations for commercialization in the system of National Academy of Agrarian Sciences of Ukraine; the absence in the budget scientific institutions of a clear algorithm for transforming a new scientific result the articles in the report, etc. and which even received a patent to fit for the commercialization of an innovative product. Each of these barriers, of course, has received the highest evaluation of the relevant expert.

Thus, in order to ensure the effective commercialization of the results of scientific research in the field of land use in the context of agribusiness 4.0, it is necessary to overcome the identified barriers both at the level of academic institutions and at the state level.

CONCLUSIONS

As a result of the study it was determined the opportunities and barriers on the way of introducing of innovations and innovative projects in the area of land use in agricultural enterprises in the context of agribusiness 4.0 in Ukraine. In general, among the 31 analyzed barriers, the TOP-5 most important, according to experts, include the following: lack of established contacts of scientists in the business environment (average assessment – 4.100); insufficient stimulation of subjects of innovative activity, in particular, authors of developments (3.900); low level of scientific and technical base of scientific organizations (3.850); the vast majority of researchers have not realized the importance of commercialization and are not able to commercialize the results of their research (3.850); there is no state support of innovation business (3.737). All barriers, however, merit attention when Ukrainian legislators and decision makers develop a new agricultural and innovation policy.

The analysis results made it possible to group all identified barriers into five thematic groups (ranked in order of importance based on average expert estimates): (i) insufficient financing of innovation activity (average assessment – 3.502); (ii) lack of competence of the subjects of innovation activity (3.412); (iii) imperfection of innovative management (3.400); (iv) imperfection of the normative-legal base of innovation activity (3.261); (v) lack of effective innovation infrastructure (3.256). Obviously, overcoming these barriers forms key opportunities for introducing innovations in Ukrainian agricultural enterprises. The main research results can be used for political and managerial decision making on introducing innovations and innovative projects in the context of ensuring formation of agribusiness 4.0 in Ukraine and its sustainable development.

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DEVELOPMENTAL FACTORS OF AGRICULTURAL CONSUMER CREDIT COOPERATIVES AS AN ALTERNATIVE FINANCIAL INSTITUTE FOR RUSSIAN AGROINDUSTRIAL COMPLEX

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Abstract

The relevance of the work is stipulated by the need to study alternative financing instruments for the Russian agro-industrial complex whose products ensure the satisfaction of primary needs and national food security. The research aimed to study the potential of agricultural credit consumer cooperatives in the Russian economy as an institution of alternative financing and the sustainability of small business in agriculture. The authors of this article relied on a system-integrated approach, including statistical and comparative analysis, as well as case method and analogy method for identifying the determinants of the development of agricultural credit cooperation. The authors have revealed that the deterrent nature of the development of agricultural credit consumer cooperatives is determined by two groups of factors: exogenous (macroeconomic financial instability, lack of necessary institutional conditions, excessive requirements from the Bank of Russia) and endogenous (level of confidence of agricultural producers, lack of financial and digital literacy in rural areas). Agricultural credit cooperation can have real potential as an alternative source of financing in the field of small and medium-sized businesses in the agro-industrial complex with the support of this institution from the state and a high level of trust at the microlevel of rural territories.

Key words**:** *agricultural credit cooperation, agricultural consumer credit cooperative, factors, agro-industrial complex, credit*

INTRODUCTION

Amid the current endogenous and exogenous challenges, one of the priorities for the national economy and specifically the agro-industrial sector is national food security. The scope of this problem was expanded by the food Doctrine of 2020, which shifts the vector of key references from solely quantitative indicators toward transforming the structure of the consumer basket with an accent on the qualitative measures. This adds relevance to the fundamental problems of economic theory, namely: who should pursue these objectives with limited resources and what needs to be done. The above objectives call for a specific focus on the essential characteristics and developmental patterns of major subjects of production across the spectrum of operational forms, considering that the Russian economy is characterized, firstly, by an uneven development profile as a result of the transformational processes in all forms of economic operations, both big and small. Secondly, a key factor of stability for small economic operations is the development of agricultural cooperation in the form of integrated structures of various typologies depending on the functions.

Despite the considerable interest in agriculture shown by government institutions and its outpacing growth compared to the overall GDP growth rate, the questions are still unresolved as to which institutional determinants shape the stability of development of various economic forms and which of them deter growth. Also, long-overlooked have been the issues of theoretical analysis of the transformation processes underway in the operational forms and economic relations in the Russian agro-industrial complex, the identification of patterns and outlook in various economic operational forms and financial needs [11].

Historically in the Russian practice, of all types of agricultural cooperation (related to production, consumption, marketing, credit and processing), the production form has been the most advanced, as exemplified by kolkhoz operations, which lasted for almost half a century before the transition to market reforms in the 1990s. The subsequent transformation led to the recovery of agricultural credit cooperation (ACC), and many hopes were pinned to it in terms of financial support and development of small economic forms (SEF). The emergence of ACC was supported by a certain institutional framework, particularly Federal Law of the Russian Federation No. 193 "On Agricultural Cooperation" dated 08.12.1995 and the National Project for the Development of Russia's Agroindustrial Complex, which provided key references for the State Programme of Agricultural Development and Regulation of Agricultural Products, Commodities and Food Markets [13].

Late in 2019, pursuant to the requirements of Federal Law No. 193-FZ "On Agricultural Cooperation" dated 08.12.1995, the organisation Agrocontrol developed the Standards of Setting up and Operation of Agricultural Consumer Cooperatives, which particularly set forth the main principles of financial capital development at an agricultural cooperative [12]. The Standards were adopted by the Ministry of Agriculture of the Russian Federation and recommended for practical references.

Changes in the market of ACC require more detailed analysis, as shown further in this paper.

MATERIALS AND METHODS

The methodological foundations in analyzing the issues of Russian cooperation were proposed by the prominent Russian scholars M. I. Tugan-Baranovskii [16] and A. V. Chaianov [3]. They, in turn, relied on the methods of comparative analysis of the first cooperative practices adopted by German agricultural producers. Chaianov used the method of analogy in combination with analysis and synthesis to come up with the theory of cooperation development. Its major propositions mark the departure points in the development of modern cooperatives, including credit cooperatives [4].

One of the main inferences of Chaianov [3] that is still relevant for the current situation is as follows. Cooperation, irrespective of its forms, helps small economic operations maintain their independence and identity by integrating the advantages of major enterprise in attracting credit. A special highlight among the modern works is the paper co-authored by the researchers of the Central Economics and Mathematics Institute (CEMI) including V. E. Dementev, R. M. Kachalov, G. B. Kleiner, N.B. Nagrudnaia, R. I. Habibullin et al. These authors made a significant scholarly contribution to the development of the theoretical foundations of cooperation based on the analysis of successful regional cases of cooperation development as a form of collective economic operations, including the comparative analysis of their advantages and drawbacks [6].

We applied the methods of quantitative analysis to study the general trends of development of agricultural consumer credit cooperatives (ACCC). In analyzing their viability, an important tool is the case method to analyze best practices of economic operation and to establish the deterrents. The methods of historical and comparative analysis helped identify the specifics of modern cooperatives and the main determinants of their further development in the Russian economic system. The systems approach underlined all major inferences and hypotheses proposed by us in the analysis of quantitative indicators in the setting up, reorganizations and liquidations of ACCC.

RESULTS AND DISCUSSIONS

ACCC as an institute to counter the problem of inadequate financial resources

The organizational economic form of ACC is realized in ACCC, which emerge as voluntary organizations of individuals (and/or legal entities) existing and/or operating in rural areas with the purpose of ensuring the financial requirements of their members. The main purpose of ACCC is mitigating financial deficits of agricultural producers by extending loans to the participants of the cooperatives from the established unit fund and other resources. Besides operating as a mutual fund, ACCC are also entitled to place idle resources in bank deposits or public securities to build up their reserves. Notwithstanding, they remain non-profit organizations as the generated income is used to increase the available funds of financial support for the participants of the cooperative. Their governance is regulated by federal laws and the organizational charter, while the key regulatory powers are administered by the Central Bank of the Russian Federation.

As of the beginning of 2020, according to the official statistics of the Central Bank, 653 ACCC are registered as operational in the State Register, 199 credit cooperatives are under reorganization and 2,007 ACCC are liquidated. Notably, the number of active ACCC declined by 9% in the single year compared to 717 ACCC as of the end of 2018. Meanwhile, the rate of discontinued ACCC rose by almost 10%. The numbers of ACCC under reorganization were almost unchanged [14]. The figure of active credit cooperatives in agriculture includes 13.3% established between 1998-2002, 30% launched in 2004-2009 and more than 50% registered since 2010. Analysts attribute this growth from the early 2000s to the policies of big banks engaging with major ACCC and contributing to their unit capital as their associated participants and reinforcing their positions as credit organizations. [5]. However, the organizations set up between 2004 and 2009 proved the least viable, as the biggest proportion (75%) of now discontinued operations as of the beginning of 2020 is made up by those established exactly in this period. The majority (70%) of institutions currently under reorganization also fall within this bracket by the time of establishment. More than half (51%) of organizations set up between 2010 and 2015 (Table 1) have maintained their stability. One of the reasons behind their viability is the combination of exogenous (particularly, geopolitical changes) and endogenous factors (associated with changes in the domestic policies of the public institutions in the Russian Federation with regard to agricultural operations).

Table 1. Dynamics of ACCC in the Russian Federation

Status	Year of registration								Total	
	1997-2003		2004-2009		2010-2015		August 2016-2020		1998-2020	
	Number	%	Number	%	Number	%	Number	%	Number	%
Active	91	14.0	171	26.0	335	51.0	56	9.0	653	100
Under reorganisation	19	10.0	144	72.4	27	13.6	9	5.0	199	100
Liquidated	249	12.4	1,501	75.0	242	12.0	15	0.6	2,007	100

Source: developed by the authors based on official data of the Central Bank [14].

Exogenous factors influencing the development of ACCC

The deterred profile of ACCC development is due to two groups of factors, endogenous and exogenous. Exogenous factors include, first of all, the general financial turbulence in the global markets and, at the macro level, the national economy. The general consequence is that the interest rate is well above the average profitability rate of operations in the agricultural sector of the national economy. This results in the gradual squeezing of SEF from the market, even as this segment specifically shapes competitiveness in developed market economies. In Russia, SEF have less chance of attracting cheap money from the primary lenders, despite certain steps of government institutions to provide funds on special terms. For example, Sberbank offers loans to individuals engaged in private subsistence farming; Rosselkhozbank provides loans for family farms. Interestingly, though, there is no official definition of a family farm. In practice, it refers mostly to peasant (private) farms (PPF) engaging exclusively individual labour efforts of the owners. Moreover, the offerings of Rosselkhozbank for PPF and individual entrepreneurs for seasonal operations cautiously state that loans are subject to several types of guarantees, while interest rates on extended loans are set individually on a case-by-case basis depending on the product and loan term [9]. The list and criteria of such guarantees are not specified or available in the public domain for bank customers. Thus, agricultural producers at the micro level of individual rural localities cannot access reliable and comprehensive information via the Internet. Additionally, Rosselkhozbank runs the Farmers Loan co-programme with the Ministry of Agriculture to provide lending on special terms at an interest rate of 5% per annum. However, all such programmes usually envisage collateral requirements given the objective risks of agricultural operations. Such collateral is usually owners' private assets, including land plots and material facilities, such as agricultural equipment, real estate and government guarantees at the regional level.

In such circumstances, an economic interest in alternative lending to be provided by ACCC built on the principles of self-governance is logical. However, the analysis of official figures from the Central Bank, as shown above, does not yet confirm this interest in practice. Interest rates on loans applying in consumer loan agreements signed by lenders with individuals (including family farms and individual entrepreneurs) depend not just on the term (under or over one year) but on the amount of the loan as well. For example, in 2019, 17.5% applied for a loan of up to 30 thousand roubles vs. 17.7% for the amount of up to 100 thousand roubles (Table 2). The rate of a long-term loan for a specific purpose extended by lenders to individuals (for more than one year) further depends on the loan amount. The cost of credit in micro-financing organizations (MFO), according to the Central Bank, is inversely related to the amount of the extended loan: 144.6% was the weighted average in 2019 for the term under one year, which is significantly higher than the rate for long-term loans. Another aspect is that the rates on long-term loans of more than 100 thousand roubles show a trend to the downside. Simultaneously, the cost of "short" money within 30 thousand roubles has been unstable over the last three years, fluctuating up and down. The reason behind the uneven dynamics is that such loan size is usually provided for essential needs (goods or services). Meanwhile, amounts over 100 thousand roubles for small PPF engaging family labour can be classified as innovation-related money used to arrange and support small business.

Table 2. Market averages for the full cost of consumer loans for individuals (%, round to one decimal place)

Private financial institutions	Unsecured consumer purpose loan (%)					
	2017 (up to 100 thousand roubles/more than 100 thousand roubles)		2018 (up to 100 thousand roubles/more than 100 thousand roubles)		2019 (up to 100 thousand roubles/more than 100 thousand roubles)	
	up to 1 year	more than 1 year	up to 1 year	more than 1 year	up to 1 year	more than 1 year
credit institutions	29.6/23.8	26.5/20.7	20.6/19.3	16.8/16.2	17.5/17.7	11.7/13.5
microfinance organisations	140/35	56.5/33.5	148/31	54.7/32.2	144.6/38.5	57.7/32.5
consumer credit cooperatives	53.7/23	45.5/31.4	54/24	43.5/26.4	57.7/23.8	40.8/25.2
agricultural consumer credit cooperatives	24.2/18.0	30.1/32.8	25.0/21.0	36.0/32.0	25.3/20.7	36.7/30.0

Source: developed by the authors based on [2].

Intriguingly, the market averages for the full cost of unsecured consumer loans for individuals in ACCC are not only steadily high, but even exceeding the rates of credit institutions.

The exogenous deterring factors include the general institutional conditions of ACCC development: the lack of clear and transparent rules for their organization, as well as the lack of well-informed and competent approach in setting up their operation. A pending priority is to clarify the aspects of agricultural credit cooperatives in the regulatory framework, taking into account the specifics of agricultural economics and the current transformations of the organizational forms of economic operation. As shown above, the number of liquidated ACCC is 2.5 times the number of active ones. Moreover, there is no dedicated state programme for developing agricultural cooperation and thus no comprehensive approach to address the efficient development of ACCC. The main focus of the government bodies in recent years has been associated with the development and support of large economic operations, primarily agricultural holdings which show no interest in the development of credit cooperation. Meanwhile, government support of credit cooperation would provide additional opportunities for small operations in their adoption of new technologies to improve production efficiencies. For example, the modern trends in the development of precision farming require considerable amounts of investment, which becomes a deterrent in the development of PPF [7].

Besides, there is an obvious contradiction: in the absence of sufficient tools for the development of ACCC, there is excessive regulatory interference in credit cooperation. Particularly, the Central Bank requires that agricultural credit cooperatives comply with the same basic ratios and standards which govern the operations of self-regulated organizations [2].

The Central Bank also concedes that efficient interactions of credit cooperatives would require the development of an independent financial institution in the form of a banking cash desk to handle payments to credit cooperatives. The need in such an institute is driven by the current trends in financial markets, specifically, the complete transition to electronic payments, while credit cooperatives still maintain cash payment systems. Another relevant priority is also the need to revise Federal Law of the Russian Federation No. 127-FZ "On Insolvency (Bankruptcy)" dated 26.10.2002. Specifically, an update is needed to clarify the exceptional powers of the general meeting of participants in a credit cooperative and the criteria of financial standing to declare bankruptcy. For now, ACCC face over-regulation and obstacles created by restrictions and standards defying the establishment of the much-needed conditions for their development as an independent financial institute. These contradictions can be viewed as deterrents, too.

Another consideration is that integration processes in rural localities are not only defined by external economic factors associated with the sanctions standoff of the West against the Russian economy but also by the changing trends in government policies with regard to the agro-industrial sector. This shows in the priority trends of the last five years, shifting from the import replacement policies to the export-oriented policies driven by the general developments of digitalisation. Another factor is the non-competitive stance of banks with regard to cooperative organizations and specifically ACCC. This is specifically felt in that banks are rather restrained when it comes to interacting with ACCC, as the latter fail to ensure proper state engagement and attract government guarantees.

The influence of endogenous factors on the development of ACCC

The main endogenous deterring factors include high transformation and transaction costs involved in the establishment of credit cooperatives as a result of not only inadequate institutional conditions but also the rural mentality. Such mentality is now particularly characterized by the tendency of lower confidence in ACCC as an alternative credit institution at the micro level in rural territories. This issue was a key topic of discussion at the Seventh All-Russian Convention of Agricultural Cooperatives attended by us. The forum's resolution states that "despite the measures being taken to popularize the ideas of cooperation in the agricultural industry and despite government support measures, agricultural consumer cooperation is now nascent at best". The role of ACCC in "improving the income rates of rural families and entrepreneurs is still minor and hardly compares to what is achieved in traditional market economies" [10].

However, the shift in values among young entrepreneurs in agroindustrial production results in higher preference levels of younger generations for new technology and particularly IT as their trusted values. Certain impact is also felt from the general policy with regard to agricultural education in Russia, when not just the curriculum and specializations are cut down in agricultural universities but also an obvious deficit is felt among the graduates in terms of professional competences in ACC. Therefore, if the departure point is the observations repeatedly heard from Russian scholars that institutional development (specifically in financial institutions) is driven by the society's established value-related behaviours and behaviour references of the economically active population, it means that even in the mid-term, there will be an inevitable transition in the search for alternative sources, forms and mechanisms of funding toward digital financial instruments, as long as new Generation Z is raised in a different socio-technological culture [1, 15]. This applies to both urban and rural citizens. Hence the logical deterred development of ACCC based on collective interactions, which does not fit in the market psychology of the young generation nor the advanced development of new technology.

Currently, the debate is still on as to the financing of economic subjects in the agroindustrial complex and the main trends of development of ACCC as alternative financing institutions to support stable small business development and ensure national food security [8]. It is still up to discussion what motivates the development of this form of collective operation at the micro level in rural territories in the circumstances when the main rules are established by government institutions at the macro level.

CONCLUSIONS

Stable development of ACCC requires not only proper institutional conditions but also changes in the image of active ACCC or their rebranding. That said, it becomes obvious that the niche or functions of an alternative or complementary source of funding not yet fulfilled by ACCC could be absorbed by innovative financial instruments powered by digital technology. We believe there are sound prospects in this respect for the development of peer-to-peer lending in agriculture.

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CHARACTERISTICS AND TYPOLOGY OF DAIRY CATTLE FARMING SYSTEMS IN WEST REGION OF ALGERIA

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Abstract

The aim of this study was to show the characteristics and to carry out a typology to define the different types of dairy cattle breeding in the state of Relizane, through an analysis of multiple correspondences, followed by an ascending hierarchical classification. The study was carried out in 73 dairy farms with 2,454 cattle including 1,432 dairy cows. The results show that 16% of farmers have not owned agricultural land, and that the utilized agricultural area of the surveyed farms is small on average to 7.47 ha, with an average fodder agricultural area of 3.9 ha which influences negatively on the feed self-sufficiency of farms and plays a preponderant role in poor feed management. The use of corn silage is practiced on 18% of farms. Breeders have an average cattle herd of 33.6 heads, 58.3% of which is represented by dairy cows. The racial composition of the cows is dominated by the imported breeds mainly the Holstein and the Montbéliarde with 57% and 34% respectively. The average number of human work units is 2.21 HWU/farm and in 47% of the farms the staff is exclusively family. The typology revealed six types of farms; these farms are mainly differentiated by the full agricultural area, the utilized agricultural area, the Forage area, the irrigated agricultural area, and by the cattle and dairy cow's population.

Key words**:** *dairy farm, survey, system, typology*

INTRODUCTION

Algeria has a herd size of 911,401 dairy cows, of which imported cows represent more than 30% [18]. According to the study by [1], National dairy production remains unable to meet market demand for milk, and that local production of raw milk only covers around 40% of demand. The public authorities are applying a policy favoring the establishment of dairy farms by the importation of heifers with high genetic potential. The goal is to increase production and thereby reduce the import bill [2]. In parallel, and in order to cover the growing milk needs, Algeria imports more than 60% of its consumption of milk powder, knowing that the average consumption of milk is 120 l /citizen /year [12]. Considerable amounts are allocated for the import of dairy products in 2017, the Algerian government imported 465,000 tons of dairy products made up of more than 90% milk powder for a value of 1.41 billion USD [5], and this places Algeria as the second importer of milk after China [15].

Many tries on the part of the government to achieve self-sufficiency in milk production, by some plans, contrary to what was expected it could not make the projected results. This is mainly linked to a deficiency of knowledge of the general milk production system and farm conditions, particularly by the absence of data proportional to their structures and their operations. However, perfect knowledge of the conditions of the farms is necessary to achieve progress in improving the dairy sector in Algeria. The factors that influence the reproducibility and productivity of cattle herds depend on the characteristics of the cows, as well as on herd management practices [11, 14].

In this context, the purpose of the paper is to provide knowledge on dairy cattle farming in the study region. To characterize the functioning of farms and the diversity of farming systems practiced, By creating a typology that will allow to distinguish the types of dairy cattle farms in the West region and to analyze the constraints which limit their productivity and thus to contribute for the development of the dairy sector.

MATERIALS AND METHODS

Study area presentation

The state of Relizane is surrounded by mountain ranges and is divided into three regions: To the north: the Dahra mountains; to the south, the Ouencheris mountains extending from east to west south of Relizane, the valleys of Mina and lower Chéliff occupy the central part of the state. All of these areas are covered with vegetation and different kinds of trees.

The full agricultural area of Relizane state is estimated at 285,473 ha, 99% of which is represented by the utilized agricultural area. The irrigated agricultural area is 17,632 ha, and The forage area is very small 22,503 ha by comparing it to that of cereal cultivation which is 149,409 ha, the different cultivated forages are vetch-oats, corn, sorghum, clover, alfalfa, barley, rye in green and forage oats [8]. The state of Relizane has 38,578 heads of cattle of which 58% is composed of dairy cows; it has 10,127 dairy cows of imported breeds mainly composed of the Holstein and Montbéliarde breed, 12,117 improved dairy cows and local dairy cattle type. The state of Relizane recorded a total milk production during the 2017/2018 campaign of 70,582,000 liters [8].

A survey was carried out from February to August of 2019 in dairy cattle farms in Relizane state. The total sample of our study consists of 73 farms, chosen randomly while respecting certain criteria:

a)The focal vocation of the farms is the breeding of dairy cattle.

b) Breeders with a breeding license.

c) Availability and cooperation of the breeder.

d) The choice is also based on the concern for a wide diversity in terms of herd size.

The farms were subjected to a questionnaire, which contains general management of farm and these variables (FAA: Full agricultural area, UAA: utilized agricultural area, FA: Forage area, CP: Cattle population, DCP: Dairy cow population, DPA: Dairy production average per cow, NB Number of buildings).

Statistical analysis

All the data collected were organized and calculated in Excel software (2016). The data processing was carried out by a multiple correspondence analysis (ACM) using SPAD version 5.5 software, carried out on all the variables, which refer to the different questions of our survey. The ACM is followed by an Ascending Hierarchical Classification (CAH), which allows individuals to be grouped into different homogeneous classes based on the modalities. Out of 31 qualitative indicator variables (both structural and functional), twelve active variables made it possible to carry out a factorial analysis of multiple correspondences. Namely full agricultural area (FAA), utilized agricultural area (UAA), Forage area (FA), the irrigated agricultural area (IAA), cattle population (CP) and dairy cows population (DCP), the practice of grazing, training in the field of cattle breeding, the type of building, type of housing, human work unit (HWU). The main factorial axes are kept for the hierarchical classification, the result of which is in the form of a dendrogram.

RESULTS AND DISCUSSIONS

General organization of farms

The age of farmers varies from 22 to 76 years with an average of 45 years, we found that 57% of farmers are under 45 years, and that in 43% of farms the age of farmers is higher at 45 years (Fig. 1).

About Level of education of breeders, it was noted that 14% of them are illiterate, while 81% have a level between primary and secondary education, and only 5% of them have a university degree (Fig. 2).

The majority of breeders (74%) have as their main activity the breeding of dairy cattle against 21% who are farmers and we observe that only 4% are traders and 1% veterinary practitioners.

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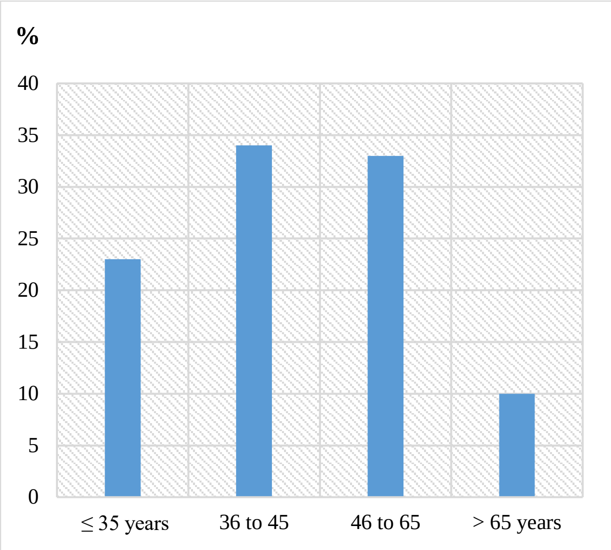

Fig. 1. Distribution of breeders by age
Source: own calculation.

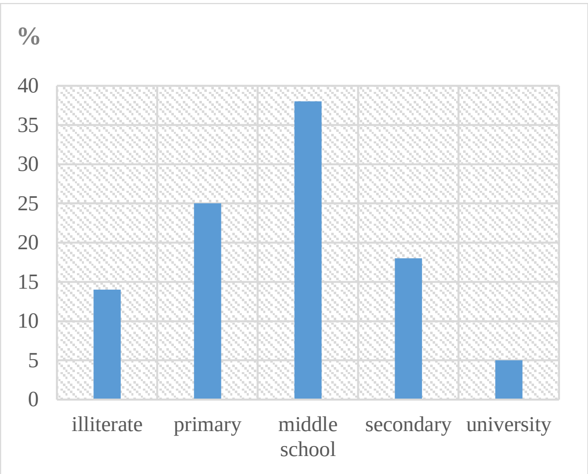

Fig. 2. Distribution of farmers according to their level of education
Source: own calculation.

We note that in 26 farms, the farmers work themselves while in 47 farms several people take care of the cattle, on average 2.21 ± 1.6 workers per farm. On farms that use labor, 47% of these farms have exclusively family staff, while in 36% of farms it are made up of employees. Only 17% of the farms have both family and paid staff.

Most breeders (78%) have no initial training in dairy farming. Only 22% have received training, including 12.5% in feeding management and 87.5% in feeding and zootechnics. Only one person has additional training in artificial insemination.

Generally, the breeders have a service provider with the veterinarian consisting of the provision of a service against payment, and have recourse to him only in case of pathology, which they cannot treat themselves. This is why there are only 12% of farms that have a partnership service (arrangement with a veterinary practice), against 88% as a service provider.

In (82%) that is the majority of farms, the age of sale of calves for fattening is between one and two years, 11% are sold at an age less than 1 year, and in 7% of farms, the sale is greater than 2 years. The breeders who have another animal species in addition to cattle breeding are 38%, on these farms in most cases 96%; the farmers aggregate a sheep farming and 4% practice poultry farming.

Heifer farming is one of the essential points but is often overlooked by breeders. Heifers are also the future of the herd; they are bred for the renewal and extension of the herd. Pre-herd management is practiced in 84% of farms; breeders keep heifers for the renewal and extension of their herd.

Characteristic of farms

Farmers breed many imported breeds, with two dominant cattle's breeds, which are Holstein and Montbéliarde (Table 1). There is a mixture of races in most of the time. Twenty six percent of farms have exclusively Holsteins and in 12% of farms, there are only Montbéliarde and in 42% of farms, these two cattle's breeds are mixed.

Table 1. Classification of the different breeds in the surveyed farms

Bovines breeds	Population	%
Holstein	812	57
Montbéliarde	490	34
Pie rouge	114	8
Fleckvieh	15	1
Local	1	0
Total	1,432	100

Source: own calculation.

The size of the dairy herds on the surveyed farms varies from two to 315 heads of cattle's with an average of 33.6 heads per farm. The number of cows per farm averages 19.6 heads (Table 2). The percentage of dairy cows in relation to the cattle population on the farms varies from 22% to 100% with an average of 60% of the size.

Table 2. Characteristics of farms in the study region

	MIN	Mean	SD	MAX
CP(heads)	2	33.6	47.5	315
DCP(heads)	2	19.6	30.15	220
DCP/CP (%)	22	60	17	100
FAA(ha)	0	7.8	13.1	100
UAA(ha)	0	7.47	11.5	85
FA(ha)	0	3.9	3.92	18
IAA(ha)	0	1.43	3.04	17
DA(ha)	0	6.04	11.1	85
FA/FAA (%)	0	63	43	100
FA/UAA (%)	0	64	43	100
IAA/UAA (%)	0	17	34	100
DA/UAA (%)	0	68	44	100

CP: cattle population. DCP: dairy cow population. FAA: full agricultural area. UAA: utilized agricultural area. FA: Forage area. IAA: the irrigated agricultural area. DA: dryland area
Source: own calculation.

The utilized agricultural area of the surveyed farms varies from zero to 85 ha with an average of 7.47 ha. About 16% of breeders do not have own agricultural land, while 58% have FAA less than 10 ha and only 26% have land with an area greater than 10 ha. The Forage area varies from zero to 18 ha with an average of 3.9 ha, and with an average percentage in the FAA and the UAA of 63% and 64% respectively. Only 26% of the surveyed farms irrigate their land, in fact 17% of the UAAs are managed as "irrigated", the average being 1.43 ha. The animals are taken to all of the farms, in free stall system; the number of cattle premises varies from one to six buildings with an average of 1.57 ± 0.86. It should be noted that 58% of farms have only one building. The buildings are of three types: open, semi-open and closed.
In most of the surveyed farms, there is not really a rationing system for cattle; the cows are not fed a ration according to their needs. Only 4% of breeders distribute a total mixed ration. The essential forages distributed on farms are oat hay, straw, corn silage and green alfalfa. The fodder being mainly of mixed origin (produced in farm and bought from the trade), only 25% of the breeders produce their own fodder The concentrate given by breeders is mostly bought from the trade; it is distributed to cows daily with an average of 11.3 ± 2kg /cow/ d. A minority, 5% of breeders, supplement the ration distributed with licking stones, multivitamins and a hepatoprotective drugs

Description of the identified groups

We have limited ourselves to the first two axes, which explain 23.45% of the information that is 12.65% and 10.80% respectively. From the ACM results reported in Figure 3, we can determine that:
The first axis expresses 12.65% of the inertia, and mainly characterizes the structure of the farms, represented by the following methods, the full agricultural area (FAA), the utilized agricultural area (UAA), Forage area (FA) and human work unit (HWU). According to Fig. 3, we can deduce that this axis distinguishes, on one side, the farms with significant potential whatsoever, in agricultural land (utilized and forage), labor, and on the other side, opposes the small farms.

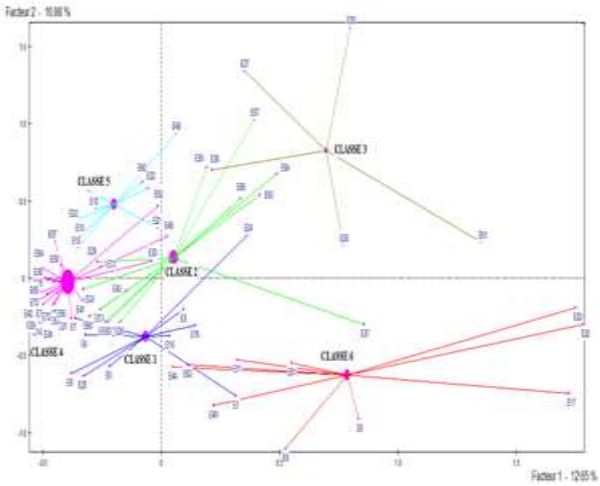

Fig 3. Graphic representation of the six typological groups identified in the state of Relizane
Source: own calculation.

The second axis explains 10.80% of the inertia and mainly characterizes the irrigated agricultural area, as well as the practice of grazing and the cattle population. This axis distinguishes at the bottom, the farms who IAA represent a considerable part of their UAA and who practice grazing while their cattle herd size are reduced and at the top of

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the farms of larger herd size and less IAA, and not practicing grazing.

An Ascending Hierarchical Classification (CHA) was performed on the results of the ACM. The result obtained is in the form of a dendrogram (Fig. 4).

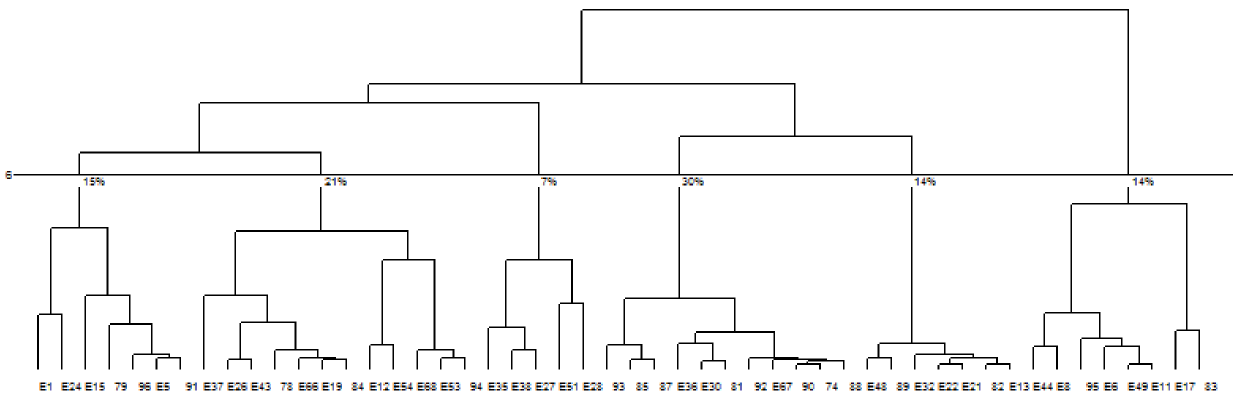

Fig. 4. Dendrogram of identified groups
Source: own calculation.

Six groups were distinguished by typology; Fig. 3 and Table 3 represent these groups. We can distinguish:

Group 01: this group corresponds to medium-sized farms with irrigated fodder crops, it is made up of 10 farms (class 1/6) or 13.7% of the total surveyed farms. These are farms with an average UAA of 5.9 ha. With a large irrigated agricultural area on average 4.85 ha and a forage area of 4.15 ha on average, this type of farming has fodder crops consisting of sorghum and alfalfa as well as oats, these crops are dominant. This type of breeding is located in the central region of the state, where water is much more available, these are well-equipped farms in semi-open type buildings. The cattle population is 26.4 heads on average including 14.5 dairy cows, which represents 54.9% of the population. The farmers in this group who practice grazing is around 60% with a low number of HWUs employed with an average of two HWUs. The majority of these breeders (60%) have received training in the breeding field.

Group 02: this group corresponds to medium-sized farms with a more cereal vocation. It consists of 14 farms (class 2/6), or 19.18% of the surveyed sample. These are farms which have an average of 8.25 ha of UAA with fodder crops which represent a large part of their land, i.e. an area of 5.39 ha on average, and a very small irrigated area which represents only 0.28 ha. These farms mainly cultivate oats and cereals for grain production. and are located largely north and south of the study area of 57.1% and 35.7% respectively, the number of HWUs employed is 2.6 HWU on average, 57.1% of the farmers practice grazing, and 71.4% have no training in dairy cattle breeding, the cattle population is on average 35.6 heads, including 21.4 dairy cows, or 60.2% of the sample.

Group 03: This group corresponds to farms with large cattle population. It has five farms (class 3/6) or 6.85% of farms, these large farms have a high dairy cow population, the cattle population is 154 heads on average including 95.8 dairy cows or 62.2 % of the group's population, which attests to the orientation of animal husbandry towards milk production. The UAA is 6.2 ha on average, the Forage area of five ha on average with the absence of irrigated areas. The number of HWUs employed is high among others in this type of groups with an average of 5.4 HWUs. These farms are found in 80% of the cases in the southern region, and those, which do not practice grazing, represent 80%, among the breeders of this group 60% were trained in the field of dairy cattle breeding. This group of breeders is well equipped and efficient in terms of type of building and housing, with the presence of a large workforce.

Group 04: This group corresponds to small farms with a small cattle population, it is the largest in number of farms, 24 farms (class 4/6) or 32.8% of farms, for this category, breeders have very little agricultural land, 2.62 ha of UAA on average with an FA of an average of 2.41 ha. The forage crop is mainly represented by forage oats, the irrigated area is very limited, 0.08 ha on average. The cattle population is 19 heads on average with an average of 10.9 dairy cows, or 57.3% of the population, these are traditional farms, and almost all breeders have no training. These farms are concentrated in the northern region (58.3%); the number of HWUs employed is very low, 1.5 HWUs on average. The breeders of these farms (54.1%) practice grazing.

Group 05: This group corresponds to dairy cattle farms without agricultural land, there are 10 farms (class 5/6), or 13.7% of the total surveyed farms, these farms are without agricultural land, forage areas are nonexistent. The size of the herd is an average of 22.9 heads, including 12.1 dairy cows, or 52.8% of the population. These farms (60%) are in the central region and 30% are in the north. No breeder in this group has training in the field and the majority do not practice grazing.

Group 06: This group corresponds to large farms with a small cattle population. This group is made up of 10 farms (class 6/6), or 13.7% of the total population surveyed. They are characterized by the small size of the herd, however, with a large agricultural area. The UAA is important, on average 27.7 ha, with a reduced FA compared to the UAA 8.6 ha and an average IAA of 4.9 ha. Most of the forage crops grown are oats, alfalfa and grain culture. The cattle population is 23.5 head on average including 12.5 dairy cows, or 53.1% of the workforce. These farms are located in 50% of the cases in the central region of the state, these farms are of old-style type, 60% of them practice grazing, and the number of HWU employed is reduced on average 2.2 HWU, 80% of breeders have no training in the field.

Table 3. Average characteristics and standard deviations of the variables for the different groups of farms identified

	Mean ± SD					
Variables	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**
FAA(ha)	6 ± 2.66	8.25 ± 1.47	6.2 ± 6.57	2.64 ± 1.57	0	30 ± 25.5
UAA(ha)	5.9 ± 2.80	8.25 ± 1.47	6.2 ± 6.57	2.62 ± 1.58	0	27.7 ± 20.8
FA(ha)	4.15 ± 2.21	5.39 ± 3.14	5 ± 5.74	2.41 ± 1.59	0	8.6 ± 5.66
IAA(ha)	4.85 ± 2.21	0.28 ± 0.72	0	0.08 ± 0.40	0	4.9 ± 5.48
Cattles	26.4 ± 16.5	35.6 ± 37	154 ± 144	19.0 ± 10.2	22.9 ± 21.0	23.5 ± 19.8
Dairy cows	14.5 ± 8.74	21.4 ± 21	95.8 ± 77.2	10.9 ± 6.59	12.1 ± 9.74	12.5 ± 11.0
HWU	2 ± 0.47	2.64 ± 2	5.4 ± 2.88	1.5 ± 0.65	2 ± 0.94	2.2 ± 1.03

FAA: full agricultural area. UAA: utilized agricultural area. FA: Forage area. IAA: the irrigated agricultural area.
Source: own calculation.

The results of this study show that a majority of young people whose age does not exceed 45 years holds the dairy cattle farms, which shows the interest given by this young generation to the breeding of dairy cattle. However, mastering the management of these farms requires a certain level of knowledge and training in the field. It has been observed that the university level of heads of farms represents only 5%; therefore, the majority of breeders do not have the appropriate level of education for the management of dairy cattle farm. Indeed, most breeders have no basic training, neither in feeding nor in zootechnics and this is the reason why the management of herds is carried out in an archaic and irrational way, which does not allow exploiting the full potential of bred cattle breeds.

The size of herd in the surveyed region is on average 33.6 cattle and 19.6 dairy cows, which is significantly higher than that reported by [3] in the eastern region of Algeria and which is in average of 24.8 cattle and 12.3 dairy cows. The average UAA in the study region is 7.4 ha, which is lower than the UAA of farms in the state of Mascara 11.6 ha on average [17], and in central region of Algeria which is on average 9.3 ha [13]. Moreover, it is slightly larger than that reported by [16] in Morocco, where breeders use an average UAA of 6 ha. On the other hand, the Forage area of herds surveyed is on average 3.9 ha, lower than what is observed in the Southwest region of Algeria where the FA is on average 5.3 ha [6]. It has been found that 73% of farmers have little or no agricultural land. Indeed, 59% of them have less than 10 ha of FAA. Feed self-sufficiency corresponds to the proportion of food intended for animals and which is produced on the farm, the lower this proportion, the more intensive livestock farming is [9]. The area devoted to fodder is very small and does not meet the feed requirements of the animals on most of the surveyed farms, which has a negative impact on the breeding of dairy cattle in the region and leaves the breeders dependent on the trade.

The less self-sufficient the farmer is to feed his animals; the more he is forced to buy animal feed. Only 25% of the farmers produce their own fodder, which partly explains the intensive farming method practiced in the region.

We have seen that the feed ration distributed to dairy cows is not based on any formula, and there is an absence of a rationing system based on the needs of dairy cows according to their physiological stage.

Unlike in Italy, According to the study of [4] Farmers reformulate, their diet every 48 ± 7 days and the feeds are tested every 52 ± 2 days in Italy. Breeders distribute high amounts of concentrate to the detriment of fodder, in order to increase milk production.

On average, 11.3 ± 2 kg of concentrate is distributed per dairy cow in the study area. This quantity is greater than what is distributed in the north of the country on average 8.47 kg /cow/d on average [7], and lower than that presented to dairy cows on farms in Morocco, and which is on average 14 kg /cow/d [16].

Corn silage is used only in 18% of farms, which differs from the Northeast and western regions of Algeria where there is no use of corn silage according to [10] and [17] respectively.

CONCLUSIONS

This study made it possible to show the reality of the situation of dairy cattle farms in the state of Relizane. Mainly agricultural land and livestock population distinguished six groups of farms.

These results underline that many of these dairy farms have little agricultural land, in particular fodder areas, which is a limiting factor in the field of milk production and at the origin of dependence on concentrate. Indeed, these farms practice a forage crop that remains partial, to this is added the problem of lack of land irrigation, which is much more noticeable in the northern region of the state where there is a low water potential.

Faced with this fact, the constraints and mismanagement that preside over dairy farming must challenge the economic sector. Strengthening and optimizing national milk production requires the implementation of a plan based on a scientific and technical approach founded on adequate criteria.

Finally, the development of cattle breeding in our country is linked to an increase and an improvement in fodder production, in particular, the production of quality silage, to have qualified breeders efficient monitoring and supervision for breeders in the technical field is required, so that to they can manage their farms in a suitable manner and have a livestock adapted to the region, and capable of facing the constraints of the sector integrating good farming practices.

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FOOD WASTE MANAGEMENT USING STATISTICAL ANALYSIS TO OBTAIN NEW FUNCTIONAL PRODUCTS

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Abstract

A problem in food industry is the various types of waste that are produced during and after food preparation. In this article, mathematical studies have been implemented to obtain what amount of food waste is most appropriate for the enrichment of food and the production of new functional products. The subject of the study are cookies and the subject is the addition of Apple peel powder (APP). Physico-chemical, organoleptic characteristics and spectral indexes of biscuits were used as an input data. Vectors of the most informative features are selected, describing main indicators of the quality of cookies. Mathematical models have been developed to describe the relationship between the amount of APP and the weighting coefficients of the feature vectors. Using the partial least squares regression (PLS), principal component analysis (PCA), and factor analysis (FA) methods, it has been determined the optimum amount of APP for cookies preparation. The study found that using the Factor Analysis (FA) method performed better than using PCA and PLS. It has been found that the amount of apple residues in cookies is APP=23,6±1,3%, which can be considered as optimal. The proposed methods and tools have the potential to reduce food and waste losses. They are also one way to reduce production costs and improve food quality.

Key words: *partial least squares, component analysis, factor analysis, equation models*

INTRODUCTION

Reducing food and waste losses in recent years has been seen as a way of reducing production costs and improving food quality. This also leads to environmental sustainability [7].

The food industry produces a large amount of waste. The problem in this industry is the various types of waste that are generated during and after food preparation. According to the FAO, one-third of food produced worldwide for human consumption (1.3 billion tonnes) is estimated to be in the waste.

Countries with a stable economy lose over 40% after harvest or during processing due to suboptimal storage and transportation conditions [6]. The waste from this industry can be used for the production of yeast, cellulose, vegetable oil [1]. This type of waste can also be a good source of biologically active substances. These biologically active substances can be used to enrich a variety of bakery and confectionery products [10].

Figure 1 shows the possible products that can be obtained from food chain waste.

Apples (*Malus domestica*) are the fruits that are the most grown in the Republic of Bulgaria. After processing the apples in drinks, jams, dried apples and other products are obtained waste products. Based on their nutritional value, they can be used as a functional ingredient in food production. Apple waste products processed to a dry fine powder may be included in the composition of foods, most often in bakery products.

Apple waste products are discarded or used for animal feed. Recent advances in biotechnology make it possible to extract valuable substances from waste apple products: biologically active compounds, organic acids, aromatic compounds, bioethanol and enzymes. Apple peel is a waste product from the production of compotes, dried apples, apple puree and apple pie [16].

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In our previous article, physicochemical and sensory parameters of biscuits enriched with 4%, 8%, 16%, 24% and 32% apple peel flour were published [12].

The purpose of this article is to predict, through mathematical studies, what amount of food waste is most appropriate for the enrichment of food and the production of new functional products.

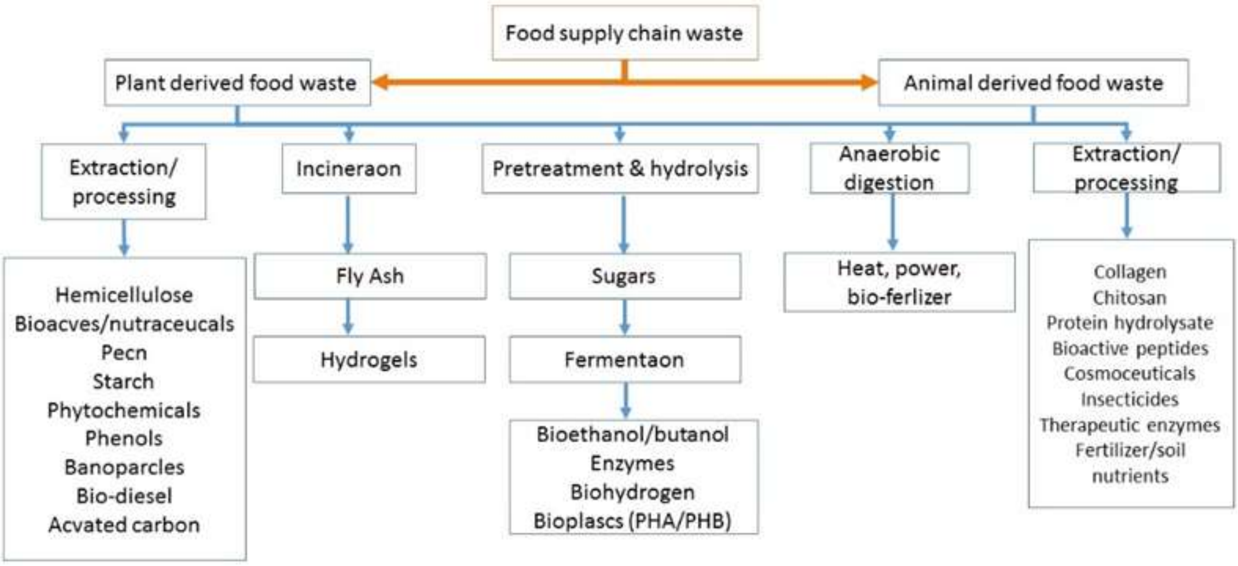

Fig. 1. Products derived from food chain waste
Source: Ravindran and Jaiswal, 2016 [13].

MATERIALS AND METHODS

The methodology for obtaining cookies and determining their basic quality indicators is described in detail in [12].

Table 1 summarizes the indicators used to evaluate the quality of cookies with and without the addition of Apple peel powder (APP). The features used are:

-F1-F5 are the physicochemical characteristics of cookies;

-F6-F8 are geometric dimensions of cookies determined by a caliper, with accuracy 0,02 mm;

-The F9-F11 are the color components of the Lab color model. They were determined with a Minolta CR-400 colorimeter (Konica Minolta, Tokyo, Japan);

-F11-F20 are the physicochemical characteristics of cookies;

-F21-F27 are the organoleptic characteristics determined by the touch panel. It consists of 20 tasters;

-F28-F38 are spectral indices determined according to the methodology presented in [2, 4].

Figure 2 shows the principle of obtaining spectral indices. The determination of the Carotenoid Transmittance Index (CTI) has been demonstrated.

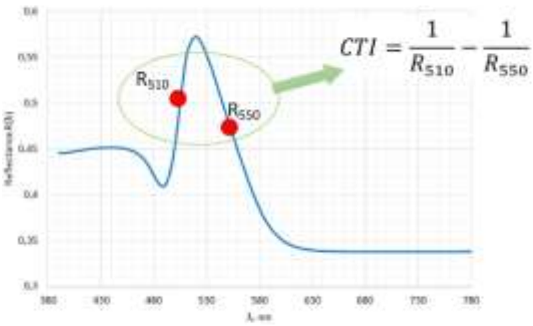

Fig. 2. Obtaining of Carotenoid Transmittance Index (CTI)
Source: Own results.

The spectral reflectance characteristics are obtained by converting the values from the LMS model into reflection spectra in the VIS region, in the range 390-730nm, according to the mathematical dependencies presented in [15].

Table 1. Cookies quality assessment indicators (features)

№	Feature	№	Feature
F1	Peak Viscosity, BU	F20	FRAP, µgTE/g DM
F2	Breakdown, BU	F21	Appearance
F3	Setback, BU	F22	Internal structure
F4	Final viscosity, BU	F23	Texture
F5	Pasting temperatura, °C	F24	Odour
F6	Width, cm	F25	Taste
F7	Thickness, cm	F26	Aroma
F8	Volume, cm^3	F27	Overal quality
F9	L*	F28	REI
F10	a*	F29	PTI
F11	b*	F30	CTI
F11	Moisture, g/100g	F31	TVI
F13	Ash, g/100g DM	F32	G
F14	Lipids, g/100g	F33	NExG
F15	Proteins, g/100g	F34	NGRDI
F16	Fibre, g/100g DM	F35	RGBVI
F17	Carbohydrates, g/100g DM	F36	GLI
F18	TPC, mg GAE/100g DM	F37	VARI
F19	DPPH, µgTE/g DM	F38	ExG

Source: Own calculation.

The organization of the cookie output data is presented in Table 2. It consists of mxn rows and columns. In our case of n=38, the number of features used describes the basic quality of the cookies. The number of columns m=6 describing the amount of additive of apple peel powder (0%, 4%, 8%, 16%, 24% и 32% APP).

Table 2. Cookies input data

%APP / Feature	P0	P1	P2	P3	…	Pm
F1	P0F1	P1F1	P2F1	P3F1	…	PmF1
F2	P0F2	P1F2	P2F2	P3F2	…	PmF2
F3	P0F3	P1F3	P2F3	P3F3	…	PmF3
…	…	…	…	…	…	…
Fn	P0Fn	P1Fn	P2Fn	P3Fn	…	PmFn

Source: Own calculation.

The selection of informative features is done by methods [8]:
-Correlation. Correlation dependence allows one to look for unknown links between the features describing basic indicators of cookie quality;
-ReliefF. This algorithm works well when evaluating the significance of characteristics for distance-based models;
-FSRNCA (Feature selection for regression using neighborhood component analysis). This algorithm also works well when evaluating the significance of characteristics for distance-based models.
The selected features are grouped into feature vectors, depending on the method used. The weight ratios of the amount of apple peel powder added were obtained by the methods [3,11]:
-Factor Analysis (FA). It is a statistical technique in which a plurality of correlating data is transformed into a new set with non-correlating artificial variables or factors that explain as much of the total variation of the raw data as possible;
-Principal Component Analysis (PCA). The task with this method is to separate variables that are linear combinations of orthogonal variables and are not correlated;
-Partial least squares regression (PLSR). Data from feature vectors obtained describing product characteristics are not used directly, but new regression factors are created that concentrate information across the entire spectrum of data used.
The relationship between the amount of APP and its weight coefficients is described in four models. Their adequacy was estimated by coefficient of determination (R2), sum of squares of error (SSE), root of mean square errors (RMSE).

The following models are used:

Second order polynomial (poly2)	$\boldsymbol{y_1 = ax^2 + bx + c}$
Third order polynomial (poly3)	$\boldsymbol{y_2 = ax^3 + bx^2 + cx + d}$
Second order sinusoidal (sin2)	$\boldsymbol{y_3 = a.\sin(bx + c) + d * \sin(ex + f)}$
First order Gaussian (gauss1)	$\boldsymbol{y_4 = a.e^{-\left(\frac{x-b}{c}\right)^2}}$

The optimal value of% APP is determined by finding the minimum or maximum value in the model describing the relationship between% APP and their weight coefficients. The interval [x1, x2] in this case is [0,40] %APP. The way to find the optimal value depends on whether the model describes an increasing or decreasing function:

$$\min_x f(x) \text{ such that } x_1 < x < x_2$$
$$\max_x f(x) \text{ such that } x_1 < x < x_2$$

Matlab software (TheMathworks Inc.) and MS Excel (Microsof Corp.) were used. All data were processed at a level of significance α=0.05.

RESULTS AND DISCUSSIONS

Fig. 3 presents the results of a selection of main features describing the quality of the cookies containing apple peel powder. The features that have values above the average for the respective method are selected.

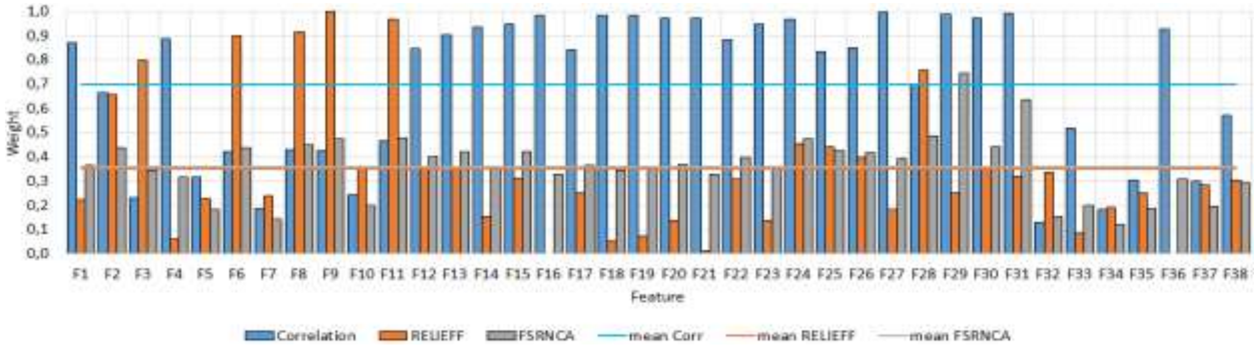

Fig. 3. Resu Source: Own results.
lts of feature selection

Table 3 shows the feature vectors obtained (FV), depending on the selection method used. FV1 contains a small part of the physicochemical and geometric features (2 features), the main part is the color components and organoleptic indicators of cookies (15 features) and part of the spectral indices (4 features). FV2 mainly contains the physicochemical, color and organoleptic characteristics of the product and only one spectral index. Like the first feature vector, FV3 contains most of the features but only 4 spectral indices.

Table 3. Selected feature vectors

Feature vector	Method	Selected features
FV1	Correlation	F1, F4, F12, F13, F14, F15, F16, F17, F18, F19, F20, F21, F22, F23, F24, F25, F26, F27, F29, F30, F31, F36
FV2	RELIEFF	F2, F3, F6, F8, F9, F11, F24, F25, F26, F29
FV3	FSRNCA	F1, F2, F6, F8, F9, F11, F12, F13, F15, F22, F24, F25, F26, F27, F28, F29, F30, F31

Source: Own calculation.

The feature vectors are used to determine the weights/loadings (according to the method used) for the different amount of APP additive in cookies. Four models were compared to describe the relationship between the amount of APP and its weight coefficients.

Fig. 4 shows the weight coefficients obtained for the amount of apple peel powder using feature vectors. Using PCA method, significant changes are shown by the weight coefficients obtained from the feature vectors FV1 and FV3.

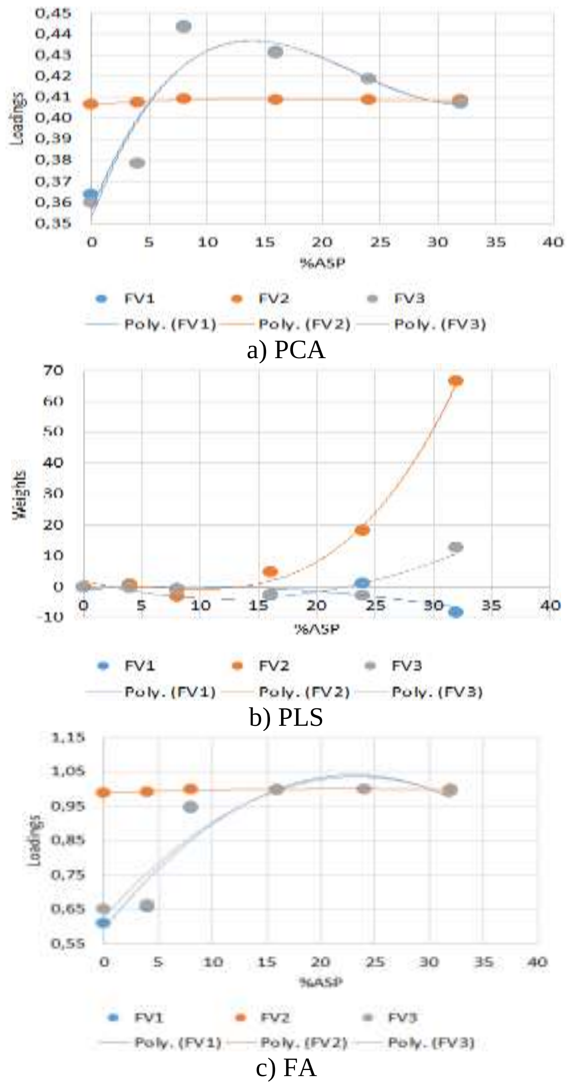

Fig. 4. Factor Loadings and weights of %APP
Source: Own results.

For those obtained with the PLS method, only the FV2 feature vector showed a significantly greater variation than the other two vectors. Again in FA the vectors of signs FV1 and FV3 showed significantly changed values of the weight coefficients compared to FV1.

Table 4 shows the results of the comparative analysis of models representing the relationship between %APP and the factor loadings obtained by the PCA method. With "Opt.", indicates the optimal amount of APP in cookies when using data from the appropriate model. SSE and RMSE error values are seen to be low (0-2%). The coefficient of determination is 0.71-0.86. This indicates that the models accurately describe the experimental data when PCA method is used.

Table 4. Model comparisons of %APP and PCA factor loadings

Feature vector	FV1				FV2				FV3			
Criteria / Model	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.
y_1	0.00	0.72	0.02	18.53	0.00	0.71	0.00	20.10	0.00	0.72	0.02	18.60
y_2	0.00	0.81	0.02	13.90	0.00	0.86	0.00	27.86	0.00	0.81	0.02	21.97
y_3	0.00	0.83	0.00	14.40	0.00	0.00	0.00	0.00	0.00	0.83	0.00	14.26
y_4	0.00	0.85	0.00	12.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00	12.00

Source: Own results.

Table 5 shows the results of the comparative analysis of models representing the relationship between %APP and the PLS weights. "Opt." Indicates the optimum amount of APP in cookies when using data from the model. In contrast to the PCA results, the SSE and RMSE error rates of up to 93% are significantly higher using this method. Significantly lower are the values of the coefficient of determination R2, which in some cases are 0. The highest values are this coefficient when using models y3 and y4, in combination with the reduced FV2 data, but at high error values up to 24%.

Table 5. Model comparisons for %APP and PLS weights

Feature vector	FV1				FV2				FV3			
Criteria / Model	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.
y_1	22.98	0.59	2.77	8.75	93.22	0.97	5.57	8.36	31.59	0.81	3.25	12.42
y_2	11.01	0.80	2.35	19.74	19.99	0.99	3.16	9.94	3.17	0.98	1.26	18.64
y_3	16.63	0.71	0.00	24.72	23.83	0.99	0.00	10.22	20.49	0.88	0.00	20.11
y_4	19.59	0.65	2.56	35.98	10.52	0.99	0.00	39.99	6.01	0.97	0.00	24.01

Source: Own results.

Table 6 shows the results of the comparative analysis of models representing the relationship between %APP and the factor loadings obtained by the FA method. "Opt." Indicates the optimum amount of APP in cookies when using data from the model. This data processing has produced significantly better results than the other two methods (PCA и PLS). SSE and RMSE error values are seen to be low (0-2%). The coefficient of determination is 0.71-0.86. This indicates that the models accurately describe the experimental data when analyzed using the factor loading from FA method.

Table 6. A comparative analysis of models for% APP and FA loadings

Feature vector	FV1				FV2				FV3			
Criteria / Model	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.	SSE	R^2	RMSE	Opt.
y_1	0,00	0,72	0,02	18,53	0,00	0,71	0,00	20,10	0,00	0,72	0,02	18,60
y_2	0,00	0,81	0,02	13,90	0,00	0,86	0,00	27,86	0,00	0,81	0,02	21,97
y_3	0,00	0,83	0,00	14,40	0,00	0,00	0,00	0,00	0,00	0,83	0,00	14,26
y_4	0,00	0,85	0,00	12,00	0,00	0,00	0,00	0,00	0,00	0,84	0,00	12,00

Source: Own results.

The analysis made showed that the best results were obtained using the FA method compared to the other two (PCA and PLS).

The calculated values were used to determine the amount of APP in cookies to produce a product with optimum quality indicators. Only those optimal values that have been obtained from models describing with sufficient accuracy the relationship between the weight coefficients and% APP are taken into account. After averaging, an amount of apple residue was obtained, %APP=23.58±1.27%, which may be considered as optimal.

The methodology proposed here improves the methods used so far by refining the way to determine the optimal amount of waste products in biscuits.

The methodology complements that of Sestrimska, 2014 [14], with the option of determining the optimal amount of one-component cookies additive.

The addition of APP is over 20%, while reducing or completely discarding the use of white crystalline sugar in cookies.

Addition of other residues such as tomato peels is possible up to 7.5% [5]. This improves the functional properties of the cookies, but does not significantly reduce the amount of basic raw materials used.

A similar effect is obtained with the addition of apple seed powder [9]. Adding more than 10% of the total raw materials used decrease the quality of the cookies. This is due to the dilution of gluten-forming proteins caused by the incorporation of fibers.

The cited publications did not apply a precise methodology for determining the optimal amount of additional raw materials used.

CONCLUSIONS

A method and tools have been developed to determine the optimum amount of APP to use as a cookie additive. The method is based on the basic indicators of the quality of cookies, as well as on a certain set of ratios between them.

Mathematical studies have predicted what amount of food waste is most appropriate for the enrichment of food and the production of new functional products.

A comparative study of different methods of successively improving assessments has been made, which substantially reduces the number of combinations of features obtained. Combining RELIEFF and FSRNCA with factor analysis (FA) results in the best results in determining the optimal amount of APP in cookies compared to the other methods used.

A comparative study was conducted to evaluate the impact of the methods used to reduce the volume of data on feature vectors and to determine their weight coefficients. The study found that using the Factor Analysis (FA) method performed better than using PCA and PLS.

The proposed methods and tools have the potential to reduce food and waste losses. They are also one way to reduce production costs and improve food quality.

Using the methods proposed would also improve the environmental sustainability.

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ASSESSMENT OF FARMERS' PARTICIPATION AND ATTITUDE TOWARDS GROWTH ENHANCEMENT SUPPORT SCHEME IN OGBOMOSO AGRICULTURAL ZONE OF OYO STATE, NIGERIA

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Abstract

Growth Enhancement Support Scheme (GESS) is a farm input subsidy programme introduced by the Nigerian government to assist farmers, and an assessment becomes imperative for effective and proper implementation. This study, therefore, examined farmers' levels of participation and attitude towards GESS. Multistage sampling procedure was used to draw 260 registered farmers as respondents. Data were collected with the aid of a structured interview schedule. The data were subjected to descriptive statistics and Pearson Product Moment Correlation was used to test the relationship between the respondents' participation and their attitude towards GESS. Farmers' mean age was 44 years and are mostly male with a mean household size of 5 people. Majority of the farmers enjoyed the provision of advisory services through the agro-input dealers, distribution of seeds and fertilizers. Significant relationships exist between age, household size, years spent in formal school and farmers' level of participation in GESS. Over half of the farmers had a moderate level of participation and favourable attitude towards GESS. The government should continue the programme and address the shortcomings such as distance to redemption centres and late delivery of inputs to increase the level of participation by farmers.

Key words: *cassava, livestock, feedstuff, farmers, utilization*

INTRODUCTION

Agriculture is a crucial subset of the economies of third world countries. Its rate of growth, however, does not keep pace compared with its essential significance in the economies of different developing countries [12]. For instance, the Nigeria agricultural sector growth dropped severely post-independence with 80% contribution to the GDP in the early 1960s to a pitiful 34% in 2003 [2].
Nigeria was the world largest importer of the United States hard red and white winter wheat with an annual import of ₦635 billion. It is also the second-largest importer of rice (₦356 billion), sugar (₦217 billion) and fish (₦97 billion) [5]. The desire in transformation plan is to achieve a hunger-free Nigeria by means of an agricultural sector that drives at income growth, advances achievement of food and nutritional security, spawn employments and transforms Nigeria into a significant player in global food markets to produce millions of farmers who are wealthy.
In recent times, there is a resurgent interest in agricultural input subsidies which was identified as a peculiar feature of agricultural growth and development policies in pitiable rural economies in Nigeria from the 1960s to the 1980s. [8] estimated significant contribution of farm input subsidies to growth, development and poverty reduction in India during the early phase of the Green Revolution but not later (although, estimated returns to some other aspects such as agricultural researches or investigation were higher). [6] argued that sustained (but not indefinite) farm-input subsidies were an essential part of successful Green Revolution packages, making a meticulous contribution, firstly within staple food supply chains, then, in the broader rural economy. The real success of the Green Revolution policy in Asian countries in driving growth and alleviation of poverty is widely acknowledged.

Nevertheless, regardless of longstanding work revealing the importance of farm-input subsidies in Indonesia [16], in fostering agricultural growth in conditions where farm-input grants should have the pleasing effect [4]. But diversion, late delivery and poor quality are much more significant constraints to fertilizer use by farmers than its expense (although access to credit was also cited as a major constraint).

Various agricultural schemes, programs and policies had been formulated and implemented with the main target of increasing agricultural output since 1960 when Nigeria got her independence. The benefits derived and shortcomings of such previous programs were employed for the execution of the farm-input-subsidy national project tagged Growth Enhancement Support Scheme, a part of the federal government's national Agricultural Transformation Agenda of the past administration. The launching of this policy document was expected to be a roadmap in solving fundamental problems associated with the agricultural sector [5].

GESS is a cost-sharing scheme between the government and the farmer. It is designed for the specific purpose of providing affordable agricultural farm-inputs like fertilizers (inorganic) and hybrid seeds to crop farmers in order to raise their output per hectare thus comparable to world standard because of the past complaints of diversion, exorbitant price and adulteration of various inputs to farmers, which ultimately led to low productivity, increased poverty, unemployment and lack of interest in farming. The scheme approach is to target beneficiaries (small scale farmers) through the use of the electronic system and by encouraging the engagement of the private sector in the distribution and delivery of fertilizers and other critical input directly to farmers. This study, therefore, assessed farmers' participation and attitude towards the growth enhancement support scheme (GESS) in Ogbomosho Agricultural zone of Oyo State, Nigeria.

Hypotheses of the study

The hypotheses of the study are stated in a null form;

H_{01}: There is no significant relationship between the socio-economic characteristics of the respondents and their level of participation in GESS.

H_{02}: There is no significant relationship between the respondents' attitude and their participation towards GESS project.

MATERIALS AND METHODS

Study area

The study was conducted in Ogbomoso Agricultural zone of Oyo state. Ogbomoso Agricultural Zone is made up of five Local Government Area (LGAs), namely Ogbomoso North Local Government Area (LGA), Ogbomoso South LGA, Ogo-Oluwa LGA, Orire LGA and Surulere LGA respectively. Ogbomoso North and South LGAs are the two urban LGAs,while the others are rural-based. The geographical location of Ogbomoso is on Latitude 81^{o}North and Longitude 4.25^{o}East. The total landmass area is about 27,249 square kilometre and total population which is estimated at 3,488,789 as of 2006 census provision figures. It is bounded in the North by Irepodun LGA in the west by Oyo LGA, south by Ejigbo L.G.A of Osun State and in the east by Asa L.G.A of Kwara State.

Sampling Procedure and Sample Size

Multistage sampling procedure was used to select the respondents for this study. Ogbomoso zone comprises five local government areas, and each local government had assigned redemption centres where farmers redeem their inputs. The respondents selected for this study include the farmers that redeemed their inputs through the GESS. In the first stage, purposive sampling technique was used to select three Local Government areas namely; Ogo-Oluwa, Oriire and Surulere due to their rurality in nature and concentration of farmers in the area. The second stage involved random selection of fifty percent (50%) of assigned redemption centres in each local government: two (2) redemption centres in Ogo-Oluwa, two (2) redemption centres in Oriire and one (1) redemption centre in Surulere that resulted into five (5) selected redemption centres. In third stage five percent (5%) of the farmers rolled out from the report of the present Oyo State Ministry of Agriculture and Rural Development (OYSMARD) were randomly selected from the five redemption centres in the three LGAs which amount to two hundred and sixty (260) farmers that makes up the sample size for the study.

Data analysis

The data for this study was analyzed using both descriptive and inferential statistics. The descriptive statistics include frequency count, percentage, mean an standard deviation while the inferential statistics include Pearson' Product Moment Correlation (PPMC) was used to test the hypotheses.

RESULTS AND DISCUSSIONS

Farmer's demographic characteristics

The farmer's demographic features are as shown on Table 1. The farmer's (respondents) age ranked from 20 to 65 years. The widespread age range concentration was between 50 to 59 years which represented 34.6%. Next was the age range between 40 to 49 years representing 29.6%, while 20.8% fell within 30 to 39 years. Those respondents who fell in the age bracket of 20 to 29 years accounted for 9.3%, although, respondents above 60 years of age represented 5.8%. The mean age of the farmers or respondents was 44.2 years. This supports the findings and report of [1], who explained that most farmers that benefitted from GES scheme were still of active and productive age. Therefore, this informed their effective utilization to enhance productivity.

In addition, 68.8% respondents were male while 31.2% were female. This shows the dominance of the male farmers in GESS. These findings probably indicated that farming activities are an energy-demanding work. Hence men are more involved in production while the women are more engaged with food processing and marketing in agriculture [15].

Moreover, regarding marital status, 59.2% of the respondents were married, while 16.9% were single, 11.9% were divorced and 11.9% were also widowed. The number of married respondents is unconnected with cultural inclinations that confer the responsibility of providing for the wellbeing of their household, according to [3]. Concerning household size, 61.9% of the respondents had up to 5 persons while 38.1% had between six to ten persons in their individual family. On average, a family had five persons. This indicates that the household size of the respondents were relatively large. Thus, this may positively influence farming activities. This agrees with the earlier findings of [14] that large family size gave an advantage of employing them for various farming activities.

Table 1. Farmer's demographic characteristics

	Percentage	Mean
Age (years)		
20 – 29	9.3	44
30 – 39	20.8	
40 – 49	29.6	
50 – 59	34.6	
>60	5.8	
Sex		
Male	68.8	
Female	31.2	
Marital Status		
Single	16.9	
Married	59.2	
Divorce	11.9	
Widow	11.9	
Household size (people)		
1– 5	61.9	5
6 - 10	38.1	
Educational qualification		
None	18.8	
Primary	21.6	
Secondary	34.6	
NCE	11.2	
Vocational	3.8	
Arabic	0.4	
Adult Education	1.2	
HND/Degree	8.5	

Source: Data Analysis, 2018.

The respondents attained various forms of education. Although 18.8% had no formal education, 21.6% had primary school education, 34.6% had secondary school education, 11.2% had NCE qualification, 3.8% had vocational training, 0.4% had Arabic education, 1.2% had adult education while 8.5% had higher diploma or degree. The high form of education or learning among the respondents, according to [15] may encourage acceptance of innovation as a way of raising farm productivity and income. [13] found that education had a significant and positive relationship with farmers' level of awareness to innovation, diffusion and adoption of innovation which is evident among the GESS respondents.

Distribution of activities in which respondents participated status in GESS

Table 2 conveys the distribution of respondents by their participation status in GESS. Most (77.3%) of the respondents regularly attended meetings concerning GESS activities, while 70% received text messages through handset concerning farm input. Others include quick response to agro-input allocation through e-wallet voucher (68.8%), regular visit to accredited agro-dealers to redeem farm input (80.4%) while, 82.7% were actively involved in the advisory services.

Table 2. Distribution of activities in which respondents participated status in GESS

Participation Statement	Percentage
Regular attendance at meetings concerning GESS	77.3
Receiving text messages from handset concerning farm inputs	70.0
Quick response to agro-inputs allocation through e-wallet	68.8
Regular visits to accredited agro-dealers to redeem the inputs.	80.4
Actively involved in the advisory services	82.7

Source: Data Analysis, 2018.

Farmers' level of participation in GESS

The result in Table 3 shows the distribution of respondent on farmers' level of participation in GESS. The result indicates that most of the farmers regularly attended meeting concerning GESS with 60.0% always attending, 22.7% often attended, 10.8% rarely attended while 6.5% never attended the meeting. Among the respondents, 32.7% indicated that they always receive text messages on their handsets concerning farm inputs, 27.3% often receive such text messages, 20.0% rarely received the messages while 20.0% never received such messages. Most of the farmers responded to agro-input allocation through e-wallet: 31.9% stated that they always quickly responded, 32.7% often responded, 21.9% rarely responded while 13.5% never responded. When asked about their visitation to accredited agro-dealers to redeem the inputs provided by GESS, 45.4% reported that they always visit the accredited agro-dealers 33.1% indicated that they often visited, 9.2% rarely visited. In comparison, 12.3% never visited the dealers. Among the respondents, 47.3% were always actively involved in advisory services, 20.4% often involved, 17.3% reported that they were rarely actively involved while 13.1% were never been actively engaged in the advisory services.

All the WMS on respondents' participation were higher than the mean score of 1.5. This shows that the farmers positively participated in the scheme. This conforms to the report of [5] that GESS is an innovative approach to fertilizer subsidy and other inputs through e-system that ensures only registered and accredited farmers benefit. This is also similar to the report of [10] on the attitude of arable crop farmers to GESS in Imo State Nigeria. [11] attributed the improved participation to the use of mobile phones as access to information from various sources similar to the observation of [9]. Therefore, mobile phone may be viewed as a tool for enhancing participation and productivity.

Categorization of respondent's level of participation

Table 4 shows the categorization of the respondent's level of participation. This revealed that 23.5% of the respondents participated in GESS at high level, and 62.7% of the respondents had moderate level of participation. In comparison, the remaining (13.8%) had low disposition towards participating in GESS. This trend of result may be due to individual inclination towards participation in GESS. From this finding, it could be deduced that most of the respondents moderately participated in GESS which may be attributed to weak communication linkage between farmers and government, late arrival of input, nearness to redemption centres and corruption.

Table 3. Distribution of Respondents by level of participation in GESS

Participation statement	Always	Often	Rarely	Never	WMS
Regular attendance at meetings concerning GESS	60.0	22.7	10.8	6.5	2.36
Receiving text messages from hand set concerning farm inputs	32.7	27.3	20.0	20.0	1.73
Quick response to agro-inputs allocation through e-wallet	31.9	32.7	21.9	13.5	1.83
Regular visits to accredited agro-dealers to redeem the inputs.	45.4	33.1	9.2	12.3	2.12
Actively involved in the advisory services	47.3	20.4	17.3	13.1	2.00

Source: Data Analysis, 2018.

Table 4. Categorization of the level of farmers' participation

Categories of levels of participation	Percentage
High	23.5
Medium	62.7
Low	13.8
Total	100

Source: Data Analysis, 2018.

Respondents' attitude towards GESS

Table 5 shows the respondents' attitude of GESS. The result revealed that majority (86.5%) agreed that farmers should actively participate in GESS to solve agricultural input distribution problems. 89.2% of the respondents agreed that GESS increases and improved crop productivity although, 80.8% agreed with the statement that the seeds supplied by the agro-dealers were sometimes low in quality.

Other statements on the respondents attitude towards GESS follow the same trend as they agreed with them in the following order; GESS increased the income of farmers (70.4%); GESS changes farming capacity (68.9%); late delivery of inputs may be a strategy to divert the supply of inputs to non-GESS registered farmers (45.7), although 21.5% of the respondents were undecided; 50% agreed that GESS could be more appropriately co-ordinated; distributed fertilizers do not meet the required quantity needed by the farmers (59.6); the distribution procedure through GESS encourages corruption (57.3 %); inadequate reimbursement of the dealers by the government may tempt them to sell the inputs to non-GESS farmers (58.4%); 46.2% of the farmers were undecided as to whether officers in charge of input distribution always expect to receive kickback from farmers. However, 44.2% agreed to the statement. About 39% agreed with the statement that says inputs were sometimes sold to farmers beyond the official prices. Although, 52.3% were undecided, this is with respect to their statement. GESS is cost-sharing scheme between farmers and government (22.4% agreed while 35.8% disagreed); The Agro-dealers prefer to deal with big farmers (26.5%); the design and operation of GESS were not beneficial to farmers (26.5%) and all farmers have access to GESS inputs (13.9%).

The weighted mean score for each statement shows the following statement on farmers' attitude towards GESS. The statements are: farmers should actively participate in GESS to solve agricultural input distribution problems (WMS=4.6); GESS increases and improves crop productivity (4.5); seeds of low quality are sometimes supplied by Agro-allied dealers (WMS=4.3); GESS increase the income of farmers (WMS=4.1); GESS changes farming capacity (WMS=4.0); late delivery of inputs may be a strategy to divert the supply of inputs to non-GESS registered farmers (WMS=3.8).

Conversely, the respondents' perceived that GESS was not properly co-ordinated (WMS=3.6) as negative or neutral, as distributed fertilizers do not meet the required quantity needed by the farmers (WMS=3.6).

Table 5. Distribution of Respondents by their Attitude to GESS

Attitudinal statement	SA	A	U	D	SD	WMS
Farmers should actively participate in GESS to solve agricultural input distribution problems.	208 (80.0)	17 (6.5)	23(8.8)	8(3.1)	4 (1.5)	4.6
GESS increases and improves crop productivity	167 (64.2)	65 (25.0)	28 (10.8)	0 (0.0)	0.0 (0.0)	4.5
Seeds of low quality are sometimes supplied by Agro-allied dealers	155 (59.6)	55 (21.2)	37 (14.2)	7 (2.7)	6 (2.3)	4.3
GESS increase income of farmers	97 (37.3)	86(33.1)	77 (29.6)	0 (0.0)	0.0 (0.0)	4.1
GESS changes farming capacity	93 (35.8)	86 (33.1)	78 (30.0)	3(1.2)	0.0 (0.0)	4.0
Late delivery of inputs may be a strategy to divert the supply of inputs to non-GESS registered farmers.	63 (24.2)	114(43.8)	56 (21.5)	18 (6.9)	9 (3.5)	3.8
GESS is not properly co-ordinated	81 (31.2)	49 (18.8)	76 (29.2)	48 (18.5)	6 (2.3)	3.6
Distributed fertilizers do not meet the required quantity needed by the farmers	67 (25.8)	88 (33.8)	55 (21.2)	30 (11.5)	20 (7.7)	3.6
Distribution procedure through GESS encourages corruption.	84 (32.3)	65 (25.0)	45 (17.3)	29 (11.2)	37 (14.2)	3.5
Inadequate reimbursement of the dealers by government may tempt them to sell the inputs to non-GESS farmers.	37 (14.2)	115(44.2)	62 (23.8)	32 (12.3)	14 (5.4)	3.5
Officers in charge of input distribution always expect to receive kick back from farmers.	51 (19.6)	64 (24.6)	120(46.2)	17 (6.5)	8 (3.1)	3.5
Inputs are sometimes sold to farmers beyond the official prices.	47 (18.1)	55 (21.2)	136(52.3)	10 (3.8)	12 (4.6)	3.4
GESS is cost sharing scheme between farmers and government.	29 (11.2)	29 (11.2)	109(41.9)	60 (23.1)	33 (12.7)	3.0
The Agro-delears prefer to deal with big farmers	33 (12.7)	36 (13.8)	112(43.1)	38 (14.6)	41 (15.8)	2.9
The design and operation of GESS is not beneficial to farmers	43 (16.5)	26 (10.0)	67 (25.8)	76 (29.2)	48 (18.5)	2.8
All farmers have access to GESS inputs	33 (12.7)	3 (1.2)	103(39.6)	73 (28.1)	48 (18.5	2.6

Source: Data Analysis, 2018.
Figures in parenthesis are percentages.
SA-Strongly agreed, A-Agreed, U-undecided, D-Disagreed, SD-Strongly disagreed, WMS-Weighed mean score

Also, they perceived that the distribution procedure through GESS encourages corruption (WMS=3.5); inadequate reimbursement of the dealers by the government may tempt them to sell the inputs to non-GESS farmers (WMS=3.5); officers in charge of input distribution always expect to receive kickback from farmers (WMS=3.5);

inputs are sometimes sold to farmers beyond the official prices (WMS=3.4); GESS is cost-sharing scheme between farmers and government (3.0) because some farmers wanted the government to be more generous; the Agro-delears dealers prefer to deal with big farmers (WMS=2.9); the design and operation of GESS is not beneficial to farmers (WMS=2.8) as redemption centres were far away from most villages; all farmers have access to GESS inputs (WMS=2.6) as this may be viewed as vague. All the statements ranked least, respectively. Therefore, it can be implied that respondents attitude towards GESS is either positive or negative depending on their disposition or preconceived notion about what the program should be like. The perceived effectiveness of GESS means the score was equal to 3.0. This result aligns with the finding of [15] on the access to subsidized fertilizer, seed, increased production and income among respondents in Ogun state.

Categorization based on the attitudinal level of respondents to GESS

Table 6 shows the categorization based on the attitudinal level of respondents towards GESS. 51.5% of the farmers had a favourable attitude towards GESS while the 48.8% had an unfavourable attitude towards GESS. This trend of the result may be due to individual dispositions towards GESS.

Table 6. Categorization based on the attitudinal level of respondents to GESS

Categories	Percentage
Favourable	51.5
Unfavourable	48.5
Total	100

Source: Data Analysis, 2018

It could be deduced from the findings that difference in attitude may be as a result of the timing of information disseminated, low access to GESS inputs, inadequate supply of fertilizers to farmers, limited duration of GESS and inadequate awareness of the programme to small-scaled farmers which is the target of GESS.

Testing of Hypotheses

The result of tests of hypotheses for this study are hereby presented. All hypotheses were stated in the null form.

Hypothesis 1

There is no significant relationship between the
respondents' participation and their attitude towards GESS.

Table 7 shows indicates that there was significant correlation between the farmers' participation and attitude towards GESS. This means that the attitude of the respondents had positive influence on the farmers' participation (r=0.108*, p=0.041) of GESS with the study area. On this, the null hypothesis was rejected, and the alternative hypotheses were accepted.

Table 7. PPMC analysis of farmers' participation and their attitude towards GESS.

Variable	N	r-value	p-value	Remark
Attitude	260	0.108*	0.041	Significant

Source: Data Analysis, 2018.

Hypothesis 2

There is no significant relationship between the demographic characteristics of the respondents and their level of participation in GESS.

The result of the analysis, as shown in Table 8 shows that there is a significant relationship between the selected demographic characteristics of the respondents and the level of participation towards GESS. significant relationship exists between the age of the respondents (r= 0.569**, p=0.000) and their extent towards participation. This implies that the level of the farmers' participation is a function of their age. This corroborates household size (r= 0.781**, p=0.000), family size (r= 0.453**, p=0.000), farming experience (r= 0.645**, p=0.000) and years spent in formal school as negative relationship with farmers' participation in the study area (r=-0.179**, p=0.004). On this note, the null hypothesis was rejected while the alternative hypothesis was accepted. This finding is contrary to the observation of [7] on the attitude of farmers to e-wallet platform of GESS for farm-input delivery in Oke-Ogun-zone of Oyo State, which revealed that age, farm size, marital status and religion does not necessarily influence adoption behaviour.

Table 8. Relationship between the socio-economic characteristics of the respondents and the level of participation towards GESS.

Demographic variables	r-value	p-value	Remarks
Age	0.569**	0.012	Significant
Household size	0.781**	0.013	Significant
Family size	0.453**	0.011	Significant
Years spent in Formal School	-0.179**	0.012	Significant

Source: Data Analysis, 2018.
**Significant at 0.01%

CONCLUSIONS

The study revealed that farmers' attitude had a positive influence on the farmers' participation in GESS. Most of the respondents were at their active and productive stage. Most of the farmers perceived GESS as a solution to input problems, using new technologies (SMS) to reach the farmers, thus, enhancing their participation through meetings, response and visit to the agro-dealers. Since the attitude of the farmers favourable influenced their participation in GESS, the government may use this favourable attitude to increase participation by enlarging the capacity of GESS or similar programme in the future.

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PIGEON PEA SEED: LEVEL OF AWARENESS, UTILIZATION AND CONSTRAINTS TO USE AS A FEEDSTUFF AMONG LIVESTOCK FARMERS IN OGBOMOSO ZONE OF NIGERIA

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Abstract

Livestock farmers (n=253) from five local government areas of Ogbomoso, Southwest Nigeria were interviewed through a well-constructed questionnaire. This study assessed the demographic characteristics of the livestock farmers, type of livestock kept, type of feed used, energy and plant protein feedstuffs used in feed compounding, level of awareness of pigeon pea seed utilization as livestock feedstuff and constraints to the use of pigeon pea seed as livestock feedstuff. The survey results revealed that the respondents were mostly part time livestock farmers, married-middle aged men ($\bar{x}$=40 years) with an average 5 years farming experience, who kept majorly poultry and pigs (55-80%) amongst other livestock. Compounded rations (53-83%) were commonly used with maize (66-100%) as the main energy feedstuff while soybean meal (87-90%), groundnut cake (77-100%) and palm kernel cake (86-92%) were the major plant protein ingredients. Majority of the respondents (70-82%) were unaware of the potential use of pigeon pea seed as livestock feedstuff but those that were aware indicated that antinutrients and or processing (88-100%) were the serious concern for use as a feedstuff. It can therefore be recommended that agricultural extensionists should work together with livestock nutritionists and re-orient the farmers with available research outputs that have addressed this constraint.

***Key words**: Cajanus cajan, livestock, feedstuff, farmers, utilization, pigeon pea seed*

INTRODUCTION

Pigeon pea (*Cajanus cajan (L.)* is a tropical and sub-tropical, leguminous, drought resistant crop majorly cultivated for its edible seeds and forage in more than 33 countries [36]. The seeds are a source of food in Asia, Africa and Latin America. World production of pigeon pea is estimated at 4.85 million tons in 2014 [24, 25]. The crop is being grown sole or inter-cropped with maize, millet, yam, cassava and sweet potato [18]. The potential of pigeon pea to mitigate the effect of climate change has been reported by [19]. They have also being reported in erosion control [15], as wind breakers and shade provider [44].

Pigeon pea seed is locally available at low cost in most Nigerian markets [20] but its low human preference attributed to long cooking time unlike other available beans and low industrial use [6] is pushing it to become unpopular, thus, on the verge of extinction in Nigeria. The seed had been reported to have a crude protein content ranging from 17%–30% [7, 20], crude fiber (CF) of 7.3%–10%, nitrogen-free extract (NFE) of 61.2%, ether extract (EE) of 1.7%–2.1% and ash of 3.1%–4.2% [5]. [10] and [20] reported that it is relatively high in lysine but low in methionine.

Pigeon pea seed offers good quality nutritional profile as a feedstuff especially for monogastrics. The seed contains antinutrients such as phytates, trypsin inhibitors, oxalate, saponins and tannins [32, 34] which have deleterious effects on various livestock species. *Cajanus cajan* contains more trypsin and chymotrypsin inhibitors than soybean seeds [30]. These antinutrients are responsible for poor protein digestibility, feed conversion ratio, growth response and villi morhometry in broilers and pigs fed of pigeon pea seed meal [13, 27]. These harmful effects could be reduced by different processing methods such as boiling, crushing, extrusion, soaking and roasting [38, 40]. Pigeon pea seed meal has a good nutritional profile and could replace maize and soybean [6]. It could be a better and cheaper protein alternative as compared to other legume grains. Heat treatments such as cooking or extrusion reduce the amount of trypsin and chymotrypsin inhibitors and increase pigeon pea digestibility [13, 14, 42].

Processed pigeon pea seed meal has good quality crude protein content and has been found a satisfactory protein ingredient constituting about 20-30% of broiler ration, quail ration and rabbit [1, 6, 11, 12, 45], while 10% inclusion has been recommended for layer chicken [8, 9]. [28] reported that pigeon pea meal could replace up to 100% soybean meal in channel catfish diet unlike 60% replacement in nile tilapia fish diet [35]. About 12-14% inclusion of pigeon pea seed meal were reported to provide acceptable results in growing pigs [26]. Pigeon pea seed meal has been reported as a protein supplement in ruminant (dairy cows, beef cattle,) diets at higher inclusion rates because they are highly digestible and supply high quality protein [17].

Therefore, since the tolerable levels of pigeon pea seed meal has been established for use in the diets of various livestocks, the level of awareness, acceptance and use among livestock farmers has to be established.

MATERIALS AND METHODS

Livestock farmers (n=253) were randomly interviewed using pre-constructed questionnaire at the available feedmills across the five Local Government Areas (LGAs) of Ogbomoso, Southwest, Nigeria. The selection was not evenly distributed because of the uneven distribution of feedmills and livestock farmers across and within Ogbomoso zone: Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogo Oluwa. The questionnaire was used to examine the demographic characteristics of the livestock farmers, type of livestock kept, type of feed used, energy and plant protein feedstuffs used in feed compounding, level of awareness of pigeon pea seed utilization as livestock feedsfuff, and constraints to the use of pigeon pea seed as livestock feedstuff. The respondents include 61 in Ogbomoso North, 90 in Ogbomoso South, 35 in Surulere, 34 in Oriire and 33 in OgoOluwa. The data collected were analysed using descriptive statistics including frequency count and percentage.

RESULTS AND DISCUSSIONS

Demographic characteristics of the respondents

The demographic characteristics of the respondents are shown on Table 1. Most of the farmers are middle aged with a mean of 40 years, mostly married men with an average of 4 persons in a household. They generally had an average of 5 years farming experience and are mostly part-time farmers with a mean income of ₦756,000 annually. This implies that most of the respondent are youths and are in their active years. This supports the findings of [3] and [29], that people within the labour force of any nation are usually active, dynamic, energetic and creative. This is unlike the report of [31] that average age of an indian farmer is 50.1 years [33], that of a US farmer is 58 years [46], Japanese farmer is 67 years while that of European farmer is more than 65 years. The age observed for farmers in the study area may be attributed to unemployment rate because the only sector that could engage many people at a time is agriculture. This may be the reason why most of the respondents were part time farmers. Men are more involved in primary agricultural production because of the energy demanding nature while the women are more engaged with food processing and marketing [43]. The farming experience revealed that majority of the respondents are new entrants engaged in other occupation as also observed by [37] and as such may not be aware of alternative feedstuffs. The drift of youths towards livestock farming may have been informed because of the increased demand for livestock products and under employment. This is also obvious from the annual income that most of the respondents are subsistence farmers which are a characteristic of Africa agricultural sectors [23].

Table 1. Demographic characteristics of the respondents

Characteristics	NORTH (n=61)	SOUTH (n=90)	SURULERE (n=35)	ORIIRE (n=34)	OGOOLUWA (n=33)	Mean
Age (years)						
20-25	3(4.92)	14(15.56)	2(5.71)	0(0.00)	1(3.03)	40
26-30	12(19.67)	27(30.00)	4(11.43)	6(17.65)	11(3.33)	
31-35	13(21.31)	18(20.00)	7(20.00)	6(17.65)	6(18.18)	
36-40	14(22.95)	12(13.33)	11(31.43)	6(17.65)	9(27.27)	
46-50	11(18.03)	10(11.11)	6(17.14)	8(23.53)	4(12.12)	
51-55	3(4.92)	7(7.78)	3(8.57)	4(11.76)	2(6.06)	
56-60	5(8.20)	2(2.22)	1(2.86)	4(11.76)	0(0.00)	
Gender						
Male	53(86.89)	80(88.89)	31(88.57)	30(88.24)	27(81.82)	
Female	8(13.11)	10(11.11)	4(11.42)	4(11.76)	6(18.18)	
Marital status						
Single	13(21.31)	36(40.00)	4(1.43)	4(11.76)	8(24.24)	
Married	44(72.13)	52(57.78)	26(74.23)	30(88.24)	24(72.72)	
Divorce	3 (4.92)	1(1.11)	3(8.57)	0(0.00)	0(0.00)	
Widowed	1(1.64)	1(1.11)	2(5.71)	0(0.00)	1(3.03)	
Household size						
1-5	52(82.25)	74(82.22)	28(80.00)	28(82.35)	24(72.73)	4
6-9	9(14.75)	16(17.78)	7(20.00)	6(17.65)	9(27.27)	
Farming experience						
1-5years	46(75.41)	62(68.89)	21(60.00)	18(52.94)	15(45.45)	5
6-10years	13(21.31)	23(25.56)	10(28.57)	6(17.65)	12(36.36)	
11-15years	1(1.64)	4(4.44)	2(5.71)	6(17.65)	6(18.18)	
16-20years	1(1.64)	1(1.11)	2(5.71)	4(11.76)	0(0.00)	
Full/Part time						
Full time	21(34.43)	28(31.11)	16(45.71)	20(58.82)	13(39.39)	
Part time	40(65.57)	62(68.89)	19(54.29)	14(41.18)	20(60.61)	
Annual income (₦'000)						
1-50	10(16.39)	14(15.56)	4(11.43)	4(11.76)	6(18.18)	756
51-100	15(24.59)	18(20.00)	4(11.43)	2(5.88)	4(12.12)	
101-200	4(6.56)	8(8.89)	1(2.86)	7(20.59)	4(12.12)	
201-500	16(26.23)	37(41.11)	10(28.57)	9(26.47)	13(39.39)	
501-1,000	11(18.03)	9(10.00)	7(20.00)	4(11.76)	3(9.09)	
>1,000	5(8.20)	4(4.44)	9(25.71)	8(23.53	3(9.09)	

Source: Field Survey, 2018.
(Percentages are in parenthesis)

Livestock kept by the respondents

Distribution of respondents based on type of livestock kept is shown on Table 2. The farmers kept monogastric animals like poultry birds and pigs; pseudo-ruminant like rabbits; ruminants like goat, sheep and cattle; fishes and micro-livestock like snail in varying combinations within each local governments varies. In all the local governments, majority (>54%) of the farmers rear poultry birds and pigs. For instance, 68.85%, 56.67%, 80.00%, 76.47% and 57.58% of the farmers kept poultry birds while 60.94%, 55.56%, 80.00%, 58.82% and 54.55% of the respondents kept Pigs in Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively. Moreover, 16.39%, 12.22%, 8.57%, 14.71% and 6.06% of the respondents kept rabbit in Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively, while 11.48%, 12.22%, 40.00%, 17.65% and 18.18% of the respondents kept goats in Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively. Also, 8.20%, 6.67%, 20.00%, 17.65% and 6.06% of the respondents kept sheep in Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively. However, 1.64%, 1.11%, 2.86%, 11.76% and 3.03% of the respondents kept cattle in Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively, while 4.92% and 1.11% of the respondents kept fish in Ogbomoso North and Ogbomoso South respectively. Similarly, 1.64% and 1.11% of the respondents kept snail in Ogbomoso North and Ogbomoso South respectively.

This shows that the respondents kept poultry and pigs more than other livestock in these areas. This could be attributed to the growing attention that poultry and pig production have received over the years in Nigeria especially in southern part where religious taboo does not hold sway against pigs. Also, quick return on investment, ability to attain market weight within short period [21] may have contributed to the choice of enterprise. Also, [22] attested that poultry and pig production are the fastest growing livestock subsector in the world and [41] reported that the growth occurs mostly in developing nations.

Table 2. Livestocks kept by the respondents

Livestock	NORTH (n=61)	SOUTH (n=90)	SURULERE (n=35)	ORIIRE (n=34)	OGOOLUWA (n=33)
Poultry	42(68.85)	51(56.67)	28(80.00)	26(76.47)	19(57.58)
Pig	26(60.94)	50(55.56)	28(80.00)	20(58.82)	18(54.55)
Rabbit	10(16.39)	11(12.22)	3(8.57)	5(14.71)	2(6.06)
Goat	7(11.48)	11(12.22)	14(40.00)	6(17.65)	6(18.18)
Sheep	5(8.20)	6(6.67)	7(20.00)	6(17.65)	2(6.06)
Cattle	1(1.64)	1(1.11)	1(2.86)	4(11.76)	1(3.03)
Fish	3(4.92)	1(1.11)	0(0.00)	0(0.00)	0(0.00)
Snail	1(1.64)	1(1.11)	0(0.00)	0(0.00)	1(3.03)

Source: Field Survey, 2018.
(Percentages are in parenthesis)
*Multiple Response

Identification of the commonly used feed types and feedstuffs

Farmers have options between finished feeds from different companies and compounded ration from available local feedstuffs (Figure 1). Although, there were multiple responses, however, in Ogbomoso North, 55.74% of the respondents used compounded feed for their livestock while 44.26% of the respondents used finished feeds. In Ogbomoso South, 53.33% of the respondents used compound feeds while 46.76% of the respondents used finished feeds.

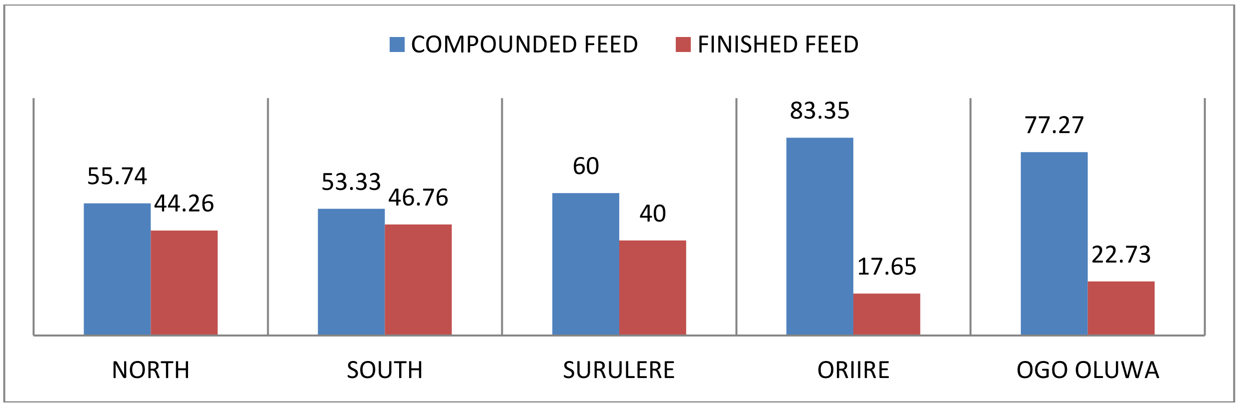

Fig. 1. Feed type use by the livestock farmers (%)
Source: Field Survey, 2018.
*Multiple Responses

In Surulere Local Government 60.00% of the respondent used compounded feeds while 40.00% of the respondents used finished feeds. In Oriire Local Government, 83.35% of the respondents used compound feeds while 17.65% of the respondents used finished feed. In Ogo-oluwa Local 77.27% used compound feeds while 22.73% of the respondents used finished feeds.

This implies that majority of the respondents from the study are used compounded feed compared to finished feeds for feeding their livestock. This could positively impact the rate of adoption of new technologies in feed formulation. Thus, in a bid to formulate their own feed the respondents would have sought to use cheap but effective feedstuffs available. Observable from the animal kept is that the major livestock reared are monogastrics which depend on formulated feeds. This supports the earlier findings of [16].

Energy Feedstuff Used in compounding Livestock feed

The respondents gave the energy feedstuffs used when compounding their livestock feed (Figure 2). Multiple responses were given by the farmers. In all the five LGAs, maize was the major energy feedstuff while sorghum which is also grain cereal and cassava peel were seldomly used. This showed that majority of the livestock farmers use maize as an energy feedstuff. This could have resulted from availability, ease of handling and nutrient composition as observed by [16]. This could limit the awareness and use of other feedstuffs by the livestock farmers. However, [39, 40] had demonstrated that sorghum and cassava can be used in poultry diets but the farmers may be unaware.

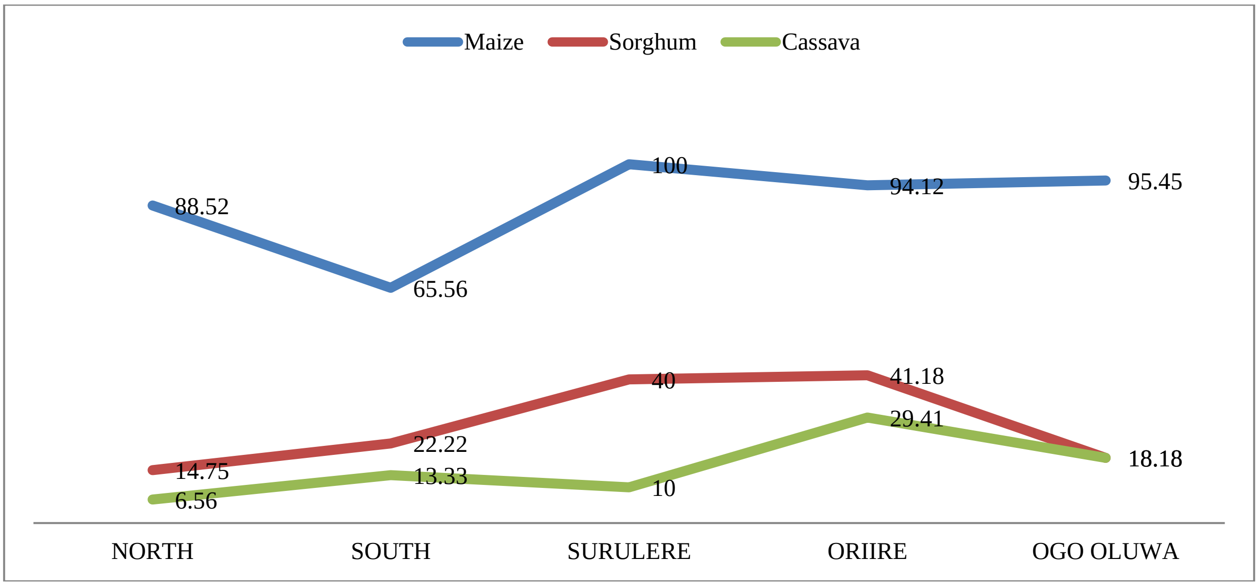

Fig. 2. Major energy feedstuff used in feed formulation
Source: Field Survey, 2018.
*Multiple Responses

Plant Protein Feedstuff Used in compounding Livestock feed

Figure 3 shows the plant protein feedstuffs used in compounding livestock feed. From the multiple response given by the respondents from the five LGAs, Soybean meal, groundnut cake and palm kernel cake were the major plant protein feedstuff while pigeon pea seed meal were unpopular. Soybean meal and groundnut cake are convectional feedstuffs but their price has led researchers to look for alternatives [38] Observation on palm kernel cake use from this study may not be unconnected use as a major feedstuff for pig farmers [4].

The use of pigeon pea seed as an alternative plant protein may be because of the availability as observed by [16] for maize. This could limit the awareness and use of pigeon pea seed as feedstuffs by the livestock farmers. [2] had demonstrated that processed African yam bean and pigeon pea seed can be used in poultry diets but the farmers may be unaware.

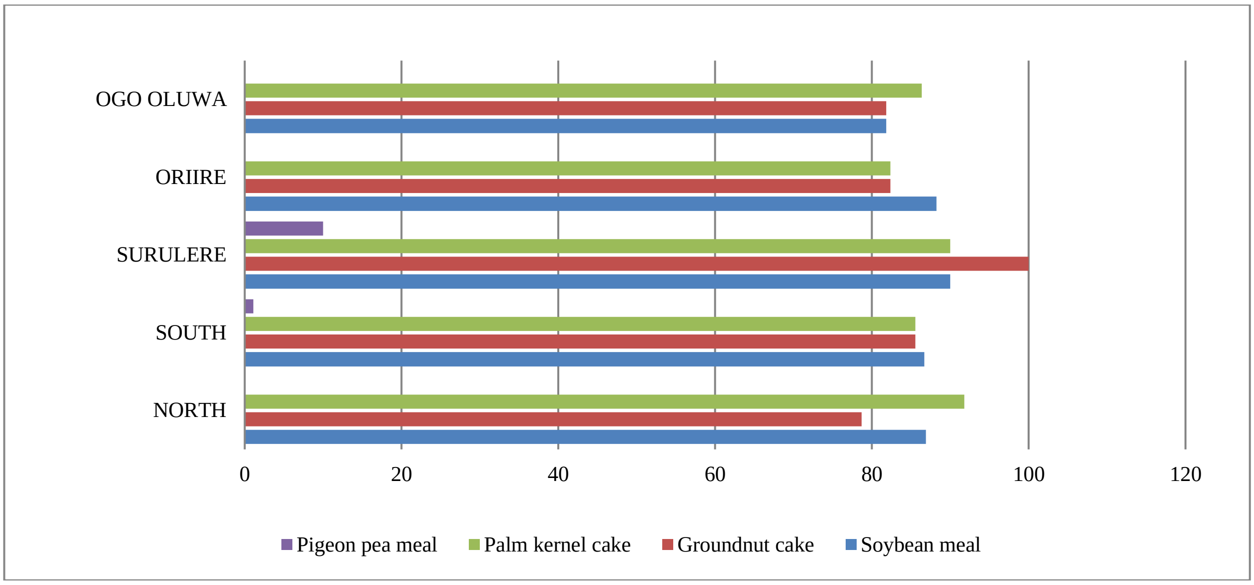

Fig. 3. Major plant protein feedstuffs used by the farmers (%)
Source: Field Survey, 2018.
*Multiple Responses

Assessment of the Level of Awareness of Utilization of Pigeon pea seed as Livestock Feedstuff

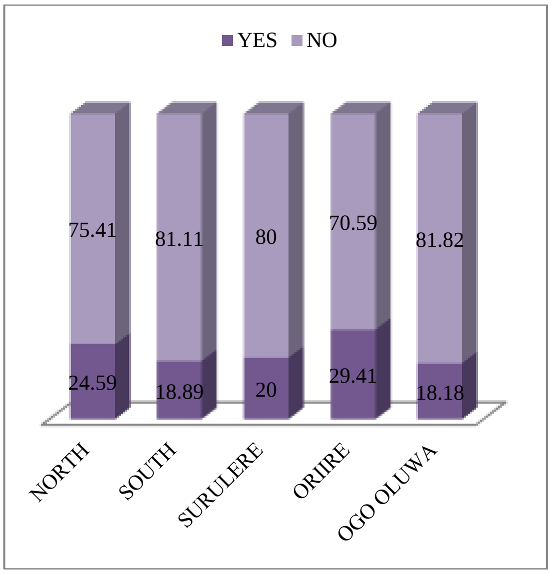

Fig. 4. Distribution of Respondent (%) Based on Awareness of Pigeon pea seed as a feedstuff
Source: Field Survey, 2018.

Figure 4 shows the distribution of respondent based on awareness of Pigeon pea seed as a livestock feedstuff. 24.59%, 18.89%, 20.00%, 29.41% and 18.18% of the farmers in Ogbomoso north, Ogbomoso South, Surulere, Oriire and Ogooluwa respectively agreed to be aware of potentials of Pigeon pea seed as a feedstuff while 75.41%, 81.11%, 80.00%, 70.59% and 81.82% from the same LGAs were unaware.

This implies that majority of the respondents were unaware of the potential use of Pigeon pea seed as livestock feedstuff.

This shows that despite the researches on nutritional profile and demonstration of use by various researchers [2, 6, 7, 20], most farmers in the study area are unaware.

Constraints to the use of Pigeon pea seed as livestock feedstuffs

Constraints to the use of Pigeon pea seed as livestock feedstuffs is shown on Table 3. Factors identified are availability, ease of use, nutrient quality, cost, quantity needed and presence of antinutrients and or processing. 93.33%, 88.24%, 100.00%, 100.00% and 100.00% from Ogbomoso north, Ogbomoso south, Surulere, Oriire and Ogooluwa identified antinutrients and or processing as the major constraint. [16] identified water content, dustiness and cost of processing as constraints for cassava peel use in livestock diet but these may not be applicable for pigeon pea seed except cost of processing.

Table 3. Constraints to the use of pigeon pea seed meal as a feedstuff based on level of awareness

Constaints	NORTH (n=15)	SOUTH (n=17)	SURULERE (n=7)	ORIIRE (n=10)	OGOOLUWA (n=6)
Availability	0(0.00)	1(5.88)	0(0.00)	0(0.00)	0(0.00)
Ease of use	0(0.00)	0(0.00)	0(0.00)	1(10.00)	1(16.67)
Nutrient quality	1(6.67)	0(0.00)	0(0.00)	1(10.00)	0(0.00)
Cost	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Quantity needed	0(0.00)	1(5.88)	0(0.00)	0(0.00)	0(0.00)
Antinutrients/ Processing	14(93.33)	15(88.24)	7(100.00)	10(100.00)	6(100.00)

Source: Field Survey, 2018.
*Multiple Responses

CONCLUSIONS

Livestock farmers in Ogbomoso zone, southwest Nigeria were mostly part time, married-middle aged men with an average of 5 years farming experience. They kept majorly monogastrics: poultry and pigs. Although, they also kept goat, sheep and other mini-livestocks in small quantity. Compounded rations were most commonly used with maize as the main energy feedstuff while soybean meal, groundnut cake and palm kernel cake were the major plant protein ingredient.

Majority of the respondents were unaware of the potential use of pigeon pea seed as livestock feedstuff but those that were aware indicated that antinutrients and or processing were the serious concern for use as a feedstuff. It can therefore be recommended that agricultural extensionists should work together with livestock nutritionists and re-orient the farmers with available research outputs that have addressed this constraint.

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AWARENESS OF CASSAVA PEEL UTILIZATION AS A FEEDSTUFF AMONG LIVESTOCK FARMERS IN OGBOMOSO ZONE OF NIGERIA

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Abstract

A well-constructed questionnaire was used to obtain data from livestock farmers through an interview schedule (n = 220) in five local government areas in Ogbomoso, Southwest Nigeria. This study assesses the characteristics of the livestock farmers, type of livestock kept, type of feed used, energy feedstuffs used in feed compounding, quantity of feed used daily, level of awareness of cassava peel utilization as livestock feedstuff, factors affecting the utilization of the identified potential energy feedstuff and constraints to the use of cassava peel as livestock feedstuffs. The survey results revealed that the respondents were mostly part time livestock farmers, middle aged men with less than 10 years farming experience, who kept majorly poultry and pigs amongst other livestock such as goat, sheep and mini-livestock. Compounded rations were commonly used with maize as the main energy feedstuff and the quantity of feed used daily indicated that they were small-scale farmers. Majority of the respondents were aware of the potential use of cassava peel as livestock feedstuff but indicated that availability of maize and sorghum, nutrient quality and seasonality influenced their utilization while ease of use and cost were factors also considered in Ogbomoso south and Ogo Oluwa for the use of sorghum. Cost and quantity were not of serious concern for use of whole cassava in livestock feed but storability, availability and seasonality were the major factors affecting its use as energy feedstuff while nutrient quality and rate of spoilage were constraints for the use of cassava peel. It can therefore be recommended that agricultural extensionist should work together with livestock nutritionists and re-orient the farmers with available research outputs that had addressed the constraints of cassava peel usage for it to compete with maize as an energy feedstuff.

Key words**:** *cassava, livestock, feedstuff, farmers, utilization*

INTRODUCTION

Cassava (*Manihot Esculenta Crantz*), is known for its edible roots. The crop thrives in regions which fell under the tropical and subtropical climates of the world. It is popular in the Sub-sahara Africa as a staple food crop [13] because of its divers uses. Africa, the largest producer contributed not less than 57% (149.54 Mt) of the global production in 2011 and Nigeria was ranked the largest producer in Africa [12]. Cassava tubers have been transformed in to numerous food and foodstuffs like *gari*, *fufu* and edible flour for making confectionaries. Thus, cassava vastly contributes to human livelihood and survival [11]. It is also a raw material for industrial production of starch flour, ethanol, wafers, gums, liquid adhesives etc.

Processing of cassava roots or tubers into these various essential food and industrial products comes with a lot of wastes of which cassava peels accounts for the largest (30%). Only an inconsequential proportion is occasionally offered to goats and other livestock [1] while the remaining enormous portions are usually piled along rural roadsides and in places where tillage and processing of the tubers is a regular and widespread subsistence livelihood activity. These peels cause environmental issues and becomes an inconvenience quite than a potential raw material and feedstuff resource in West Africa [2].

The incapability to salvage the situation and reuse the peels economically leads to unneeded waste and reduction of natural materials and resources. The peels have the potentials for the production of fuel in the form of biogas, substrate for mushroom culture and quality animal feedstuff [6; 3; 18; 5; 10] but local farmers are rarely aware of these potentials especially as a feed resource if processed.

This study therefore assessed the level of awareness of cassava peel utilization as a feedstuff among livestock farmers in Ogbomoso Zone of Nigeria.

MATERIALS AND METHODS

A total of 220 livestock farmers were randomly selected and interviewed across the five Local Government Areas (LGAs) of Ogbomoso, Southwest, Nigeria. The selection was not evenly distributed because of the uneven distribution of feedmills and livestock farmers across and within Ogbomoso zone: Ogbomoso North, Ogbomoso South, Surulere, Oriire and Ogo Oluwa. The respondents'/livestock farmers were randomly interviewed using pre-constructed questionnaire at the available feedmills. The questionnaire consists of seven categories: characteristics of the livestock farmers, livestock kept, feed type used, energy feedstuff used in feed compounding, quantity of feed used daily, level of awareness of cassava peel utilization as livestock feed, factors affecting the utilization of the identified potential energy feedstuffs and constraints to the use of cassava peel as livestock feedstuffs. The respondents include 64 in Ogbomoso North, 56 in Ogbomoso South, 30 in Surulere, 40 in Oriire and 32 in Ogo Oluwa. The data collected were analysed using descriptive statistics including frequency count and percentage.

RESULTS AND DISCUSSIONS

Characteristics of the respondents

The farmers exhibit many similar characteristics (Table 1) among the five LGAs.

First, they were mostly middle aged. Their average age is around 42, and they were mostly men.

Table 1. Characteristics of the Respondents

Characteristics	North	South	Surulere	Oriire	Ogo Oluwa	Mean
Age						
21-30	21(32.81)	25(44.64)	9(30.00)	8(20.00)	10(31.25)	42
31-40	28(43.75)	22(39.29)	18(60.0)	26(65.00)	14(43.75)	
41-50	10(15.63)	9(16.07)	3(10.0)	5(12.50)	6(18.75)	
51 and above	5(7.81)	0(0.00)	0(0.00)	1(2.50)	2(6.25)	
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)	
Gender						
Male	57(89.06)	53(94.64)	27(90.00)	33(82.50)	31(96.88)	
Female	7(10.94)	3(5.36)	3(10.00)	7(17.50)	1(3.13)	
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)	
Farming experience						
1-5	37(57.81)	37(66.00)	13(43.33)	14(35)	15(46.88)	7
6-10	23(35.94)	12(21.43)	10(33.33)	20(50)	6(18.75)	
11-15	3(4.69)	5(8.93)	4(13.33)	2(5.00)	8(25.00)	
16-20	1(1.56)	1(1.79)	3(10)	2(5.00)	2(6.25)	
21-25	0(0.00)	1(1.79)	0(0.00)	1(2.50)	0(0.00)	
26-30	0(0.00)	0(0.00)	0(0.00)	1(2.50)	1(3.13)	
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)	
Full/partime						
Full time	24(37.50)	19(33.93)	13(43.33)	20(50.00)	15(46.88)	
Part time	40(62.50)	37(66.07)	17(56.67)	20(50.00)	17(53.12)	
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)	

Source: Field Survey, 2018.
(Percentages are in parenthesis)

Secondly, they generally had less than 10 years farming experience. On the average of 7 years. Finally, they are mostly part-time farmers. This implies that most of the respondents are youths and are in their active years. This supports the findings of [9] and [4], that people within the labour force of any nation are usually active, dynamic, energetic and creative. This could boost their adoption of cassava peel as a feedstuff for livestock since they are likely to adopt new technologies unlike the older people who are more conservative. According to [19] farming activities is an energy demanding work; hence men are more involved in production while the women are more engaged with food processing and marketing in agriculture. Most of the farmers are new comers who are engaged in other businesses or occupation as also observed by of [15] and as such may not be aware of alternative feedstuffs. Although, the livestock industry in Nigeria had spanned through many decades [7], the outbreak of diseases such an Avian influenza and African swine disease caused a lot of farms to fold up. The drift of youths towards livestock farming may have been informed because of the increased demand for livestock products and under employment.

Livestock kept by the respondents

Table 2 shows the distribution of respondents based on type of livestock kept. There were some variations in the livestock regime among the five LGAs. Although, the farmers kept poultry birds, pigs, goat and sheep but the combination varies. Other livestock kept are rabbit, snail, cattle and fish.

Table 2. Distribution of Respondents Based on Type of livestock Kept

Livestock	North	South	Surulere	Oriire	Ogo oluwa
Poultry	46(71.88)	28(46.43)	26(86.67)	31(77.50)	22(68.75)
Pig	39(60.94)	40(71.43)	15(50.00)	26(65.00)	20(62.50)
Goat	16(25.00)	6(10.71)	8(26.67)	13(32.50)	9(28.13)
Sheep	8(12.50)	2(3.57)	5(16.67)	7(22.50)	8(25.00)
Rabbit	7(10.94)	4(7.14)	6(20.00)	8(20.00)	8(25.00)
Snail	2(3.13)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Cattle	1(1.56)	0(0.00)	3(10.00)	1(2.50)	2(6.25)
Fish	1(1.56)	0(0.00)	0(0.00)	0(0.00)	0(0.00)

Source: Field Survey, 2018.
(Percentages are in parenthesis)
*Multiple Response

For example, in Ogbomoso North, 71.88% of the respondents kept poultry birds, 60.94% of the respondents kept pigs, 25.00% of the respondents kept goats, 12.50% of the respondents kept sheep, 10.94% of the respondents kept rabbits, 3.13% of the respondents kept snail, 1.56% of the respondents kept cattle and 1.56% of the respondents kept fish as their livestock. In Ogbomoso South, 46.43% of the respondents kept poultry birds, 71.43% of the respondents kept pigs, 10.71% of the respondents kept goats, 3.57% of the respondents kept sheep, 7.14% of the respondents kept rabbits and 3.57% of the respondents kept turkey. In Surulere, 86.67% of the respondents kept poultry birds, 50.00% of the respondents kept pigs, 26.67% of the respondents kept goats, 16.67% of the respondents kept sheep, 20.00% of the respondents kept rabbit, 6.67% of the respondents kept turkey, while 10.00% of the respondents kept cattle. In Oriire Local Government 77.50% of the respondents kept poultry birds, 65.00% of the respondents kept pigs, 32.50% of the respondents kept goats, 22.50% of the respondents kept sheep, 20.00% of the respondents kept rabbits, 10.00% of the respondents kept turkey while 2.50% of the respondents kept cattle. In Ogo-Oluwa local government 68.75% of the respondents kept poultry birds, 62.50% of the respondents kept pigs, 28.13% the respondents kept goats, 25.00% of the respondents kept sheep and rabbit, 3.13% of the respondents kept turkey, while 6.25% of the respondents kept cattle. This implies that a larger percentage of the respondents kept poultry and pig with other livestock in smaller number. This distribution could be as a result of vast growing attention that poultry and pig production have received over the years in Nigeria. Also, quick return on investment, ability to attain market weight within short period (FAO, 2011) [8] may have contributed to the choice of enterprise.

Identification of the commonly used feed types and feedstuffs

Besides the availability of finished feeds from different companies, most farmers use compounded ration, although, there were multiple responses, however, major feed type use is compounded from available feedstuffs (Table 3). In Ogbomoso North, 85.94% and 31.25% of the farmers used compounded and finished feed respectively while 92.86% and 17.86% of the farmers in Ogbomoso South used compounded and finished feeds respectively. The respondents from Surulere Local Government used 86.67% compounded feeds and 23.33% used finished feeds. 85% and 22.50% of the farmers respectively used compound finished feed in Oriire Local Government.

Moreover, the respondents from Ogo-oluwa Local Government used 90.63%
compound feeds and 28.13% finished feeds respctively.

Consequently, majority (more than 80%) of the respondents from the 5 local governments used compounded feed compared to lower percentages that used finished feeds for feeding their livestock. This could positively impact the rate of adoption of new technologies in feed formulation since majority of the livestock farmers do not use finished feed, meaning that they will have to formulate their own feed and they would have sought to use cheap but effective feedstuffs available such as cassava peel. Observable from the animal kept is that the major livestock reared are monogastrics which depend on formulated feeds. The result from [7] gave credence to this finding.

Table 3. Distribution of Respondents Based on Feed Type Used in Feeding their Livestock

Feed type	**North**	**South**	**Surulere**	**Oriire**	**Ogo Oluwa**
Compounded Feed	55(85.94)	52(92.86)	26(86.67)	34(85.00)	29(90.63)
Finished Feed	20(31.25)	10(17.86)	7(23.33)	9(22.50)	9(28.13)

Source: Field Survey, 2018.
(Percentages are in parenthesis)
*Multiple Responses

Energy Feedstuff Used in compounding Livestock feed

During this survey, farmers were asked to give their subjective energy feedstuffs used when compounding their livestock feed (Table 4).

Table 4. Distribution of Respondents Based on Energy Feedstuff Used in Feeding their Livestock

Energy feedstuffs	**North**	**South**	**Surulere**	**Oriire**	**Ogo oluwa**
Maize	57(89.06)	53(94.64)	27(90)	37(92.50)	32(100.00)
Sorghum	14(21.87)	4(7.14)	4(13.33)	6(15.00)	4(12.50)
Cassava peel	12(18.75)	9(16.07)	4(13.33)	6(15.00)	1(3.12)

Source: Field Survey, 2018.
(Percentages are in parenthesis)
*Multiple Response

Comparable response was given by the farmers. In all the five LGAs, maize was the major energy feedstuff while sorghum which is also grain cereal and cassava peel were seldomly used.

The use of these alternatives to maize was higher in Ogbomoso North than other LGAs. This show that majority of the livestock farmers use maize as an energy feedstuff. This could have resulted from availability, ease of handling and nutrient composition as observed by [7].

This could limit the awareness and use of cassava peel as feedstuffs by the livestock farmers.

[16; 17] had demonstrated that sorghum and cassava can be used in poultry diets but the farmers may be unaware.

Assessment of the Quantity of Feed Used Daily and Frequency of energy Feedstuffs used

Table 5 shows the inquiry about the quantity of feed used daily and the frequency of energy feedstuffs used. More than 60 % of the farmers in Ogbomoso North, South, Oriire and Ogo Oluwa use about 100kg of feed daily compared to around 50 % in Surulere, while between 25-27% farmers in all LGAs use between 101- 200 kg daily.

This implies that majority of the respondents used about 100kg of feed for their livestock daily. Thus, most of the farmers are small scale farmers and this is majorly because they are mostly part-time farmers. Commercial farms which used large quantity of feed may be said to have their own feedmill as reflected in this result.

Table 5. Distribution of Respondents Based on Quantity of Feed Used Daily and Frequency of energy Feedstuffs used

	North	South	Surulere	Oriire	Ogo Oluwa
Quantity of feed used					
< 100kg	39(60.94)	37(66.07)	16(53.33)	29(72.50)	20(62.50)
101-200	14(21.88)	15(26.79)	7(23.33)	8(20.00)	8(25.00)
201-300	6(9.38)	3(5.36)	3(10.00)	0(0.00)	4(12.50)
301-400	1(1.56)	0(0.00)	1(3.33)	2(5.00)	0(0.00)
401-500	2(3.13)	1(1.79)	1(3.33)	0(0.00)	0(0.00)
>501	2(3.13)	0(0.00)	0(0.00)	1(2.50)	0(0.00)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Frequency of energy feedstuff use					
Maize					
Often	53(82.81)	49(87.50)	23(76.67)	35(87.50)	28(87.50)
Rarely	9(14.06)	7(12.50)	2(6.67)	3(7.50)	4(12.50)
Never	2(3.13)	0(0.00)	5(16.67)	1(5.00)	0(0.00)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Sorghum					
Often	16(25.00)	1(1.79)	3(10.00)	8(20.00)	3(9.38)
Rarely	25(39.06)	42(75.00)	17(56.67)	18(45.00)	23(71.88)
Never	19(29.69)	12(21.43)	9(30.00)	11(27.50)	4(12.50)
Indifference	4(6.25)	1(1.79)	1(3.33)	3(7.50)	2(6.25)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Cassava peel					
Often	20(21.25)	7(12.50)	11(36.67)	12(30.00)	8(25.00)
Rarely	23(35.94)	30(53.57)	9(30.00)	18(45.00)	11(34.38)
Never	18(28.13)	15(26.79)	9(30.00)	9(22.50)	10(31.25)
Indifference	3(4.69)	4(7.14)	1(3.33)	1(2.50)	3(9.38)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Whole cassava					
Often	14(21.88)	2(3.57)	7(23.33)	7(17.50)	3(9.38)
Rarely	8(12.05)	3(5.36)	3(10.00)	7(17.50)	2(6.25)
Never	24(37.5)	32(57.14)	11(36.67)	14(35.00)	11(34.38)
Indifference	18(28.13)	19(33.93)	9(30.00)	12(30.00)	16(50.00)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)

Source: Field Survey, 2018.
(Percentages are in parenthesis)

From the result, 87.5% of the farmers attested that they often use maize in their diet formulation in Ogbomoso South, Oriire and Ogo Oluwa while it was 82.81% in Ogbomoso north and 76.67% in Surulere. This shows that maize is a major energy feedstuff as also shown on Table 5. 25% of the farmers in Ogbomoso north often use sorghum in feed formulation which is the highest among the LGAs while between 2-20% often use it in other LGAs.

Most of the farmers in the five LGAs admitted to rarely use it while 12.5-30% had never used sorghum in feed formulation. In Ogbomoso North, 21.25% of the respondents often use cassava peel as livestock feedstuff, 35.94% of the respondent rarely use cassava peel, 28.13% of the respondent never used cassava peel while 4.69% of the respondents were indifferent to using cassava peel as livestock feedstuff. In Ogbomoso South, 12.50% of the respondents often use cassava peel as livestock feedstuff, 53.57% of the respondents rarely use cassava peel, 26.79% of the respondents never used cassava peels, 7.14% of the respondents were indifferent to using cassava peel as livestock feedstuff. In Surulere Local Government, 36.67% of the respondents often use cassava peel, 30.00% of the respondents rarely use it, 30.00% never used cassava peel while 3.33% of the respondents were indifferent to using cassava peel as livestock feedstuff. In Oriire Local Government, 30.00% of the respondent often use cassava peel as livestock feedstuff, 45.00% of the respondents rarely use cassava peel, 22.50% of the respondents never used cassava peel while 2.50% of the respondents were indifferent to using cassava peel as livestock feedstuff. In Ogo-Oluwa Local Government, 25.00% of the respondents often use cassava peel as livestock feedstuff, 34.38% of the respondents rarely it, 31.25% of the respondents never used cassava peel as livestock feedstuff while 9.38% of the respondents were indifferent to using cassava peel as livestock feedstuff. This implies that majority of the respondents rarely use cassava peel as livestock feedstuff.

Some farmers who often use cassava as a feedstuff can be found in Ogbomoso north (21.88%) and Surulere (23.33) while in all LGAs, majority of the farmers had never use whole cassava and this ranges from 34.38 – 57.14%. This implies that majority of the respondents never used whole cassava as livestock feedstuff. This may be because of the knowledge gap of its proper utilization or because it is a major staple food.

As earlier stated for energy feedstuff used in compounding livestock feed; majority of the livestock farmers use maize as an energy feedstuff. This could have resulted from availability, ease of handling and nutrient composition [7], thus limited the awareness and use of cassava peel as feedstuffs by the livestock farmers.

Assessment of the Level of Awareness of Utilization of Cassava Peel as Livestock Feedstuff among Respondents

Table 6 shows the distribution of respondent based on awareness of cassava peel utilization as a livestock feedstuff. 85.94, 85.71, 83.33, 87.5 and 87.5% of the farmers in Ogbomoso north, Ogbomoso South, Surulere, Oriire and Ogo oluwa respectively agreed to be aware of potentials of cassava peel as a feedstuff while 14.06, 14.29, 16.67 12.5 and 12.5 % from the same LGAs were unaware.

Table 6. Distribution of Respondent Based on Awareness of Cassava Peel Utilization

Awareness	**North**	**South**	**Surulere**	**Oriire**	**Ogo Oluwa**
Yes	55(85.94)	48(85.71)	25(83.33)	35(87.5)	28(87.5)
No	9(14.06)	8(14.29)	5(16.67)	5(12.5)	4(12.5)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)

Source: Field Survey, 2018.
(Percentages are in parenthesis)

This implies that majority of the respondents were aware of the potential use of cassava peel as livestock feedstuff. This is similar to the report of [14] that most cassava processors in rural communities of southwest, Nigeria were aware of the potential uses of cassava peel for mushroom production, animal feed and biogas production but were unaware of any improved form of utilization causing it being disposed as waste.

Factors Affecting the Utilization of the Identified Potential Energy Feedstuffs

Factors considered to be responsible for the utilization of identified potential energy feedstuff (Table 7) are availability, ease of use, nutrient quality, seasonality, cost, quantity needed and others such as dustiness, processing etc. Of these factors, for maize, availability and seasonality cut across all the LGAs.

Ease of use and cost were factors for consideration for livestock farmers in Ogbomoso south and Ogo Oluwa while in Ogbomoso north (14.06) and Surulere (16.67) considered nutrient quality. This implies that majority of the respondents indicated availability of maize, nutrient quality and seasonality of maize as the major factors affecting its utilization as livestock feedstuff. This corroborates the report of [7].

As observed for maize, availability and seasonality cut across all the LGAs for the use of sorghum.

Table 7. Distribution of Respondent Based on Factors Affecting their Utilization of Identified Potential Energy Feedstuff

Factors	North	South	Surulere	Oriire	Ogo Oluwa
Maize					
Availability	24(37.5)	14(25)	14(46.67)	17(42.50)	11(34.38)
Ease of use	4(6.25)	12(21.43)	1(3.33)	2(5.00)	5(15.63)
Nutrient quality	9(14.06)	4(7.14)	5(16.67)	3(7.50)	1(3.12)
Season	12(18.75)	6(10.71)	3(10.00)	9(22.50)	8(25.00)
Cost	2(3.13)	8(14.29)	1(3.33)	1(2.50)	4(12.50)
Quantity	4(6.25)	2(3.57)	0(0.00)	0(0.00)	0(0.00)
Others	9(14.06)	10(17.86)	6(20)	8(20.00)	3(9.37)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Sorghum					
Availability	24(37.50)	14(25.00)	14(46.67)	17(42.50)	11(34.38)
Ease of use	4(6.25)	12(21.43)	1(3.33)	2(5.00)	5(15.63)
Nutrient quality	9(14.06)	4(7.14)	5(16.67)	3(7.50)	1(3.12)
Season	12(18.75)	6(10.71)	3(10.00)	9(22.50)	8(25.00)
Cost	2(3.13)	8(14.29)	1(3.33)	1(2.50)	4(12.50)
Quantity	4(6.25)	2(3.57)	0(0.00)	0(0.00)	0(0.00)
Others	9(14.06)	10(17.86)	6(20.00)	8(20.00)	3(9.37)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Whole cassava					
Availability	14(21.88)	4(7.14)	6(20.00)	12(30.00)	6(18.75)
Ease of use	5(7.81)	2(3.57)	3(10.00)	3(7.50)	2(6.25)
Nutrient quality	2(3.13)	1(1.79)	4(13.33)	0(0.00)	0(0.00)
Season	14(21.88)	10(17.86)	5(16.67)	6(15.00)	7(21.88)
Cost	7(10.94)	1(1.79)	2(6.67)	1(2.50)	3(9.37)
Quantity	2(3.13)	3(5.36)	0(0.00)	0(0.00)	2(6.25)
Other	20(31.25)	35(62.50)	10(33.33)	18(45.00)	12(37.50)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)

Source: Field Survey, 2018.
(Percentages are in parenthesis)

The observable similarity in the use of maize and sorghum may be because they were grains because availability of maize, nutrient quality and seasonality of maize and sorghum as the major factors affecting its utilization as livestock feedstuff.

Prominent factors affecting the utilization of cassava in all considered LGAs were others such as dustiness, processing and storability. Season is also a factor across the LGAs. Availability of the whole cassava was also prominent except in Ogbomoso south (7.14%) while nutrient quality was of concern to farmers in Surulere. Although, cost and quantity was not of serious concern and this implied that it is not costly but storability, availability and seasonality of whole cassava as the major factors affecting its use as energy feedstuff.

Constraints to the use of cassava peel as livestock feedstuffs

Constraints to the use of cassava peel as livestock feedstuffs on Table 8, shows that availability (67.5-75%), ease of use (73.33-78.57), seasonality (56.25-93.33), cost (83.33-93.75), quantity needed (80.00-90.63) were not constraints to the use of cassava peel in livestock diets except nutrient quality (53.33-71.87, other than in Ogbomoso North 51.56%) and spoilage (54.69-87.50%). Other constraints identified by [7] were water content, dustiness and cost of processing.

Table 8. Constraints to the use of cassava peel as livestock feedstuffs

Constraints	North	South	Surulere	Oriire	Ogo Oluwa
Availiabilty					
Yes	16(25.00)	14(25.00)	9(30.00)	13(32.50)	8(25.00)
No	48(75.00)	42(75.00)	21(70.00)	27(67.50)	24(75.00)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Ease of use					
Yes	14(21.87)	12(21.43)	8(26.67)	10(25.00)	8(25.00)
No	50(78.13)	44(78.57)	22(73.33)	30(75.00)	24(75.00)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Nutrient quality					
Yes	31(48.44)	37(66.07)	16(53.33)	26(65.00)	23(71.87)
No	33(51.56)	19(33.93)	14(46.67)	14(35.00)	9(28.13)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Seasonality					
Yes	18(28.13)	12(21.43)	2(6.67)	12(30.00)	14(43.75)
No	46(71.88)	44(78.57)	28(93.33)	28(70.00)	18(56.25)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Cost					
Yes	7(10.94)	6(10.71)	5(16.67)	5(12.5)	2(6.25)
No	57(89.06)	50(89.29)	25(83.33)	35(87.5)	30(93.75)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Quantity needed					
Yes	6(9.37)	10(17.86)	6(20.00)	8(20.00)	3(9.37)
No	58(90.63)	46(82.14)	24(80.00)	32(80.00)	29(90.63)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)
Spoilage					
Yes	35(54.69)	42(75)	19(63.33)	25(62.50)	28(87.50)
No	29(45.31)	14(25)	11(36.67)	15(37.50)	4(12.50)
Total	64(100.00)	56(100.00)	30(100.00)	40(100.00)	32(100.00)

Source: Field Survey, 2018.
(Percentages are in parenthesis)

CONCLUSIONS

Livestock farmers in Ogbomoso zone, southwest Nigeria were mostly part time, middle aged men with less than 10 years farming experience. They kept majorly poultry and pigs. Although, they also keep goat, sheep and other mini-livestocks in small quantity. Compounded rations were most commonly used with maize as the main energy feedstuff and the quantity of feed used daily indicated that they were small scale farmers.

Majority of the respondents were aware of the potential use of cassava peel as livestock feedstuff but indicated that availability of maize and sorghum, nutrient quality and seasonality affects their utilization while Ease of use and cost were also factors considered in Ogbomoso south and Ogo oluwa for the use of sorghum. Cost and quantity were not of serious concern for use of whole cassava but storability, availability and seasonality were the major factors affecting its use as energy feedstuff while nutrient quality and rate of spoilage were constraints for the use of cassava peel. It can therefore be recommended that agricultural extensionist should work together with livestock nutritionists and re-orient the farmers with available research outputs that has addressed the constraints of cassava peel usage for it to compete with maize as energy feedstuff.

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INVESTIGATING THE WEST AFRICA AGRICULTURAL PRODUCTIVITY PROGRAMME FOR EFFECTIVENESS AMONG MAIZE FARMERS IN MAMOU, REPUBLIC OF GUINEA

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Abstract

The West Africa Agricultural Productivity Programme (WAAPP) is an agricultural and development agenda aimed at reducing hunger and poverty amongst the ECOWAS nations. Maize is an emphasis crop being promoted by the WAAPP, Republic of Guinea. The WAAPP was therefore investigated for Context, Input, Process and Product (CIPP) effectiveness among maize farmers in Mamou, Republic of Guinea. A total of 176 beneficiary maize farmers were selected through a three-stage sampling procedure, and information was obtained using a well-structured interview schedule. Data were analysed using mean, t–test and Pearson Product Moment Correlation (PPMC) at $\alpha_{0.05.}$ *Subsidy on fertilizer, supply of improved maize seeds, training on pest management and fertiliser application were the most accessed project deliverables. The context-input, process and product phases of the project objective hierarchy were rated effective, with average yield of 1.37 tonnes/ha among beneficiaries, compared to the national average of 1.29tonnes/ha. Farmers' perceived effectiveness of the WAAPP significantly correlated with maize yield. Hence, the WAAPP in Guinea is concluded to be characterized by consistency, ensuring that the identified maize production needs were sufficiently addressed, resulting in improved yield.*

Key words: *perceived effectiveness, agricultural interventions, improved maize productions*

INTRODUCTION

Maize is one of the most important cereal crops in Sub-Saharan Africa (SSA) owing to its proven contribution to food security. [13] argues that with rice and wheat, maize is one of the three most important cereal crop in the world. An estimated 208 million people in SSA depend on maize as a source of food security and economic wellbeing, occupying more than 33 million ha of SSA's estimated 200 million ha of cultivated land. Considering the low average maize grain yields that are still pervasive in farmer's fields, meeting the projected increase in demand for maize grain in Africa presents a challenge. The 2010-2013 FAO data show that the total harvested is close to 0.7 million hectares, with annual production of nearly 1.5 million metric tons.

Maize is one of the most important cereal crops grown in Guinea and one of the main crops to which policies and donor-funded interventions are often directed. In area cultivated, maize ranks third after rice and fonio (millets with small grain). It is one of the main crops produced in Guinea and its production expanded over some few years in the past reaching up to 700,000 MT around 2016, and by 2018, up to 819,000 MT [22]. However, in the recent past, the demand for maize has risen in a consistent manner in Guinea, leaving a huge deficit demand-supply deficit. This has been linked to, among other factors, population increase, intense competition from livestock farmers and other key actors, whose finished products depend on maize grain as a raw material. Some of these products include food industries like corn flakes, custard, flour mills, and distilleries, among others. Reports have revealed [5] that an estimated 60 percent of maize supply is used for animal feed, and only 15–17 percent (or about 100,000 MT) is used for human consumption. Reports have also shown that although, productivity of common cereals has fluctuated over the past few decades, it witnessed a more of consistent decline from 1967 at 1.502 to 1.167 tonnes per hectare as of 2017, a far-cry compared to Ghana's 1.873 t/ha, Nigeria's 1.462 t/ha and Cote d'Ivoire's 2.148 t/ha [21]. This reflects the presence of a weak institutional capacity and inefficient framework for technological and scientific breakthroughs at improving domestic production. This perhaps explains the reason for a widening demand-supply gap. Slow pace of growth and poor productivity of maize in Guinea has also been attributed to factors such as climate change, inadequate agricultural technologies, pests and disease attack on crops, underfunding of extension services [7], among others.

The National programme of agricultural investment and food security (*Programme National d'Investissement de la Sécurité Alimentaire*, *PNIASA)* is one of the many critical components of the Government's Agricultural More Production [11]. The Ministry of Agriculture is in charge of providing support services to farmers in line with the provisions in the policy directions of the government. These supports are in the forms of agricultural campaigns, provision of subsidies on agricultural inputs like fertilizer, seed and agro-chemical to the farmers in order to increase yield, enhance farmers' income and promote national and household food security. The ministry also partners with international development organisations to implement specific agricultural programmes in line with clearly specified mandates. Maize is one of the target crops due to its direct role for economic growth, first as an important food security crop, and second, as a source of raw materials for industry.

Specific programmes have also been designed and implemented in successions. However, available information on the trajectories of food security situation in the country over the past years indicates that no significant improvements have been achieved as productivity did not improve significantly [8]. There have also been recent and ongoing efforts as a consequence of partnership between the government and international development agencies. One of such includes the current Guinea Poverty Reduction Strategy of the country's Agricultural Development Policy, through which platform the West African Agricultural Productivity Programme (WAAPP), Guinea, is being accommodated. The WAAPP is a poverty and hunger reduction intervention mainstreamed by the Economic Community of West African States (ECOWAS) in line with the Sustainable Development Goals 1 and 2 [18]. It is partly funded by the World Bank and partner countries and aims to develop a more productive and sustainable agricultural sector in 13 West African countries in order to ensure future food security [16]. The strategy is with the objective of achieving 6% agricultural growth and increasing food production and supply in West Africa, and works in collaboration with scientists, researchers, extension workers and farmers. In Guinea, the programme is being directly implemented under the supervision of the Ministry of Agriculture. The intervention provides assistance on three priority areas of which maize is key. It provides subsidies on maize inputs as a way of motivating maize farmers and other farmers; as well as complimentary advisory services. The WAAPP is implemented at the national level and targets specific regions according to their agro-ecological potential and market access and maize was categorized under priority food crop, which also included rice, poultry (egg), potato, and farmed fish (fresh and smoked) [17]. Mamou region of Guinea is known for intensive cultivation of maize. The WAAPP implementation for maize started in 2007, and expected to wind up in December, 2019.

It has been years into the implementation of the WAAPP; and available information suggests that the intervention may have only yielded marginal dividends. For example, [6] data reveals that the aggregate maize output in 2019 estimated at 871,000 tonnes was about 14 percent above the annual average figure. However, in spite of the 2019 above-average production, import requirements for the 2019/20 peak season are forecast at above-average level of 765,000 tonnes. Although, the improvement, no doubt can be interpreted to mean positive implication for a better food security situation, however, an aggregate of 113,000 people have been estimated by [6] as severely food insecure as at March 2020. The situation is expected to grow worse to 267,000 people between June and August 2020 [6]. These are however generic statistics and can hardly be used as a reliable metrics upon which the WAAPP intervention can be assessed for performance. An enterprise-specific assessment of the WAAPP efforts based on emphasis crops and livestock is surely a step closer to evaluating the attainment of the overall programme's goals.

Evaluations of programmes and related interventions have in the past been conducted using different designs, with objective indicators often favoured ahead of the subjective. The former being the estimation of the actual value of the outcome indicator (in this case, maize yield) while the latter is often referred to an assessment of the extent to which stakeholders, in most cases, beneficiaries, perceive the intervention to have yielded desired result. However, use of subjective approach is often considered most suitable for situations where more than one programmes are implemented across the same beneficiaries, due to the obvious difficulty in making inferences for causality. One of the most commonly used approaches in such case is through the feedback from direct beneficiaries as an expression of satisfaction, or otherwise, with the implementation procedure and eventual outcomes [3, 4]. A combination of these two methods can however be employed so as to eliminate or reduce measurement/instrument bias through triangulation. A significant correlation between the objective and subjective indicators will therefore be an indication of congruence in this case. It is therefore on the basis of the foregoing that it becomes important to investigate the extent to which the WAAP followed the expected implementation procedures as indicated in maize yield and hence as perceived by farmers. A dearth of such empirical investigation in both methodological approach and result therefore necessitates this study. Answers were sought to the following research questions.

(i)What are the project deliverables to which the WAAPP beneficiaries had access?

(ii)How effective do farmers rate the context, input, process and product (outcome) implementation of the WAAPP?

(iii)How does maize yield of farmers correlate with effectiveness indicators (input, process

Theoretical framework

The study is explained by the Context, Input, Process and Product (CIPP)**.** The CIPP model is a programme evaluation model developed by Daniel Leroy Stufflebeam and his colleagues in the 1960s. It is a model that requires the evaluation of context, input, process and product in judging a project's value. It is designed to systematically guide evaluators and stakeholders in posing relevant questions and conducting assessments at the beginning of a project, while it is in progress and at its end. According to the model, an evaluation is defined as a systematic investigation of the value of a programme [14]. Context evaluation, for example emphasizes an assessment of the situations in terms of needs and opportunities within a defined context [15]. Input evaluation on the other hand provides information for determining the resources used to meet the goals of the program [9]. Such resources sometimes may include human, social, physical, natural and human. Process evaluation addresses the questions of whether the inputs are being put into appropriate use and in such a way that will help the programme achieve the intended objectives. The Product phase is the assessment of the extent to which the goals of the programme has been achieved. It measures, interprets and judges a project's outcomes based on their merit, worth, significance and probity. The study uses this theory to guide the evaluation process for the WAAPP for improved maize production in Mamou, Guinea.

MATERIALS AND METHODS

Study area and sampling procedure

According to the administrative division, the prefecture of Mamou is the capital of the Administrative Region of which it counts in total 13 local areas, plus the urban communities which are Timbo, Porédaka, Dounet, Boulliwel, Tolo, Konkouré, Saramoussaya, Gongoré, Soyah, Ouré-Kaba, Niagara, Kégneko and Téguéréya. Mamou prefecture covers an area of 8,000 km^2 with a population of 236,326 inhabitants, including 121,326 women and 114,964 men, and an average population density of 30 per km^2. It is bounded in the South by Sierraleone; in the North by the prefectures of Tougué and Dalaba; in the East by the prefectures of Faranah and Dabola; in the West by that of Kindia. Its geomorphological unit is characterized by high plateaus of Fouta Djallon whose soils remain lateritic. Fulani, Dialonke, and a minority of Malinke, Sousou and foresters are the main ethnic groups of the prefecture. The most popular economic activities are handicrafts, farming which include maize, fruit and vegetable production, extensive livestock farming, fonio, sweet potato, peanut, , cassava. Also, it is a region with a privileged geographical position, a crossroad between the different regions of the country and between the countries bordering the North and the South. Domestic production is particularly important for some speculations.

The population for the study consisted of the all maize farmers beneficiaries of WAAPP in Mamou. Three Local Government Areas (LGAs) out of thirteen in Mamou where maize farming is the major activity and where the WAAPP for maize are being implemented were purposively selected. The selected local government areas were Soumbalako, Tolo and Dounet. Thereafter, a total of seven communities (50%) were randomly selected across the sampled LGAs, making two, three and two from Sumbalako (from 3), Dounet (from 5) and Tolo (from 4) communities, respectively. There is an average of 25 farmer organization in each of the seven selected communities, with an average membership size of 20. Five (20%) of Farmer organisation was then selected in each community, giving a total of 35 organizations across the seven communities. With an average of 20 members, five farmers (25%) were also randomly selected from each organization. This makes a total of 175 respondents sampled in all for the study. The data for the study was collected using structured interview schedule to elicit information from maize farmers in the different communities.

Measurement of variables and analysis of data

In measuring project deliverables respondents had access to, farmers indicated from a list of items, the programme deliverable(s) to which they had access to by indicating ‘yes’ for access and ‘no’ for non-access, with scores of 2 and 1 assigned, respectively. Yield of maize was measured in local measuring scale and converted to Kilogramme and Tonnage equivalents. Effectiveness as perceived by beneficiaries was measured by asking respondents to indicate the effectiveness of the WAAPP on maize on a 10-point rating scale where, 0 indicates not effective and 10 represents maximum effectiveness for each item. Effectiveness was measured for the context-input, process and product (outcome) phases of the project execution process as guided by the CIPP Model. Score for effectiveness was then computed and used in the test of hypotheses. Descriptive statistical tools such as frequency counts, percentages, and Pearson Product Moment Correlation were used to test the hypotheses. All hypotheses were tested 5% level of significance.

RESULTS AND DISCUSSIONS

Project deliverables to which farmers have access

The result in Table 1 shows deliverables in ranking order of access by respondents. Improved maize seed was ranked most accessed benefits by WAAPP intervention beneficiaries. This is consistent with the World Bank report [16] that WAAPP delivered 10,500 tons of seeds to up to 200,000 farmers in Guinea and two other countries. Access to improved seed was followed by subsidy on fertilizer and intensive agricultural campaign which rank second and third, respectively. Respondents however ranked provision of small irrigation machine and training on irrigation crop farming as the second least accessed project deliverables, respectively. This result is an indication that the WAAPP intervention programme on maize is geared towards making basic inputs of direct consequences to maize production available. In this case, fertilizer and improved maize varieties being rated first further underscores that low productivity was the chief maize production challenge for which interventions like WAAPP became important (Table 1).

Table 1. Project deliverables to which farmers have access in the intervention programmes

Input subsidy	**Mean**	**Rank**
Subsidy on Fertilizer	1.91	2
Access to improved maize seed	1.95	1
Agricultural Campaign	1.91	2
Phyto sanitary products	0.75	5
Small irrigation machine	0.49	8
Agricultural tools for maize	0.90	4
Water availability for domestic use	0.71	7
Information on irrigation for dry season maize farming	0.73	6
Education/advisory services		
Training to the Farmers on best maize agronomic practices	0.99	3
Research service on improve maize varieties	0.73	6
On-farm Extension service	0.96	4
Improved maize pest management practices	1.32	1
Improved maize diseases management practices	0.95	5
Fertilizer application techniques	1.18	2
Information on improve seed sourcing	0.74	7
Training on livelihood diversification	0.56	8

Source: Field survey, 2019.

Project deliverables also include the education sub-objective. The result reveals that training on improved maize pest management practices, fertilizer application techniques, and best maize agronomic practices were identified as the most accessed education-related deliverables.

This further indicates that farmers were provided with corresponding agronomic education on the appropriate handling of inputs which were provided. This result is consistent with the general objective of the WAAPP which is to improve productivity by increasing access to improved seeds, other agricultural inputs and dissemination of innovations among actors, among other support services [20].

Maize yield (ton/ha)

Using the Guinea's current maize yield average of 1.29 tonnes/ha [23] as the benchmark, the study categorised farmers into high level of productivity (score ≥ benchmark value) and low level (scores < benchmark score) as shown in Table 2. The result reveals that majority (60.2%) of the respondents were categorized as having high maize yield, as against 39.2 which recorded low maize yield. This in an indication that the project has improved the yield of maize and this is expected to translate to improvement in farming household members' welfare. The result shows consistency with the average yield of 1.37 tonnes/ha among beneficiaries, which is a significant improvement over the overall 1.29 tonnes/ha, recorded as the national average. This result concurs with [17] which affirmed that the maize production in Guinea had grown by 13 percent from 2011. However, the result further implies that a lot more efforts is required to scale up production beyond the current level considering the value is still below the average yield index for the SSA region which according to [1]'s assertion was way below appropriate.

Effectiveness of the WAAPP

Context-input effectiveness

The result reveals that appropriate targeting of beneficiary was ranked as the first most perceived context-input effectiveness indicator, followed by needs assessment/identification of problems. Inputs and advisory services being delivered in the most acceptable way was ranked third, followed by input supply meeting the needs of the maize farmers. This is an indication that the implementation of WAAPP is guided by the sound knowledge of the importance of agricultural input [10] and support services [12] to agricultural productivity. Decision making process and appropriateness of description of modalities for collection of deliverables were the least ranked indicators for WAAPP effectiveness by farmers. The result is an indication that the WAAPP must have taken to the bottom-up approach for design and execution of intervention, which is participatory in nature and important for sustainability. It is therefore an indication that the programme is addressing farmers' needs for the present time, and also not undermining economic, social and environmental needs and capabilities of the future generation. This argument concurs with the [20] where the Programme underscores the importance of demand-driven technology generation and adoption process which the Programme adopts in its implementation process (Table 2).

Table 2. Perceived context and input effectiveness of the WAAPP

Items	Mean	Rank
Targeting of beneficiaries	9.90	1
Needs assessment/identification	8.20	2
Soil testing and assessment	3.90	6
Participation of stakeholders	3.65	7
Decision making process	3.25	8
Description of modalities for collection of deliverables	4.15	5
Inputs and advisory delivered in the most acceptable way	6.95	3
Adequate of input to meet maize farmers' needs	5.55	4

Source: Field survey, 2019.

Process effectiveness

Process effectiveness comes next to the context and input effectiveness as guided by the CIPP Model. The result of the analysis reveals that input supply met the needs of the maize farmers as it ranked first. The programme also improved farmers' knowledge of best agronomic practices, and as well improved access to fertilizer among farmers, as these ranked second and third indicators, respectively. The result on process effectiveness gives credence to the result obtained for context-input effectiveness (Table 3) as it translates to the required effective process, which is also expected to engender attainment of intervention goals. It is also an indication that both the input and educational services provided by the WAAPP yielded the desired immediate dividend. It is noteworthy, however, that the process phase of the WAAPP intervention is pivotal and direct to improved productivity of maize which is the focal goal of the programme, without which the programme's overall objectives cannot be achieved, even under very favourable external factors.

Table 3. Process effectiveness of maize intervention programmes of WAAPP

Indicators	Mean	Rank
Training on pests and disease management	4.15	6
Input supply meet the needs of the maize farmers	6.40	1
Functional link to source of credit facilities	4.65	5
Appropriateness of fertilizer supply for the local soil	5.80	4
Improved farmers knowledge of best agronomic practices for maize	6.25	2
Access to fertilizer	6.10	3
Training on improved crop production	5.35	6
Subsidy on basic farm input	5.55	5

Source: Field survey, 2019,

Product effectiveness of the WAAPP

The study reveals in Table 4 that increased maize productivity, low incidence of pests and diseases, and higher profit margin were the most rated indicators of product effectiveness of the WAAPP among maize farmers in the study area. This result simply indicates that the WAAPP intervention was able to, through a carefully-planned and well-monitored process, achieve improved productivity and hence profit making from the maize production enterprise. This is expected to also have direct positive effect on poverty among the farming population, as well as improve the food security of the nation, if the project is scaled up to cover bigger geographical space and beneficiaries, following a similar, but improved implementation procedure. The result is consistent with the claims by the WAAPP [19] that the intervention increased, by 34%, the economic situation of farmers as well as transformed communities. This argument is also consistent with the [16] document on implementation of WAAPP which indicated agricultural productivity as the main impact target as enshrined in the project's Theory of Change. It also aligns with the initial philosophy of the programme which seeks to fight hunger and poverty in line with the United Nations' Sustainable Development Goals 2 and 1, respectively [18].

Table 4. Product effectiveness of WAAPP on maize

Indicators	Mean	Rank
Increased productivity	6.70	1
Improved market participation	5.30	7
Higher profit margin	6.15	3
Increase income level	5.15	8
Improved socio-economic development	5.90	4
Flood control benefits	3.10	6
Low incidence of maize disease infestation	5.55	5
Low incidence of pest	6.45	2

Source: Field survey, 2019.

Relationship between project deliverables and effectiveness WAAPP maize intervention programme

The study reveals (Table 5) that there is significant relationship (r = 0.708) between project deliverables which respondents accessed from maize intervention programme. This is an indication that the more the respondents accessed the deliverables in inputs and advisory services, the more effective the programmes were rated. This is an indication that the programme is characterized by consistency, ensuring that the benefits accessed by beneficiaries addressed the identified needs. Also, the study reveals a significant relationship between respondents' perceived effectiveness of the programme and maize productivity, which is an indication that the more effective the programme was perceived, the more productive the famers were. This therefore is an indication of causality by coherence as explained by [2]. This result further shows that since majority of the respondents perceived the WAAPP intervention on maize to be effective, about the same proportion had recorded high level of productivity in their maize production enterprise.

Table 5. Project deliverables and perceived effectiveness

Relationship	r	P
Project deliverables and effectiveness	0.708**	0.000
Yield and perceived effectiveness:		
- Input	0.345**	0.000
-Process	0.186*	0.027
- Product (outcome)	0.237**	0.005
-Overall effectiveness	0.269**	0.001

*significant at 5%, **significant at 1%
Source: Field survey, 2019.

CONCLUSIONS

The study infers and concludes that the WAAPP programme achieved moderate levels of effectiveness as established by the favourable feed-back from farmers. The study further establishes that farmers' favourable perceived effectiveness of the WAAPP programme was not unconnected with improved yield which majority achieved in their maize production enterprises. Finally, based on the coherence achieved in the two approaches to determining the effectiveness of the WAAPP intervention for an improved maize production, the intervention is hereby concluded to be effective. Therefore, on the basis of these conclusions, the following recommendations are considered important:

(i)Input subsidy should be considered an important agricultural policy content and as such policy direction and legislation should incorporate seamless access to inputs among farmers and implementation should pursued by the government with requisite commitment;

(ii)Government agricultural interventions should adopt a demand-driven process for a much participatory, result-oriented and sustainable effort;

(iii)Agricultural interventions should not only put emphasis on dissemination and/or transfer of agricultural technologies to perceived end-users, requisite trainings and advisory services for an appropriate deployment of such technologies should form an integral component of such efforts.

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BEE HONEY PRODUCTION CONCENTRATION IN ROMANIA IN THE EU-28 AND GLOBAL CONTEXT IN THE PERIOD 2009-2018

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Abstract

The paper analyzed honey production concentration in Romania in the period 2009-2018 using the specific indicators: number of beekeepers, bee hives, honey production and yield per bee hive, and methods like: trend equation, Herfindhal-Hirschman concentration index (HHI), regression models, correlations and determination coefficients to examine the gains in comparison with the period 2007-2016. The results pointed out that both the number of bee colonies and honey production increased in a high measure, only honey yield remained stable (20 kg/year). In 2018, Romania came on important positions in the EU-28 top honey producing countries as follows: 2nd position for 1,689.5 thousand bee hives, 1st position for 30,000 tons honey production, 3rd position for 80 average number of bee hives per apiary, and 18th position for 20 kg honey yield per bee hive. In 2018, the distribution of the bee hives and honey production in the territory was: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, 10.6% West and 1.2% Bucharest-Ilfov. Compared to 2009, honey production increased in 2018 in almost all the micro-regions, except North East, where it remained stable. HHI indices had values below 0.15 reflecting a low concentration. Compared to the period 2007-2016, in the interval 2009-2018, the mean for the number of bee hives and honey production increased, the correlation and determination coefficients recorded higher values for the pair of indicators: honey production and the number of bee hives and for the honey production and yield, while for the average yield and the number of bee hives the values were smaller. Regression equations attested that honey production is about 50% determined by the number of bee hives and in smaller proportion by honey yield. Beekeeping has to continue to develop for assuring the pollination of the agricultural crops, the preservation of biodiversity and environment and for providing healthy products for consumers, jobs and incomes for the rural population. The EU and National Programmes for Apiculture will strengthen this sector keeping pace with the increased competitiveness on the EU honey market.

Key words: *bee hives, honey production, concentration, Romania*

INTRODUCTION

Having in mind the landmark scientific treatise "On the Origin of Species" by Charles Darwin (1859) who mentioned "The life of man would be made extremely difficult if the bee disappeared.",
"The Life of the Bee" written by Maurice Maeterlinck (1901) and quotes such as: "Remove the bee from the earth and at the same stroke you remove at least one hundred thousand plants that will not survive", attributed to Albert Eistein (1941), as mentioned in the "Canadian Bee Journal", and "If all bees disappeared off the earth, four years later all humans would also have disappeared", also attributed to Albert Eistein who made this calculus, as mentioned in 1965 in "Abeilles et Fleurs", we can not deny the importance of bees and beekeeping on the Earth [38].
Bees give and preserve life, produce healthy products for humans (honey, propolis, royal jelly, beewax, bee venom etc), help farmers pollinating their cultivated crops and preserve biodiversity and environment.

In their hard activity to collect nectar and pollen to nourish the family, bees are flying for kilometers from a flower to another. About 77% of the existing plants on the Earth are pollinated by bees. Grace to bees fruit trees and bushes, agricultural crops (sunflower, rape, linen, mustard, various leguminous plants, melons, strawberries, etc) are pollinated and assure a high production and food for people, the production gain exceeding more than 15 times the value of the apicultural products [40, 43].

Beekeeping is an important activity in the rural areas but also in the surroundings of the urban ones, offering a pleasant job outdoor and bringing important incomes to beekeepers.

Romania is the first among the top honey producing countries in the EU: Spain, Hungary, Germany, Italy, Greece, France, and Poland. Beekeeping has a long tradition in Romania for more than 2,500 years and its performance is due to the good geographical position, variety of relief forms, a temperate continental climate, a large range of wild flora and cultivated agricultural crops, experienced beekeepers and first of all *Apis Mellifera Carpatica*, the most valuable bee able to produce honey and pollen of an exceptional quality. Beekeeping is practiced in all the eight micro-regions of development which prove that the country has a high potential for producing honey and other apicultural products. This activity is practiced fulltime or part-time, it is a healthy job being run outdoors and brings satisfactions and incomes to the apiculturists. Honey production is high in Romania covering the internal market needs and also assuring deliveries to export representing more than 60 % of output. Romanian honey is well appreciated in the Western European countries Germany, United Kingdom, Nordic countries, Italy being the most important beneficiaries [29, 32,34, 36].

In the EU, all the countries are practicing apiculture in various breeding systems and production conditions. Bee products are well appreciated by consumers that is why the EU would like to produce more honey to cover consumers' demand. Despite that the EU comes on the 2nd position in the world as a honey producer after China, internal production is not enough and this oblige the EU to import honey from China, Ukraine, Argentina etc. [4, 21, 23].

According to the EU programmes of apiculture development for the near future, a more and more importance is given to honey production growth and quality which needs important funds to help beekeepers to increase the number of bee hives and apiary size, to improve bee family power and apiary endowment, to make innovation and modernization and assure a high quality of honey, even to extend organic honey production and increase efficiency along honey chain.

In this context, the purpose of the paper was to analyze the number of bee hives, honey production and yield per bee hive in order to assess the concentration degree of honey production in Romania at the national and territorial level in the period 2009-2018 compared to the period 2007-2016 and other EU-28 top producing countries.

This research continues the investigations started in the earlier studies [21, 23, 34, 36] in order to bring more arguments in terms of correlations and regression models which reflect the increase of honey production concentration in the two periods mentioned above.

MATERIALS AND METHODS

Data collection

The data used in this research were collected from various sources such as: National Institute of Statistics Tempo Online, Eurostat, Faostat, Knoema and others. The period includes the last decade 2009-2010 [3, 4, 5, 6, 15].

The following specific indicators used in this study have been the following ones: (i) number of beekeepers; (ii) number of bee hives at the national level and in the territory by micro region of development; (iii) number of bee hives per apiary; (iv) extracted honey production at the national level and in the territory by micro region of development; (v) honey yield per bee hive at the national level and in the territory by micro region of development; (vi) concentration of the number of bee hives; (vii) concentration of honey production; (vii) efficiency in honey production at apiary level.

Methodological aspects

In this study, there were used the following methods:

Index method, based on the Index with fixed basis, whose formula is: $I_{t/t0} = (X_t/X_0)100$, where X_t is the level of the indicator X in the last year of the analysis, 2018, and X_0 is the level of the same indicator X in the first year of the analysis, 2009;

The trend method based on various mathematical models suitable to the distribution of the values of each analyzed indicators in the graph; the models used in this study were the linear regression equation,

$Y = bx + a$,

and polynomial equation,

$Y = ax^2 + bx + c$.

Descriptive statistics including mean, standard deviation and coefficient of variation was determined for number of bee hives at the national level, honey production and honey yield in the period 2009-2018 versus 2007-2016;

The comparison method destined to identify the similarities and discrepancies between Romania and the other top honey producing countries in the EU-28, and also between various regions of development in the country;

The structural index (SI%) reflecting the share of an item in the total level of an indicator. This index was used to analyze the dispersion of the number of bee hives, honey production and honey yield in the territory by micro-region, and also to establish the market share of Romania among the EU-28 top 10 honey producing countries.

Herfindahl-Hirschman Index, HHI, was used to express the concentration of the number of bee families and honey production, using the formula:

$$HHI = \sum_{i=1}^{n}(g_i)^2$$

where: $g_i = \frac{x_i}{\sum_{i=1}^{n} x_i} = \frac{x_i}{x_j}$

i = the micro-region of development, i = 1,2,....8;

X_i = the value of the analyzed variable in the micro-region i;

X_j = the value of the variable at the country level;

g_i = the share of the micro-region i in the value of the variable at the country level, X_j.

The correlation coefficient as well as *R square* were used to assess in what measure the variation of the dependent variable is determined by the change of the independent variable. For this purpose the following three pairs of indicators were studied: honey production and honey yield, honey production and number of bee hives, honey yield and number of bee hives. The values of the correlations coefficients were compared between the two periods 2009-2018 and 2007-2016.

Regression models were established for the three pairs of indicators mentioned above and then they were compared in the two period of time taken into consideration 2009-2018 and 2007-2016.

The results were explained and commented and presented in tables and graphics, and the corresponding interpretations and comments were added. The main ideas resulting from this research were presented at conclusions.

RESULTS AND DISCUSSIONS

Number of beekeepers

During the last decade, the number of beekeepers in Romania increased grace to the National Programme for Apiculture for the period 2011-2013 approved in 2010 by the EU based on CE Regulation no.1234/2007 [1, 13].

Also, the National Programme for Apiculture for the period 2020-2022 is destined to continue the improvement of honey and other bee products output in Romania and their commercialization by offering financial support to the apiculturists to assure the apiary inputs and sustaining the marketing of the bee products [14].

This reflects the interest on the development of apiculture in Romania as a recognition of its tradition and performance in beekeeping

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across the time and of its importance in agriculture and rural areas.

The need to grow honey production in the EU is one of the objectives of the Common Agricultural Policy, because honey demand is higher than the internal supply and, to assure consumption, it is needed to import honey. More than that, bee colonies are important for pollination of the agricultural crops and are a component of biodiversity which must be preserved.

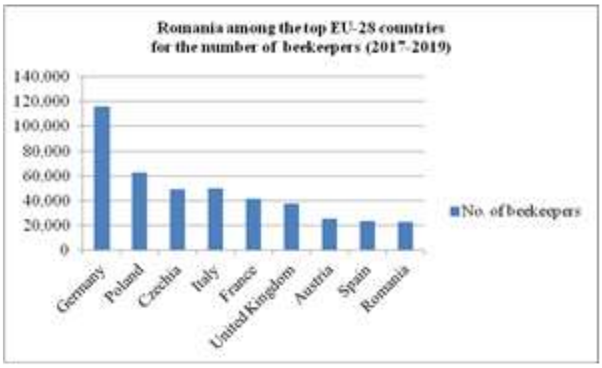

Fig. 1. Romania's position in the EU-28 for the number of beekeepers, 2017-2019
Source: Own design based on the data from [3, 4].

In 2018, Romania had 22,930 apiculturists placing the country on the 9th position in the EU after Germany, Czech Republic, Italy, France, United Kingdom, Austria and Spain. The share of Romania in the total number of 606,082 beekeepers existing in the EU-28 was 3.8 %. All these nine countries summed 70.7 % of the total number of apiculturists in the EU (Fig.1).

The number of apiculturists is expected to reach 23,161 meaning a surplus of 1 % in the period 2020-2022 compared to 2017-2019. At the EU level, in the period 2020-2022 it is expecting that the number of beekeepers to be 652,305, by 7.62% more than in the last three years.

Number of bee hives

A general ascending trend was noticed regarding the bee colonies whose number accounted for 1,689,500 in the year 2018 compared to 1,057,186 in 2009, meaning by 59.8% more than at the beginning of the studied period. The average annual growth rate in the analyzed period was 5.98% (Fig. 2). This aspect was stimulated by the interest of beekeepers to enlarge the apiary size in order to improve the extracted honey production and its efficiency, and also to benefit of the financial aid offered by the Government by means of the National Programme for Apiculture 2020-2022 which provides the conditions that the beekeeper to own at least 75 bee hives, to have certified competences in apiculture, the hives to be identified and registered by the National Agency for Zootechnics.

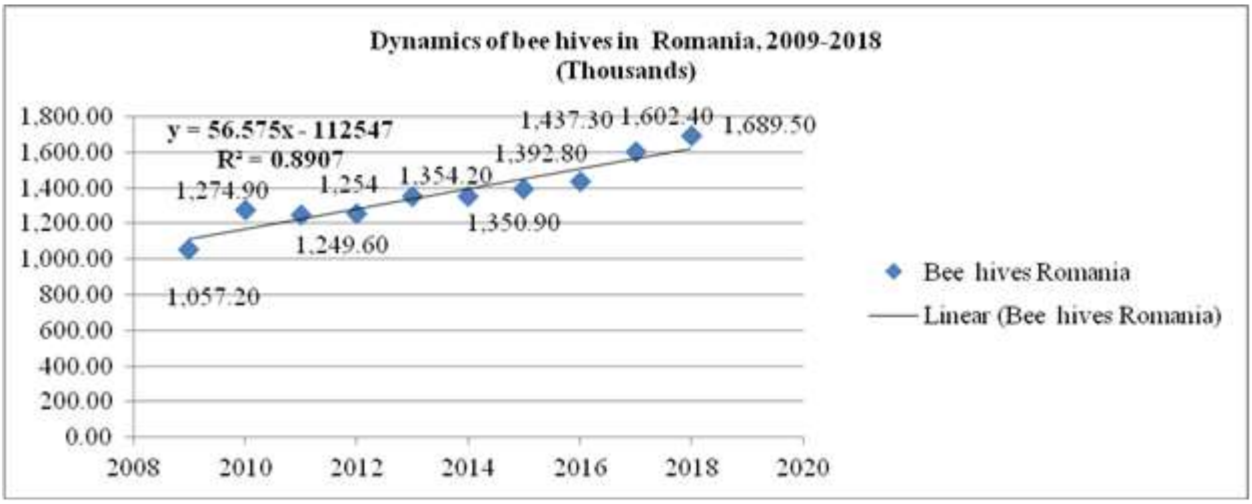

Fig. 2. The evolution of the number of bee hives in Romania, 2009-2018 (Thousands)
Source: Own design based on the data from [15].

According to Eurostat, for the number of bee hives, Romania came on the 4th position in the EU-28 in the year 2009, when there were 998,000 bee hives and on the 2nd position in the EU after Spain for 1,849 thousands in the year 2018 (Table 1).

The data from Table 1 showed that in almost top 10 countries dealing with apiculture the number of bee hives increased in order to stimulate bee honey production, to better satisfy honey demand and grow the amount of honey destined to export.

Table 1. Romania's position among the top 10 EU-28 countries for the number of bee hives in 2018 versus 2009 (%)

2009			2018		
	EU-28	11,327,699 bee hives		EU-28	17,577,000 bee hives
Crt. No.	Country	%	Crt. No.	Country	%
1	Spain	21.09	1	Spain	16.84
2	Poland	12.80	2	Romania	10.52
3	Greece	11.82	3	Poland	9.29
4	Romania	8.81	4	Italy	8.50
5	France	7.81	5	France	8.27
6	Germany	6.13	6	Greece	7.74
7	Bulgaria	5.76	7	Hungary	7.03
8	Italy	4.41	8	Germany	5.00
9	Czech Republic	4.40	9	Bulgaria	4.45
10	Hungary	3.72	10	Portugal	4.36

Source: Own calculation based on [3].

The growth rate of the number of bee hives in the analyzed decade was the following one: 298.8 % in Italy, 293.82 % in Hungary, 240 % in Portugal, 85.2 % in Romania, 64.43 % in France, 26.50 % in Germany, 23.8% in Spain, 19,98 % in Bulgaria, 12.62 % in Poland, and 1.56 % in Greece. As a result, in 2018, all these 10 countries kept 82 % of the EU-28 number of bee hives.

Also, it is important to mention that the EU-28 reached 18.5 million bee hives representing 75 % of the number of bee hives existing in Europe.

This is a recognition of the importance allotted by the EU to beekeeping which is a very important sector in agriculture for assuring the pollination of the cultivated crops, for maintaining biodiversity, offering jobs and incomes for the rural population and for covering better the requirements in honey and other bee products on the EU-28 market where self-sufficiency in honey is only 60%.

Also, for its number of bee hives, in 2018, the EU-28 represented 22.65% of the 81.06 million bee hives worldwide.

The distribution of bee hives in Romania's territory

A relatively large variation regarding the dispersion of bee hives from a region to another is specific to Romania as there are many factors of influence such as: the local tradition in beekeeping, the existence of the floral resources for pickings, the floristic structure of the cropped and wild area, climate conditions etc.

In 2018, the number of bee hives by micro region of development was the following one: 324.4 thousands (19.2%) in South West Oltenia, 282.4 thousands (16.7%) in South East, 230.6 thousands (13.6%) in North West, 228.9 thousands (13.5%) in South Muntenia, 219.3 thousands (13%) in North East, 221.2 thousands (12.5%) in the Central part, 176.1 thousands (10.5%) in West and 16.5 thousands (1%) in Bucharest-Ilfov area. These figures show the existence of some discrepancies regarding the distribution of the bee hives in the territory.

In the period 2009-2018, the number of bee hives increased in all the micro regions as follows: +78.5% in the North West, +37.1 % in the Center, +52.7% in the North East, + 107.35% in South East, +38.9% in South Muntenia, +2.4% in Bucharest - Ilfov, +86.55 in South West Oltenia, and + 26.4% in the West.

During the analyzed decade, it was also noticed a change regarding the share of the region in the total number of bee hives at the country level as follows: either an increase of the share of the number of bee hives like in North West, South East and South West Oltenia regions or a decline like in the Central part, North East, South Muntenia, Bucharest-Ilfov and West areas (Table 2).

Table 2. The distribution of bee hives by micro region in Romania in 2018 versus 2009 (%)

	2009	2018
Romania's number of bee hives (Thousands)	1,057.2	1,689.5
North West	12.2	13.6
Center	14.6	12.5
North East	13.6	13.0
South East	12.9	16.7
South Muntenia	15.6	13.5
Bucharest – Ilfov	1.5	1.0
South West Oltenia	16.5	19.2
West	13.1	10.5

Source: Own calculation based on the data from [15].

The number of bee hives per apiary

Romania comes on the 3rd position in the EU for the number of 80 bee hives per apiary after Greece (147 bee hives) and Spain (103 bee hives). Compared to the EU-28 average apiary size, Romania has in average a 4 times larger apiary (Fig. 3).

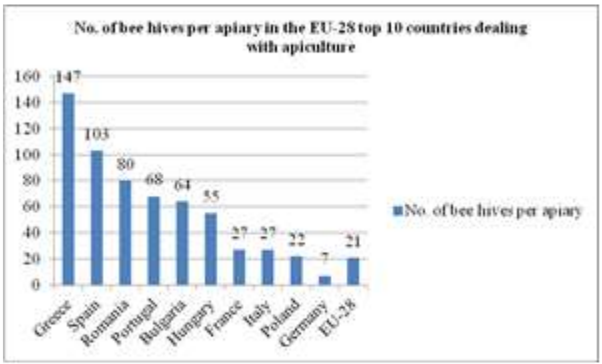

Fig. 3. Romania's positing among the EU-28 top 10 countries dealing with beekeeping
Source: Own design based on the data from [3].

If in 2004, the average apiary size was smaller than 50 bee hives, in a period of 14 years, Romania succeeded to raise its dimension to 80 bee hives, meaning an increase of 60 %. A higher size of the apiary is specific to a commercial company whose purpose is to produce more and increase the owner's profit [18, 19].

However, at present, in Romania there is a large variety of apiaries regarding the number of bee hives, ranging between 20 bee families in case of the beginners in beekeeping and about 600 bee families in case of the oldest apiculturist with an experience of more than 50 years. The structure of the apiary size is still dominated by the smaller apiaries having less than 100 bee families.

The research results in the counties of the South Muntenia region of Romania proved that apiary size is closely connected to economic efficiency in beekeeping, knowing that the higher the number of bee families per apiary, the higher honey production and apiculturist income and profit [26, 27, 28, 30, 31, 32].

Extracted honey production

Honey production registered a general increasing trend in Romania despite that during the studied interval there were noticed peaks and declines caused by the climate change which affected pickings. in spring season, usually cold rains appear when *Acacia* trees are in bloom, then in summer season long droughts diminish pickings at rape and sunflower also having a negative impact on honey production, as happened in 2009, 2014 and 2016 [44].

In 2018, honey production reached 29,162 tons being by 46.3% higher than in 2009 when it accounted for 19,937 tons (Fig. 4).

As mentioned by Eurostat, for the record of 30.9 thousand tons honey output, Romania came on the 1st position in the EU-28, being followed by Spain, Germany, Hungary, Italy, Poland, France, Greece, Bulgaria and Portugal. All these top 10 countries together produced 217.7 thousand tons representing 76.9% of the EU-28 honey output in 2018, which accounted for 283 thousand tons [39, 42] (Fig. 5).

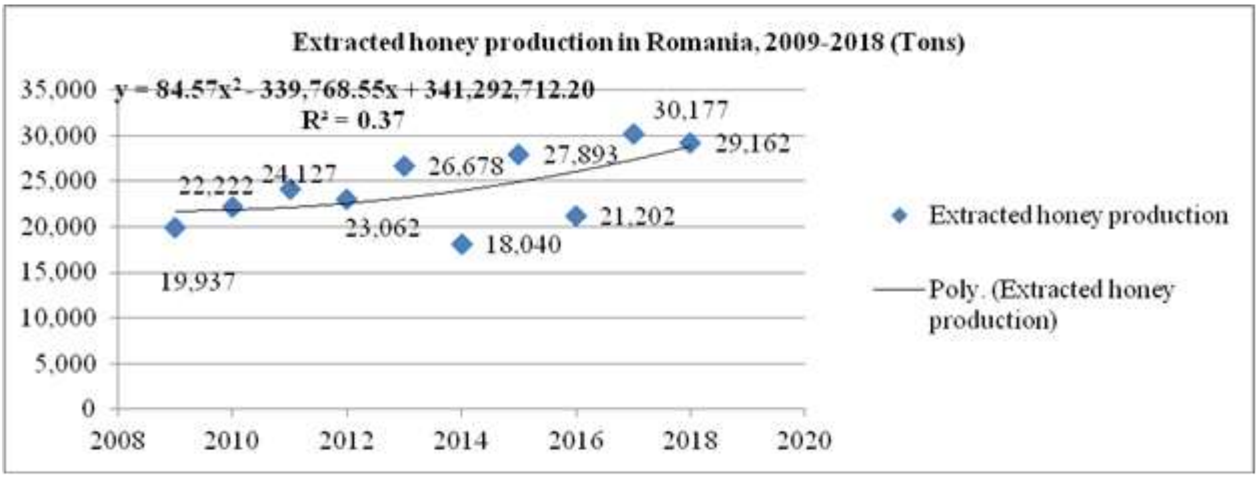

Fig.4. Dynamics of extracted honey production in Romania in the period 2009-2018 (tons)
Source: Own design based on the data from [15].

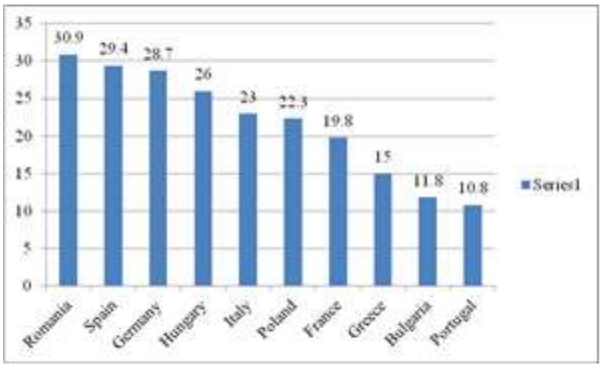

Fig.5. Romania's position among the EU-28 top 10 honey producing countries (Thousand tons)
Source: Own design based on the data from [3].

For its market share in the EU-28 honey output, Romania passed from the 3rd position in 2009 on the 1st one in 2018, and also other countries passed on higher positions such as Germany, Poland, Italy, France, and Greece (Table 3).

In 2018, all these top 10 countries produced 218.7 Thousand tons honey representing 77.27% of the EU-28 honey output.

Table 3. Romania's market share among the top 10 EU-28 honey producing countries in 2018 versus 2009 (%)

2009			2018		
	EU-28	204,725 Tons		EU-28	283,000 Tons
Crt. No.	Country	%	Crt. No.	Country	%
1	Spain	15.79	1	Romania	10.92
2	Hungary	11.00	2	Spain	10.38
3	Romania	9.74	3	Germany	10.14
4	Germany	8.04	4	Hungary	9.18
5	Greece	7.81	5	Poland	8.23
6	France	7.58	6	Italy	8.12
7	Poland	6.84	7	France	7.00
8	Italy	4.99	8	Greece	5.30
9	Bulgaria	4.65	9	Bulgaria	4.17
10	United Kingdom	4.01	10	Portugal	3.82

Source: Own calculation based on [3].

In the same year, the EU-28 contributed to the world honey production by 283 thousand tons, representing 15.28% of the global honey production which accounted for 1,851 thousand tons.

If we compare with the situation in 2009, when the EU-28 market share in the global honey output was 13.54 %, we may affirm that in 2018 the EU contribution to the world honey production was much higher.

However, at the global level, honey production is dominated by China with a share of 24%, followed by the EU - 28 with 15.2%, and then by other countries: Turkey 6%, Argentina 4%, Iran 4%, USA 4%, Ukraine 4%, Russia 4%, India 4% [5].

Distribution of honey production in the territory of Romania

It is a relatively large variation regarding the dispersion of honey production from a micro region to another and this is in close relationship with the number of bee hives distribution and also with the possibilities to assure the pickings of the bee colonies which depends in a high measure not only of the agricultural crops structure, the floristic composition of the wild flora, but also on the climate conditions.

In 2018, the contribution of the regions to the national honey production was the following one: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, 10.6% West and 1.2% Bucharest-Ilfov area. These figures are almost similar with the weight of the number of bee hives by region in the total number of hives existing in the country.

In the period 2009-2018, honey production increased in all the micro regions as follows: +75.5% in the North West, +8.9% in the Center, +52.5% in the North East, + 85% in South East, +47.1% in South Muntenia, +13.1% in Bucharest - Ilfov, +55.5 in South West Oltenia, and + 13.5% in the West.

During the analyzed decade, 2009-2018, it was also noticed a change regarding the share of the region in the total honey production at the country level as follows: either an increase like in North West, North East, South East, South Muntenia and South West Oltenia regions or a decline like in the Central part, Bucharest-Ilfov and West areas (Table 4).

Table 4. The distribution of honey production by micro region in Romania in 2018 versus 2009 (%)

	2009	2018
Romania's honey output (tons)	19,937	29,162
North West	12.1	14.6
Center	16.1	12.0
North East	12.8	13.3
South East	12.8	16.2
South Muntenia	13.5	13.6
Bucharest – Ilfov	1.5	1.2
South West Oltenia	17.4	18.5
West	13.8	10.6

Source: Own calculation based on the data from [15].

Honey yield per bee hive

A sinuous trend from a year to another was registered by honey yield for many reasons. First of all due to the higher growth rate of the number of bee hives in the analyzed interval, 59.8%, compared to 46.3% growth rate in honey production.

It is known that about 50 % of honey production depends on the number of bee hives as proved by [10].

Also, the picking opportunities were deeply influenced by the change in the climate conditions mainly in spring season when the trees in bloom were damaged by huge rainfalls or low temperatures and in summer season the hot weather and long and severe drought diminished the floral resources. In this way, the power of the bee hives was affected and the apiculturists had to make efforts to offer feed supplements.

The diseases caused by bacteria, viruses, parasites and fungi as well as bee intoxication and death determined by the chemical treatments (pesticides, insecticides, neonicotonoides) applied to cultivated crops have diminished the number of bee families by the so called "colony collapse disorder" and their production as well [34].

The year 2015 was the most favorable for apiculture and honey yield per apiary reached the highest level, 20.03 kg/bee family, compared to the previous year 2014 when the pickings were deeply affected by the unfavorable conditions and Romania

registered the lowest honey yield, only 13.35 kg/bee hive.
In 2018, the average honey production per bee hive accounted for 17.24 kg, being by 8.44% smaller than 18.83 kg achieved in 2009 as attested by the statistical data provided by National Institute of Statistics (Fig. 6).

Fig. 6. Romania's honey yield in the period 2009-2018 (kg/bee hive)
Source: Own calculation based on the data from [15].

However, if we take into consideration Eurostat data, Romania registered 20 kg honey per bee hive, performance which placed it on the 18th position in the EU-28 (Table 5).

Table 5. Honey yield per bee hive in 2018 versus 2009 in the EU-28 top 20 producing countries (kg/bee hive)

2009			2018		
	EU-28 Average	18 kg/bee hive		EU-28 Average	22 kg/bee hive
Crt. No.	Country		Crt. No.	Country	
1	Finland	36.6	1	Finland	47.0
2	Germany	23.7	2	Germany	35.0
3	Estonia	23.2	3	United Kingdom	34.0
4	Portugal	21.6	4	Lithuania	30.0
5	Italy	20.4	5	Austria	30.0
6	Romania	20.0	6	Sweden	30.0
7	France	17.5	7	Estonia	26.0
8	Austria	16.9	8	Luxembourg	26.0
9	Sweden	16.6.	9	Belgium	25.0
10	Lithuania	15.8	10	Italy	25.0
11	Bulgaria	14.6	11	Latvia	22.0
12	Slovenia	14.3	12	Netherlands	22.0
13	Czech Rep.	13.8	13	France	21.0
14	Spain	13.5	14	Hungary	21.0
15	Hungary	13.4	15	Denmark	20.0
16	Latvia	12.6	16	Ireland	20.0
17	Greece	11.9	17	Croatia	20.0
18	Cyprus	9.8	18	Romania	20.0
19	Poland	9.7	19	Slovenia	19.0
20	Belgium	7.3	20	Bulgaria	17.0

Source: Own conception based on [3, 4].

However, compared to other EU countries whose honey yield per bee hive increased in the analyzed interval, in Romania yield performance remained unchanged at 20 kg per

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bee hive. This is explained by the unfavorable conditions Romania was facing in many of the last years due to the climate change.

Distribution of honey yield per bee hive in the territory of Romania

Honey yield is different from a region to another depending on the local conditions which reflect the real situation regarding the impact of climate change on production performance.

The highest average production per bee hive was 20.8 kg, recorded in Bucharest-Ilfov region, where there is the lowest number of bee hives, and the lowest honey production per bee family was 16.5 kg, registered in the Central region, where both the number of bee hives and honey production is decreasing. Therefore, it is a difference of 4.3 kg honey per bee hive between these two regions.

In the other micro regions of development, honey yield per bee colony was the following one in the decreasing order: 18.4 kg in North West, 17.7 kg in North East, 17.7 kg in West, 17.3 kg in South Muntenia, 16.7 kg in South East, and 16.6 kg in South West Oltenia.

In the period 2018 compared to 2008, honey yield per bee hive increased only in South Muntenia and Bucharest - Ilfov areas, while in the other regions: North West, Center, South East, South West Oltenia, and West decreased and in North East it remained constant (Table 6).

Table 6. Distribution of honey yield per bee hive by micro region of development in Romania in 2018 versus 2009 (kg/bee hive)

	2009	2018
Romania's honey yield (kg/bee family)	20.0	20.0
North West	18.7	18.4
Center	20.8	16.5
North East	17.7	17.7
South East	18.7	16.7
South Muntenia	16.4	17.3
Bucharest – Ilfov	18.9	20.8
South West Oltenia	19.9	16.6
West	19.7	17.7

Source: Own calculation based on the data from [15].

The concentration degree of the number of bee hives and honey production in Romania

All the indicators which have been presented above proved that in Romania it is a general trend of concentration regarding the bee hives and bee production, but a stagnation in honey yield justified by the negative impact of climate change and chemical treatments applied in agricultural crop cultivation.

However, using the well known Herfindahl-Hirschman Index, HHI, the results proved that in Romania the level of concentration of the number of bee hives is low as HHI was < 0.15 in almost all the years of the last decade, except the year 2017 when the index exceeded a little this threshold. In case of honey production, HHI was also < 0.15 reflecting a weak concentration in most of the years, except 2016 and 2017 when HHI was a little higher than 0.15 (Table 7).

Table 7. Dynamics of Herfindahl-Hirschman indices for the number of bee hives and honey production in Romania in the period 2009-2018

	HHI for the number of bee hives	HHI for honey production
2009	0.1399	0.14.10
2010	0.1393	0.1429
2011	0.14.04	0.1501
2012	0.1409	0.1492
2013	0.1446	0.1414
2014	0.1459	0.1491
2015	0.1437	0.1418
2016	0.1463	0.1515
2017	0.1535	0.1516
2018	1.2353	0.1436

Source: Own calculation.

For the EU-28, based on Eurostat data, the calculated values of this index for the number of bee hives was HHI = 0.0831 and for honey production HHI = 0.1342. If we compared these values with the ones registered in

Romania, we may conclude that in this case it is a little higher concentration in Romania than at the EU level.

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Comparatively concentration in the period 2009-2018 versus 2007-2016

Continuing the research started in 2017 regarding honey production in Romania, in this study the concentration of honey production was also approached based on the dynamics of the correlations coefficients, determination coefficients and regression equations in order to point out the differences achieved in the interval 2009-2018 compared to the period 2007-2016 [34].

The growth of honey production in the period 2009-2019 was proved by the higher ***values of the correlation coefficient*** between honey production and honey yield r = 0.603 compared to r = 0.585 in the period 2007-2016, and between honey production and the number of bee hives, r = 0.688 compared to 0.580 in the reference period.

But, between honey yield and the number of bee hives, it was found a lower value of the correlation coefficient, r = 0.161 in the period 2009-2018 compared to r = 0.314 in the interval 2007-2016. This reflected that the number of bee hives increased with a higher rate during the last ten years in comparison with honey production growth rate, which diminished honey yield (Table 8).

Table 8. Comparison regarding the correlation coefficients in the period 2009-2018 versus 2007-2016 for the three pairs of the main indicators characterizing honey production

Correlation between:	Correlation coefficient, r	
	2007-2016	2009-2018
-Honey production and honey yield	0.587	0.603
-Honey production and the number of bee hives	0.580	0.688
- Honey yield and the number of bee hives	0.314	0.161

Source: Own calculation.

The values of the determination coefficient were in general low reflecting a weak influence of the variation of the independent variable on the change of the dependent one.

In case of honey production as dependent variable on honey yield, R square showed that 34.5% of the variation of honey yield influenced honey production in the period 2007-2016, and in the period 2009-2018 it was noticed a slight increase at 36.3%.

The variation of honey production was also influenced in a small proportion by the change in the number of bee families, more exactly only 33.6% in the period 2007-2016, but in a higher proportion, 47.4% in the interval 2009-2018.

The determination degree of honey yield by the change in the number of bee families was the smallest one, In the period 2007-2016, only 31.4% of the variation of honey yield was caused by the change in the number of bee colonies, and in the period 2009-2018, the proportion declined to 2.61% (Table 9).

The regression equations also proved the evolution of the impact of the change in the independent variable on the change of the dependent one.

In case of honey production as dependent variable on honey yield, the regression equations showed that in the period 2009-2018 a change with one unit in honey yield could increase honey production by 1,129.31 units compared to only 913.66 units in the period 2007-2016.

The regression equations for honey production depending on the number of bee families reflected that in the period 2009-2018 a change with one unit in the number of bee hives could produce an increase by 15.515

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units in honey production compared to 12.466 units in the period 2007-2016.
Finally, the regression equations for honey yield reflected the negative impact of the number of bee hives in the both analyzed periods. In 2007-2016, an increase by one unit in the number of bee hives led to a decline by 0.0043 units in honey yield, while in the period 2009-2018 the decrease is a little smaller, 0.0019 units (Table 9).

Table 9. Comparison regarding regression equations and R square in the period 20092-108 versus 2007-2016 for the three pairs of the main indicators characterizing honey production

Regression of:	Period	Regression equation	R square	F	Sign. F
- Honey production depending on honey yield	2007-2016	Y = 913.66X + 5,647.44	0.345	4,213	0.0741
	2009-2018	Y = 1,129.31 X + 4,159.54	0.363	4,574	0.0648
- Honey production depending on the number of bee hives	2007-2016	Y = 1.466 X + 6,598.04	0.336	4,056	0.0787
	2009-2018	Y = 15.515X + 3,051.79	0.674	7,221	0.0276
- Honey yield depending on the number of bee hives	2007-2016	Y = - 0.00434X + 23.25	0.314	0.8769	0.3764
	2009-2018	Y = -0.00194X + 20.446	0.0261	0.2146	0.6555

Source: Own calculation.

How efficient is honey production in Romania compared to the EU-28 main producing countries?

Based on the data provided by Eurostat [3] for the top honey producing countries in the EU-28, we used the average production cost and average honey price for polyfloral honey in the period 2017-2018 at the apiary gate and calculated the profit or loss per kg of honey and the profit or loss per bee family in the year 2018. The results are presented in Table 10.
Romania has the lowest honey producer price at the apiary gate, Euro 2.25/kg ranking the country on the 28th position. To produce one kg of honey, an apiarist spent Euro 2.58 per kg, and for this level of production cost Romania occupied the 22nd position in the EU-28.
As a result, making the difference between price and cost it resulted a loss of Euro 0.33/kg, reflecting that honey production in Romania is not efficient, and for this result, the country came on the 24th position in the EU-28 [20, 22, 33].
In the period 2017-2018, at the EU level, average price for polyfloral honey varied between Euro 19.25/kg in Ireland, the highest level, and Euro 2.25/kg in Romania, the lowest one. Therefore, in Romania, average honey price is 3 times less than the EU average price which accounts for Euro 6.46/kg.
The average production cost varied at the EU level between Euro 10/kg in Belgium, the highest level, and Euro 2.58 in Romania, the lowest one, while the EU average production cost was Euro 3.90/kg.

Table 10. Profit/loss per kg honey and profit/loss per bee family carried out in the year 2018 by the beekeepers of EU-28 top honey producing countries

	Honey yield (kg/bee hive)	Average production cost (Euro/kg)	Average honey price at the apiary gate (Euro/kg)	Profit/Loss pe honey kg (Euro/kg)	Profit/Loss per bee family (Euro/bee hive)
Romania	20.0	2.58	2.25	-0.33	-6.60
Spain	9.92	2.73	6.50	+3.77	+37.40
Germany	32.08	6.90	6.22	-0.68	-21.81
Hungary	21.02	2.10	5.16	+3.06	+64.32
Italy	15.39	3.88	5.08	+1.20	+18.47
Poland	13.65	3.15	5.81	+2.66	+36.31
France	13.62	5.27	9.40	+4.13	+56.25
Greece	11.02	5.40	9.00	+3.60	+39.67
Bulgaria	15.07	1.31	3.52	+2.21	+33.30
Portugal	14.06	5.15	4.06	-1.09	-15.32

Source: Own calculation based on [3].

Profit per kg honey recorded the highest level in Ireland, accounting for Euro 12.25 and the lowest level was found in Italy, Euro 1.20.

Three EU countries registered losses. It is about Romania: Euro -0.33 per kg, Germany Euro -0.68 and Portugal Euro -1.09 per honey kg (Table 10).

However, this calculus is a hypothetical one, considering that profit comes exclusively from marketed polyfloral honey. But, we know that bee families produce carious types of honey depending on the flora variety they collected the nectar.

In Romania, about 25% of honey production is *Acacia* honey which has the highest price compared to polyfloral honey.

Many of the apiculturists are accustomed to practice direct delivery to loyal clients and in this case the price per honey kg could rage between Euro 5.15- 6.18, therefore 2-2.5 times higher than the average price of the polyfloral honey.

Only considering this solution, we could consider that beekeeping in Romania is a good deal and apiculture could be an attractive activity.

But, the climate change, extreme meteorological phenomena affected pickings, the treatments applied to agricultural crops killed a part of the number of bee families and reduced their power, with a negative impact on the honey production, honey yield per bee hive, in other words diminished the economic efficiency in beekeeping.

But this tragedy happened not only in Romania, other EU countries such as: France, Hungary, Italy, Greece were complaining of the damages recorded in beekeeping due to the factors mentioned above [41].

That is why subsidies and financial support by beekeeping development programmes are compulsory to sustain this sector to help apiculturists to procure powerful and high breeding value queens, new bee hives, bee swarms, modern equipment for honey extraction and honey bottling, to open shops and sell their products under local labels and trademarks. Innovation in apiculture has to be sustained like in all the other sector of agriculture in order to assure the sustainable development [8, 9, 10]. Romania has a high-quality honey which explains why Romanian honey is so much required on the EU market. But bulk sale at a price of about Euro 2-2.5 per kg is not efficient and it is not correlated with the exceptional quality of the product.

Table 11. Honey food balance sheet in Romania compared to the EU-28 top producing countries in 2017 versus 2016 (Thousand tons)

	Years	Production	Import quantity	Stock variation	Export quantity	Domestic supply quantity
Romania	2016	21	3	2	10	16
	2017	25	4	0	12	17
Spain	2016	31	29	-1	27	33
	2017	29	32	0	25	36
Germany	2016	22	84	-4	24	86
	2017	20	93	3	24	86
Hungary	2016	24	2	0	17	9
	2017	24	1	-2	22	5
Italy	2016	10	23	7	8	18
	2017	10	24	9	7	18
Poland	2016	19	24	0	14	29
	2017	17	26	0	16	27
France	2016	11	36	5	5	37
	2017	12	36	6	5	37
Greece	2016	21	3	4	2	18
	2017	22	6	6	3	19
Bulgaria	2016	10	2	2	9	1
	2017	12	2	- 1	13	2
Portugal	2016	14	6	4	7	9
	2017	11	7	2	7	9

Source: [6].

The insufficient promotion of honey, honey price higher than sugar price per kg in close relationship with the average income per household are factors which affect domestic consumption which is enough low compared to the one in the Western EU countries [36].

This is proved by Honey food balance sheet in Romania compared to the EU-28 top producing countries (Table 11).

The supply per inhabitant varies in the EU-28 top producing countries between 0.12 kg/capita/year in Poland and 1.59 kg in Greece. In Romania, honey supply is 0.75 kg/year/inhabitant (Fig. 7).

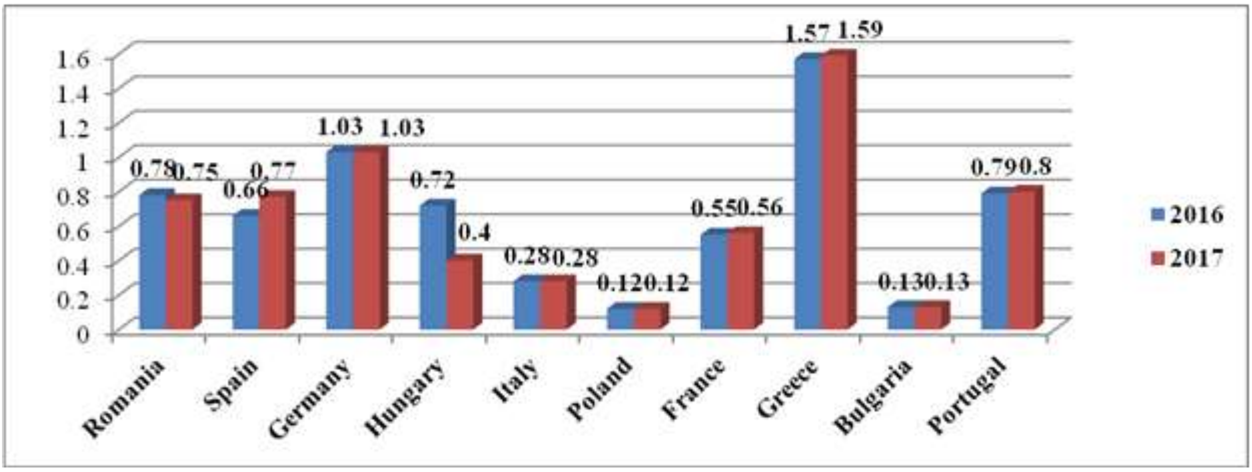

Fig. 7. Average honey supply per inhabitant and year in the EU-28 top producing countries (kg/capita)
Source: [45].

For this reason, the EU is an important honey importer from various countries, in 2018 the import value of the 208 thousand tons imported honey from outside of the EU was Euro 452 millions, being by 25 % higher than in 2013. The main importing countries are the ones where consumption is high and the offer is not balanced such as Germany, United Kingdom, Belgium, Poland and Spain. Despite that it has a higher production than consumption, Romania started to import honey a few years ago, but the quantities are enough small being around 3 tons. The main honey suppliers are China, Ukraine, Argentina, Mexico and Chile [7].

Also, the EU-28 exports honey, the amount sold in other countries accounting for 137,000 tone in 2018. The highest exporting countries being Hungary (14.5%), Belgium (13.8%), Spain (13.1%), Germany (11.6%), Poland (10.9%), Romania's export represent about 12 thousand tons (8.7%) meaning about 15 % of its production [11, 16, 17].

The export of honey is compulsory because of the impossibility as the Beekeepers Associations to pay the supermarket taxes and increase honey price at the shelf level which could affect in a higher proportion domestic consumption. The main beneficiary of the Romanian honey is Germany, and the increased competitiveness with honey provided by China, Ukraine, Argentina at a lower price causes major difficulties to the Romanian Beekeepers' Associations to export honey at a higher price corresponding to its high quality [2, 12]. Honey trade balance is a positive one, honey being among of the agricultural products for which exports are higher than imports and increase the efficiency of agro-food trade.

The access of Romania into the EU in 2007 had a beneficial impact on the whole economy, including agriculture and in beekeeping as well [24, 25, 29, 35, 36].

All these aspects reflect why beekeeping in Romania and in the EU has to be financially supported, first of all to cover the domestic market requirements and then to stimulate export.

CONCLUSIONS

The research results proved that in Romania the number of bee hives and honey production have substantially increased in the last decade, 2009-2018, while honey yield per bee family remained relatively at the same level of 20 kg/year.

In 2018, Romania had 1,689.5 thousand bee hives, for which the country is placed on the 2nd position in the EU-28, about 30,000 tons honey production for which it comes on the 1st position, the average number of bee hives per apiary is 80, for which the country is ranked the 3rd and 20 kg honey yield per year for which it is ranked the 18th.

Both the number of bee hives and honey production followed the same distribution in the territory: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, and 10.6% West. The only exception is Bucharest-Ilfov area with a share of 1.2%.

The highest honey yield per bee hive was achieved in Bucharest-Ilfov (20.8 kg), while the lowest one was registered in the Central area (16.5%).

In the period 2018 compared to 2009, honey yield per bee hive increased only in South Muntenia and Bucharest - Ilfov areas, while in the other regions: North West, Center, South East, South West Oltenia, and West decreased and in North East it remained stable.

However, it is important that honey production raised in all the regions.

Herfindahl-Hirshman indices reflected a low degree of concentration in Romania both for the number of hives and honey production.

The values of the mean for the number of bee hives and honey production were higher in the period 2009-2018 compared to the period 2007-2016. Also, the correlation and determination coefficients registered higher values for the pair of indicators: honey production and the number of bee hives and for the honey production and yield, while for the average yield and the number of bee hives the values were smaller.

Regression equations attested that honey production is in about 50% determined by the number of bee hives and in smaller proportion by honey yield.

Concentration of honey production is slowly running, but it is compulsory for better satisfying consumption of a healthy product, for maintaining beekeeping as an important sector for the pollination of the agricultural crops, the preservation of biodiversity and life on the Earth.

Beekeepers have to efficiently use the EU funding for strengthening this sector in the future in Romania's agriculture keeping pace with the increased competitiveness on the EU honey market.

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EWES AND GOATS' CONTRIBUTION TO THE EU-28 MILK PRODUCTION IN THE PERIOD 2010-2018

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Abstract

The paper analyzed the trends and relationships in the EU ewes and goats livestock and milk output in the period 2010-2018 based on Eurostat Data using the fixed basis index, descriptive statistics, average yearly growth rate, Bravais- Pearson correlation coefficients, determination coefficient and regression models. The results attested the important contribution given by the two species to the EU milk sector in order to diversify cheese varieties and stimulate consumption and export. While sheep livestock declined in general, and the goats population increased, ewes and goats' milk delivered to dairy industry increased. In the decreasing order, the main EU countries raising sheep are Spain, Romania, Greece, Italy and France, and the main countries growing goats are Greece, Spain, Romania, France, Italy and Netherlands. Raw milk production increased in case of the both species in many countries. Ewe milk is mainly produced in Greece, Spain, Italy and France, while goat milk is especially produced in France, Spain, Netherlands and Greece. The diverse policies, management and marketing and production performance from a country to another pointed out the need to improve farmers skills in resources, livestock and production management, to encourage them to join in associations to benefit of low-price inputs and a direct access to market. The coupled aids financed by the EU are incentives to sustain sheep and goat farming and dairy sector, farmers' income, the valorization of the natural resources, the development of the disadvantaged rural and peri-urban areas, animal health and welfare, environment quality and biodiversity, and the offer of organic dairy products to consumers.

Key words: *sheep and goats livestock, milk output, trends, relationships, European Union*

INTRODUCTION

Sheep and goats are an important resource for the development of sustainable animal production, for maintaining the specificity of the landscapes, for valorizing the plains, hilly and mountain resources, for assuring pastures and meadows management and land management to combat forest fires, for valorizing the cultural heritage in producing traditional products, for preserving the environment and biodiversity under the climate change, for tourism and rural tourism development, for assuring a better living standard for the rural population.

More than this the EU regulations issued during the last decade were destined to sustain farmers facing high costs to continue their profession and assure them incomes mainly in the disadvantaged, fragile rural and peri-urban areas, to assure animal health and welfare, to preserve the autochtonuous breeds and transhumance specific to these species, to stimulate the increase of livestock as long as since 1980 this lost about 25 million heads and increase production with a benefic impact on consumption of healthy meat and dairy products [3, 7, 13, 22, 27].

The attractiveness of the sheep and goat farming is justified by its advantages among which the most important are: the capability to adapt to various farming systems: extensive, semi-intensive, intensive and mixed, the ability to valorize the resources of grasslands, the fast and earlier rotation of live animals because of the specificity of reproductive activity, high breed diversity and genetic potential, the need of low capital goods (sheds, equipment etc.), low production cost compared to dairy farming, high-quality meat and dairy products [5, 18, 19, 20, 21].

The higher and higher interest for goats milk and especially cheese has led to a high growth in goats population which exceeds one billion at the global level. That's way in the EU, goats milk production and cheese-making are supported either in the traditional on-farm processing and in the industrialized sector, assuring high quality products and the best organized market for selling them [16, 17].

In 2015, the EU-28 had 98,587.99 thousand sheep and goats, of which sheep 87.32%.

Of the total number of animal farms existing in the EU, 850,000 (14%) are dealing with sheep growing, while 450,000 farms (7%) are raising goats. The average flock size is 113 sheep and 26 goats, but it varies from a country to another depending on farm and breed structure, market requirements, specializations and traditions.

Sheep and goats are grown for their economic importance in agriculture and rural areas for producing high value animal products with lower costs than dairy cows: meat, milk, cheese, and also wool and skins whose marketing could assure revenues for producers.

As self-sufficiency is lower than 100 dues to the decline in livestock caused by the infectious diseases and decoupled premium for sheep and goats, for covering the market needs, the EU is obliged to import sheep and goats mainly from New Zealand and Australia [1].

Sheep and goats meat is about 2% of the EU meat production, but in UK, Ireland and Greece it represents larger percentages varying between 8% and over 50 %.

Sheep and goats' milk accounts for about 3% of the EU milk output and delivered to dairies as dairy cows are the main supplier. The main milk producing countries in the EU are: Greece, Spain, France, Romania and Italy. Cheese, which is the principal product achieved of sheep and goats' milk, accounts for 9% in total cheese production and the main cheese producing member states are Spain, Italy, France and Greece [6, 33].

In this context, the purpose of the paper was to analyze the trends in the EU sheep and goats milk output delivered to dairies in the EU in close relationship with the dynamics of livestock in the period 2010-2018.

The expectations are that the measures taken by the EU Commission in 2014 sustained the sheep and goat sector for maintaining the traditional culture in eco-friendly sheep and goats farming, the beauty of the landscapes, for encouraging the young farmers to develop business in this sector and reduce migration, for satisfying better consumer's preferences for local natural products like milk and cheese.

MATERIALS AND METHODS

The paper analyzed separately the sheep and goats livestock, and also raw milk delivered to dairies by ewes and goats in the main countries growing these two species and giving an important contribution to the EU milk production.

The data were collected from Eurostat Data base both for livestock and milk production for the period 2010-2018.

The used methods in this study have been: (i)the fixed basis index, (ii)comparison method, (iii)descriptive statistics regarding: mean, standard deviation, coefficient of variation, (iv) average annual growth rate, (v) Bravais-Pearson coefficients of correlations, (vi) regression equations and (vii) coefficient of determination.

The results were graphically illustrated and included in tables and commented, and finally the conclusions ended this research work emphasizing the main aspects found.

RESULTS AND DISCUSSIONS

Sheep Population

According to the Eurostat Data updated at 18.05.2020, the sheep livestock in the EU-28 in the year 2015 accounted for 86,088.12 thousand heads. Unfortunately, for the year 2018 the data are not still updated, except for the countries which reported the situation.

The most important EU countries raising sheep are: Spain, Romania, Greece, Italy, France, Portugal and Bulgaria. Other countries such as: Croatia, Austria, Slovakia and Cyprus are growing a smaller number of sheep. In 2018, all these countries together had 53,754 thousand sheep (Fig.1).

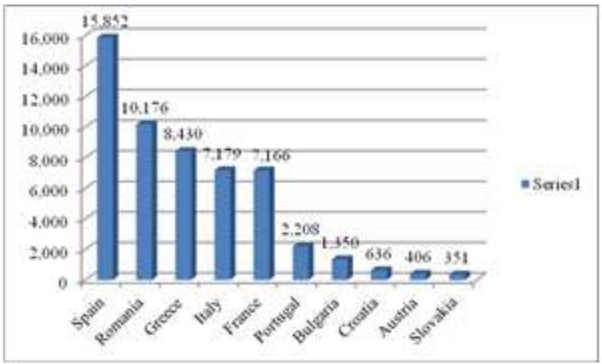

Fig.1. Sheep livestock in the main EU growing countries in 2018 (Thousand heads)
Source: Own design based on the data from Eurostat, 2020 [11].

The evolution of sheep population in the main EU raising countries in the period 2010-2018 was different from a country to another reflecting either a decreasing trend or an increasing one. The statistics showed that the sheep livestock registered a decreasing trend in the analyzed period in the following countries: in Spain by 14.6% from 18.5 million heads in 2010 to 15.85 million in 2018; in Greece by 14% from 9.79 million heads in 2010 to 8.43 million in 2018; in Italy by 9.2% from 7.9 million to 7.18 million, in France by 10% from 7.95 million to 7.15 million, in Portugal by 1% from 2.22 million in 2010 to 2.20 million in 2018, in Bulgaria by 1.4% from 1.36 million to 1.35 million, and in Slovakia by 11 % from 394 thousand heads in 2010 to 351 thousand heads in 2018.

In other countries the sheep population increased as follows: in Romania by 20.89 % from 8,41 million heads in 2010 to 10.18 million in 2018, in Croatia by 0.9% from 630 thousand heads to 636 thousand heads, and in Austria by 13.4% from 358 to 406 thousand heads (Table 1).

Table 1. Dynamics of sheep population in the main EU raising countries, 2010-2018 (Million heads)

	Spain	Romania	Greece	Italy	France	Portugal	Bulgaria	Croatia	Austria	Slovakia	Cyprus
2010	18.5	8.4	9.8	7.9	7.9	2.2	1.4	0.63	0.35	0.39	0.33
2011	17.0	8.5	9.7	7.9	7.6	2.2	1.4	0.63	0.36	0.39	0.35
2012	16.3	8.8	9.2	7.0	7.4	2.1	1.3	0.67	0.36	0.41	0.35
2013	16.1	9.1	9.3	7.2	7.2	2.1	1.3	0.62	0.35	0.40	0.31
2014	15.4	9.5	9.1	7.1	7.1	2.0	1.3	0.60	0.35	0.39	0.32
2015	16.0	9.8	8.8	7.1	7.0	2.0	1.3	0.60	0.35	0.38	0.32
2016	15.9	9.9	8.7	7.3	7.1	2.2	1.3	0.62	0.38	0.37	ND
2017	15.9	10.	8.6	7.2	6.8	2.2	1.3	0.63	0.40	0.37	ND
2018	15.8	10.2	8.4	7.2	7.1	2.2	1.3	0.63	0.41	0.35	ND
2018/ 2010 %	85.4	120.8	85.7	90.8	90.0	100	98.6%	109.0	113.4	99.0	-

Source: Own calculation based on Eurostat Data base, 2020 [11].
ND - No data.

The statistical parameters for sheep livestock in the top five EU countries are presented in Table 2. The mean sheep livestock in each country is representative, reflecting a homogenous population as long as the values of the variation coefficient is smaller than 10%.

In Spain, Greece, Italy and France the sheep population declined by a little more than 1% yearly.

Romania registered a high annual growth rate, + 2.31%, as sheep growing was encouraged by the transitory aid offered by the Romanian Government for sheep identification and registration for the farms with more than 50 female sheep of one year old, according to the EU Regulation No. 1307/2013 and the coupled aid from European Agriculture Guarantee Fund (EAGF) for the farms with 150-500 sheep [8, 9, 15, 24, 31].

Table 2. Statistical parameters: mean, standard deviation, variation coefficient and average annual growth rate for sheep livestock in the top five EU countries

	Spain	Romania	Greece	Italy	France
Mean (Thousand heads)	16,369.88	9,364.66	9,091.40	7,337.11	7,294.11
St. Dev.	923.53	656.34	490.21	338.89	327.95
Coefficient of variation (%)	5.64	7.00	5.39	4.62	4.49
Average annual growth rate in the period 2010-2018 (%)	-1.62	+2.31	-1.55	-1.02	-1.11

Source: Own calculations.

Goats population

In 2015, according to Eurostat, there were 12,499.17 thousand goats. For the year 2018, it is not yet displayed the goat livestock. However, the existing data reflect that the EU countries where goats are raised are: Greece, Spain, Romania, France, Italy, Netherlands, Portugal and Bulgaria. Smaller flocks are also grown in Cyprus, Germany, Austria, Croatia and Belgium. All these countries together had 11,608 thousand goats in 2018 (Fig.2).

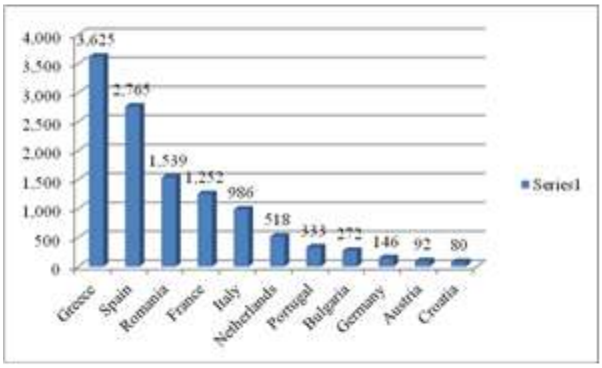

Fig.2. Goats livestock in the main EU growing countries in 2018 (Thousand heads)
Source: Own design based on the data from Eurostat, 2020 [10].

In the period 2010-2019, the evolution of the goats population varied from a country to another.

The following countries registered an increasing trend of the number of goats: by 24 % in Romania from 1,241 thousand heads in 2020 to 1.539 thousand heads in 2018, in Italy by 0.3 % from 983 thousand heads to 986 thousand heads, in Netherlands by 37.4 % from 377 thousand heads to 518 thousand heads, in Austria by 27.7 % from 72 thousand heads to 92 thousand heads and in Croatia by 6.6% from 75 to 80 thousand heads. In other countries the number of goats declined as follows: by 18.76% in Greece from 4,462 thousand heads in 2010 to 3,625 thousand heads in 2018, by 3.5% in Spain from 2,904 to 2,765 thousand heads, in France by 13.6% from 1,448 to 1,252 thousand heads, in Portugal by 20.5% from 419 to 333 thousand heads, in Bulgaria by 23.6% from 356 to 272 thousand heads, and in Germany by 2.7% from 150 to 146 thousand heads (Table 3).

Table 3. Dynamics of goats population in the main EU raising countries, 2010-2018 (Million heads)

	Greece	Spain	Romania	France	Italy	Netherlands	Portugal	Bulgaria	Cyprus	Germany	Austria	Croatia
2010	4.4	2.9	1.2	1.4	0.9	0.4	0.4	0.3	0.3	0.1	0.07	0.07
2011	4.3	2.7	1.2	1.4	0.9	0.4	0.4	0.3	0.3	0.2	0.07	0.07
2012	4.3	2.6	1.3	1.3	0.9	0.4	0.4	0.3	0.3	0.2	0.07	0.07
2013	4.4	2.6	1.3	1.3	1.0	0.4	0.4	0.2	0.2	0.1	0.07	0.07
2014	4.2	2.7	1.4	1.3	0.9	0.4	0.4	0.3	0.2	0.1	0.07	0.06
2015	4.0	2.8	1.4	1.3	1.0	0.5	0.4	0.3	0.2	0.1	0.07	0.06
2016	3.9	3.1	1.5	1.2	1.0	0.5	0.3	0.2	ND	0.1	0.09	0.08
2017	3.8	3.1	1.5	1.2	1.0	0.5	0.3	0.2	ND	0.1	0.09	0.08
2018	3.6	2.8	1.5	1.2	1.0	0.5	0.3	0.3	ND	0.1	0.09	0.08
2018/ 2010 %	81.24	96.5	124.0	86.4	100.3	137.4	79.5	76.4	-	97.3	127.7	106.6

Source: Own calculation based on Eurostat Data base, 2020 [10]. Note: ND- No data.

The statistical parameters for goats' livestock in the top six EU countries are shown in Table 4. The mean sheep livestock in each country is representative, reflecting a homogenous population as long as the values of the variation coefficient is smaller than 10%. The values of the variation coefficients below 10% reflect that in case of Greece, Spain, Romania, France and Italy the goats' population is homogenous, therefore, the means are representative, while in Netherlands where CV% is 13.52 % this reflects that the population of goats is relatively homogenous and the mean is relatively representative.

The annual growth rate was negative in case of Greece, Spain, France and Italy, while in Romania and Netherlands it had positive values, the annual increase being more than double in Netherlands compared to Romania. The incentives to stimulated the development of goats' sector in Romania came partially as a transitory aid from the Government and as a coupled aid from European Agriculture Guarantee Fund (EAGF) for the farms with 50-500 female and male goats [9, 15, 30, 32].

Table 4. Statistical parameters: mean, standard deviation, variation coefficient and average annual growth rate for goats' livestock in the top six EU countries

	Greece	Spain	Romania	France	Italy	Netherlands
Mean (Thousand heads)	4,110	2,807	1,382	1,287.55	968.22	450.88
St. Dev.	295.71	174.35	119.11	80.79	37.73	60.96
Coefficient of variation (%)	7.19	5.25	8.61	6.27	3.89	13.52
Average annual growth rate in the period 2010-2018 (%)	-2.08	-0.38	+2.66	-1.51	-0.03	+4.55

Source: Own calculation.

Ewes' milk production. The countries which produce the highest ewe milk output are Greece, Spain, Italy and France. In another group are included Cyprus, Portugal, Bulgaria and Romania, followed by Slovakia, Austria and Croatia which bring a smaller contribution to the EU ewe milk production (Fig.3).

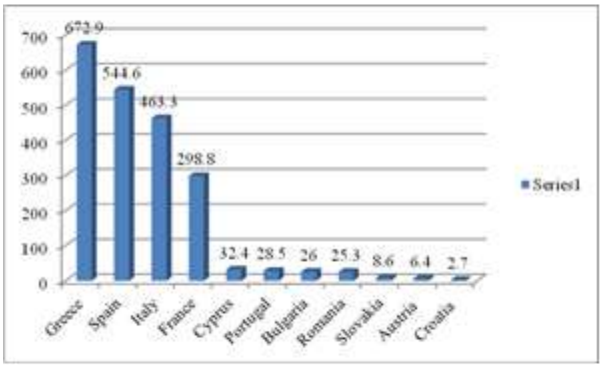

Fig.3.Ewes' milk production in 2018 in the main producing EU countries (Thousand tons)
Source: Own design based on the data Eurostat, Data Base, 2020 [12].

Looking at Fig.1, we may easily notice that in 2018, all these 11 countries produced together 2,109.5 thousand tons milk, of which 93.8 % that is 1.979.6 thousand tones is achieved by four countries: Greece, Spain, Italy and France, meaning 15.23 times more than all the other 7 countries.

Milk produced by ewes and delivered to dairies increased in almost producing countries, except Bulgaria and Croatia.

The milk output growth in the period 2010-2018 was: + 77.2 % in Cyprus, +72.4% in Austria, + 62.5% in Slovakia, + 53.9% in Romania, + 44.1 in Spain, +22.4% in Greece, + 22.3 % in Portugal, +12.4% in France, + 7.2 % in Italy (Table 5).

From an economic point of view, sheep are grown in the EU for milk, meat, and in a few member states for wool.

Milk is important for producing cheese and meat has become also important during the last years due to high demand on the Arab market [2, 4, 23, 25, 26].

The statistical parameters for ewes' milk in the top five EU countries raising sheep reflect a high production performance in Greece, Spain, Italy and France, varying between 566.97 thousand tons per year in Greece and 277.09 thousand tons per year in France.

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Table 5. Dynamics of ewes' milk production in the main EU producing countries, 2010-2018 (Thousand tons)

	Greece	Spain	Italy	France	Cyprus	Portugal	Bulgaria	Romania	Slovakia	Austria	Croatia
2010	549.7	378.0	432.2	265.9	18.3	23.3	30.2	16.4	5.3	3.7	2.8
2011	518.6	368.7	419.5	272.1	18.6	21.7	23.4	14.3	4.8	3.9	2.8
2012	496.3	363.5	406.2	269.7	18.1	24.3	25.2	15.8	5.1	4.7	2.9
2013	519.5	368.4	383.8	262.8	16.4	24.2	25.1	18.1	5.6	4.6	2.7
2014	540.4	456.7	372.5	266.0	22.1	23.9	26.1	27.3	7.3	4.2	3.0
2015	548.3	538.2	397.5	271.1	23.6	26.4	19.5	29.7	6.6	5.4	2.8
2016	606.2	539.4	424.8	292.5	28.8	28.3	22.5	32.8	7.1	4.7	3.1
2017	650.9	514.2	427.4	294.8	32.3	28.4	36.3	29.8	6.9	5.8	2.8
2018	672.9	544.6	463.3	298.8	32.4	28.5	26	25.3	8.6	6.4	2.7
2018/ 2010 %	122.4	144.1	107.2	112.4	177.2	122.3	86.1	153.9	162.5	172.4	98.5

Source: Own calculations based on the data from Eurostat, Data Base, 2020 [12].

Despite its high sheep population for which Romania came on the 2nd position in the EU, production performance was very small just 23.3 thousand tons per year in the analyzed period. This is due to low production potential of the local breeds, the small herd size per farm and farm structure, low forage resources mainly in the recent years with long period of drought, the extensive growing system largely used and the existence of disadvantaged areas [30].

The coefficients of variation registered low values below 10 % in case of France, Italy and Greece reflecting a homogenous production in the analyzed interval and that the means are representatives. In case of Spain, the variation coefficient was 18.28 reflecting a relatively homogenous production, and in case of Romania the variation coefficient had a high value, CV =30.55 %, meaning that the ewes' production varied very much, and the mean is not representative (Table 6).

Table 6. Statistical parameters: mean, standard deviation, variation coefficient and average annual growth rate for ewes' milk delivered to dairies in the top five EU countries based on sheep livestock

	Spain	Romania	Greece	Italy	France
Mean (Thousand tons)	452.42	23.30	566.97	414.15	277.09
St. Dev.	82.74	7.12	61.99	27.52	14.08
Coefficient of variation (%)	18.28	30.55	10.93	6.64	5.08
Cumulated raw milk, 2010-2018 (Thousand tons)	4,071.79	209.73	5,102.8	3,727.39	2,493.85
Average annual growth rate (%)	+4.90	-1.54	+2.48	+0.80	+1.37

Source: Own calculation.

Goats' milk production. The highest amount of goat milk is produced by three EU countries: France, Spain, Netherlands and Greece, which all together achieved 1,451.39 thousand tons in the year 2018.

Table 7. Dynamics of goats' milk production in the main EU producing countries, 2010-2018 (Thousand tons)

	France	Spain	Netherlands	Greece	Belgium	Italy	Cyprus	Portugal	Romania	Germany	Austria	Bulgaria	Croatia
2010	531.2	337.8	178.9	151.6	8.5	24.9	17.9	12.2	3.9	ND	8.8	4.6	4.2
2011	547.0	315.5	190.2	132.6	9.0	23.7	21.8	13.5	3.4	ND	11.8	4.9	4.3
2012	506.8	302.4	212.7	114.5	9.5	27.9	20.1	12.7	4.7	12.6	12.6	7.1	4.3
2013	468.5	295.0	227.3	123.0	9.3	27.5	18.3	13.1	7.1	13.2	11.8	7.2	3.6
2014	471.2	372.4	239.6	128.7	12.5	28.5	21.9	14.0	15	13.5	12.3	8.2	3.5
2015	474.9	467.82	257.0	129.7	45.6	33.2	23.1	16.1	16.8	13.3	12.1	8.3	3.7
2016	484.2	435.4	289.0	141.8	55.8	31.7	23.2	18.0	18.3	14.6	11.8	10.7	4.0
2017	484.4	491.4	315.0	149.5	69.6	37.1	30.4	21.9	17.9	15.3	12.6	12.1	4.2
2018	497.5	461.4	340.0	152.5	69.4	43.4	29.8	21.7	16.1	15.5	14.6	9.00	4.3
2018/ 2010 %	93.6	136.5	190.0	100.6	817.1	174.2	165.7	178.0	412.8	122.8	165.6	194.4	102.1

Source: Own calculation based on the data from Eurostat, Data Base, 2020 [12]. Note: ND-No data.

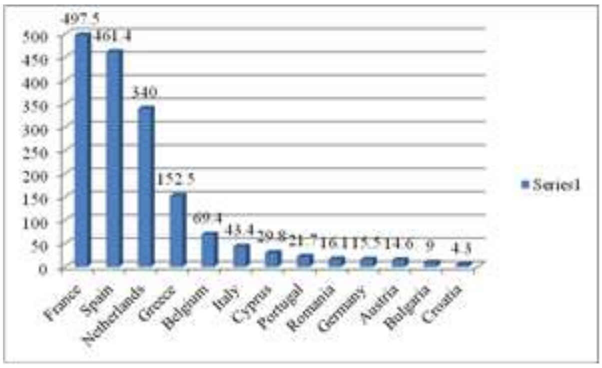

Fig.4. Goats' milk production in 2018 in the main producing EU countries (Thousand tons)
Source: Own design based on the data Eurostat, Data Base, 2020 [12].

In the analyzed interval, almost the producing goat milk registered an important increase of production, except France where milk output declined by 6.4%.

The growth rate varied between 0.6 % in case of Greece and 717.1 % in case of Belgium (Table 7).

The other group of producing countries includes, in the decreasing order of output level, the following countries: Greece, Belgium, Italy, Cyprus, Portugal, Romania, Germany, Austria, Bulgaria and Croatia, which all together carried out only 223.77 thousand tons, that is 6.48 times less than the top four countries (Fig.4.).

The statistical parameters for goats' milk in the top six EU countries raising goats reflect a high production performance in France, Spain, Greece, and Netherlands, varying between 496.25 thousand tons per year in France and 135.98 thousand tons per year in Greece. Despite the high goats livestock raised in Romania and its fast increase mainly in the last years with a benefic impact on production, the milk output level is still small, only 11.47 thousand tons per year, far away from the one recorded by the other EU countries mentioned above [30].

In France where goat sector is very well developed and consolidated along the milk chain the variation of production was small, as reflected by the variation coefficient, CV%= 5.52%. In Greece, CV%= 9.95%, also reflecting a representative mean and small production variation. In Spain and Italy the variation coefficients were about 20% showing a relative homogenous milk production, but in Romania the CV% = 56.75% meaning a completely heterogenuous milk performance in the analyzed period. Like in case of ewes' milk production, goats' milk performance depended on the sheep breeds and their potential, the extensive system of goats raising largely extended, and mainly on the forage resources which could not be assured at the required level due to the severe droughts. But, during the last five years, the livestock and production increased as a result of the aids coming from the EU funds (Table 8).

Table 8. Statistical parameters: mean, standard deviation, variation coefficient and average annual growth rate for goats' milk delivered to dairies in the top six EU countries based on goats livestock

	Greece	Spain	Romania	France	Italy	Netherlands
Mean (Thousand tons)	135.98	386.56	11.47	496.25	30.88	249.97
St. Dev.	13.54	77.98	6.51	27.44	6.26	55.37
Coefficient of variation (%)	9.95	20.17	56.75	5.52	20.27	22.15
Cumulated milk output, 2010-2019 (Thousand tons)	1,223.9	3,479.1	103.22	4,466.24	277.99	2,249.79
Average annual growth rate (%)	+0.06	+4.05	+34.75	-0.71	+8.24%	+10 %

Source: Own calculation.

The share of sheep and goat raw milk delivered to dairies in Total milk collection

In the EU-28 total milk collection, dairy cows are the main contributors, accounting for about 97%. In 2018, the EU raw milk production accounted for 172.2 million tons, of which about 12.2 million tons were used on farms by the farmer's family or directly sold to clients, and the remaining of 160 million tons were delivered to dairies, and of this amount 156 million tons were produced by dairy cows and the rest by other specie including ewes, goats and buffalos [28, 29].

The contribution of various species to the EU milk production in 2018 was the following one: 96.81% cow milk, 1.62 % ewe milk, 1.33 % goat milk and 0.24 % buffalo milk [12].

The EU contributes by about 17% to the world goat milk output grace to its high yields per goat [22].

The analysis presented above proves that there are several countries in the EU raising sheep and goats for producing milk and the hierarchy based on the performance in raw milk delivered to dairies has been already shown.

Based on these figures, it was determined the share of raw milk produced by ewes and goats in the total raw milk delivered to dairies.

Despite that ewes' and goats' contribution to total raw milk looks to be small, it is increasing year by year in almost all the countries raising these species.

The highest contribution to milk production is given in Greece where the share of ewes and goats is 44.91 % and respectively 10.18% in total raw milk output. On the 2nd position is Cyprus with 11.1 % for ewes' milk and 10.18 % for goats' milk. Ewes have also an important share in total raw milk delivered to dairies in: Italy 3.74%, Bulgaria 3.64%, Romania 1.82 %, France 1.16%.

Goats are also important in milk production contributing to total raw milk by: 2.29% in Netherlands, 1.94% in France, 1.36% in Belgium, 1.26 % in Bulgaria, 1.16% in Romania, 0.43 % in Austria and 0.35% in Italy (Table 9).

Table 9. The share of ewes' and goats' milk in the total raw milk produced in the EU-28 in the year 2018

	Total raw milk delivered to dairies (1,000 Tons)	of which:			Share in total raw milk		
		Ewes' milk	Goats milk	Ewes' and Goats' milk	Ewes' milk (%)	Goats' milk (%)	Ewes' and Goats' milk (%)
Belgium	5,088.13	-	69.37	69.37	-	1.36	1.36
Bulgaria	712.50	26.0	9.0	35.00	3.64	1.26	4.91
Germany	ND	-	15.52	15.52	-	-	-
Greece	1,498.30	672.9	152.5	825.40	44.91	10.18	55.09
Spain	ND	544.64	461.38	1,006.02	-	-	-
France	25,639.67	298.8	497.51	796.31	1.16	1.94	3.10
Croatia	ND	2.74	4.26	7.00	-	-	-
Italy	12,384.22	463.35	43.44	506.79	3.74	0.35	4.09
Cyprus	292.09	32.40	29.76	62.16	11.1	10.18	21.28
Netherlands	14,872	-	340	340	-	2.29	2.29
Austria	3,379.53	6.38	14.56	20.94	0.19	0.43	0.62
Portugal	ND	28.55	21.72	50.27	-	-	-
Romania	1,285.19	25.25	16.14	41.39	1.82	1.16	3.22
Slovakia	ND	8.60	-	8.60	-	-	-

Source: Own calculations based on the data from Eurostat Statistics Explained, [12].
ND- No available data.

In the EU sheep and goat farming is a complementary source of raw milk which could be processed either on farm using traditional manufacturing methods or in industrialized units for obtaining various sorts of cheese which are preferred by consumers in many of the member states, but also are required on the international markets.

However, there are difference among the producing countries regarding the milk and cheese chain which result in various level of performance in production, product quality and efficiency.

However, most of the products achieved from ewes and goats' milk are natural products, of high quality, are obtained under the safety and hygiene and animal welfare regulations which assure a good image in the consumer's eyes and contribute to the decision to purchase and consume them.

In France, Spain, Greece, Italy, Netherlands, the milk and cheese chain is very well organized and efficient, there are well known brands such as "Feta cheese" carried out in Greece, "Pecorino cheese" in Italy, which are successfully consumed in the EU market and not only. In many countries, various sorts of cheese have a protected origin attested by PDO label which is a guarantee of the product quality and safety [14].

The relationships between milk production and sheep and goats' livestock in the EU main growing countries

In case of sheep milk sector

The values of the coefficients of correlation reflect that between the sheep population and milk production available for dairies exists a positive and strong relationship mainly in Romania, r = 0.890, and Greece, r = 0.771, a positive and medium connection in Spain r = 0.545 and France r = 0.492 and a positive but weak link in Italy, r = 0.281.

Therefore, in case of the countries with a high value of correlation coefficient like Romania and Greece, ewes' milk production depends in a higher proportion on the number of sheep, more exactly of ewes, while in the other countries France, Spain and Italy, milk output depends much more on other factors such as: yield level, growing system, feeding quality, flock size per farm.

The value of the coefficient of determination confirms the above affirmation and shows that in Romania 79.3 % and in Greece 59.5% of the variation in the ewes' milk output depends in a higher measure on the number of sheep. In the other three countries, the change in the ewes' milk production is determined in a lower proportion by sheep livestock, more exactly: 29.7 % in Spain, 24.2 5 in France and only 7.9 % in Italy.

The regression equations reflect that an increase by one thousand heads in sheep livestock will lead to:

- a decline in milk output by 0.0488 thousand tons in Spain, by 0.0975 thousand tons in Greece and by 0.0211 thousand tons in France;
- an increase in milk production by 0.0228 thousand tons in Italy and by 0.0096 thousand tons in Romania (Table 10).

Table 10. Relationships between raw milk production delivered to dairies and sheep and goats' population in the main EU growing countries

Country	Regression model	R^2	r	F	Sign. F
Relationship between ewes' milk production and livestock					
Spain	Y = -0.0488 X +1,251.57	0.297	0.545	2,961	0.1289
Romania	Y= 0.0096 X -67.1528	0.793	0.890	26.87	0.00127
Greece	Y= -0.0975 X + 1,454.09	0.595	0.771	10.302	0.0148
Italy	Y= 0.0228 X +246.629	0.079	0.281	0.601	0.4635
France	Y= -0.0211 X+ 431.179	0.242	0.492	2.235	0.1784
Relationship between goats' milk production and livestock					
Greece	Y = -0.0243X +236.15	0.283	0.532	2.765	0.1402
Spain	Y = 0.3003 X -456.421	0.455	0.675	5.8666	0.0459
Romania	Y =0.0526 X - 61.35	0.927	0.962	89.3318	3.1005
France	Y = 0.2709 X + 147.40	0.636	0.797	12.2363	0.0100
Italy	Y =0.0569 X -24.25	0.117	0.342	0.9328	0.3663
Netherlands	Y = 0.8750 X -144.57	0.928	0.963	90.5731	2.9605

Source: Own calculation.

In case of goats milk sector

The relationship between livestock and milk production is a positive and very strong one as attested by the values of the correlation coefficients in Netherlands r = 0.963, Romania r = 0.962, France r = 0.797, Spain r = 0.675, a positive and medium relationship in Greece, r = 0.532, and a positive and weak connection in Italy, r = 0.342.

The same aspect is confirmed by the determination coefficient whose values showed that the variation in goats' milk production is influenced by the variation in goats livestock as follows: 92.8% in Netherlands, 92.7% in Romania, 63.6% in France, 45.5 % in Spain, 28.3 % in Greece and 11.7% in Italy. Obviously, the difference up to 100% of variation is given by the change of other factors peculiar to each country.

The regression equations reflected that an increase of the number of goats by one thousand will:

- decline milk production by 0.0243 thousand tons in Greece;
- increase milk output by 0.8750 thousand tons in Netherlands, by 0.2709 thousand tons in France, by 0.3003 thousand tons in Spain, by 0.0569 thousand tons in Italy and by 0.0526 thousand tons in Romania (Table 10).

CONCLUSIONS

The analysis proved that sheep and goats have an important economic role in the EU agriculture, more exactly in the dairy sector as confirmed by the increased contribution to milk production in order to diversify cheese offer and satisfy better consumers' needs and create availabilities for export.

While sheep livestock is diminishing in the main growing countries, the goats population has a fast growing.

The main countries dealing with sheep farming are Spain, Romania, Greece, Italy and France, while the main member states growing goats are: Greece, Spain, Romania, France, Italy and Netherlands.

Both ewes' and goats milk production increased in general in various proportions from a country to another, with a few exceptions.

The main producing countries of ewes' milk are: Greece, Spain, Italy and France, while the main countries producing goat milk are: France, Spain, Netherlands and Greece.

The regulations approved by the EU Parliament during the last decade have been real incentives to sustain sheep and goat farming and dairy sector, to maintain employment and incomes of the farmers, the beauty of the landscapes, biodiversity, animal health and welfare, environment quality and the offer of healthy organic dairy products to consumers.

However, the adopted policies regarding sheep and goats sector management and market have a large variability from a country to another. It is very important as farmers to have high skills to be able to assure a sustainable resources, livestock and production management and benefit of a direct access to markets. Producers associations play an important role in providing low price farm inputs, in accessing the technical services, and in sustaining the delivery of the final products in the market to benefit of the increasing demand.

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SILK TRADE IN THE EUROPEAN UNION: TRENDS IN THE PERIOD 2010-2019

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Abstract

The paper analyzed in the EU silk export, import and trade balance in the period 2010-2019 pointing out the main tendencies and the role and position of the major "actors" in silk commercial transactions. The data provided by International Trade Center were processed using the fixed basis index, descriptive statistics, average annual growth rate, and trend method based on regression models. The results showed that the EU-28 is the most important importer and consumer of raw silk and also the top exporter of textiles and fashion products worldwide. However, the silk export and import values declined at the EU level and also in the top 10 countries "players" in the silk market. The countries with the major impact on the silk export and import in the EU are, in the decreasing order: Italy, Romania, France, United Kingdom and Germany whose market share represented 94.32% in the EU export and 86.9 % in the EU import in the year 2019. A lower market share in case of silk import have Bulgaria, Slovenia, Portugal, Spain and Austria as well. China and India are the main suppliers of raw silk and other silk products for the EU, but also Vietnam and Thailand. The EU developed a new clustering strategy enlarging the geographical area where silk products could be produced cheaper, the workforce could be more efficiently used increasing productivity and sales in the silk products market. In this way, raw silk could be provided locally preventing a possible decline of China supply.

Key words**:** *silk, export, import, trade balance, trends, EU-28*

INTRODUCTION

Silk has always been a high value natural fiber, a suitable raw material for producing high quality fabrics and clothes and many other things that humans created for having a better life.
Despite that synthetic fibers dominate the textile and clothes market due to their low production cost, silk is maintaining its position as "Queen of textiles" being a pleasant, fine, delicate, resistant, shining, luxury fiber which confer an elegant appearance to the final products [2, 36, 39, 40]. Mulberry silk dominates production, consumption and international trade, but there are also other sorts of silk such as eri silk, tasar silk, muga silk which are used for various purposes.
Mulberry silk has the most important share in total silk production as it has a large variety of uses: textiles such as silk, deluxe, satin, chiffon, chinnons, crep, broacarde, also clothes such as: scarves, ties, blouses, shirts, skits, dresses, suits, jerkins, socks many of them being carried by well known designers. But silk is also used for producing elegant carpets, furniture covers, draperies, pillow and sofa covers, bed sheets, wall sheets etc [8, 10, 15, 28].
The increasing demand of silk textiles and clothes has led to silk price growth with a positive impact on the development of silkworms growing, silk cocoon and raw silk output in more than 60 countries and also of international trade with silk [3, 26].
Silkworms growing and silk industry stimulate business in small sized enterprises,

require a low capital investment and production processes which are environmentally friendly assuring a sustainable development. Therefore, they are important sources of jobs and income which improve the living standard of the population mainly in the rural areas, limiting migration to the cities [27, 39].

In 2018, the world silk production accounted for 159,649 metric tons. However, silk keeps just 0.2 % of the global textile production, the major producers being in Asia: China, India, Uzbekistan, Vietnam, Thailand, Korea, Japan, followed by South America: Brazil and Columbia [9, 10, 35, 41, 43]. Europe has been for many years the 2nd important silk producer after Asia, but nowadays, it is major silk importer and consumer after the USA.

However, due to the dramatic silk price growth along its chain till the final product, silk demand has changed being oriented to other substitute textiles. As a consequence, a few European countries such as: Italy, France, Germany, United Kingdom and Switzerland have become silk converters. But, the major producer, supplier and consumer of silk and silk products remains Asia. The geographical distribution of silk production and consumption has intensified silk international trade, which is run under the International Trade Rules for Raw Silk (ITR), adopted by ISA Congress in 1997.

The commercial transactions with silk are based on a contract concluded between seller and buyer under ITR as stipulated in the contract clause. These ITR provisions are also applicable to any silk transactions specified in national and transnational agreements [7, 24].

In this context, the purpose of the paper was to analyze the dynamics of the EU silk export and import, as well as trade balance in the last decade, 2010-2019, emphasizing the role and position of the major member states, as "players" in silk international trade.

MATERIALS AND METHODS

Data collection

The statistical data used in this study were picked up from international data bases such us: International Trade Center and International Sericicultural Commission for the last decade, more exactly for the interval 2010-2019 [10, 7].

The main indicators approached in this research have been the following ones:

-silk export, silk import and trade balance at the global level;

- silk export, silk import and trade balance at the EU-28 level;

- silk export, silk import and trade balance in the top 10 EU countries.

-the share of the EU silk export and import in the world silk export and import

-the share of the top EU countries in the EU-28 silk export and import.

Methodology

The main methodological procedures included:

Index method, in its variant, Fixed basis Index, offered the opportunity to examine the dynamics of the indicators in the period 2010-2019. In this case, it was utilized the formula: $I_{t/t0} = (X_t/X_0)100$, where X_t is the level of the indicator X in the last year of the analysis, i.e. 2019, and X_0 is the level of the same indicator X in the first year of the analysis, i.e. 2010.

The market share of a country in the EU export or import value was established using the formulas:

$S_{E\%}= (E_i/E)100$ in case of the export structure, where E_i is the export value of the country i, where i= 1, 2,...10, and E is the EU silk export value.

$S_{I\%}= (I_i/I)100$ in case of the import structure, where I_i is the import value of the country i, where i= 1, 2,...10, and I is the EU silk import value.

The trend method was used to identify the main tendencies in silk export, import and trade balance at the EU level using suitable mathematical models like polynomial equations. The results were explained and commented and presented in tables and graphics. Finally, the corresponding conclusions were drawn.

RESULTS AND DISCUSSIONS

Global Silk Production

Silk production at the global level after a continuous increase till the year 2015, when it reached 202,072.83 metric tons, it entered in a decline so that in 2018, its level accounted for 159,648 metric tons, being by 21 % smaller than in 2015 (Fig.1).

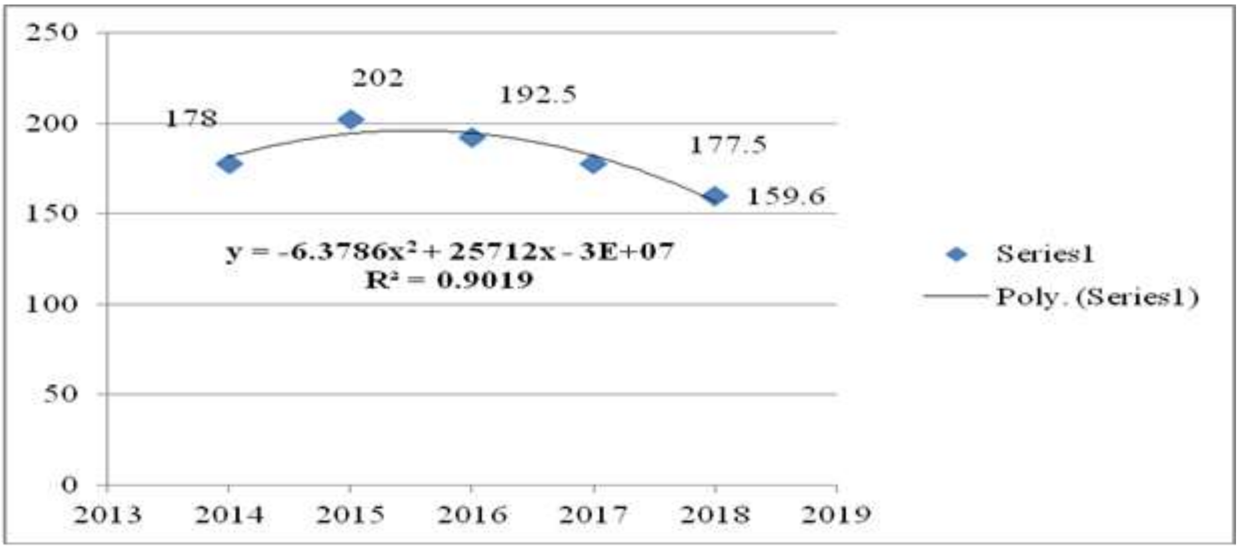

Fig. 1. World raw silk production, 2014-2018 (Thousand metric tons)
Source: Own design based on the data from [10].

In 2018, the highest raw silk production was registered by China, 120,000 metric tons representing 75.16% of the global production and by India, 35,261 metric tons, meaning 22.08 %. Therefore, these two countries are the top silk producers worldwide, all together having 97.24% market share. Other countries have a much smaller contribution to the global silk output; Uzbekistan (1.12%), Vietnam (0.42%), Thailand (0.42%), Brazil (0.41%) and North Korea (0.21).

The figures give above reflect that the EU is not among the world producers of silk, in this field its performance is far away from being competitive. In fact the EU is a top importer and consumer of silk, and also an exporter of final silk products

This happened because of the price growth along the product chain and the pressure of the other natural fibres like cotton and synthetic fibres which have a lower price per final product and determined some changes in consumer' s behaviour [10, 22, 26].

However, the decline in silk production did not affect so much the farmers dealing with silkworms growing because besides silk, a large range of by-products and wastes resulting from this field of activity has an important economic value as well. It is about: defective cocoons (double, pierced, perforated cocoons) which are used for producing fancy silk fabrics, dead and dried pupae are used as feedstuff for fishes and fertilizer, larval dejections are also good fertilizers, mulberry leaves, roots and wood are used as biomass, mulberry fruits are processed in food industry. Therefore, sericiculture is not only a source of silk, but also of many other secondary products which could be successfully used in pharmaceutical, cosmetic, cellulose and food industry. These new opportunities for a better valorisation of sericicultural products could help this field of activity to become more efficient and profitable [1].

World and the EU-28 Silk export

Following the decline in silk production at the global level, silk export registered a decrease by 415 in the last decade. The export reached USD 1.93 Billion in 2019 compared to USD 3.26 Billion in 2010. In the EU, it was noticed a similar decreasing trend, but the decline was not so severe, accounting for only 21.33%. In 2019, the EU-28 silk export value accounted for USD 550 Million compared to USD 700 Million in 2010 (Fig. 2 and Fig. 3).

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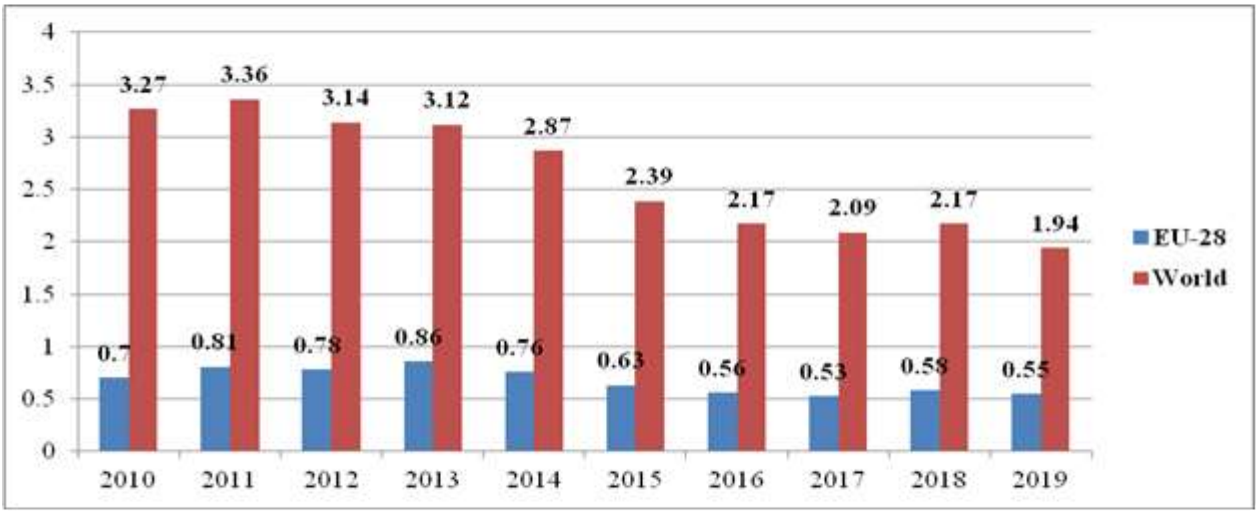

Fig. 2.Dynamics of silk export value at the global and the EU-28 level, 2010-2019 (USD Billion)
Source: Own design based on the data from [11, 12].

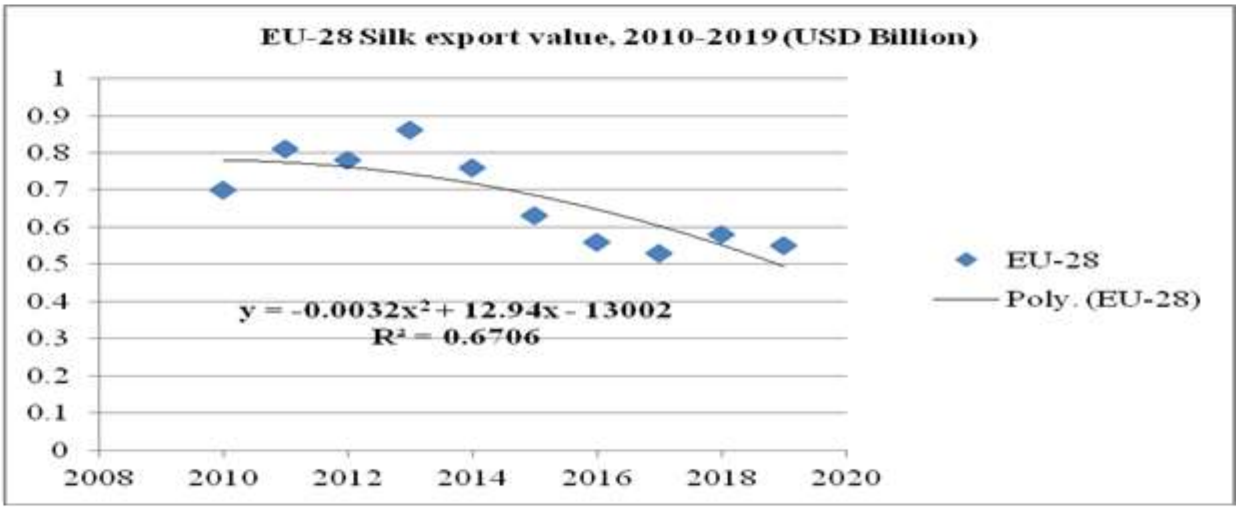

Fig. 3.Silk export value trend in the EU-28, 2010-2019 (USD Billion)
Source: Own design based on the data from [12].

The average annual decline rate in the EU-28 was -2.13%, representing 50% of -4.07% at the global level. As a consequence, the market share of the EU-28 silk export in the world silk export increased from 21.42% in 2010 to 28.40% in 2019.

World and the EU-28 Silk import

The value of silk import also declined at the global level from USD 2.48 Billion in 2010 to USD 1.75 Billion in 2019, meaning -29.75% less, at an average annual decline rate of -2.97.

In the EU-28, the silk import value has also decreased but in a lower proportion. In 2019, the EU import accounted for USD 0.66 Billion compared to USD 0.80 Billion in 2010, meaning by 17.715 less, at an average annual decline rate of -1.77% (Fig.4 and Fig.5).

Position of the EU countries in the EY and World silk export and import value in 2019

In 2019, the main EU-28 silk exporting countries were: Itlay, Romania, France, United Kingdom, and Germany which come on the top 5 positions. They are followed by Slovenia, Belgium, Austria, Spain and Lithuania.

Of these countries, the first five silk exporters of the EU are among the top 10 exporting countries in the world, Italy occupying the 2nd position after China, Romania the 4th position, France the 6th position, United Kingdom the 9th position and Germany the 10th (Table 1).

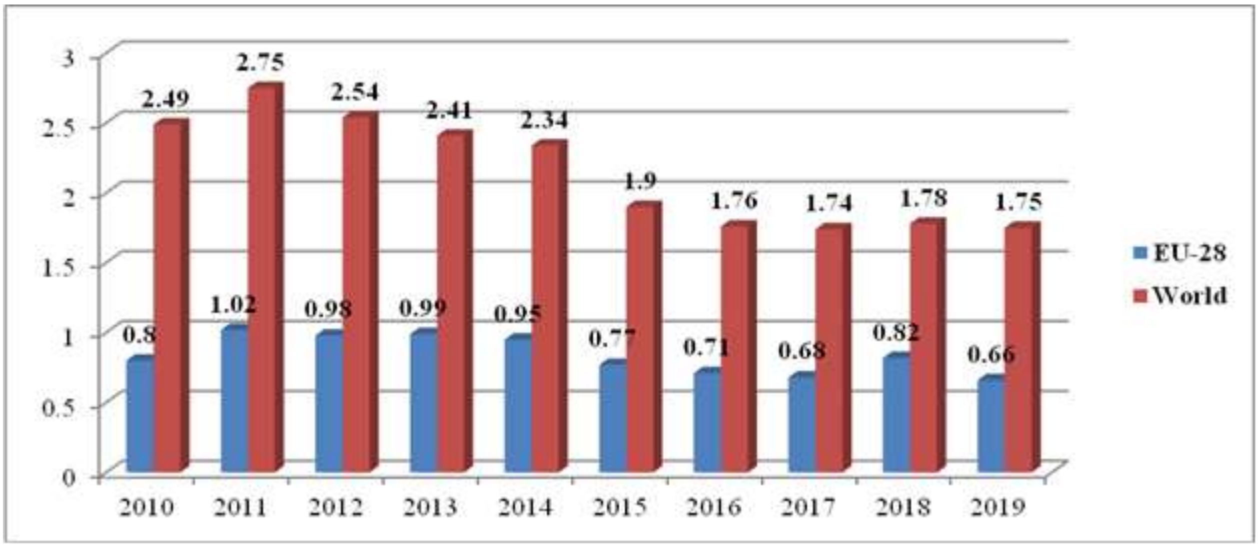

Fig. 4. Dynamics of silk import value at the global and the EU-28 level, 2010-2019 (USD Billion)
Source: Own design based on the data from [13].

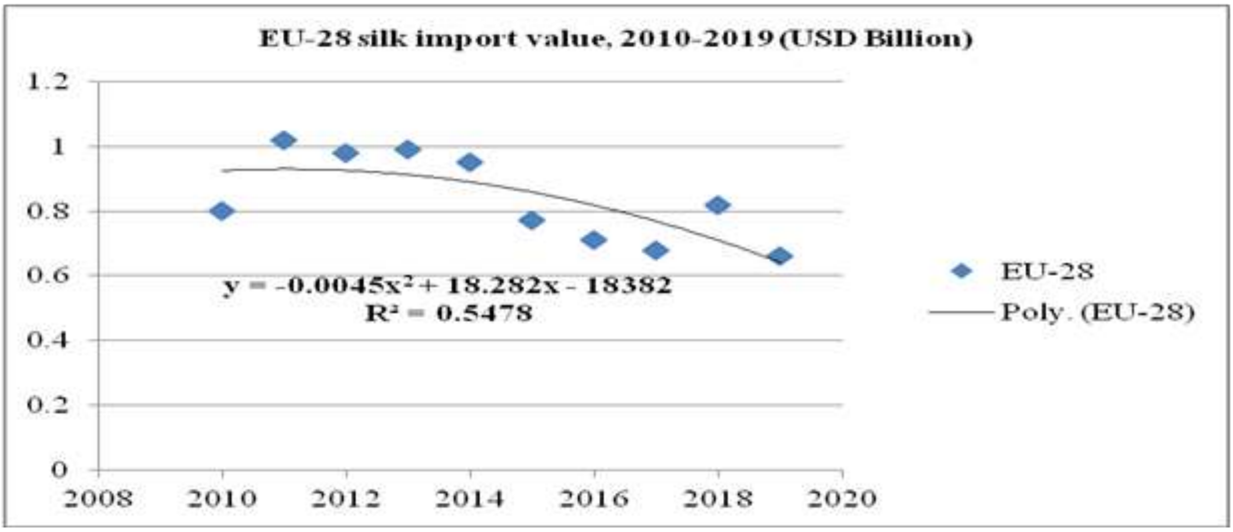

Fig. 5. Dynamics of silk import value trend in the EU-28, 2010-2019 (USD Billion)
Source: Own design based on the data from [13].

Based on the import value in 2019, at the EU level, the top 10 countries are in the decreasing order: Italy, Romania, France, United Kingdom, Germany, Bulgaria, Slovenia, Portugal, Spain and Austria. At the world level, only Italy, Romania and France are among the top 10 silk importing countries, occupying the 1st, the 4th and, respectively, the 7th positions. They are followed by United Kingdom, Germany and Bulgaria, which are ranked the 113th, 14th and 19th at the global level (Table 1).

The evolution of silk export value in the EU top 10 exporting countries

Silk export registered a decrease in almost all top 10 EU countries, except Romania. The decline differed from a country to another varying between 89/76% in Spain, the highest reduction and 8.75 % the lowest one in Bulgaria. In Romania, silk export value increased 2.13 times in the analyzed interval.

The cumulated value of silk export on the whole 2010-2019 interval established the following hierarchy of the top five exporting countries: Italy is on the top position, its export accounting for USD 3,426 Billion. France achieved USD 889.3 Billion, Romania USD 865 Billion, Germany USD 715.1 Billion and United Kingdom USD 387.8 Billion.

The market share of the top 10 silk exporting countries in the EU-28 export value is presented in Table 2.

Table 1. Position of the EU countries in the EU and World silk export and import value in 2019

	Position in the EU-28 for		Position in the World for	
	Export value	Import value	Export value	Import value
Italy	1	1	2	1
Romania	2	2	4	4
France	3	3	6	7
United Kingdom	4	4	9	13
Germany	5	5	10	14
Slovenia	6	7	13	23
Belgium	7	11	18	32
Austria	8	10	18	30
Spain	9	9	22	28
Lithuania	10	14	25	46
Bulgaria	11	6	27	19
Netherlands	12	13	29	41
Poland	13	12	37	33
Hungary	14	15	40	49
Denmark	15	18	41	66
Greece	16	16	42	60
Ireland	17	20	44	77
Sweden	18	25	46	96
Portugal	19	8	48	25
Latvia	20	23	52	82
Czech Republic	21	17	53	62
Finland	22	22	55	79
Croatia	23	19	60	70
Estonia	24	24	66	87
Slovakia	25	21	85	78
Cyprus	26	26	109	109
Malta	27	28	115	121
Luxembourg	28	27	116	112

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

Table 2. The market share of the top 10 exporting countries in the EU-28 silk export value in 2019 compared to 2010 (%)

	2010		2019
EU-28 (USD Billion)	**699.95**	**EU-28 (USD Billion)**	**550.66**
1.Italy	54.28	1.Italy	51.82
2.Germany	12.23	2. Romania	18.24
3.France	11.59	3.France	12.94
4.United Kingdom	6.78	4.United Kingdom	5.70
5.Romania	6.71	5.Germany	5.62
Total	***91.59***	***Total***	***94.32***
6.Spain	4.14	6.Slovenia	2.05
7.Austria	1.44	7.Belgium	0.88
8.Belgium	1.34	8.Austria	0.82
9.Netherlands	0.24	9.Spain	0.54
10.Bulgaria	0.19	10.Lithuania	0.35
Total top 10	**98.94**	**Total top 10**	**98.96**

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

The figures from Table 2 confirm that the main silk exporting countries are Italy, Romania, France, United Kingdom and Germany, all together contributing to the EU-28 silk export value by 94.32 %.

The evolution of silk import value in the EU top 10 importing countries

The value of silk import also registered a descending trend in the last decade in almost all the top 10 countries of the EU, except Romania and Bulgaria. The decline in the interval 2010-2-19 varied between -84.66% in case of Spain, the highest reduction, and -3.295 in case of Italy, the smallest one.

The growth rate in the whole interval was +81.61% for Romania and +27.61 % for Bulgaria.

Based on the cumulated silk import value in the period 2010-2019, the descending hierarchy of the top five countries was the following one: Italy USD 3.79 Billion, Romania USD 1 Billion, France USD 0.96 Billion, Germany USD 772 Billion and United Kingdom USD 0.96 Billion.

The market share of the top 10 silk importing countries in the EU-28 import value is presented in Table 3.

Table 3. The market share of the top 10 importing countries in the EU-28 silk import value in 2019 compared to 2010 (%)

	2010		2019
EU-28 (USD Billion)	**803.82**	**EU-28 (USD Billion)**	**661.47**
1.Italy	41.04	1.Italy	48.24
2.Germany	11.46	2. Romania	15.82
3.France	11.08	3.France	11.90
4.United Kingdom	8.20	4.United Kingdom	5.52
5.Romania	7.16	5.Germany	5.42
Total	***78.94***	***Total***	***86.90***
6.Spain	6.92	6.Bulgaria	2.38
7.Portugal	2.27	7.Slovenia	1.78
8.Austria	1.81	8.Portugal	1.38
9.Belgium	1.62	9.Spain	1.29
10.Bulgaria	1.54	10.Austria	1.17
Total top 10	**93.10**	**Total top 10**	**94.90**

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

The figures from Table 3 attest that the main silk importing countries are Italy, Romania, France, United Kingdom and Germany, all together contributing to the EU-28 silk export value by 86.90 %, being followed by Bulgaria, Slovenia, Portugal, Spain and Austria, all these 10 countries accounting for 94.90% in the EU-28 silk import value.

Italy is both the top silk exporter and also importer and consumer in the EU-28. It comes on the 2nd position in the world for its export value after China and it is on the 1st position for its import value.

Silk yarn and yarn spun from silk waste, put up for retail sale; silk-worm gut, having the code 5006 represent the object of Italy export and import [6].

The evolution of Italy export and import in the period 2010-2019 is presented in Table 4.

Table 4. Italy - Silk yarn and yarn spun from silk waste, put up for retail sale; silk-worm gut, Code 5006 exports and imports, 2010-2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2019/ 2020 %
Export Quantity (kg)	56,468	19,927	55,179	66,602	22,792	25,579	17,712	14,039	20,355	5,560	9.84
Import Quantity (kg)	10,341	10,767	24,494	25,337	8,297	13,120	12,701	15,775	11,582	21,030	203.36
Export value USD Billion	1.62	1.46	2.02	1.78	2.42	2.51	1.99	1.50	0.86	0.42	25.92
Import value USD Billion	0.76	0.89	1.54	1.25	1.13	1.44	0.97	0.99	0.90	0.72	94.73

Source: Own calculation based on the data from [42].

The main suppliers of silk yarn and yarn spun from silk waste, put up for retail sale; silk worm gut for Italy in 2019 were: Japan (78%), Romania (8.79%), Germany (6.55%), and China (5.67%).

The main beneficiaries of silk yarn and yarn spun from silk waste, put up for retail sale;

silk worm gut sold by Italy in 2019 were: USA (16.6%), Japan (12.8%), Madagascar (10.3%), Bulgaria (10.3%), Tunisia (7.62%), Hong-Kong (6.53%), China (5.91), Romania (5.54%), Spain (4.81), Germany (4.02%), as mentioned by [38, 42].

Italy silk import consists mainly of raw silk and silk yarn, but also women blouses and garments. Italian silk products are well known worldwide (scarves, ties, blouses, shirts etc).

The core of silk ready-made products in Italy is the region Como, at the border with Switzerland, where a long tradition has been developing across the centuries. The silk industry in the region is well developed as the area is an ideal environment for mulberry trees plantations and silkworms rearing.

Como's silk is very appreciated for elegant dresses, scarves, ties and accessories. Many mills and silk factories were set up in the area and are proud of their high quality products sold on the domestic market and also abroad wearing the label "Made in Italy".

The international trade is in benefit of Italy, the value of exports exceeding the value of imports in the period 2010-2017, the trade balance being a positive one, but in 2019 and 2019 the import value was higher than the export value which led to a negative silk trade balance.

Romania is ranked the 4th in the world and the 2nd in the EU both for silk export and import value. During the last 10 years, Romania passed from the 5th position in 2010 to the 2nd position in 2019. The country has a long tradition in sericiculture, keeping a rich collection of over 60 silkworm breeds and hybrids [16, 18, 19].

The activity is a business of the small family farms, where silk cocoons are processed mainly in a traditional manner in handicrafts, belts, brooches, necklaces, silk blouses, house decorations etc or industrially [17, 20, 21, 25].

The activity is an efficient one mainly in the integrated farms where silk cocoons are processed till the final product using a low investment capital and family labour, emphasizing on production diversification to increase value added, productivity and competitiveness [23, 30, 31, 32, 33, 34].

Romania's trade has negative balance, being a net importing country of silk as long as the import value exceeds the import value. Romania exports mainly silk yarn (75%), woven fabrics (15%, and raw silk (8.4%), and imports: raw silk (74.8%), woven fabrics (18.4%) and silk yarn (5.5%). Silk yarn is the only product with a positive trade balance.

About 99.9% of silk is exported in the EU, while the imports come especially from China (62%) and the EU (38%) [29].

France maintains its 3rd position in the EU both for silk export and import value, but at the global level is ranked the 6th for export and the 7th for import.

France is deeply oriented in high quality silk fabrics, 70% of them being used for clothing and the rest for curtains, wall covers, bed spreads and other internal decorations. The main beneficiary of the French silk products is the USA.

The core of silk industry in France was Lyon area, located in East Central France in the Auvergne-Rhone-Alpes region. Lyon is the capital of silk trade, and an important part of UNESCO World Heritage, where tourists could visit among other important attractions the Silk Museum and the Fabric Museum. Nowadays, silk industry is well developed benefiting of modern techniques and equipments for processing silk into beautiful and high quality final products [6, 14].

United Kingdom is ranked the 4th in the EU both for silk export and import value, and it occupies the 9th position for export and the 13th position for import at the global level.

Silk industry in United Kingdom started in North West England and London area. It is a component of the apparel, interiors and textile trade through the supply of raw and unfinished materials, fabrics and garments. A large range of silk products are achieved in UK such as: silk yarns, fabrics and garments, but also other products for surgery sutures in medicine, silk gloves for pilots, handmade silk fabrics used in the restoration of castles and palaces throughout Europe [6].

Germany remained constant on its 5th position in the EU, while at the global level is ranked the 10th for silk export and the 14th for import. The main silk suppliers for

Germany are China, India and Thailand. Also, smaller amounts of silk are imported from Vietnam and Brazil. The raw silk is transformed into high quality textiles and clothing well appreciated by consumers.

The main silk products imported are: blouses, shirts, handkerchiefs, ties, shawls, scarves, mufflers, mantillas and veils [6].

The silk trade balance in the EU-28 and at the global level

While at the global level, exports exceed imports, and the silk trade balance is a positive one, in 2019, the value of the balance being USD 189.66 Million, at the EU-28 level, the silk trade balance was negative in the analyzed interval (Fig.6).

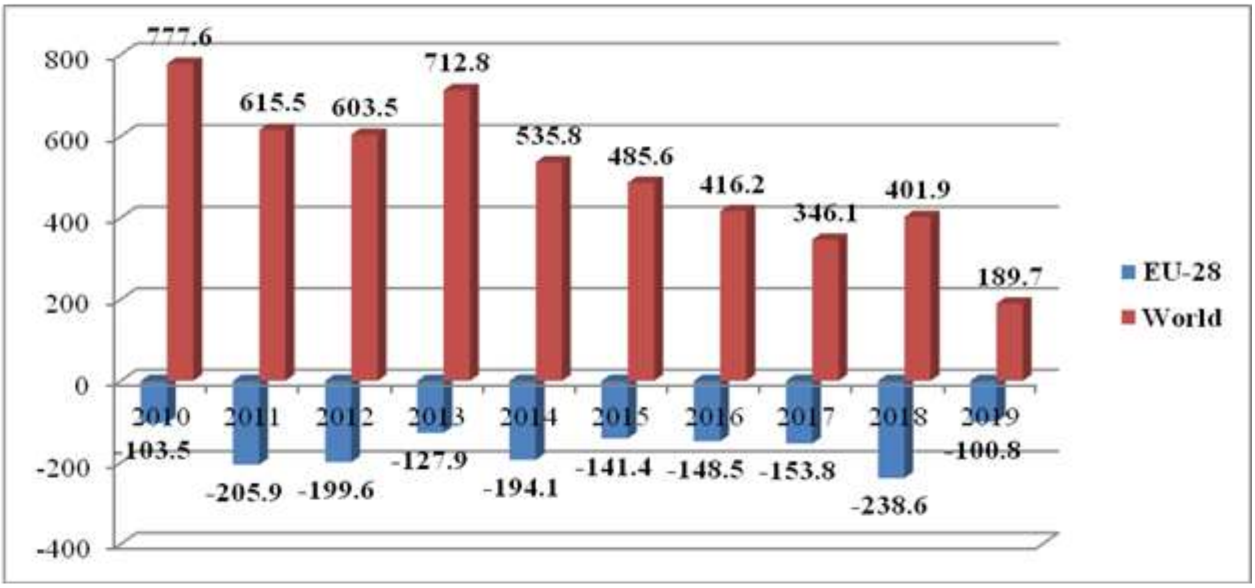

Fig. 6. Silk trade balance in the EU-28 and at the global level, 2010-2019 (USD Million)
Source: Own design and calculations.

The silk trade balance in the top five exporting and importing countries in the EU is presented in Table 5, which shows that all the countries are not importing countries of silk.

Table 5. Silk trade balance in the EU-28 top five exporting and importing countries, 2010-2019 (USD Million)

	Italy	Romania	France	United Kingdom	Germany
2010	+49.9	-10.6	-7.9	-18.4	-6.5
2011	-27.4	-21.7	-15.2	-14.2	-17.5
2012	-7.4	-9.0	-24.5	-21.3	-8.2
2013	-29.6	-29.1	-2.5	-17.5	+ 5.1
2014	-62.4	-7.8	+18.8	-19.7	-8.6
2015	-54.5	-4.2	+4.7	-21.6	-1.4
2016	-39.8	-29.0	+1.7	-15.1	-3.7
2017	-60.3	+3.7	-20.3	-11.8	-6.5
2018	-99.7	-27.5	-19.9	-18.2	-4.8
2019	-33.8	-4.2	-7.5	-5.1	-4.9
2019/2010 %	67.58	39.73	94.16	27.75	74.65
Average annual rate (%)	-3.24	-6.03	-0.58	-7.22	-2.53

Source: Own calculations.

Silk industry plays an important role in the EU textile and clothing sector which is very well developed and industrialized. This sector absorbs 1.7 million people of the EU workforce in more than 185,000 companies whose turnover exceeds Euro 166 Billion. The main feature of these companies is their small size, the number of their employees being smaller than 50 persons. This reflects what an important role plays this sector in the economy in assuring employment and incomes for the local population.

In the EU-28, about 33% of the textile and clothing production is dominated by Italy, France, Germany and Spain. Also, other member states such as Greece, Portugal, Romania, Bulgaria and Poland bring their contribution to clothing production.

The major part of production is sold on the internal market, but about 20% is object of exports on various markets.

During the last decade the high production cost in silk producing and processing has led to a new orientation paying more attention to the regions situated in the Mediterranean area where silk products could be achieved with lower expenses. More than this important innovations and technical changes were made in order to produce a larger variety of high quality products including more value added and in this way to face better the increased competitiveness in the silk market.

In this way, the EU silk products brands could be better sustained based on the new clustering strategy adopted in the textile and clothing industry largely operating on a wider geographical area [4, 37].

Only in this way, the EU could keep its 2nd position as exporter of textiles and clothing in the world and increase its market share in the world sales.

For attaining its goal, the EU developed an investment plan in silk sector as well, based on projects which have the purpose to implement innovations and make sericiculture and reeling sectors sustainable fields of activity providing more high-quality raw silk from the internal producers as an alternative to a possible decline in China's silk output and supply.

This initiative launched by EURATEX, the European Apparel and Textile Confederation, which is the representative of the textile and clothing industry in Europe, will assure a favorable environment for producing textile and fashion products in Europe and will support the sustainable development of the local economy in many regions [4, 5].

CONCLUSIONS

This research proved how important is silk industry as a component of textile and clothing industry in the EU. The EU is at present the most important importer and consumer of raw silk in order to produce high quality and elegant textile and fashion products whose brands are well known all over the world.

The key "players" in the EU-28 exports and imports of raw silk are: Italy, Romania France, United Kingdom and Germany. These five countries, all together, have a market share of 94.32% in the EU-28 silk export value in 2019. Regarding import, these five countries contributed by 86.9 % to the EU-28 silk import value in the same year. Smaller contributions had also Bulgaria, Slovenia, Portugal, Spain and Austria.

Despite that at the EU-28 level the exports and imports of raw silk registered a decreasing trend in the period 2010-2019, and mainly in almost top 10 countries, in Romania the silk export value increased 2.13 times and the silk import value raised in Romania by 8.61 % and in Bulgaria by 27.61%.

The silk trade balance is a negative one at the EU level and also in all the top 10 key "actors" in the silk market, because the EU is focused on imports which supply the raw silk for the textile and clothing industry.

The main suppliers of raw silk and other silk products for the EU are: China and India, but also Vietnam and Thailand, and in a smaller proportion Brazil.

Silk industry looks to strengthen its position within the EU textile and clothing industry grace to the new clustering strategy enlarging the geographical area where silk products could be achieved at lower cost, and offering jobs for the local population and increasing the turnover of the sector.

The EU vision is to transform sericiculture and reeling sector into sustainable activities which could provide more and higher quality silk raw taking into consideration the risk of smaller supply from China in the future.

For the local producers, besides the raw silk production, silk by-products for non-textile purposes may be considered an alternative to enlarge the variety of silk products, to increase productivity and utilize in a more efficient way labor force and satisfy better the consumers' preferences.

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SORGHUM PRODUCTION IN ROMANIA IN THE PERIOD 2010-2019 - TRENDS AND DETERMINANT FACTORS

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Abstract

The paper analyzed the dynamics of Sorghum cultivated area, production and yield in the decade 2010-2019 pointing out the position of Romania among the EU-28 producing countries, the relationship between production and yield using ANOVA, and regression analysis in terms of linear fit. The results showed that the cultivated area increase by 52.7 % in reaching 15,712 ha in 2019. The West and South West regions cultivate 81 % of Romania's cropped area with Sorghum. Production increased 3.2 times reaching 60 thousand tons in 2019, 80% being achieved by West region (63.4 %) and South West Oltenia (10.5%). Sorghum yield was doubled in 2018 achieving 3,819 kg/ha, the highest records being in North East and West. Romania is ranked the 4th in the EU-28 after France, Italy and Hungary for Sorghum cultivated surface, production and yield. Between production and yield is a positive and strong relationship, r = 0.842 and R^2 = 0.710, reflecting that 71 % of the variation of production is caused by yield change. The regression model Y = 0.0112 x + 13.424, shows that if Sorghum yield increases by one unit, production will grow by 13.43 units. Therefore, a higher productivity per surface unit will contribute to production growth. For this reason, farmers have to use modern technologies involving high potential varieties and hybrids, optimized tillage, fertilization, sowing depth, plant density, distance between rows, correct and timing application of the agricultural works, the use of modern equipments for tillage, sowing, crop maintenance and harvesting. The technologies have to be adapted to climate change, meaning the use of earlier cultivars, looking for a new depth of sowing where soil moisture content favours seeds germination and chose the best harvesting moment.

Key words**:** *Sorghum, cultivated area, production, yield, trends, Romania*

INTRODUCTION

Sorghum is the 5th cereal in the world after maize, wheat, rice and barley which is important for nourishing millions of people and animals on our planet and also providing raw material for processing industry. This is due to Sorghum high nutritional value being rich in protein, starch, fiber, micro elements, its high starch and fiber digestibility and also a high energetic value [4, 32].

That is why it is largely spread in the world being cultivated in more than 110 countries from all the continents and especially in the regions with hot climate and low precipitations below 450 mm per year as the crop is highly resistant to drought, a reason to be named "the cereal of the arid zones" [31].

It is a plant with multiple uses: food, feed, a resource for bio energy, biofuels and other materials, it has a high productivity and lower production cost in arid area compared to maize, and it is friendly with the environment.

A large variety of food could be produced of Sorghum, such as: grains, flour, gluten-free bread, baked goods, porridge, cookies, cakes, pancakes, sweet juice, vinegar, sweeteners, sweet spices, light and alcoholic drinks. More than 50% of the global Sorghum production is used for these purposes [1, 6].

Sorghum is used in feed rations for poultry, dairy cows, steers and pigs for fattening and also for pets. Depending on the animal species, Sorghum could be used in various forms: grazing pasture, green mass, hay, silage, fodder pellets. About 40% of Sorghum production is destined for animal feeding.

From the rest of about 10 % of production, Sorghum is used in the manufacturing industry as biomass for producing renewable energy, electricity and heat, as a resource for achieving biofuels (bioethanol, solid and gaseous fuels), as a resource for obtaining other materials: paper, textiles, building, chemical and plastic materials, brushes, brooms, floral arrangements etc. [1, 8].

Because there are differences between demand and offer among various regions and countries in the world, Sorghum is subject of international trade. The main producing and exporting countries are USA, Mexico, Nigeria, Sudan, India, China, Argentina, and the principal importing countries are China, Mexico, Japan, EU etc. [10].

Sorghum has specific characteristics which allow this crop to be successful in the competition with maize in the warm climate countries. Its special capacity to resist to high temperatures is due to its deep root which is able to penetrate the soil to find moisture and prove its high water uptake capacity, a reason why the plant is cultivated on non irrigated land and in this way Sorghum gives its contribution to water preservation, a reason to be considered environmentally friendly. Therefore, Sorghum is an alternative in the areas where maize cultivation is limited by climate conditions [33].

Research results proved that in the drought prone environments, Sorghum is able to give a higher yield and net returns than maize in the hot months. The higher and higher the temperature in August, the higher the yield difference between Sorghum and maize [35].

In biogas production, the hybrids of Sweet Sorghum and Sorghum-Sudan grass were able to produce by 27% more ADW than maize in the drought periods [33].

In the USA, Sorghum cropping is subject of business depending on price volatility, farmers being attracted to produce more Sorghum when its grain price is at least 1.1 times higher than maize price [37].

Besides its tolerance to drought, water efficiency, high nutritive and energetic value, environmentally friendly, Sorghum proved that its production cost is lower than in case of maize. For this reason Sorghum is used in animal rations replacing maize, for instance in silage production for dairy cows [16].

Global warming whose effects are more and more visible in all the fields, including agriculture, has determined scientists and practitioners to innovate agricultural technologies adapting them to the new climate conditions [12, 34].

The EU is also facing with increased temperatures and long severe droughts in its Southern and Eastern countries. Not being an important producer of Sorghum, but an important importer, the EU Commission considered that Sorghum could be promoted in the countries where their geographical position, soil and climate conditions allow to extend the cultivated surface and increase production [1, 8].

Besides other countries like France, Italy, Spain, Hungary, Romania is also included in the EU Program destined to Sorghum promotion.

Romania is an important cereal producer and exporter in the EU with a long tradition in cropping maize, wheat, barley, oats, rice, Sorghum, millets etc. [11, 22, 24, 30]. However, maize and wheat are the top cereals produces and exported by Romania [17, 20, 21, 25, 26, 27, 28, 29].

In this context, the extend of the cultivated surface in Romania imposed new experiments to test more local and foreign Sorghum cultivars and hybrids for assessing the impact of various technological factors (seeding density, distance between rows, sowing period, seeds germination, fertilization degree, harvesting moment etc) on yield and production performance. The results proved that Sorghum has a better behaviour on non irrigated land and during the severe drought period giving high production and profit to farmers [6, 7].

Recent research results showed that in South East Muntenia region, if Sorghum is sown at a distance of 70 cm between rows and receive N120P60K60 fertilization level, it could produce 9.22 tons/ha. If only the distance between rows it is extended from 50 cm to 70 cm, the yield surplus varies between 0.21 and 0.48 tons/ha [19].

In Central Moldavia, for a N120P120 fertilization level, it resulted an yield varying between 7,043 kg and 10,279 kg/ha depending on the used hybrids [23].

In Dobrogea region, where drought reached the highest level and rainfalls are scarced for years, Sorghum looks to be the best crop compared to maize on non irrigated surfaces. Taking into consideration the climate change, crop technologies have been adapted by farmers as follows: the sowing period was moved one month in advance compared to the traditional technology as the crop to benefit of the moisture accumulated in the soil during winter season and help seed germination, earlier hybrids with a shorter vegetation period were chosen to avoid the hot and droughty season in June, the treatments for crop protection involved herbicides and pesticides of the last generation [13, 14]. In Amzacea area, a surplus of 1,331 kg/ha was obtained using Alize hybrid sown on March 23 compared to April 15, 2019 [15].

In this context, taking into account the increased interest of farmers to extend the cultivated surface and produce more Sorghum in Romania, the purpose of the paper was to analyze the trends in Sorghum production in the period 2010-2019 in order to identify the changes that have occurred and the position of Romania among the EU producing countries. Also, a statistical approach was applied to evaluate the existing link between cultivated area, production and yield and to establish the best fitted regression model.

MATERIALS AND METHODS

Data collection

This research is based on empirical data provided by National Institute of Statistics Tempo Online, and Eurostat for the decade 2010-2019.

Sorghum crop performance in Romania was analyzed using the following indicators: (i) cultivated area, (ii) production, and (iii) yield.

Methodological aspects

The empirical date were processed using the following methodology:

Fixed Index, with its formula: $I_{t/t0} = (X_t/X_0)100$, for studying the dynamics of each indicator in the last year 2019 compared to the first one, 2010 and establishing the growth rate in the last decade;

The average annual growth rate, $\bar{\Delta} = (y_n - y_0)/(n - 1)$;

The graphical illustration of the dynamics of the three studied.

The structural index (SI%) to analyze the dispersion of the cultivated area, production and yield by region of development.

Descriptive statistics including mean, standard error, standard deviation, minimum and maximum value and coefficient of variation for the three indicators mentioned above in the period 2010-2018.

The comparison method in order to assess the position of Romania among the EU-28 top Sorghum producing countries and also to estimate the contribution of various regions of development to the cultivated area, production and yield.

The correlation coefficient, R square, Adjusted R square, and Standard Error were used to assess in what measure Sorghum production is influenced by cultivate area and productivity per ha.

ANOVA and linear regression fit Y = bx +a were used to establish the influence of the independent variable X, Sorghum yield, on the dependent variable Y, Sorghum production.

The results were presented in tables and graphics, and specific comments and interpretations accompanied them. Finally, conclusions included the main ideas resulting from this research and also issued a few recommendations for farmers in order to improve Sorghum production.

RESULTS AND DISCUSSIONS

Sorghum types cultivated in Romania

Four groups of Sorghum are cropped in Romania: grain Sorghum, sweet Sorghum, broom Sorghum and forage Sorghum. Each of them are produced for various purposes as shown in Table 1.

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Table 1. Sorghum types cultivated in Romania

Sorghum type	Purposes for cultivation
Broom Sorghum	-Genetic resource for sweet and grain Sorghum breeding
Sweet Sorghum	-Biomass for renewable energy and raw materials for processing industry
Forage Sorghum	-Animal feeding (green mass, silage and hay)
Grain Sorghum	-Food, grace to its high protein content, gluten-free and lower fat than maize

Source: Adapted by author based on literature [2, 3, 5].

Cultivated area

In the period 2010-2019, the cultivated area with Sorghum registered a general ascending trend. In 2019, 15,712 ha were cultivated compared to 10,283 ha in 2010, reflecting an increase by 52.79 %, which means by +5.27% average annual growth rate. However, across this decade, the cultivated surface registered an ascending slope from the year 2010 to the peak of 21.7 thousand ha in the year 2013. After that, Sorghum was cultivated on smaller and smaller areas, which in the year 2016 recorder the lowest level of 9.2 thousand ha. But, since 2016 until 2019, Sorghum was again cultivated in larger and larger surfaces, unfortunately, they never reached the peak recorded in 2013 (Fig. 1).

In 2019, the cultivated area with Sorghum in Romania represented 9.6% of the EU-28 cultivated surface with this crop. From this point of view, Romania is ranked the 4th in the EU, after France (42.4%), Italy (23.7%) and Hungary (13.1) (Fig. 2).

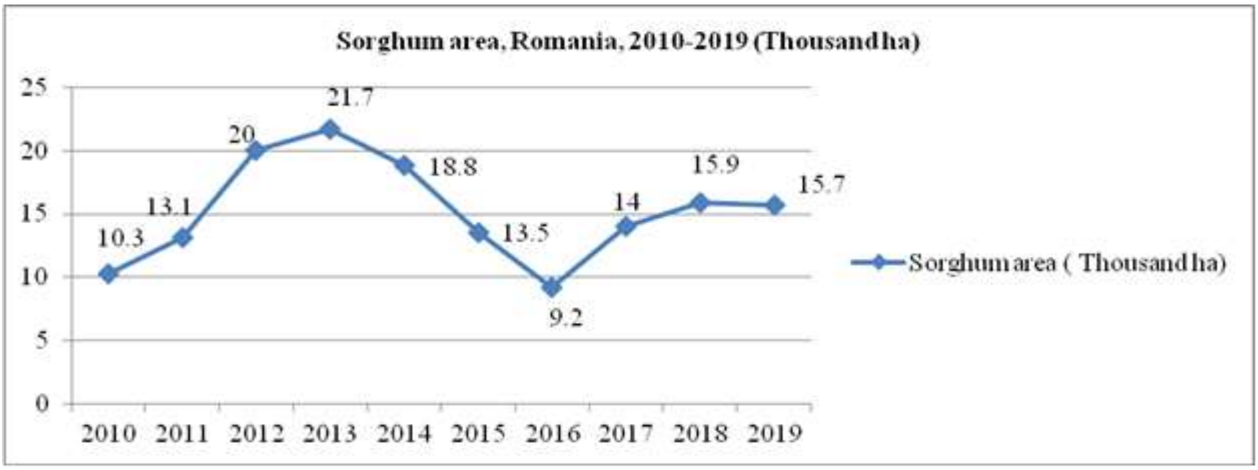

Fig. 1. Dynamics of Sorghum cultivated area, Romania, 2010-2019 (ha)
Source: Own design based on the data from [18].

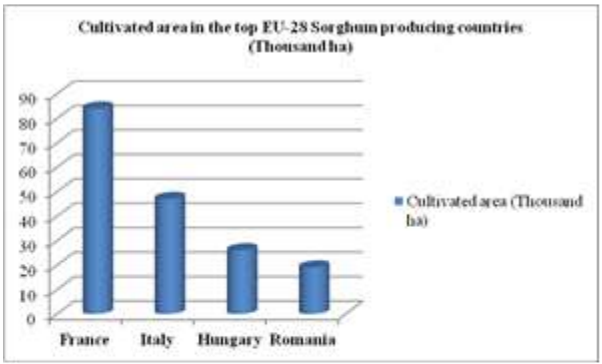

Fig. 2. Romania's position for Sorghum cultivated area among the EU-28 top producing countries in 2019
Source: Own design based on the data from [9].

In Romania, Sorghum is mainly cultivated in the West, South West Oltenia, South East, South Muntenia and North West, these five regions together accounting for 94% of the whole cultivated area with this crop.

The top position is occupied by the West area whose surface with Sorghum represents 57.5% of Romania's Sorghum area. On the 2nd position is South West Oltenia keeping 13.7%.

In the studied period, the sown area with Sorghum increased by 7,309 ha, meaning +426.6% in the West part of the country, in North West by 792 ha, meaning +249.8%, and in North East by 431 ha, i.e. + 111.3%. Smaller increases were also noticed in South Muntenia and Center, but in two regions the cultivated surface was diminished: in South East by -67.2% and in South West Oltenia by -41.3% (Table 2).

Table 2. Cultivated area with Sorghum in 2019 versus 2010 by micro region in Romania

	2019		2010		2019 versus 2010	
	ha	%	ha	%	Δ ha	Δ%
Romania	15,712	100.0	10,283	100.0	+5,429	+52.7
North West	1,109	7.0	317	3.1	+792	+249.8
Center	90	0.6	29	0.3	+61	+210.3
North East	818	5.2	387	3.8	+431	+111.3
South East	1,317	8.4	3,070	29.8	-1,753	-67.2
South Muntenia	1,185	7.5	1,048	10.2	+137	+13.1
Bucharest-Ilfov	22	0.1	63	0.6	-41	-65.1
South West Oltenia	2,149	13.7	3,656	35.5	-1,507	-41.3
West	9,022	57.5	1,713	16.7	+7,309	+426.6

Source: Own calculation based on the data from [18].

Sorghum production

During the last decade, Sorghum production increased 3.21 times or by +221.3% with an average annual growth rate of +22.135. In 2019, Romania produced 60,010 tons Sorghum compared to 18,677 tons in 2010 (Fig. 3).

Fig. 3. Romania's Sorghum production, 2010-2019 (Thousand tons)
Source: Own design based on the data from [18, 36].

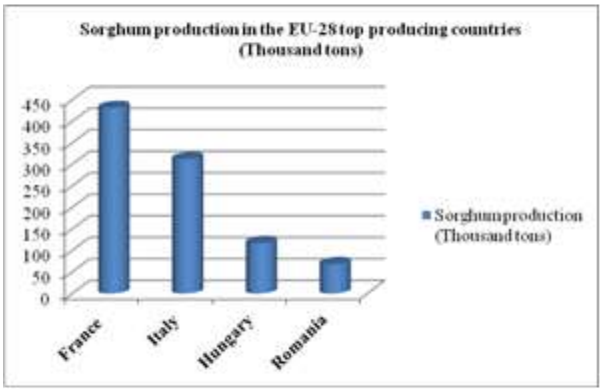

Fig. 4. Romania's position for Sorghum production among the EU-28 top producing countries in 2019
Source: Own design based on the data from [9].

According to Eurostat, Romania comes also on the 4th position for Sorghum output after France, Italy and Hungary. The contribution of these four countries to the EU-28 Sorghum production (1,019 thousand tons) accounted for 42.3%, 30.6%,11.5% and 6.7%, summing 91.1% (Fig. 4).

Sorghum production is not equally achieved in the territory of Romania, and more than this important changes from a region to another have been noticed in the analyzed interval.

In 2010, the top position was occupied by South West Oltenia whose share in the national production was 35.1%, followed by South East with 23.9%, West with 18.1% and South Muntenia with 14.1%, these four regions producing that time 91.2% of Romania's Sorghum output.

In 2019, the West region in on the top position contributing by 63.4%, being followed by South West Oltenia with 10.5%, summing about 80%, reflecting the growth of production concentration (Table 3). It is obviously normal such a situation as long as these two regions cultivate 71.2% of Sorghum surface.

Table 3. Sorghum production 2019 versus 2010 by micro region in Romania

	2019		2010		2019 versus 2010	
	Tons	%	Tons	%	Δ Tons	Δ%
Romania	60,010	100.0	18,677	100.1	+41,333	+221.3
North West	3,799	6.3	777	4.2	+3,022	+388.9
Center	364	0.6	32	0.2	+332	+1,037.5
North East	3,830	6.4	700	3.7	+3,130	+447.1
South East	3,643	6.1	4,457	23.9	-814	-28.3
South Muntenia	3,979	6.6	2,639	14.1	+1,340	+50.8
Bucharest-Ilfov	61	0.1	128	0.7	-67	-47.6
South West Oltenia	6,286	10.5	6,563	35.1	-277	-4.3
West	38,048	63.4	3,381	18.1	+34,667	+1,025.3

Source: Own calculation based on the data from [18].

Sorghum yield

The performance in Sorghum yield has also recorded and ascending trend in the studied period. If in 2010, Romania produced 1,816 kg/ha Sorghum, in 2019, the yield was 2.1 times higher, i.e. 3,819 kg/ha. The average annual growth rate in the whole analyzed interval accounted for 11.03% (Fig. 5).

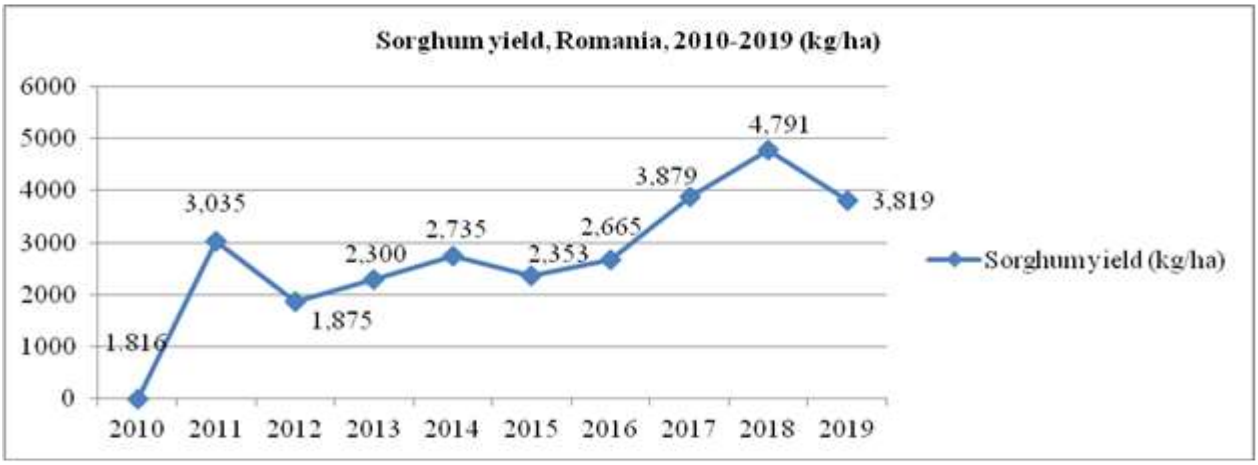

Fig. 5. Romania's Sorghum yield, 2010-2019 (kg/ha)
Source: Own design based on the data from [18].

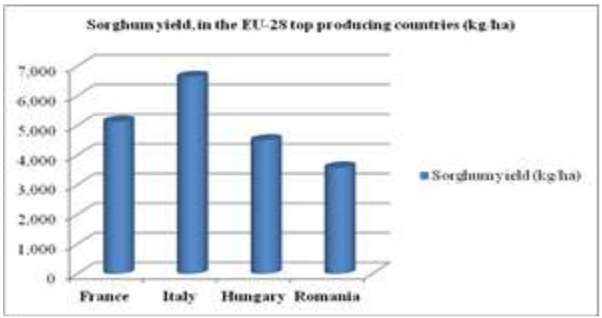

Fig. 6. Romania's position for Sorghum yield among the EU-28 top producing countries in 2019
Source: Own design based on the data from [9].

Compared to the other three top Sorghum producing countries in the EU-28, Romania comes on the 4th position for its yield level after Italy (6,638 kg/ha), France (5,130 kg/ha) and Hungary (4,500 kg/ha) (Fig. 6).

The change in the national average yield of Sorghum was deeply influenced by the different records carried out at the level of each region in the analyzed interval.

South Muntenia (2,518 kg/ha) and North West (2,451 kg/ha), followed by West, Bucharest-

Ilfov, South West Oltenia and North East and South East.

In 2019, the highest yield was achieved in North East accounting for 4,683 kg/ha and West, 4,217 kg/ha. In South West Oltenia, which is on the 2nd position for the cultivated area and production, the yield was only 2,925 kg/ha, by 31% less than in the West region.

The results presented in Table 4 reflect a higher yield performance in all the regions in the analyzed decade, ranging between +33.35 in South Muntenia to +264.7% in the Central area.

Table 4. Sorghum yield 2019 versus 2010 by micro region in Romania

	2019	2010	2019-2010	
	kg/ha	kg/ha	Δ kg/ha	Δ%
Romania	3,819	1,816	+2,003	+110.2
North West	3,424	2,451	+973	+39.6
Center	4,023	1,103	+2,920	+254.7
North East	4,683	1,809	+2,874	+158.8
South East	2,767	1,452	+1,315	+90.5
South Muntenia	3,357	2,518	+839	+33.3
Bucharest-Ilfov	2,773	2,032	+741	+36.5
South West Oltenia	2,925	1,795	+1,130	+62.9
West	4,217	1,974	+2,243	+113.6

Source: Own calculation based on the data from [18].

Descriptive statistics

The results regarding the main statistical parameters for Sorghum cultivated area, production and yield are presented in Table 5.

The variation coefficients have high values which reflect the followings:

- in case of cultivated area with Sorghum, CV = 26.6% tells us that the values of this variable are relatively heterogeneous and the mean is less representative;
- in case of production, CV = 39.3% shows that the series of data has heterogeneous values and the mean is not representative;
- in case of yield, CV = 47.56% also reflects a high heterogeneity among data and in consequence the main is not representative.

Table 5. Descriptive statistics for Sorghum studied indicators in the period 2010-2019

	Cultivated area (ha)	Production (Thousand tons)	Yield (kg/ha)
Mean	15.22	44.37	2,745.38
Std.Error	1.28	5.51	412.98
Std. Deviation	4.05	17.43	1,305.96
Min	9.2	18.6	1,816
Max	21.7	76.3	4,791
Variation coefficient (%)	26.6	39.3	47.56

Source: Own calculations.

The relationships between Sorghum cultivated area, production and yield

For studying the three pairs of possible relationship between these three indicators, the correlation coefficients, r, the determination coefficients, R^2, adjusted R square and Standard Error were calculated and their results are presented in Table 6.

A strong positive correlation coefficient was found between production and yield, r = 0.842, much higher than in case of the connection between production and cultivated area, r = 0.509 and r = 0.157, the weakest value between yield and cultivated area.

Also, in case of the link between production and yield, the coefficient of determination recorded the highest value, R^2 = 0.710, reflecting that 71% of the production variation is caused by the change in Sorghum yield.

The adjusted R square had the highest value also in case of the relationship between production and yield, Adj. R Square = 0.674, and the standard error had the smallest value, Std. Err. = 9.95 compared to the other two pairs of indicators.

The relationship between production and cultivated area was characterized by a positive and medium correlation, r = 0.509, by the fact that only 25.9% of the variation in production is determined by the cultivated surface, as proved by R^2 = 0.259.

The correlation coefficient r = 0.157 reflected that between yield and cultivated surface with Sorghum it is a positive but very weak relationship, R^2 showed that practically the variation of the cultivate area has no impact on average production and in addition Standard error had a very high value (Table 6).

Table 6. The values of r, R^2, Adjusted R square and Standard Error for the three pairs of studied indicators

Pairs of indicators	r	R^2	Adj. R square	Std. Error
Production and Yield	0.842	0.710	0.674	9.95
Production and cultivated area	0.509	0.259	0.166	15.91
Yield and cultivated area	0.157	0.024	- 0.097	1,367.97

Source: Own calculation.

The variance and regression analysis

Based on these results mentioned above, it was taken the decision to analyze the dependence of production, considered the variable Y on yield level, considered the variable X, using the variance and regression analysis, whose results are shown in Table 7.

ANOVA presents the regression between production on yield, the residual variance caused by other nonregistered factors, residual and total variance determined by all the factors.

Fisher test, F, reflected the ratio between the two dispersions connected by the degrees of freedom.

The regression parameters, a and b, allowed us to establish the regression model under the form of a linear fit, Y = 0.0112 X + 13.474.

The availability of the regression fit was attested by F stat whose value was higher than the table critical value, as well as by the significance level which is almost zero, Sign. F = 0.0021 (Table 7).

Table 6, Variance and regression analysis between Sorghum production and yield

ANOVA						
		df	SS	MS	F	Sign. F
Regression		1	1,943.89	1,943.89	19.65	0.0021
Residual		8	792.22	99.02		
Total		9	2,736.12			
Regression parameters						
	Coefficients	Std. Error	t stat	P - Value	Lower 95%	Upper 95%
Intercept	13.474	7.650	1.761	0.116	- 4.166	31.11
X var 1	0.0112	0.0025	4.430	0.0021	0.0053	0.0171

Source: Own calculation.

The confidence intervals for each regression parameter, a and b, of the linear fit model were the following ones: - 4.166 < a < 31.11 and 0.0053 < b < 0.0171 for 0.05 threshold (95% lower and upper) (Table 7).

Replacing the X values in the linear fit, Y_x = 0.0112 X + 13.474, there were determined the values of the predicted Y**.** As long as the sum of the adjusted Y depending on X is equal with the sum of the empirical values, the parameters a and b of the regression model are correctly calculated.

Also, the residuals reflect the prediction error calculated as difference between the observed and forecasted value, and finally the standard error in terms of standard residuals is also presented in Table 8.

Table 7. Predicted Y and residuals

Observation	Predicted Y	Residuals	Standard residuals
1	13.49543557	5.104564426	0.544071897
2	47.62920472	-8.029204719	-0.85579577
3	34.57520859	2.924791415	0.31173998
4	39.35792269	10.44207731	1.112972693
5	44.25317124	7.246828764	0.772405938
6	39.95435527	-8.254355268	-0.879793525
7	43.46543009	-19.06543009	-2.032095954
8	57.12711225	-2.82711225	-0.30132881
9	67.39025404	8.909745962	0.949648586
10	56.45190555	3.548094446	0.378174966

Source: Own calculation.

The quality of the linear regression model is also confirmed by the residual plot for Sorghum yield which tells us that between the yield, the independent variable and the residuals, there is no any relationship (Fig. 7).

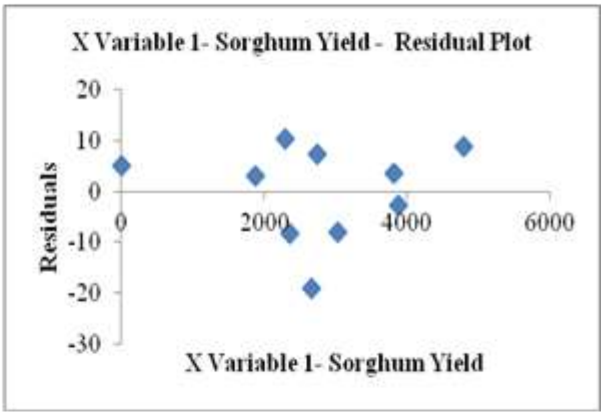

Fig. 7. Sorghum yield and residuals diagram
Source: Own result.

Therefore, the linear fit availability is confirmed and the model could be used now to forecast Sorghum production based on yield.
The model Y = 0.0112 X + 13.474 shows that if X, Sorghum yield will vary by one unit, then, Y, production will grow by 13.43 units. The increased of yield by 2 units will determine the growth of production by 13.4964 units.

CONCLUSIONS

The research results proved that in Romania farmers are interested to extend the cultivated surface with Sorghum and increase production.
The analysis showed that the cultivated area increase by 52.7 % in the last decade reaching 15,712 ha in 2019. About 81 % of the are cultivated with Sorghum is situated in the West and South West regions where soil and climate conditions are the most favorable.
Sorghum production increased 3.2 times reaching 60 thousand tons in 2019. The highest contribution to Sorghum output is given by West region 63.4 % and South West Oltenia 10.5%, representing together 80% of Romania's production.
Sorghum yield had a general increasing trend achieving 3,819 kg/ha in 2019, when it was recorded a double level compared to the year 2010.
The highest average production was recorded in North East and West, accounting for over 4,200 kg/ha.
Romania is ranked the 4th in the EU-28 after France, Italy and Hungary for Sorghum cultivated surface, production and yield.
The statistical analysis showed that between production and yield is a positive and string relationship, attested by the correlation coefficient, r = 0.842 and the determination coefficient R^2 = 0.710, which reflected that 71 % of the variation of production is caused by the deviations in Sorghum yield.
As a consequence of ANOVA and regression analysis, it was found that the regression model Y = 0.0112 x + 13.424, which shows that an increase by one unit of Sorghum yield could increase production by 13.43 units.
Therefore, this research proved that in case of Sorghum, a higher productivity per surface unit will contribute to the improvement of production.
In consequence, farmers interested in Sorghum cultivation have to be aware that their business will be a successful one if they

will use modern technologies involving high potential varieties and hybrids, optimized tillage, fertilization, sowing depth, plant density, distance between rows, correct and timing application of the agricultural works, the use of modern equipments for tillage, sowing, crop maintenance and protection and harvesting.

Technological factors have to be adapted to climate change. The long periods of drought during the last years obliged many farmers to adapt technologies to the new conditions using earlier cultivars, changing the depth of sowing in relations with the soil moisture content to allow seeds germination and to offset the moment of harvesting in a more suitable period.

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OILSEEDS CROPS: SUNFLOWER, RAPE AND SOYBEAN CULTIVATED SURFACE AND PRODUCTION IN ROMANIA IN THE PERIOD 2010-2019 AND FORECAST FOR 2020-2024 HORIZON

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Abstract

The paper analyzed the dynamics of the cultivated area and production in oilseeds crops, especially on sunflower, rape and soybean, in Romania in the decade 2010-2019 in order to identify the main trends and changes, using trend line models and to set up the forecast for 2020-2014 horizon, based on the results of 2019 and the average annual growth in the analyzed period. In 2019, Romania cultivated 1.8 million ha with oilseeds crops, of which 71.3% sunflower, 19.6% rape and 8.8% soybean, and produced 4,792 thousand tons seeds, of which 74.4% from sunflower, 16.6% from rape and 8.6% from soybean. The areas and output increased in case of sunflower and soybean, while rape registered a decline. For the year 2024, it is expected as Romania will cultivate 2,015 thousand ha with oilseeds plants, of which sunflower 77.3 %, rape 13.2% and soybean 10.3%, and to produce 6,133 thousand tons seeds of which 79% from sunflower, 11.7% from rape and 7.5 % from soybean. Rape crop was deeply affected by the severe droughts in the last years and this diminished seeds output. In 2019, Romania occupied the following positions in the EU-28 for production performance: the 3rd for oilseeds output, the 1st for sunflower seeds, the 2nd for soybean seeds and the 5th for rape seeds. To increase performance in oilseed sector, Romanian farmers have to adapt to the climate change paying attention to the following technological aspects: to use high earlier and production potential varieties and hybrids and resistant to drought, diseases and pests; to chose the best period for sowing depending on the soil moisture and temperature, to assure an optimum fertilization level, crop maintenance and harvesting.

Key words: *oilseed crops, sunflower, rape, soybean, cultivated area, production, trends, forecast, Romania*

INTRODUCTION

Oleaginous plants are important from an economic, social and environment point of view as they provide food, feed and raw materials for manufacturing industry and are friendly with the environment.

Among oleaginous plants, soybean, sunflower, rape, groundnuts, cotton, palm kernel and copra are the main important.

The fruit, seeds and other parts of these plants have a high nutritive and energetic value. Their oil content ranges in large limits between 20% and 60% and also protein content between 16% and 42% depending on species. Their chemical composition is also rich in fiber, cellulose, vitamins and minerals etc and justifies why oleaginous plants are so needed in our life [4, 8, 17].

Vegetal oil is used for preparing various tasty and high digestible food dishes, canned food, bakery products, margarine, dietary products, cakes, chocolate, soap, pesticides, oil for paintings [18].

Oil produced from soybean, sunflower and rape are a source of bio-fuel (bio-diesel) which contributes to pollution reduction and preserves environment quality.

The groats resulting after oil extraction are rich in protein (30-50%), fats, vitamins, non-nitrogenous extractive substances which are important for cattle, pigs and poultry feeding, the shells of the seeds are used for producing ethyl alcohol and concentrated feed for animals [18].

From an agrotechnical point of view, oleaginous plants are good precursory crops for winter cereals and hoeing plants used in crop rotation for weed control [5].

More than theses, the oils seeds crops are highly efficient assuring a good profitability per cultivated ha and high net returns to agriculturists [21, 22].

These are reasons why the demand of oil seeds especially for oil food and bio-fuel is higher and higher and this is an incentive for the producing countries to raise the cultivated areas and production and intensify international trade [23, 25, 26, 27].

In 2019, the world oilseeds production accounted for: 336.11 Million MT for soybean, 54.97 Mil. MT for sunflower, 68.2 Mil.MT for rape seeds, 45.38 Mil. MT for groundnuts, 44.84 Mil.MT for cotton seeds, 19.85 Mil.MT for palm kernel [30].

The EU pays a special attention to oilseeds sector increasing the cultivated surface and production in the last decades for sustaining oil consumption and also bio-fuel industry. In the year 2019/2020, the EU-28 cultivated 10.43 Million ha with rape, sunflower and soybean and the seeds production is estimated at 28.13 Million tons [12].

Grace to its geographical position, fertile soil and temperate continental climate, oleaginous plants find favorable conditions to grow in Romania, which is an important producer and exporter of oilseeds both in the EU and worldwide. The main oleaginous plants cropped in the country being sunflower, rape and soybean, and a very small proportion flax and castor, and their cultivated areas and production performance raised across the time [14, 15, 16, 20, 26,28, 29].

Since 2013, the EU launched a special programme "involving innovation and research to improve oil and protein content and support the development of the oilseeds crops value chains, apply integrated weeds management, fight against diseases and pests" which stimulated the main producing countries, including Romania to intensify their efforts to reach a higher performance [31].

In this context, the paper aimed to analyze the trends and changes in the cultivated area and production for sunflower, rape and soybean in Romania in the last decade, more exactly 2010-2019 in order to assess the country performance compared to the other producing countries in the EU-28 and to forecast the 2020-2024 horizon.

MATERIALS AND METHODS

Data collection

The empirical data utilized in this research work for the cultivated area and oilseeds production were taken from the National Institute of Statistics Tempo Online, and Eurostat for the period 2010-2019.

Methodological aspects

The data were processed both at the national level and also for the main three oilseed crops: sunflower, rape and soybean, flax and castor being of less importance.

The principal methodological aspects taken into consideration in this study have been the following ones:

Trend line and function, based on the linear regression, $y = a + bx$, which was displayed on every chart and the *coefficient of determination* which accompanied the mathematical model to justify in what measure the model is suitable to the dynamics of each analyzed variable and for each crop.

The illustration graphs were used to point out much better how the values of each studied variable are spread in the chart.

Fixed basis index, with its well known formula $I_{t/t0} = (y_t/y_0)100$ was useful for assessing the percentage increase or decrease of each variable level in the last year of the interval compared to the first one.

The average annual growth rate has been determined based on the formula: $\overline{\Delta y} = (y_n - y_0)/(n - 1)$;

The structural index (SI%) was used in order to quantify the share of each oilseed crop in the total cultivated area and seeds production in each year of the analyzed period.

The comparison method allowed to identify which are the main oilseeds plants cultivated in Romania and which ones contribute in the highest proportion to seeds production. Also, this method was used to compare Romania's performance in cultivated area and oilseeds production to the levels achieved by other EU-28 member states.

Forecast of the cultivated area and seeds production for the horizon 2020-2024 was established taking into account the observed records noticed in the year 2019, the last one of the analyzed chronological data for the two indicators and also the average annual growth in the period 2010-2019.

For this purpose, Extrapolation Method was used to estimate the future levels for cultivated surface and production using the formula: $y_t = y_o + n_0 \times \overline{\Delta y}$, where: y_t is the extrapolated indicator for t time horizon; y_o is the value of the indicator in the first year of the analysis, considered the basic value; n_0 is the number of years of in the forecast horizon; and $\overline{\Delta y}$ is the average annual growth in absolute value.

The results were included in tables and displayed on charts, accompanied by comments and interpretations. The main ideas resulting from the research results were presented in the conclusions from the end of the paper.

RESULTS AND DISCUSSIONS

Cultivated area

Oilseeds cultivated area increased by 27.38 % from 1,413 thousands ha in 2010 to 1,800 thousand ha in 2019. The average annual growth was 43 thousand ha in the analyzed interval. This was due to farmers who were interested to grow the cultivated area with oilseeds crops, mainly with sunflower, rape, soybean and in a smaller measure with flax and castor. But, the main crops which cover 99.6% of the whole cultivated area with oilseeds plants are sunflower, rape and soybean (Fig. 1).

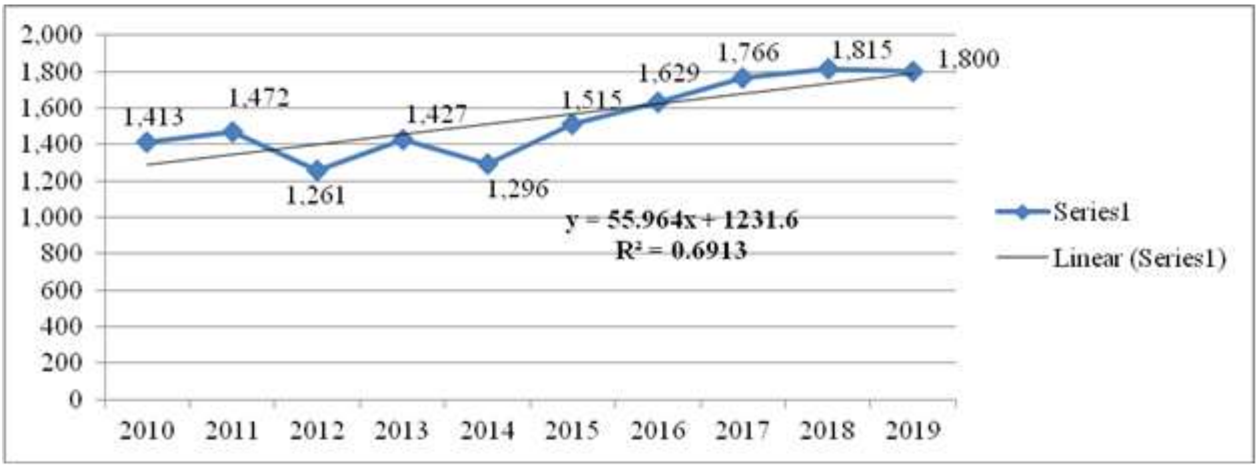

Fig. 1. Cultivated area with oilseeds crops, Romania, 2010-2019 (Thousand ha)
Source: Own design based on the data from [19].

For oilseeds cultivated area, including sunflower, rape and turnip rape for seed and soybean, Romania comes on the 2nd position after France, being followed by Germany, Bulgaria, Poland, Hungary and United Kingdom. Romania's share in the cultivated area of the EU-28 with oilseed crops was 13.04% while France keeps 19.37% (Table 1).

The cultivated area with ***sunflower*** increased by 62.19% in the last decade from 791 thousand ha in 2010 to 1,283 thousand ha in 2019. Sunflower is "the queen" of oilseeds plants dominating rape and soybean from the point of view of the sown and harvested area and obtained production [24, 26].

This crop brings a high satisfaction to farmers by its high production and returns as well. Sunflower seeds are destined for producing oil in the manufacturing industry to cover the domestic market needs in food and bio-fuel and also they are subject of export [2, 9] (Fig. 2).

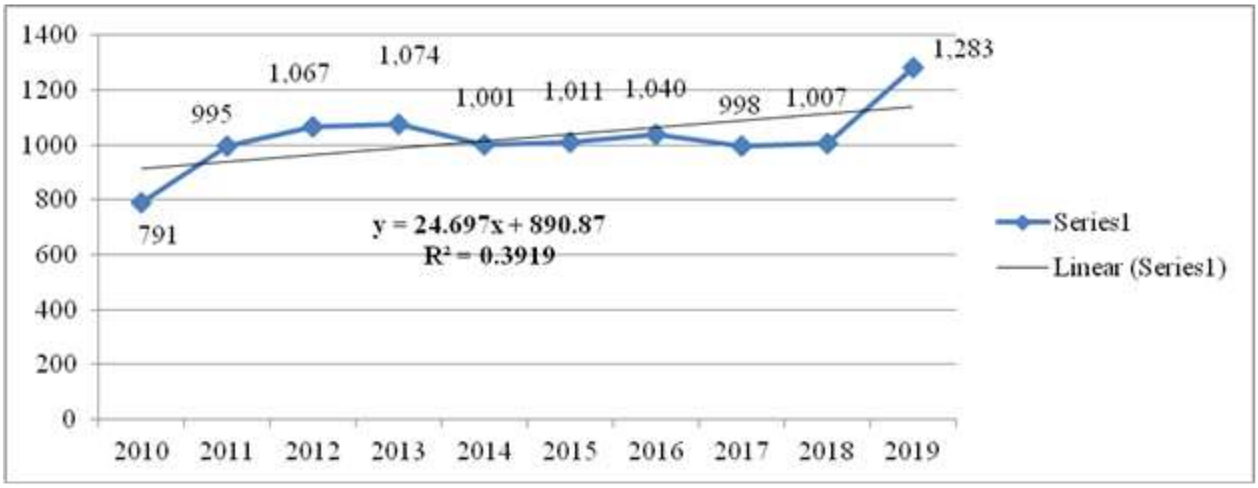

Fig. 2. Cultivated area with sunflower, Romania, 2010-2019 (Thousand ha)
Source: Own design based on the data from [19].

In the EU-28, Romania is on the top position for the cultivated area with sunflower which accounted for 1,111.5 ha, representing 26.48% of the EU surface with this crop in the year 2018. Other important European countries for sunflower cultivation are, in the decreasing order: Bulgaria, Spain, France and Hungary [1, 13] (Table 1).

Rape is also a supplier of oil for bio-fuels which determines Romanian farmers to cultivate larger surfaces and produce more seeds [6, 28].

The cultivated area with rape accounted for 353 thousand ha, being by 34.27% smaller than in 2010, when it was 537 thousand ha. However, in the analyzed period, it was found a general increasing trend, but also variations in certain periods. In the period 2010-2012, the surface declined reaching the smallest level in 2012, only 105 thousand ha. Starting from 2013, farmers begun to cultivate larger surfaces with rape and in 2018, the cultivate area registered the highest level, 633 thousand ha. This happened as rape is considered one of the crops of high importance in the EU-28 for producing bio-fuels and farmers benefited of substantial incentives to increase production (Fig. 3).

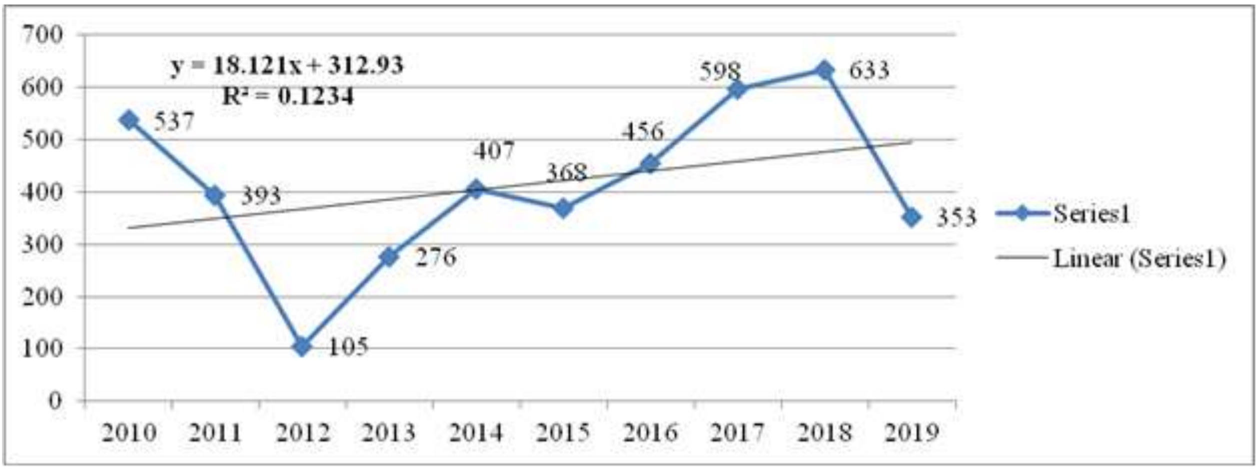

Fig. 3. Cultivated area with rape, Romania, 2010-2019 (Thousand ha)
Source: Own design based on the data from [19].

For the cultivated area with rape, accounting for 367.9 thousand ha in 2018, Romania was situated on the 5th position in the EU-28, after France, Germany Poland and United Kingdom [13].

The cultivated area with ***soybean*** increased in Romania in the highest proportion in the studied interval by 146.87% or 2.46 times. In 2019, this crop was cultivated on 158 thousand ha in comparison with only 64 thousand ha in 2010 (Fig. 4).

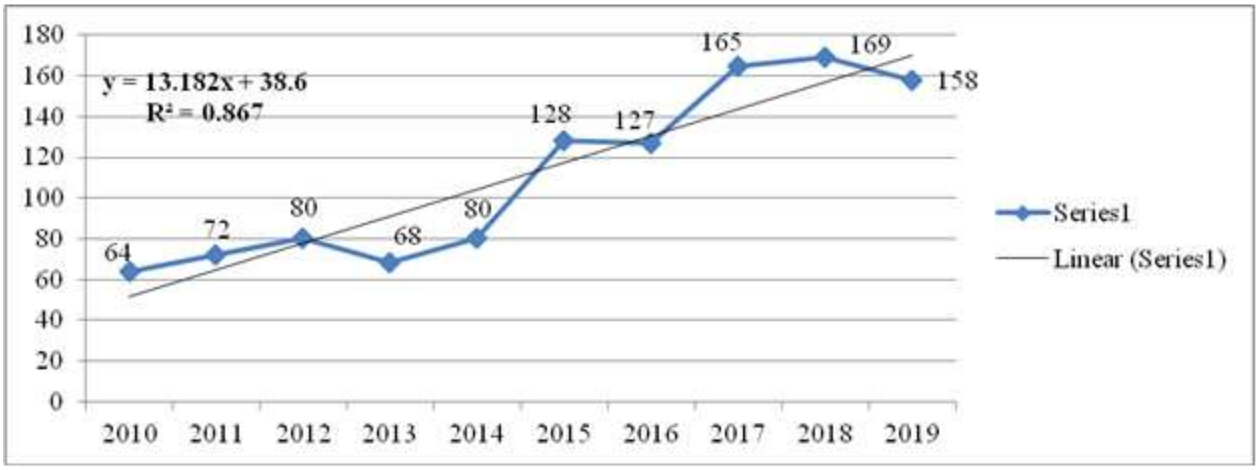

Fig. 4. Cultivated area with soybean, Romania, 2010-2019 (Thousand ha)
Source: Own design based on the data from [19].

In the EU-28, Romania comes on the 2nd position for the cultivated area with soybean, after Italy, being followed by France, Croatia and Hungary [3, 7, 11, 13] (Table 1).

Table 1. Romania's position in the EU-28 for the cultivated area and production of oilseeds crops in the year 2015

Sunflower, rape and soybean			Sunflower			Rape and turnip rape for seeds			Soybean		
	Cultivated area ('000 ha)	Production ('000 tons)		Cultivated area ('000 ha)	Production ('000 tons)		Cultivated area ('000 ha)	Production ('000 tons)		Cultivated area ('000 ha)	Product. ('000 tons)
EU-28	11,555.1	31,913.5	EU-28	4,196.9	7,906.4	EU-28	6,465.3	21,701	EU-28	892.9	2,440.1
France	2,238.8	6,827.1	Romania	1,111.5	1,1785.8	France	1,498.6	5,307.6	Italy	309	1,117
Romania	1,507.5	2,967.3	Bulgaria	810.8	1,599.2	Germany	1,285.5	5016.8	Romania	128.1	262
Germany	1,315.9	5,086.1	Spain	736.9	769.2	Poland	947.1	2,700.8	France	122	334.2
Bulgaria	1,015.0	2,174.9	France	618.2	1,185.8	United Kingdom	652	2,542	Croatia	88	196.4
Poland	954	2,711.8	Hungary	611.1	1,557	Romania	367.9	919.5	Hungary	71	145.9
Hungary	904.2	2,293.3									
United Kingdom	652	2,571.0									

Source: Eurostat, 2020 [19].

The distribution of the cultivated area with oil seeds crops in Romania is presented in Table 2, from where we may easily notice that the largest surface is sown with sunflower which performs very well in the plains having a good soil and climate conditions in general.

Table 2. The structure of the cultivated area with oil plants by crop, Romania, 2010-2019 (%)

	Sunflower	Rape	Soybean	Flax	Castor
2010	56.0	38.0	4.5	0.07	1.43
2011	67.6	26.7	4.9	0.14	0.66
2012	84.6	8.3	6.3	0.23	0.57
2013	75.3	19.3	4.8	0.21	0.39
2014	66.9	27.2	5.3	0.13	0.47
2015	66.7	24.3	8.4	0.13	0.47
2016	63.8	28.0	7.8	0.12	0.28
2017	56.5	33.9	9.3	0.11	0.19
2018	55.5	34.9	9.3	0.11	0.19
2019	71.3	19.6	8.8	0.17	0.13

Source: Own calculation based on the data from [19].

It is obviously that the interest of farmers for sunflower is high as long as this crop produce a high production of seeds of which an important part is subject of a successful export after covering the required oil supply for domestic consumption and industry.

Therefore, the share of sunflower in the cultivated area with oilseeds crops increased from 56% in 2010 to 71.3% in 2019.

The share of rape in the cultivated area with oil seeds crops has largely varied from 8.3% in 2012 to 38% in 2010, the highest weight and also in 2018, the share was 34.9%.

Regarding soybean, the share of this plant in the cultivated area with oil plants increased from 4.5% in 2010 to 8.8% in 2019, after the highest level achieved in the years 2016 and 2017, reflecting a higher and higher importance among oil seeds crops (Table 2).

Oilseeds production

A double oil seeds production was registered by Romania in 2019, accounting for 4,792 thousand tons compared to 2,378 thousand tons in 2010. The growth of the cultivated land with this crop as well as the yield performance have had a good impact on output level. The average annual growth in oilseeds production in the analyzed interval was + 268.2 thousand tons (Fig. 5).

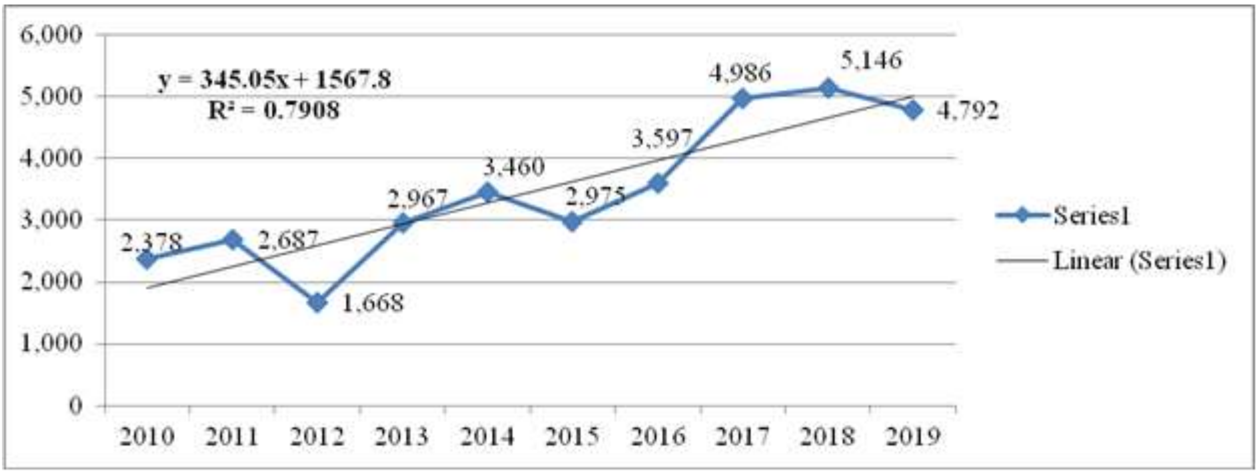

Fig. 5. Oilseeds production, Romania, 2010-2019 (Thousand tons)
Source: Own design based on the data from [19].

For its high production of sunflower, rape and soybean seeds Romania came on the 3rd position in the EU-28 after France and Germany [13] (Table 1).

Sunflower production is the main contributing factor to the increase of oils seeds production. If in 2010, sunflower accounted for 53.1% in total oil seeds production achieved by Romania, in 2019, its share reached 74.4% (Fig. 6).

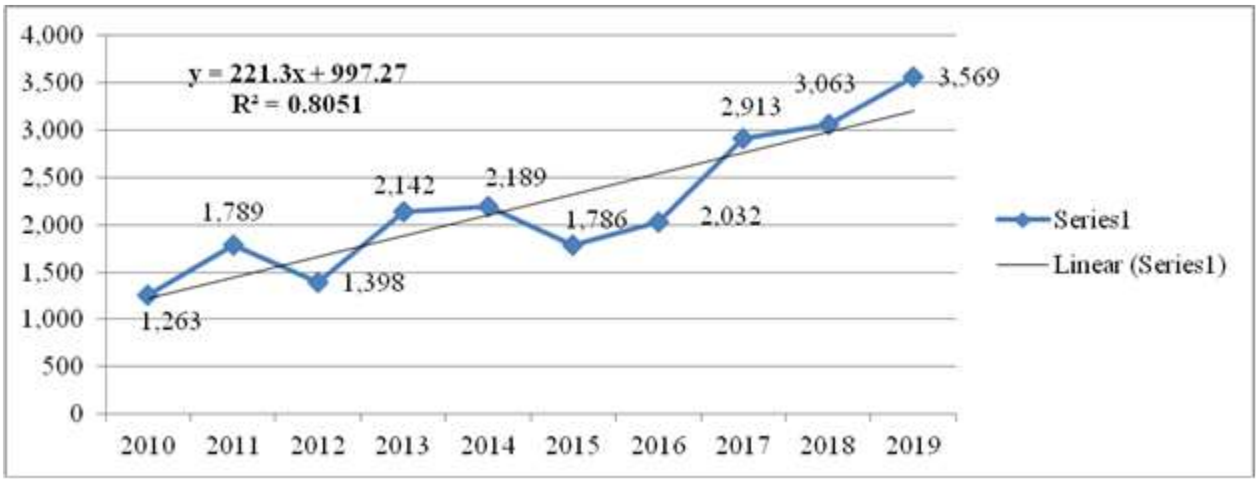

Fig. 6. Sunflower seeds production, Romania, 2010-2019 (Thousand tons)
Source: Own design based on the data from [19].

Compared to 1,263 thousand tons carried out in 2010, in 2019, Romania produced 3,569 thousand tons sunflower seeds, by 182.58% more, reflecting an average annual growth of +256.2 thousand tons (Fig. 6). In the last years 2015-2019, Romania kept its top position in the EU-28 for its sunflower seeds output [1, 13, 26] (Table 1).

Also, Romania is ranked the 4th at the world level for sunflower seeds production after Ukraine, Russia and Argentina, and being followed by China [10].

Rape seeds output has also registered a general ascending trend, but with some inflexions determined by the climate change, the long periods of drought like in the year 2012, when production recorded the lowest level, 157 thousand tons, and 2019, when production accounted for 798 thousand tons, being by 15.4% lower compared to the 2010 level and by 50.5% lower than in 2018 (Fig. 7).

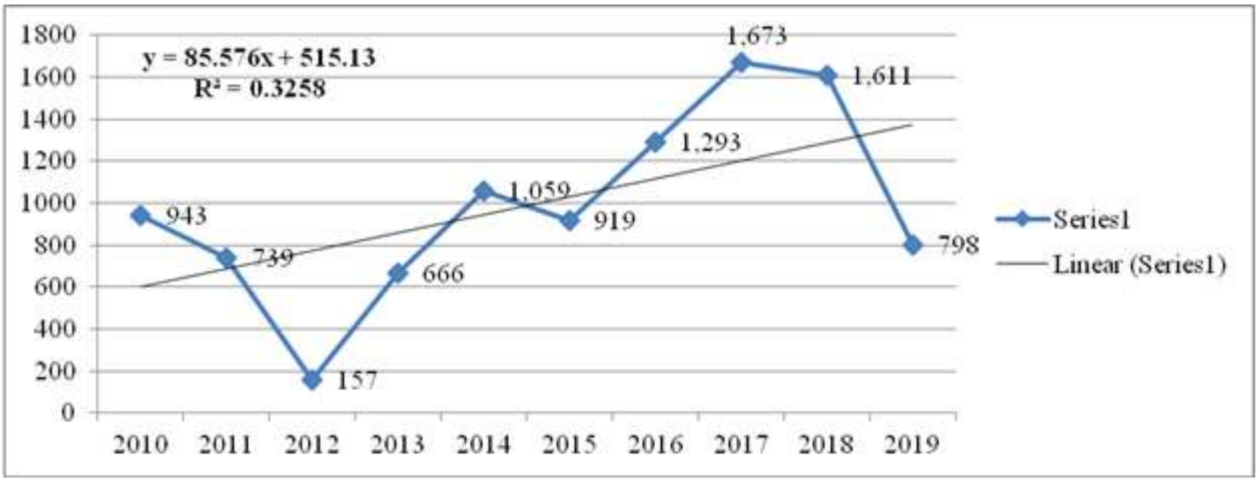

Fig. 7. Rape seeds production, Romania, 2010-2019 (Thousand tons)
Source: Own design based on the data from [19].

For rape seed production, Romania is ranked the 5th in the EU-28 after France, Germany, Poland, and United Kingdom [13] (Table 1).

Soybean seeds production has also recorded an increasing trend so that in 2019 it reached 416 thousand tons, being 2.77 times higher than in 2010. The highest production level was noticed in 2018, being sustained not only by the raised cultivated area but also by the mean performance per ha [7, 16, 31] (Fig. 8).

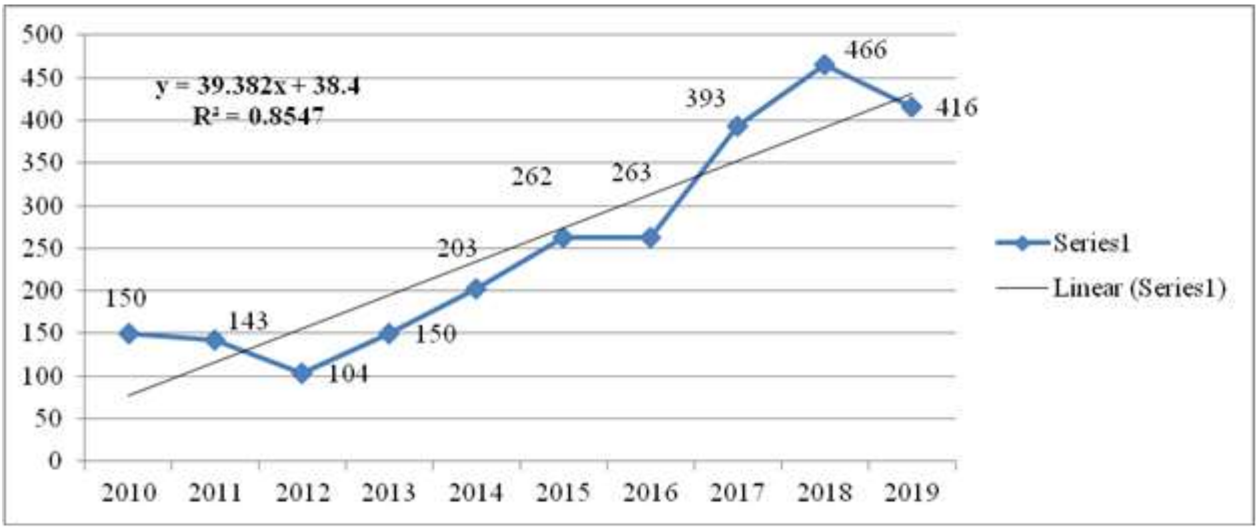

Fig. 8. Soybean seeds production, Romania, 2010-2019 (Thousand tons)
Source: Own design based on the data from [19].

For its soybean production Romania is on the 3rd position in the EU-28 after Italy and France [13]. However, Romania is back on the list of the main world soybean producers, the leader being USA [3] (Table 1).

The distribution of oilseeds production by crop is different due to the important place each crop place in Romania's vegetal production.

Sunflower is far away the most important oilseeds crop in Romania, giving 74.5% contribution to the national output in 2019 compared to 53.1 % in 2010.

On the 2nd position comes rape whose share in oilseeds output declined from 40% in 2010 to 16.65 in 2019. However, the decrease of rape weight at 9.4% in 2012 and at 16.6% in 2019 was caused by the severe drought in those years.

Rape succeeded to contribute to oilseeds production by 35.9% in 2016, which was the highest share registered after 40% in 2010. Therefore, rape crop is able to give good production if the climate conditions are favorable.

The share of soybean accounted for 6.3% in 2010 oilseeds production and for 8.75 in 2019, reflecting a positive tendency. But, the highest weight 9.1% was achieved in the year 2018.

Small production shares belong to the other two oilseeds crops, flax and castor (Table 3).

Table 3. The structure of the oilseeds production by crop, Romania, 2010-2019 (%)

	Sunflower	Rape	Soybean	Flax	Castor
2010	53.1	40.0	6.3	0.08	0.52
2011	66.5	27.5	5.3	0.11	0.59
2012	83.8	9.4	6.2	0.18	0.42
2013	72.2	22.4	5.0	0.13	0.27
2014	63.3	30.6	5.9	0.08	0.12
2015	60.0	30.9	8.8	0.13	0.17
2016	56.5	35.9	7.3	0.08	0.22
2017	58.4	33.5	7.9	0.08	0.12
2018	59.5	31.3	9.1	0.06	0.04
2019	74.5	16.6	8.7	0.12	0.08

Source: Own calculation based on the data from [19].

Forecast of cultivated area with oilseeds crops and of seeds production

Starting from the performance achieved in the year 2019 and taking into consideration the average annual growth in the analyzed period 2010-2019, it was established the forecast for 2020-2024 horizon.

It is estimated that in the year 2024, Romania will cultivate oil seeds crops on 2,015 thousand ha of which 1,558 thousand ha with sunflower, 267 thousand ha with rape and 208 thousand ha with soybean (Table 4).

Table 4. Forecast for the cultivated area with oilseeds plants in Romania for the 2020-2024 horizon (Thousand ha)

		Oilseeds crops	Sunflower	Rape	Soybean
Average annual growth rate, $\bar{\Delta}$		$\bar{\Delta} = 43$	$\bar{\Delta} = 55$	$\bar{\Delta} = -20$	$\bar{\Delta} = 10$
2019	Achieved	1,800	1,283	353	158
2020	Estimated	1,843	1,338	333	168
2021	Estimated	1,886	1,393	313	178
2022	Estimated	1,929	1,448	293	188
2023	Estimated	1,972	1,503	280	198
2024	Estimated	2,015	1,558	267	208

Source: Own calculation.

In case of production, it was estimated that the oilseeds output will reach 4,792 thousand tons in the year 2024. And the levels of production by crops could be the following one; 4,850 sunflower seeds, 718 rape seeds and 561 soybean seeds (Table 5).

Table 5. Forecast for the oilseeds production by crop in Romania for the 2020-2024 horizon (Thousand tons)

		Oilseeds crops	Sunflower	Rape	Soybean
Average annual growth rate, $\bar{\Delta}$		$\bar{\Delta}$ = 268.2	$\bar{\Delta}$ = 256.2	$\bar{\Delta}$ = -16	$\bar{\Delta}$ = 29.5
2019	Achieved	4,792.0	3,569	798	416
2020	Estimated	5,060.2	3,825.2	782	445
2021	Estimated	5,328.4	4,081.4	766	474
2022	Estimated	5,596.6	4,337.6	750	503
2023	Estimated	5,864.8	4,593.8	734	532
2024	Estimated	6,133.0	4,850.0	718	461

Source: Own calculation.

Therefore, there are expected increases of production in case of sunflower and soybean, and a decline in case of rape.
Of course, this forecast supposes that in the next five years the technological factors and soil and climate conditions will remain unchanged.

CONCLUSIONS

The research results pointed out the efforts made by Romania to increase the oilseeds cultivated area and production during the decade 2010-2019.
In 2019, Romania cultivated 1.8 million ha with oleaginous plants, of which 71.3% sunflower, 19.6% rape and 8.8% soybean, the surfaces increased in case of sunflower and soybean and declined in case of rape.
The oilseeds production has also had an ascending dynamics and in 2019 the output reached 4,792 thousand tons, of which; 74.4% sunflower seeds, 16.6% rapeseeds and 8.6% soybean seeds. While sunflower and soybean seeds production increased, rape seeds production recorded a decline.
The forecast for the year 2024 is that Romania will cultivate 2,015 thousand with oleaginous plants, of which sunflower 77.3 %, rape 13.2% and soybean 10.3%, and regarding production performance it is expected to obtain 6,133 thousand tons oilseeds of which 79% from sunflower, 11.7% from rape and 7.5 % from soybean.
The decline in rape production is explained by the severe droughts Romania was facing during the last years which affected very much especially this oil crop.
Taking into account its oilseeds production performance, in the EU-28, in 2019, Romania came on the 3rd position for the whole oilseeds output, on the 1st position for sunflower output, on the 2nd position for soybean output and on the 5th position for rape production.
Taking into account these results, Romanian farmers have to continue to improve their performance in oilseeds production by paying attention to the following aspects:
- to use high production potential varieties and hybrids and resistant to drought, diseases and pests;
- to use only the homogenous seeds at sowing so that to be able to obtain an uniform culture;
- to identify the optimum moment for sowing according to the favourable conditions related to soil moisture and air temperature which have a positive influence on seeds germination, plant appearing, pollination and oil content;
- to assure an optimized crop rotation, avoiding monoculture;
- to optimize the fertilization level avoiding the excess in nitrogen and the lack of phosphorous and potassium, which could led to a lower seeds and oil production and a diminished plant resistance to fall;
- to keep under control weeding applying modern integrated technologies;
- taking into account the climate change Romania was facing during the last years, farmers have to adapt the technologies to the new conditions using earlier cultivars, choosing the best period for sowing depending on the soil moisture and

temperature, assuring an optimum fertilization level and crop maintenance and harvesting.

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SORGHUM PRODUCTION IN THE EU-28 IN THE PERIOD 2008-2019 AND ITS FORECAST FOR 2020-2014 HORIZON

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Abstract

The paper analyzed the status of Sorghum cultivated area, production and yield at the EU-28 level and in each producing country in the period 2008-2019, and then the forecast for these indicators was estimated for the horizon 2020-2024. Fixed index, trend line, descriptive statistics and regression modeling were used to process the data. The cultivated surface with sorghum in the EU reached 197 thousand ha in 2019, being almost double than on 2008. The cultivated area with Sorghum increased in all sorghum producing countries: France, Italy, Hungary, Romania, Bulgaria, Austria and Greece, except Spain and Slovakia were it remained constant. The largest cropped areas are in France, Italy and Romania, accounting for 76%. Sorghum output doubled its figure and in 2019 reached 1,019 thousand tons. About 91% of production being achieved by France (431), Italy (312), Hungary (117) and Romania (68). The EU yield was 5,179 kg/ha, but higher yields were recorded by Austria, Italy and France. In 2024, it is estimated that the EU will produce 1,045 thousand tons sorghum. Production will increase in Italy, Austria, Bulgaria, Romania and Greece, will decline in France and Hungary and will remain constant in Spain and Slovakia. The EU will continue to pay attention to this crop as a response to climate change. The main purposes of sorghum being animal feed, biomass for bio-fuels, raw material in food industry, component in crop rotation, maintenance of biodiversity and environment preservation.

Key words: *Sorghum, cultivated area, production, present status, forecast, EU*

INTRODUCTION

Sorghum is among the top cereals cultivated in the world coming on the fifth position after corn, rice, wheat and barley [23].
Sorghum is one of the basic crops providing food in the geographical regions with the highest temperatures and arid climate of the globe like Africa, Central America, and South Asia, where grains are not able to produce as much as it is needed to nourish the population. Therefore, Sorghum is an important plant in human nutrition.
Secondly, Sorghum is an important animal feed for pigs, poultry, and even dairy cows in various recipes (mixed concentrated feed, silage, grazing etc).
Thirdly, Sorghum is a raw material, an excellent resource of biomass for producing renewable energy in terms of bio-fuels.
While the tropical and semi-tropical countries from Africa, Central America Asia are interested to produce Sorghum especially as human food, in the USA, South America and Europe, Sorghum is mainly used as animal feed and as a bio-fuel resource [10].
This crop is highly resistant to high temperatures and long periods of drought as it has a deep root able to penetrate the ground and find moisture. Its requirements for water are lower compared to other crops, and for this reason it is appreciated as a friendly plant with the environment assuring water preservation.
The need in fertilizers is also low in case of Sorghum compared to corn, as its long and branched root has the capacity to fix nitrogen from the soil, a reason to include this plant in crop rotation reducing the amount of fertilizers per ha and production costs [23].

In the regions where maize is deeply affected by the extreme phenomena like high temperatures and severe droughts due to the climate change, Sorghum looks to be the only alternative to produce food, feed and bio-fuels.

The world Sorghum production increased across the time and reached 66 million tons, the top level in 2015, then it declined a little, and stabilized around 60 million tons in 2020/2011, keeping its 5th position among the world most cultivated cereals [24, 26, 37, 38, 40].

The top 10 producing countries worldwide, based on Sorghum output level in 2019 in million metric tons, were, in the decreasing order: USA (8.7), Nigeria (6.7), Ethiopia (5.2), India (4.6), Mexico (4.3), Sudan (4), China (3.6), Argentina (2.5), Brazil (2.20 and Niger (1.9) [16, 35].

The world cultivated area with *Sorghum bicolor* increased from 40.9 million ha in the year 2000 to 44.77 million ha in 2016, being ranked the third after maize and barley [16, 18, 29, 35].

Production increased due to the higher and higher requirement for consumption, whose level reached 63.2 million tons globally in 2017. The biggest Sorghum consumers are China (14%), followed by USA, Sudan, Mexico, India, Ethiopia and Argentina.

Due to the high demand, Sorghum global trade has been intensified so that in 2017, it was traded an amount of 7.6 million tons. The main exporting countries are USA, Australia, Argentina and Ukraine, while the principal importing countries are China, Japan, Mexico, the EU-28, Kenya and South Africa [24].

The changes in Sorghum cultivated area, yield, production and trade at the global level and in various geographical regions are caused by a large range of factors among which the most important ones are: climate change, demographic growth, economic development, agricultural inputs, demand for other agricultural crops, the scarcity of agricultural resources, the need to preserve biodiversity, traditions in agricultural practices and cultures, production and consumption, and cereal price volatility [25].

The EU-28 is not an important producer of Sorghum, but its interest has become more evident for this plant mainly during the last decades when the change in the global climate started to affect almost all European countries, but especially the ones situated in the Southern, Central and Eastern part of Europe, where the temperatures have significantly increased year by year and long periods of drought and other extreme meteorological phenomena diminished agricultural production and farmers' income. Therefore, sorghum cultivation in the EU is related to weather conditions (spring frosts, spring-summer droughts, heat waves, winds, heavy rainfalls) which affect seeds germination, plant development in vegetation stage, pollination, harvesting and lead to production and income losses, to an unbalanced demand/offer ratio with a negative effect on price.

Bioethanol is considered the fuel of the future which could produced green energy, preserving the fossil resources, assuring a healthy environment diminishing the release of CO_2 in the atmosphere. For this reason, Sorghum is an alternative to corn in the temperate regions for producing biomass for ethanol or biogas production, and farmers look to be interested in this business [6, 9, 27].

The need to adapt crop structure and mapping to climate change and produce bio-fuels determined the EU to establish a Programme which promote Sorghum among farmers sustaining their business with subsidies destined to expand the cultivated area, increase yields and production, and reduce imports [11, 12, 20, 23].

As a result, Sorghum started to be cultivated area on larger surfaces in France, Italy, Romania, Spain, Bulgaria, Hungary, and even in Austria, Greece and Slovakia. Compared to maize, Sorghum proved its higher efficiency in production performance being drought resistant and lower cost [33, 36].

It is expected as the geographical area of sorghum cultivation to move to the Northern European countries because of the high temperatures which also reached this part of the continent and where it is a lower water requirement. In this area, sorghum could be an alternative to corn silage in various variants [13, 15].

In this context, the paper aimed to study the dynamics of Sorghum cultivated area, yield and production at the EU-28 level and in the producing countries in the period 2008-2019 and estimate the production forecast for the period 2020-2014.

MATERIALS AND METHODS

Data collection

The paper was set up based on the data provided by Eurostat for the period 2008-2019.

The studied indicators were:

(i)cultivated area with Sorghum both at the EU level and by each producing country;

(ii)Sorghum production both at the EU level and by each producing country;

(iii)Sorghum yield both at the EU level and by each producing country.

These indicators were studied in their dynamics identifying the main trends both at the EU-28 level and in each producing country. Based on these results, it was established the level of sorghum production in the period 2020-2024 for each country and at the EU level.

Methodological aspects used in this study

Dynamics analysis was used in order to quantify the growth rate on the interval 2008-2019, based on the formula: $I_{FB(\%)} = (Y_n/Y_0)100$, where: Y_n is the value of the variable in the year n and Y_1, the value of the variable in the year 0.

Trend line for each indicator was established using the linear regression, $Y(t_i) = a + bx_{ti}$

Descriptive statistics in terms of mean, standard deviation, coeffcient of variation, minumum and maximum value.

The market share of each Sorghum producing country in the EU-28 cultivated area with Sorghumand production.

Forecast for the 2020-2014 horizon was established using the system of normal equations and the Least Square Method which allowed to determine the value of the parameters a and b and finally to set the linear regression model, $Y(t_i) = a + bx_{ti.}$

The results are included in tables and illustrative graphics and the main aspects have been commented and interpreted.

Finally, the key results are pointed out in conclusions.

RESULTS AND DISCUSSIONS

Cultivated area

The EU-28 has a relatively small cultivated area with Sorghum, but its dynamics reflects a continuous increasing trend in the period 2008-2019. From 97 thousand ha in 2008, the EU doubled its sorghum surface which accounted for 187 thousand ha in 2019 (Fig. 1).

In Europe, there are four types of Sorghum which are cultivated: Grain Sorghum, Sweet Sorghum, Sudan grass along with Sorghum and Broomcorn [4].

Sorghum is cultivated in a small number of countries situated mainly in the Southern, Central and Eastern Europe, where climate conditions are suitable for this crop. Because during the last decade higher temperatures and drought affected cereal crops in this geographical part of Europe, Sorghum could be an alternative to maize having a high resistance to drought grace to its deep root able to find water in the ground and giving high productions which could be successfully used as animal feed, raw material for renewable energy based on biomass, and even as food being a gluten-free plant with mutiply uses in food industry.

The countries dealing with Sorghum cropping in the EU are France, Italy, Hungary, Romania, Spain, Bulgaria, and in a smaller measure Austria, Greece and Slovakia.

The purposes why Sorghum is grown in the EU is as animal feed, as raw material for bio-fuels, and medicinal goals, as the plant is gluten-free and could be included in treatments against various diseases, in food industry for carrying out various flours, syrups, beer and other products and also it is expected as production growth to reduce imports [9, 31].

Sorghum is used in animal diets (as silage for dairy cows), mixed feed (for poultry and pigs), grace to its low tannin content in the chemical composition.

But, from a country to another, the purposes could differ.

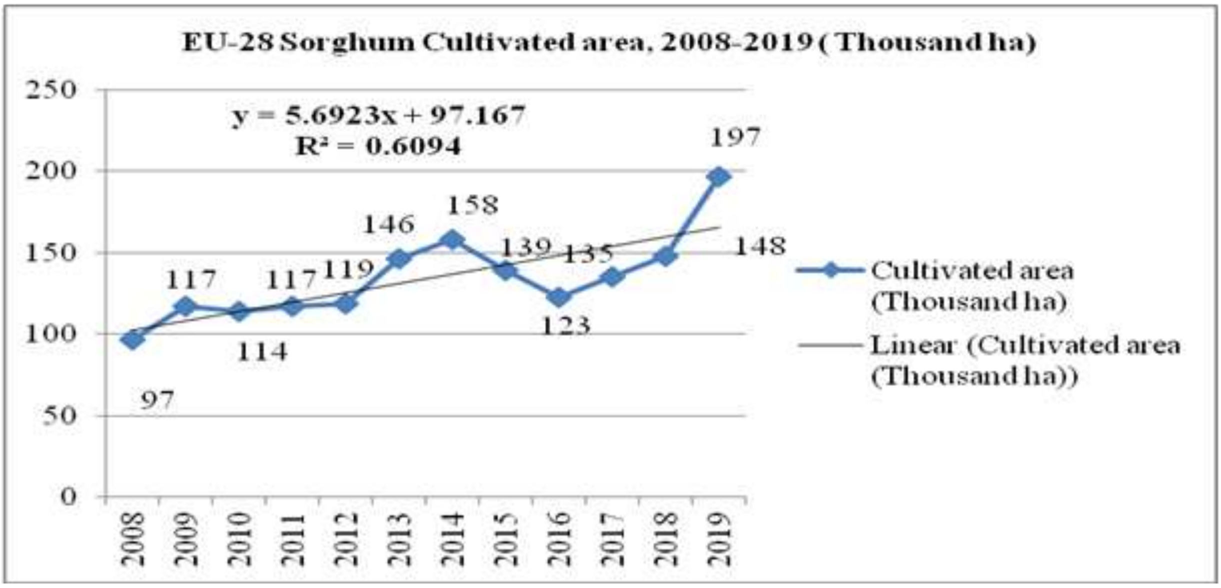

Fig. 1. The cultivated area with Sorghum in the EU-28, 2008-2019 (Thousand ha)
Source: Own calculation and design based on Eurostat Data, 2020 [14].

In France, Sorghum is mainly raised in the South West of France, but also in North East where fodder production is not enough. It is also a good plant in crop rotation to assure a better weed, pest and disease management, and has a benefic economic and environmental impact, taking into account as it could be also used for methanisation [39].

In Italy, Sorghum is produced on larger surfaces than millet, and the main purposes are: animal feed for pigs and cattle (mixed feed, silage, green mass, grazing), biomass for bio-fuels (ethanol and biogas), and raw material for food and pharmaceutical industry. Sorghum is cultivated in almost all the regions of Italy, and during the last decades in the territories where maize is usually cropped. The largest surfaces cultivated with Sorghum are in Emilia-Romagna Region (about 22%), but also Modena (11.3%), Ravenna (9.4%), Ferrara (8.3%), Forli-Cesena (4.3%), Alessandria (3.7%), Sienna (2.4%) etc. The production varies between 7-8 tons/ha, the highest level being achieved in the North-Central Italy. Because *Diabrotica virgifera* affected very much the crops in the Northern Italy, Sorghum cropped after maize succeeded to avoid damages [6, 9, 27].

In Spain, Sorghum is raised in North West of Madrid in the region of Castilla y Leon, and it is mainly used for pig feeding with mixed food. The extend of surfaces and production will diminish the imports from France and Ukraine, and also will be in the benefit of the farmers affected by droughts for other crops in the South West of Spain and in the North East [19].

In Hungary, grain sorghum is a substitute of maize in fodder mixtures for poultry (30–50%) and pigs (20%), and also it is used in food industry as a gluten-free and low tannin compound in various products. Compared to maize, Sorghum silage is a good forage for cattle and sheep in winter, to maintain yields in dry seasons and on less fertile soils. Sudan grass is used for grazing, chopped green mass, silage and hay [17]. Specific to Hungary it is the tradition as maize and sorghum to be cultivated together, according to the long intercropping cultivation system for producing silage for dairy cows. In the dry years, sorghum performed much better than maize and the mixed silage proved a higher quality given by the higher nutritive value than cultivating Sorghum alone [22].

In Romania, Sorghum is used as grains and also green mass. Grains are used for producing mixed feed for poultry and pigs, and green mass is used as such or grazing or as silage for dairy cows. Also, grains are used in food industry for producing flour, starch, ethylic alcohol, beer, juices, alcohol and also for medicines. In the recent decade, farmers look to be more interested to cultivate Sorghum as biomass for bio-fuels (biogas, bioethanol) due to the attractive subsidies offered by the EU and to avoid losses registered in rape and maize crops due to the severe and long droughts recorded during the last years [28, 29, 30].

Sorghum is successfully cultivated in the West, North West, South and South East Romania, but also in the South Moldavia and Transilvania [3].

Sorghum yield performance varies between 4,000 and 7,000 kg per ha, but it also could reach about 10,000 kg. Economically, Sorghum crop is less costing than maize crop, due to the lower consumption of fertilizers and water, and produce a similar nutritive value like maize, sometimes even higher in case of a few hybrids. In addition, it is very resistant to *Diabrotica* attack [1].

In Austria, Sorghum has become more important due to the damages caused by *Diabrotica* in maize crop. At present Austria has 10,000 ha cultivated with sorghum, situated mainly in the pig breeding areas like Styria, Upper Austria, Lower Austria and Carinthia. Sorghum is produced to be used mainly like animal feed (mixed feed for pigs, and silage), for which the surfaces are continuously extending. Also, it is cultivated for biomass, for which the cultivated areas are stable. It is an efficient crop, with a low production cost, because it does not need any plant protection, except weed control [34].

In Greece, Sorghum bicolor L. Moench is used as an alternative for producing biomass of syrup or dry matter under a specific irrigation regime in the Central part of the country [32]. it also proved to be more profitable than maize for forage production under stressed conditions, a reason to extend the use of sorghum in crop rotations for forage for increasing farm income and protecting environment [8, 21].

In the analyzed period the cultivated area with Sorghum increased in all these countries, except Spain and Slovakia were it remained relatively stable. In the period 2008-2019, in France, the cultivated area increased from 37 thousand ha to 84 thousand ha in 2018 (+127%), in Italy from 39 thousand ha to 47 thousand ha (+20%), in Romania from 8 thousand ha to 19 thousand ha (+137%), in Hungary from 4 thousand ha to 25 thousand ha (+525%), in Bulgaria from 2 thousand ha to 7 thousand ha (+200%), and in Spain remained relatively constant at 7 thousand ha. Austria started to cultivate Sorghum on 1 thousand ha in 2010 and in 2019 the surface became 4 times higher. Greece started to cultivated this crop since 2014 on 2 thousand ha and in 2019 cultivated 3 thousand ha. Slovakia also started Sorghum cropping since 2009 and remained on the same surface of 1 thousand ha till present (Table 1).

Table 1. Statistical parameters of the cultivated area in the EU-28 Sorghum producing countries, 2008-2019

	EU-28	FR	IT	RO	HU	ES	BG	AT	EL	SK
N	12	12	12	12	12	12	12	10	6	11
Mean	134.1	53.0	43.5	13.2	6.6	7.5	4.5	2.4	2.8	1.0
St. Dev.	26.28	12.3	4.77	5.18	6.08	0.79	2.15	1.17	0.41	0.00
CV%	19.60	23.20	10.96	36.47	92.12	10.53	47.77	48.75	14.64	0
Min	97	37	38	6	3	6	1	1	2	1
Max	197	84	52	22	25	9	8	4	3	1
2019/ 2008%	203.1	227.0	120.5	237.5	625.0	100.0	300.0	400.0	150.0	100.0

Source: Own calculation based on Eurostat Data, 2020 [14].

If in 2008, the share of the cultivated area by each country in the EU cropped area with Sorghum was: 40.21% Italy, 38.15% France, 8.25% Romania, 7.2% Spain, 4.12% Hungary and 2.06% Bulgaria, in 2019 the situation was the following one: 42.64% France, 23.86% Italy, 12.695 Hungary, 9.65% Romania, 3.56% Spain, 3.55% Bulgaria, 2.03% Austria, 1.52% Greece and 0.5% Slovakia.

Sorghum production

In the EU-28, Sorghum output raised from 516 thousand tons in 2008 to 1,019 thousand tons in 2019, meaning a 1.97 times higher level than in the first year of the analysis (Fig. 2).

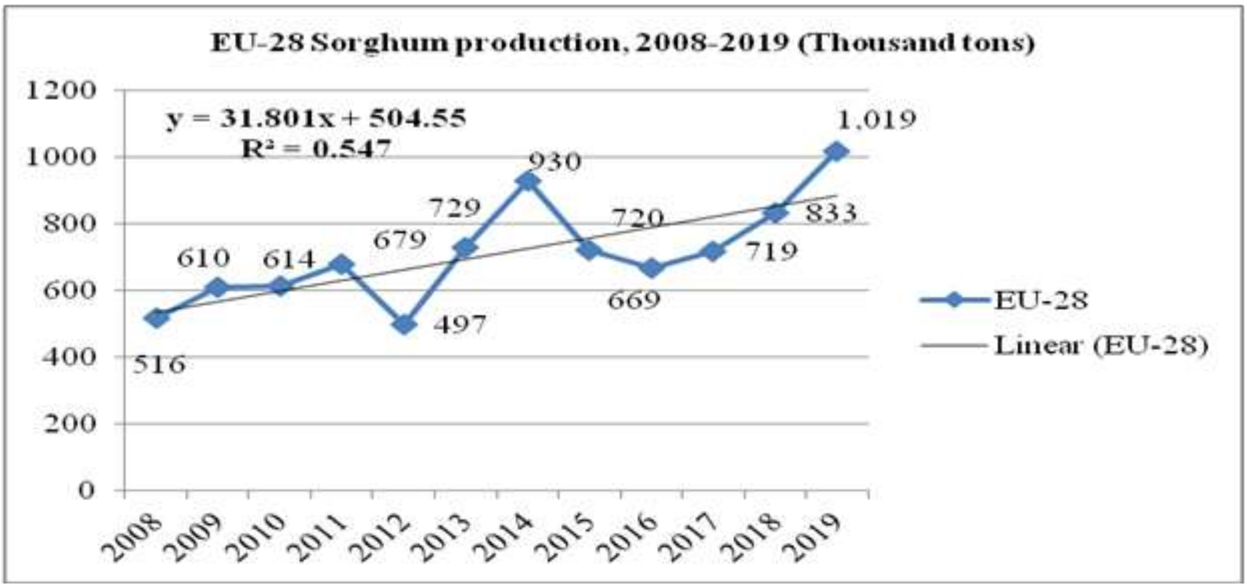

Fig. 2. Sorghum production in the EU-28, 2008-2019 (Thousand tons)
Source: Own calculation and design based on Eurostat Data, 2020 [14].

In the interval 2008-2019, Sorghum production increased in all the EU producing countries in various proportions. In France, it raised from 231 thousand tons to 431 thousand tons (+86.5%), in Italy from 225 thousand tons to 312 thousand tons (+38.6%), in Hungary from 14 thousand tons to 117 thousand tons (+737.7%), in Romania from 21 thousand tons to 68 thousand tons 9 (+223.8%), in Spain from 22 thousand tons to 27 thousand tons (+22.7%), in Bulgaria from 2 thousand tons to 23 thousand tons (+1,050%), in Austria from 7 thousand tons in 2010 to 30 thousand tons in 2019 (+328.5%), in Greece from one thousand ton in 2011 to 8 thousand tons in 2019 (+700%), and in Slovakia from one thousand ton in 2010 to 3 thousand tons in 2019 (+200%) (Table 2).

Table 2. Statistical parameters of the Sorghum production in the EU-28 producing countries, 2008-2019

	EU-28	FR	IT	RO	HU	ES	BG	AT	EL	SK
N	12	12	12	12	12	12	12	10	9	9
Mean	711.25	300.0	277.17	40.58	25.66	35.00	13.00	16.60	5.88	1.80
St. Dev.	155.03	61.49	54.26	19.82	30.22	9.33	9.51	8.46	3.55	0.78
CV%	21.79	20.49	19.57	48.84	117.77	37.32	73.15	50.96	60,37	43.33
Min	497	231	159	14	8	22	2	7	1	1
Max	1,019	431	369	76	117	51	36	30	10	3
2019/ 2008 %	197.4	186.5	138.6	323.8	835.7	122.7	1,150.0	428.5	800.0	300.0

Source: Own calculation based on Eurostat Data, 2020 [14].

In 2008, the contribution of the producing countries to the EU production was: France 44.78%, Italy 43.61%, Spain 4.26%, Romania 4.07% and Hungary 2.71%. In 2019, the situation was as follows; France 42.305, Italy 30.62%, Hungary 11.48%, Romania 6.67%, Austria 2.945, Spain 2.655, Bulgaria 2.26%, and on the last position Greece and Slovakia with 0.79% and, respectively 0.29%.

Sorghum yield at the EU level was in general over 5,000 kg/ha in almost all the studied years, except 2012 and 2013. If in 2008, the yield was 5,319 kg/ha, in 2019, it accounted for 5,172 kg/ha by 2.8% less. The lowest yield was registered in 2012, 4,176 kg, while the highest yield was recorded in 2014 and accounted for 5,886 kg/ha (Fig. 3).

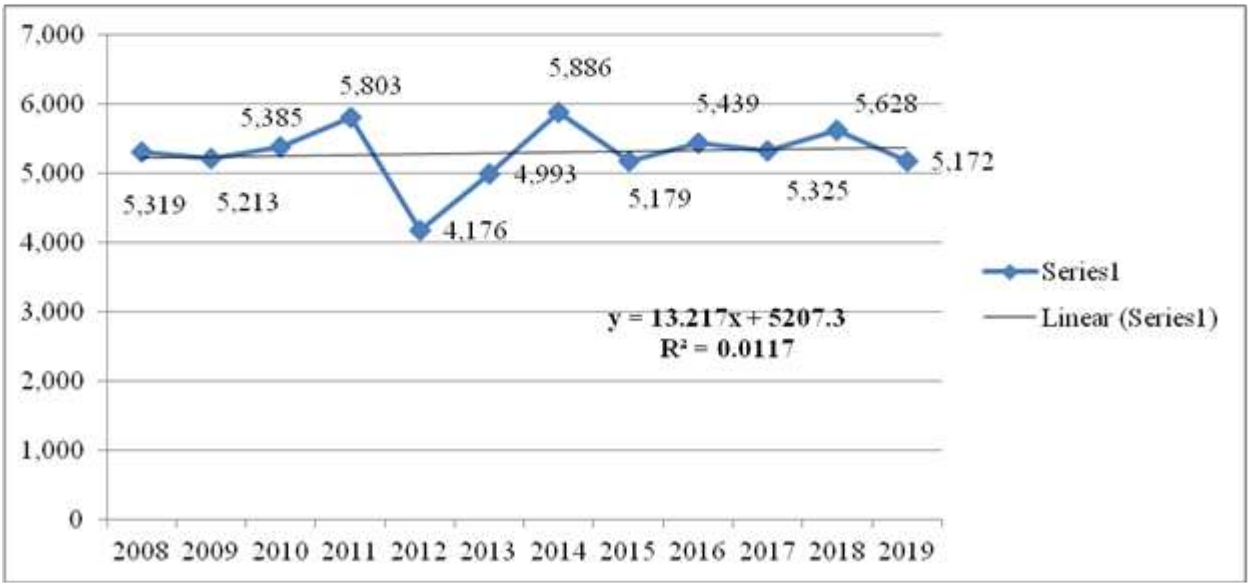

Fig. 3. EU-28 Sorghum yield, 2008-2019 (kg/ha)
Source: Own calculation and design based on Eurostat Data, 2020 [14].

Average production varied from a country to another depending on the variety and hybrids, local soil types and fertility, climate conditions, applied technologies, and farm structure.
It was noticed that the highest average yield in the analyzed interval was registered, in de decreasing order, as follows: Austria, Italy, France, Spain, Hungary, Greece, Romania, Bulgaria, and Slovakia.

Compared to 2009, in 2019, Sorghum yield was higher in Italy (+15.06%), Romania (+36.34%), Hungary (+33.71%), Spain (+22.71%), Bulgaria (+228.6%), Austria (+7.14%), and Slovakia (+50%), and lower in France (-17.82%), and Greece (-23.80%). Also, at the EU-28 level, the average yield declined by 2.77% (Table 3).

Table 3. Statistical parameters for Sorghum yield in the EU producing countries, 2008-2019

	EU-28	FR	IT	RO	HU	ES	BG	AT	EL	SK
N	12	12	12	12	12	12	12	10	6	6
Mean	5,293	5,625	6,337	2,824	3,498	4,657	2,673	6,967	2,916	2,167
St. Dev.	439.74	494.41	841.64	847.33	682.57	1,113.02	859.67	977.51	444.04	752.77
CV%	8.30	8.78	13.28	30.00	19.51	23.89	32.16	14.03	15.22	34.74
Min	4,176	5,104	4,184	1,850	2,667	3,143	1,000	5,000	2,333	1,000
Max	5,886	6.535	7,350	4,750	4,680	6,857	4,500	8,500	3,500	3,000
2019/ 2008 %	97.23	82.18	115.06	136.34	133.71	122.71	328.60	107.14	76.20	150.00

Source: Own calculation based on Eurostat Data, 2020 [14].

Sorghum production forecast for the 2020-2014 horizon

Using the linear regression models resulted for the EU-28 and each country producing Sorghum, it was established the forecast for the coming years 2020-2024, as presented in Table 4.

For the EU, it is expected as in 2020, Sorghum production to be lower than in 2019, and even in the coming years, and just in = 2024 to reach 1,045 thousand tons, being a little higher than in 2019.

In France, it is expected as Sorghum output to decline and reach 402 thousand tons in 2024, by 6.7% less than in 2019 [5].

In Italy, it is estimated that Sorghum production to continue its growth and reach 343 thousand tons in 2024, by 10% more than in 2019.

In Hungary, it is expected as the exceptional production of 117 thousand tons registered in 2019 not to be reached in the next years. The forecast for 2024 being for only 84 thousand tons.

Romania will continue to increase production year by year, being estimated that in 2024, the country will produce 86 thousand tons Sorghum.

Spain is expected to produce 35 thousand tons in 2020 and then production to remain stable till 2024 and for this reason it will continue to be the main importing country in the EU [2].

Bulgaria will substantially grow its Sorghum production which is expected to account for 35 thousand tons in 2024 by 52% more than in 2019.

Austria will also grow its production which it is expected to reach 42 thousand tons in 2024, meaning by 40% more than in 2019.

In Greece, also Sorghum output is estimated to raise and reach 16 thousand tons in 2024, a double level than in 2029.

In Slovakia, it is appreciated that Sorghum production will decrease in the next three years and in 2023 and 2024 to remain relatively stable at about 3 thousand tons (Table 4).

Table 4. Sorghum production forecast for 2020-2024 horizon (Thousand tons)

	Regression model	2020	2021	2022	2023	2024
EU-28	Y = 31.80 X + 504.54	918	950	982	1,013	1,045
France	Y = 9.727 X + 236.77	363	373	383	392	402
Italy	Y = 6.272 X + 236.39	318	324	330	337	343
Hungary	Y = 5.538 X - 10.333	62	67	73	78	84
Romania	Y = 4.29 X + 12.696	68	73	77	81	86
Spain	Y = 0.0419 X + 34.727	35	35	35	35	35
Bulgaria	Y = 2.062 X - 0.409	26	28	31	33	35
Austria	Y = 2.654 X + 1.917	31	34	36	39	42
Greece	Y = 1.05 X + 0.538	12	13	14	15	16
Slovakia	Y = 0.1575 X + 0.933	2.5	2.7	2.8	3	3.1

Source: Own calculation.

CONCLUSIONS

The EU pays more attention to sorghum as a solution of adaptation to climate change mainly in the countries situated in the South, Central and Eastern Europe.

Sorghum will continue to be cultivated for animal feeding (poultry, pigs, cattle) under various forms and rations, also as biomass for bio-ethanol and biogas, as raw material in food industry, in agriculture technologies as a component in crop rotation, as a item to maintain biodiversity and for environment preservation.

Sorghum is the best alternative for maize in animal feeding, taking its high production performance, similar nutritive value, achieved at a lower cost. Therefore, it is a solution for farmers not to lose production and income in the years affected by extreme meteo phenomena, especially by the lack of precipitations, high temperature and long period of droughts.

In the analyzed interval, 2008-2019, the EU-28 doubled its cultivated area with sorghum which accounted for 197 thousand ha in 2019.

The cultivated area with Sorghum increased in all sorghum producing countries: France, Italy, Hungary, Romania, Bulgaria, Austria and Greece, except Spain and Slovakia were it remained constant.

The largest cropped areas are in France, Italy and Romania, accounting for 76%.

Sorghum output doubled its figure in the studied interval and in 2019 reached 1,019 thousand tons.

About 91% of production being achieved by France (431 thousand tons), Italy (312 thousand tons), Hungary (117 thousand tons) and Romania (68 thousand tons).

The EU yield was 5,179 kg/ha in 2019, but Austria, Italy and France are able to exceed this production level.

In 2024, it was estimated that the EU will produce 1,045 thousand tons sorghum, as it is expected an important production growth in Italy, Austria, Bulgaria, Romania and Greece, will decline in France and Hungary, but in Spain and Slovakia it is estimated that production will remain at the level of 2019.

In the EU, sorghum remains as an alternative to maize in forage production, in biomass resources for bio-fuels and also as raw material for food processing industry in the regions affected by droughts.

For farmers it is a crop which could assure high production at lower costs, a better crop rotation, high incomes and profit, a reason to extend the cultivated areas and increase production using high value hybrids and modern technologies adapted to climate change.

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STRENGTHENING THE SKILLS OF FUTURE SPECIALISTS IN ACCORDANCE WITH THE DEVELOPMENT TRENDS OF THE ANIMAL HUSBANDRY SECTOR IN THE REPUBLIC OF MOLDOVA

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Abstract

The main purpose of this paper was to use the analysis of the animal husbandry sector of the Republic of Moldova as a tool for predicting skills to be improved in related professional education programs. In order to achieve the proposed goal, the general trends in the evolution of the sector in the Republic of Moldova were evaluated; these trends were compared to those of the European Union level. The general problems of the sector were identified and, on this basis, the skills to be improved were deduced within the professional education programs of agricultural profile. The research resulted in the recommendations to improve skills in related professional education programs so as to create prerequisites for a higher quality educational service and, respectively, to optimize the contribution of professional education in increasing the performance of the animal husbandry sector.

Key words*: *animal husbandry, education, Republic of Moldova, skills

INTRODUCTION

Climate change, globalization, economic crises caused by various factors are challenges for all activities and fields, but especially for agriculture - a sector that has significant roles in economic and social development. One of the landmarks of the quality of the respective roles is the increase of productivity in its broadest sense, as "a measure of the rate at which we convert inputs (such as labour, land, water and energy) into outputs. It is not about how much we produce but how efficiently we produce" [1, p.3]. Achieving this goal is a process that is both necessary and difficult at the same time due to the existence of a series of factors, also called drivers of change, as shown in Figure 1.

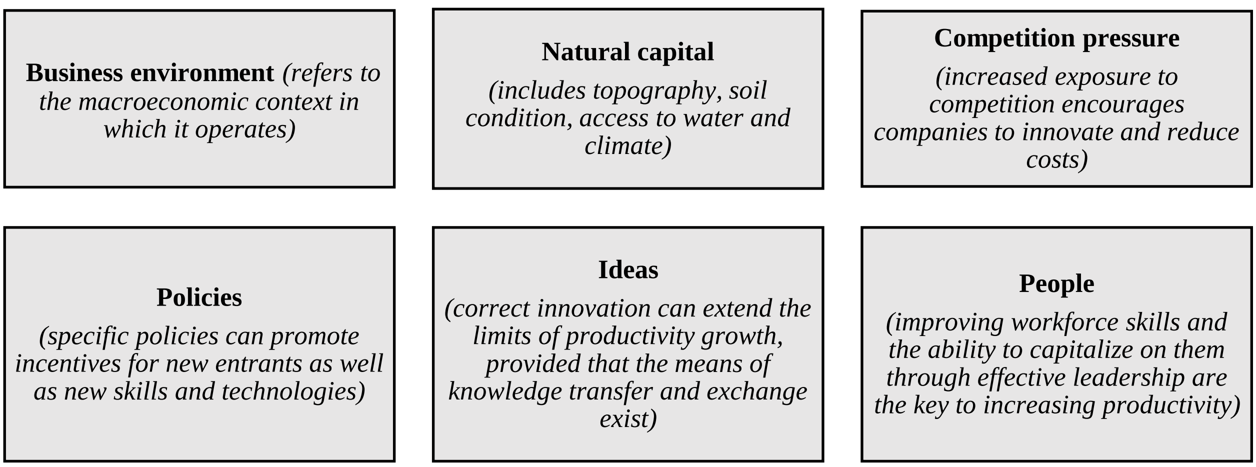

Fig. 1. Drivers of agricultural productivity growth
Source: Developed by the authors based on [1, p.5].

Thus, we can say that, along with other factors, the human factor is considered an essential and inextricable driver of agricultural productivity growth to meet the challenges and play its roles. Development of workforce planning and human resource management skills in the branch is necessary to improve business performance, to increase a better equipment of the branch in order to respond and adapt to changes, and to increase its capacity to sustain productivity growth [7, p.8].

The development needs of the agricultural workforce have been dramatically affected by the global changes that have taken place in the roles of the public and private sectors, as well as the drastic advances in technology [13]. In this context, it is stated that in the ever-expanding world, human resource development must be examined and organized according to globalization, cultural differences, educational opportunities and trends and consequences of these challenges for organizations, respectively [16].

The key element of human resources interventions in agriculture is competencies, which are defined as „*knowledge, skills and know-how applied and mastered in a specific context"* [8]. Thus, we find that skills are a component of competencies, representing "*the ability to use one's knowledge effectively and readily in execution or performance"* [9]. As businesses restructure and adapt, skills also need to evolve, entrepreneurial and leadership skills becoming more important [1, p.7]. Through their more detailed examination, in the process of a sectorial study conducted in the UK in the field of agriculture, forestry and fishing, three groups of skills needed to be developed according to the degree of priority were identified, they are set out in Figure 2.

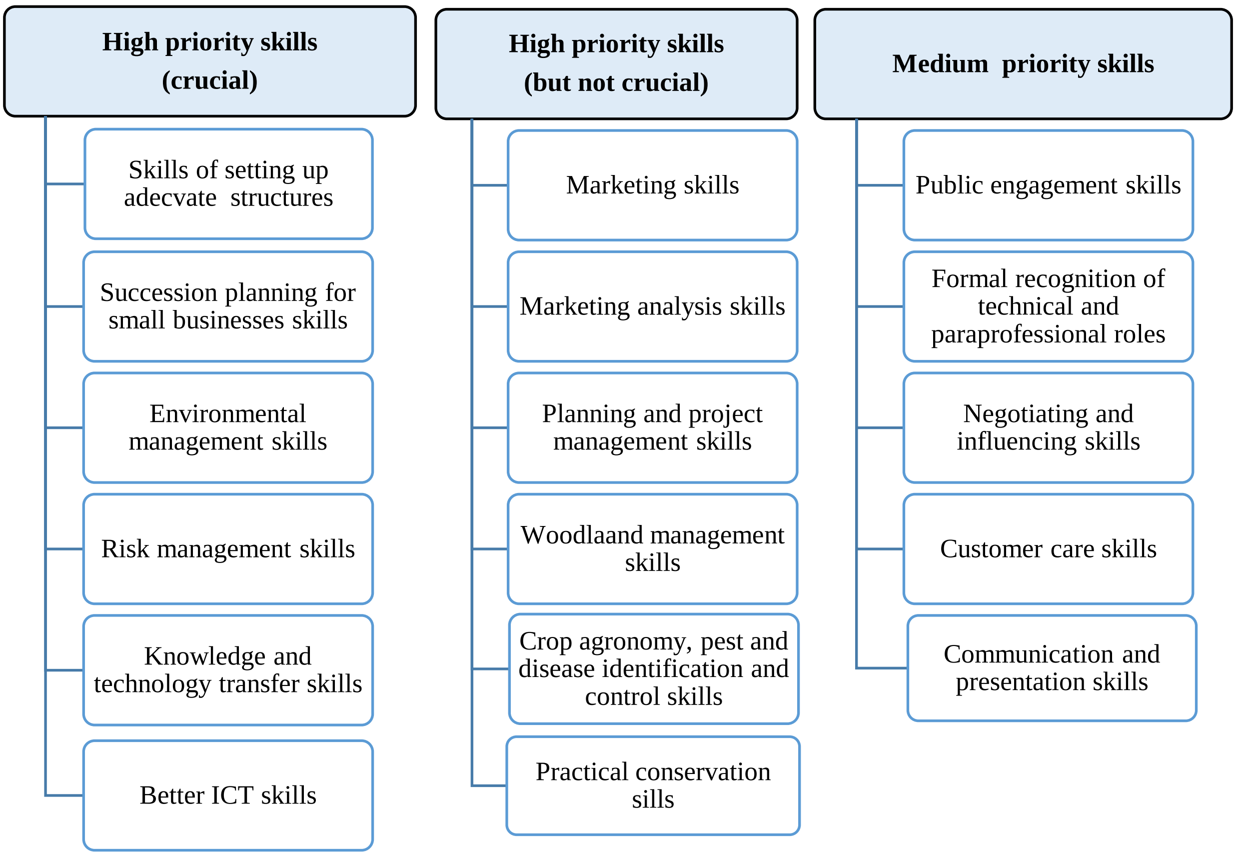

Fig. 2. Skills needed to be developed for the agriculture, forestry and fishing depending on the degree of priority
Source: Developed by the authors based on [14].

Given the complexity of the skills needed to be improved, and the agricultural work itself, it is clear that their development requires a strategic approach, which would integrate the efforts of government and of the sector [7, p.7]. In this context, it is considered vital to recognize the role of education systems in the development of human resources needed by the sector [16]. Implicitly, the exercise of that role by the institutions in the professional education system is required as one of their main missions which involves a continuous adaptation of the offered skills to the current needs and, moreover, to the future needs of the sectors. A significant factor of the success of fulfilling the mentioned role is the knowledge of the needs of the sectors, this fact being possible through the analysis of their tendencies and problems.

MATERIALS AND METHODS

The carried out research had the following stages:
(1)Summary of approaches on the need and role of skills to ensure the prosperity of agriculture in the current conditions;
(2)Assessment of general trends in the evolution of the animal husbandry in the European Union;
(3)Analysis of the development of the animal husbandry in the Republic of Moldova in terms of quantitative and qualitative indicators;
(4)Identifying the factors that diminish the efficiency of the animal husbandry in the Republic of Moldova;
(5)Specifying the skills to be improved within the professional education programs of agricultural profile in the context of the problems found in the development of animal husbandry;
(6)Predicting the medium and long-term effects of the proposed interventions in professional education programs.
The assumed tasks were performed by the following methods: analysis of economic indicators reveling the development of the animal husbandry sector in the Republic of Moldova and in the European Union; assessment of trends in the Republic of Moldova compared to those from the European Union; investigation of analytical and scientific publications related to the sector development; the synthesis of the basic ideas and the deduction of the areas to be improved and, implicitly, of the skills necessary to ensure these improvements; predicting their effects in the medium and long term by using the tree of objectives technique; formulation of reasoning and final recommendations on the necessary interventions in the programs.
The statistical databases www.statistica.md, https://ec.europa.eu/eurostat/data/database, as well as a series of analytical studies and scientific publications that reveal the evolution and problems of the sector served as sources of information.

RESULTS AND DISCUSSIONS

In the context of the concern to achieve the sustainable development objectives, increased attention is paid to animal husbandry, which is the sector responsible for balanced and healthy nutrition of the population, also having other particularly important roles, as shown in Figure 3.

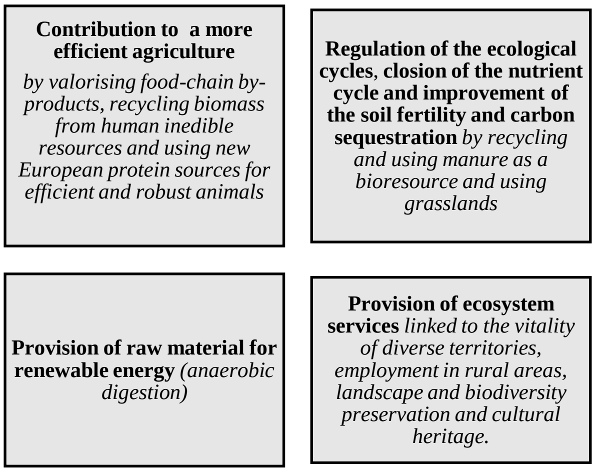

Fig. 3. The roles of the animal husbandry in the global economy
Source: Developed by the authors based on [2, p.1].

According to the available statistical data, at the European Union level in 2018 the livestock population consisted of 148 million pigs, 87 million cattle, 98 million sheep and goats. The data on the evolution of the livestock in the EU, revealed by the livestock population growth index, are shown in Figure 4.

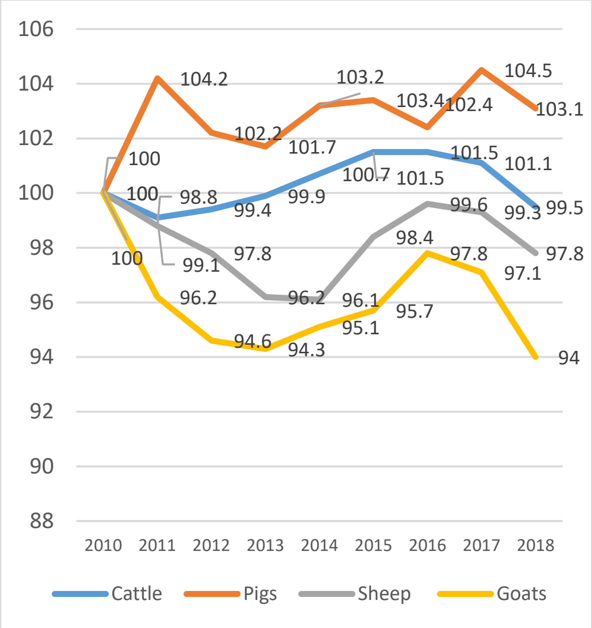

Fig. 4. Livestock population growth index in the EU countries in 2010-2018
Source : [4].

Almost half of the total volume of meat produced in 2018 was pork (23.8 million tonnes). Also, 15.2 million tonnes of poultry, 7.9 million tonnes of beef, 0.8 million tonnes of sheep and goat meat were produced. The total quantity of milk produced at the EU level in 2018 amounted to 172.2 million tonnes.

Even if in the period 2010-2018 there were no stable increasing trends of animal products volume, the year 2018 imposed itself by higher indicators compared to 2017 due to the growing concerns for the sector`s development. Thus, the production of pork increased by 2.1% in 2018 compared to the previous year, being exceeded the level of 2010 by 2.1 million tonnes. The production of beef increased by 1.7% in 2018 compared to the previous year; the volume of sheep and goat meat in 2018 was the same as in the previous year, and poultry meat production increased by 4.8%, being 3.2 million tonnes above the level of 2010 [4].

Animal husbandry has a key contribution to the European Union economy: of the total value of agricultural production of €434.3 billion in 2018, €172 billion (39.6%) was provided by animal husbandry [4]. Increased attention to animal husbandry is justified, as it is considered a key element of the vitality of many European territories [2, p.2], including its contribution to economic growth and poverty reduction [6, 15].

In the context of the above mentioned, the significance of the sector is obvious for the economic and social prosperity of the Republic of Moldova. However, the data that reflect the level of development of animal husbandry in the Republic of Moldova show more than modest trends. Thus, if we examine the livestock evolution by comparing the data of 2018 with those of 2010 (Table 1), we find out that the livestock population increased only in three groups of animals: rabbits, donkeys and bees. At the same time, the number of cattle, pigs, sheep, goats and horses substantially reduced.

Table 1. Livestock evolution in the Republic of Moldova within the period 2010-2018

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cattle, thousands of heads	216	203.9	191.2	188.9	191.2	186.1	182.3	167.4	144.8
Pigs, thousands of heads	478.5	438.6	410.4	420	472.8	453.2	439	406.4	397.3
Sheep and goats, thousands of heads	905.5	832.4	824	849.2	874.7	868.4	869.8	841.7	768.7
Horses, thousands of heads	52.2	49.6	46.4	45	41.9	39.4	36.8	33.6	29.9
Donkeys, thousands of heads	2.8	2.5	2.4	2.1	2.2	2	3.1	5	3.8
Rabbits, thousands of heads	277	277.4	267	296.2	326.1	350.2	366.7	376.5	351.5
Bee families, thousands of units	105.2	111.7	110.6	115.9	124.3	135.9	148.1	163.6	178.7

Source: Developed by the authors based on [10].
Note: There have not been identified complete official data on the poultry evolution.

A deeper investigation of the situation is possible by highlighting the trends in the evolution of the managed livestock, separately, by enterprises and owned by the individual sector (Tables 2 and 3).

Table 2. Livestock evolution managed by the enterprises from the Republic of Moldova within the period 2010-2018

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cattle, thousands of heads	11.6	12.1	11.6	12.3	13.7	15.1	18.3	19.1	18.2
Pigs, thousands of heads	139.4	120.6	142	158.7	196.8	185.7	191.4	184.5	206.2
Sheep and goats, thousands of heads	20	20.8	17.6	19.7	23.9	27.5	25.1	25	20.4
Horses, thousands of heads	1.1	0.9	0.8	0.6	0.5	0.4	0.4	0.3	0.2
Domestic rabbits, thousands of heads	1.3	0.7	0.7	1	0.6	15.1	11.4	13.2	11.6
Bee families, thousands of units	4.6	3.6	3.8	3.7	3.2	2.9	3.1	2.6	2.2

Source: Developed by the authors based on [10].

Table 3. Livestock evolution of the individual households from the Republic of Moldova within the period 2010-2018

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cattle, thousands of heads	204.4	191.8	179.6	176.6	177.5	171.0	164.1	148.3	126.6
Pigs, thousands of heads	339.1	318.0	268.4	261.3	276.0	267.4	247.6	221.9	191.1
Sheep and goats, thousands of heads	885.5	811.6	806.4	829.5	850.8	840.9	844.7	816.7	748.3
Horses, thousands of heads	51.1	48.7	45.6	44.4	41.4	39.0	36.4	33.3	29.7
Donkeys, thousands of heads	2.8	2.5	2.4	2.1	2.2	2.0	3.1	5.0	3.8
Domestic rabbits, thousands of heads	275.7	276.7	266.3	295.2	325.5	335.1	355.3	363.3	339.9
Bee families, thousands of units	100.6	108.1	106.8	112.2	121.1	133.0	145.0	161,0	176,5

Source: Developed by the authors based on [10].

By generalizing the data on the evolution of the herds shown in Tables 2 and 3, we can positively assess the growth trends on some groups of animals that have been modeled in enterprises, because enterprises are able to ensure a higher efficiency of sector (ensuring better animal maintenance conditions, applying more advanced production technologies, etc.). However, the reduction of the livestock of the individual sector, on some groups of animals being particularly substantial, diminishes the potential of the sector to exercise its attributions to ensure the food needs of the population.

The quality of livestock management can be estimated through economic indicators. The first step in this regard is to assess the animal and poultry yield (Table 4).

Table 4. Animals and poultry yield in agricultural enterprises in the Republic of Moldova within the period 2010-2018

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018
The average milk yield per cow, kg	2,993	3,224	3,380	3,225	3,742	3,468	3,939	4,363	3,626
Egg yield per laying hen, pieces	224	210	177	196	213	193	196	206	206
Wool yield per sheep, kg	2	2	1	2	2	2	2	1	2

Source: Developed by the authors based on [10].

By examining the evolution of animal and poultry yield during the research period, we find out a more beneficial situation, noting a stable growth rate of the average milk yield per cow, as well as a stable level of the average amount of wool per sheep with the exception of 2012 and 2017. The average number of eggs per laying hen had fluctuating trends during the considered period. At the same time, we can notice the absence of stable growth trends of the animal and poultry yield in the analyzed period. By comparative examination of the indicators obtained in 2018 and 2010, we find out that only the cattle yield

has increased, while the sheep yield is the same, and the poultry yield in 2018 is lower than the basis of comparison.
The data reflecting the evolution of the main types of animal products are presented in Table 5 and show an increase in the volume of production in the analyzed period (2010-2019), with the exception of the volume of wool.

Table 5. Obtaining the main types of animal products in the Republic of Moldova within the period 2010-2019

Indicators	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Livestock and poultry in live weight, q	417,386	439,726	459,553	564,133	620,026	690,985	763,885	750,694	862,529	849,463
Cow milk, q	144,814	147,126	155,727	157,586	213,111	225,079	246,755	242,455	218,348	234,743
Eggs, thousand pieces	276,192	241,918	242,162	242,049	246,498	253,491	292,665	316,191	317,980	297,754
Wool, q	417	333	276	289	363	343	404	337	411	322

Source: Developed by the authors based on [10].
Note: Data refer to agricultural enterprises of all types.

However, the increasing trends of the analyzed indicators are not sufficient for relaunching the animal husbandry in the Republic of Moldova and for returning to the production level registered before the privatization process. Thus, by the comparative analysis of the data concerning the volume of production marketed in 2019 compared to 1980 (Table 6), a positive situation is registered only in poultry, while the sales of cattle, pigs, sheep and goats in live weight, as well as milk have decreased considerably.

Table 6. The comparative analysis of the volume of animal production sold in the Republic of Moldova in 2019 compared to 1980

Indicators	1980, thousand tonnes	2019, thousand tonnes	The growth index
Cattle in live weight	143.0	12.7	8.88
Pigs in live weight	182.0	82.7	45.44
Sheep and goats in live weight	9.0	4.2	46.67
Poultry in live weight	55.0	57.6	104.73
Cow milk	1187.0	331.7	27.94

Source: Developed by the authors based on [10].

The slow pace of the sector`s development is also confirmed by the data regarding the evolution of animals and animal products` imports and exports in the period 2010-2018 (Fig.5), which shows a visible prevalence of imports over exports.

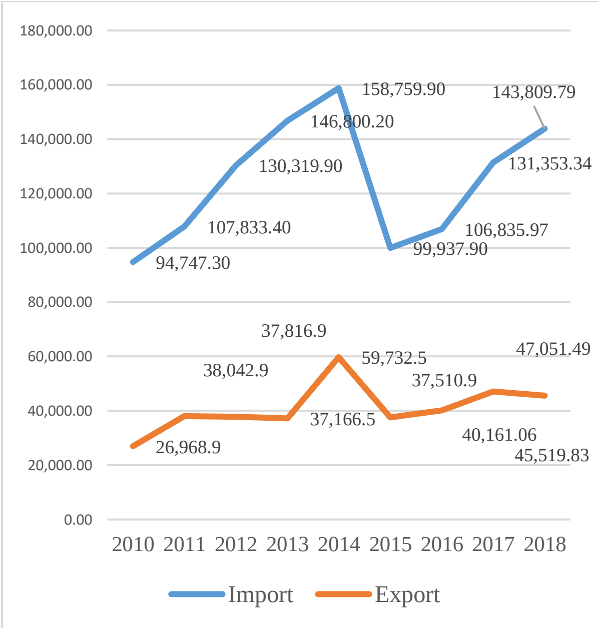

Fig. 5. Comparative analysis of the evolution of the animals and animal products` imports and exports in the period 2010-2018, thousand dollars
Source: Developed by the authors based on [10].

By generalizing the above mentioned we can deduce that the process of revitalization of the animal husbandry sector in the Republic of Moldova, after the decline that occurred with the privatization of agricultural enterprises at the end of the last century, is still very slow and with modest results, the last statement being justified by low production efficiency [3, 5, 11, 12], which substantially diminishes the competitiveness of the sector. Implicitly, several groups of factors could be identified that condition the low efficiency of the animal production, they are set out in Table 7.

Table 7. Factors conditioning the low profitability of animal husbandry sector in the Republic of Moldova

Groups of factors according to their nature	The factors` content
Technological factors	• Constraints caused by the internal resources (especially limited feed); • Insufficient good quality pastures caused by unfavorable weather conditions and insufficient irrigation capacities; • Harnessing non-competitive breeds.
Managerial factors	• Poorly developed risk management tools; • Lack of knowledge in product promotion.
Economic and financial factors	• Relatively high local production costs; • Low animal productivity; • Limited share of investments; • Limited share of foreign capital in long-term active investments; • High interest rates on bank loans and the short period of time for which loans are offered; • Lack of the necessary resources to carry out at least partial production processing.
Factors regarding the state mechanisms for managing the sector	• Instability of legislation, which increases business costs and creates difficulties in making forecasts for longer periods of time; • Instability of the country's policy in the field of international cooperation.
Market factors	• Tough pressures caused by cheaper animal imports; • Difficulties in penetrating the markets (including external ones) due to the inability to compete with cheaper, subsidized meat and dairy products coming from the EU and other markets; • Underdevelopment of the land market.
Natural factors	• Unfavorable weather conditions.

Source: Developed by the authors based on [3, 5, 11, 12].

Through the synthetic evaluation of the data presented in Table 7 we conclude that the animal husbandry`s efficiency can be increased through a system of complex and varied measures in terms of content (technological, economic-financial, organizational, managerial, legislative-normative, etc.).

The quality of their implementation depends on the degree of involvement of different actors, but also on their ability to ensure a synergy of efforts.

Increasing the quality of skills offered within the related professional education programs is one of the factors capable of generating multiple effects on different time horizons, these being systematized in Figure 6 developed by applying the tree of objectives` technique.

Thus, as shown in Figure 6, two basic objectives of grade I are identified that must be assumed by the professional education system in the field of animal husbandry with reference to improving skills related to applied technologies, as well as entrepreneurial and managerial. Implicitly, specific objectives are set for the improvement of concrete skills within the course units.

The immediate expected effects are to increase animal yield, product quality, to streamline supply and sales processes, to provide the necessary financial resources and, consequently, increase the efficiency of the production factors` management.

In the long term, the sector is expected to increase its performance and its contribution to GDP.

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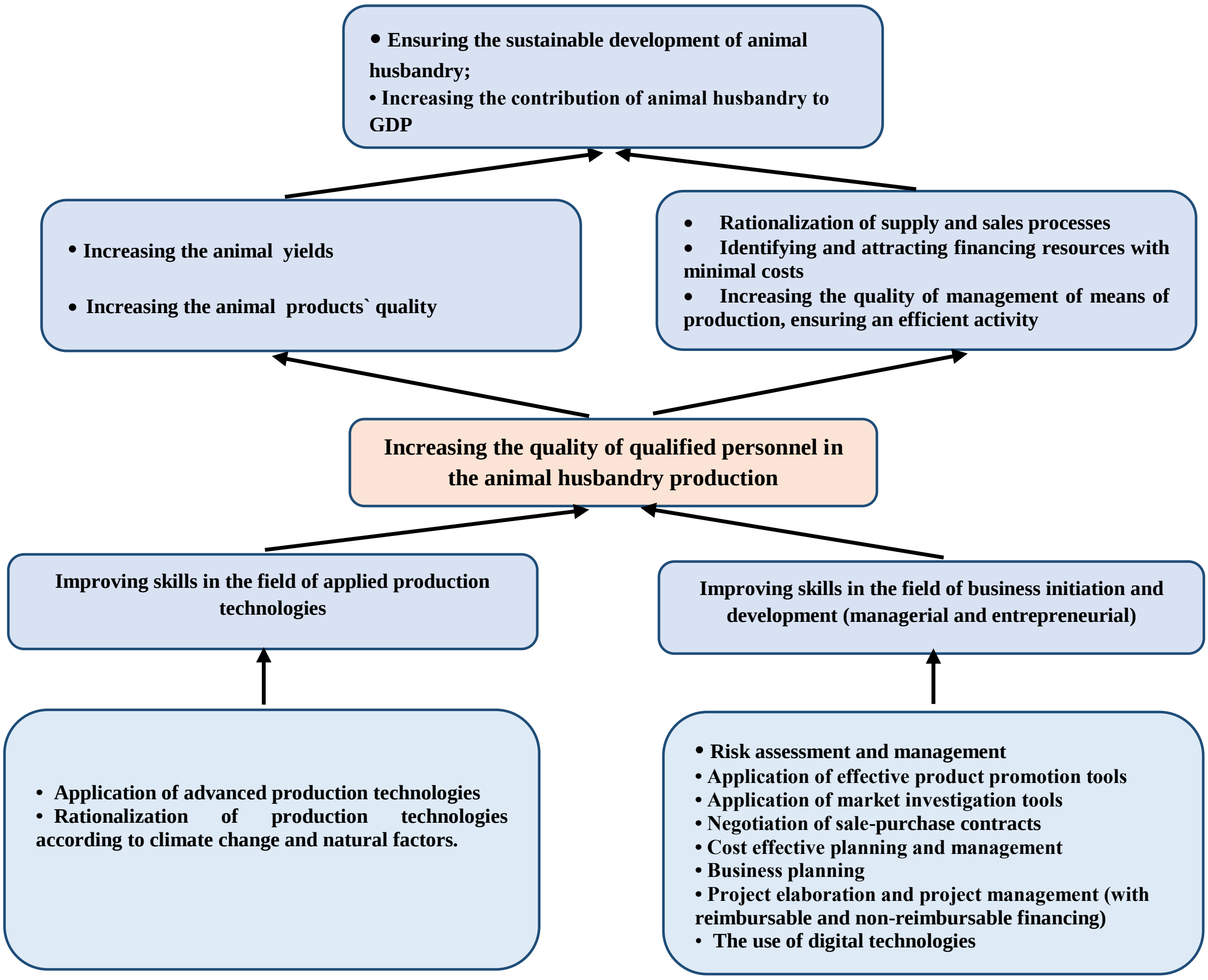

Fig. 6. The tree of agricultural education objectives regarding the improvement of skills in the field of animal husbandry
Source: Developed by the authors.

CONCLUSIONS

The analysis of the animal husbandry sector in the Republic of Moldova shows modest development trends, unable to contribute to its revitalization and the optimal exercise of the roles assumed in achieving the objectives of sustainable development and poverty reduction. The relaunch of the sector, the achievement of higher performance indicators is possible by combining the efforts of several actors, agricultural professional education institutions having an active role, as providers of skilled labor.

By investigating the problems related to the sector, the areas where the respective educational institutions can be involved were identified, as well as the competencies that need to be improved, namely:

I. *In the field of applied production technologies*:

-Application of high performance production technologies;

-Application of advanced production technologies;

-Rationalization of production technologies according to climate change and natural factors.

II. *In the field of business initiation and development*:

-Risk assessment and management;

-Application of effective product promotion tools;

-Application of market investigation tools;

-Negotiation of sale-purchase contracts;

-Cost effective planning and management;

-Business planning;

-Project elaboration and project management (with reimbursable and non-reimbursable financing);
-The use of digital technologies.

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INVESTMENT APPRAISAL OF SELECTED CLIMATE SMART AGRICULTURAL (CSA) PRACTICES AMONG SMALL SCALE COCONUT FARMERS IN LEYTE, PHILIPPINES

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Abstract

Small scale coconut farmers are facing unprecedented challenges when attempting to increase productivity because of the occurrence of extreme weather events and changing climatic conditions. This paper investigates the practices adopted by coconut farmers in response to climate variability and assesses the agricultural practice using an investment lens to evaluate its profitability and potential for scaling up. We use farmers' survey data complemented with focus group discussion and key informant interviews. Results show that investing in coconut banana intercropping and the use of improved coconut variety are among the potential options that the farmers can adopt. The comparison of these climate smart agricultural practices to conventional coconut farming shows positive incremental benefit and the financial analysis yields positive net present value and higher internal rate of return. These suggest that the adoption of climate smart agricultural practices generates higher farm productivity compared to the conventional farming system. This implies that there is a high potential for improving coconut productivity through scaling up of these feasible options that small-scale farmers can adopt. Considering the capacities of local farming communities, there is a broad scope for government and non-government organizations in enhancing the role of climate smart agricultural practices in coconut farming.

Key words*: *climate smart agriculture, cost benefit analysis, farming system, productivity

INTRODUCTION

The coconut industry in Eastern Visayas region, Philippines, particularly in Leyte province, hosts an array of challenges whose impacts are felt across the value chain [6]. If not addressed, these challenges will continue to constrain the sector, resulting in yields and incomes below their potential. The region is vulnerable to natural disasters such as typhoons due to its geographical location [28]. On November 8, 2013, the super typhoon Haiyan (locally known as Yolanda) hit Eastern Visayas and caused massive devastation in lives, properties and livelihood [15]. For the coconut industry, an estimated 33 million coconut trees, across 295,191 hectares of land have been damaged, putting the livelihoods of more than one million farming households at risk [23]. Small scale farmers who relied on coconut farming were heavily affected because Filipino coconut farmers are considered among the poorest of the poor in the agricultural communities [1] [7] [17] [22].

Coconut used to be the most extensively cultivated crop in Eastern Visayas. According to the Philippine Statistics Authority (PSA) (2016) [20], coconut production in Leyte reached 526,559 metric tons per year, covering a total farm area of 167,974 hectares before the to super typhoon Haiyan hit in 2013. In the following year, production fell by more than 60% to 194,050 metric tons covering a total farm area of just 94,744 hectares [20]. Coconut farming is an essential source of economic activity among farmers [7]. However, the occurrence of strong typhoons is damaging the limited income stream of small-scale coconut farmers. Farmers will constantly face a lot of income shocks from frequent and stronger typhoons

[7] [10] [24]. This poses a serious threat to coconut production adversely affecting livelihoods of small scale farmers [3] [6]. The damage inflicted by typhoons on coconut farming will take a longer time to fully recover because it will take an average of 7-9 years for coconut trees to fully mature after replanting. Some farmers are disproportionately impacted than others. Farmers who don't have access to farming facilities and infrastructures are more vulnerable to calamities than those who have access [6].

Coconut farmers are facing unprecedented challenges when attempting to increase productivity because of the occurrence of extreme weather events and changing climatic conditions. Farmers need information on appropriate climate smart agricultural practices in order to effectively adapt to extreme weather events and unpredictable climate conditions. With this, the adoption of climate smart agriculture (CSA) practices are relevant in the area. The CSA are practices that have significant potential to enhance the productivity and help in mitigation and adaptation to climate change [3] [5]. This study will investigate the adoption of CSA practices among small scale coconut farmers and asses its profitability using cost benefit analysis. The results of this study will help farmers and investors to investigate the viability of adopting climate smart agricultural practices in coconut production. This would benefit not just the small scale coconut farmers but also the coconut industry as a whole. It would help the policymakers in formulating policies that can effectively contribute to the improvement of livelihood of coconut dependent farmers.

MATERIALS AND METHODS

Study site

The study was carried out in the province of Leyte, located in Eastern Visayas region, Philippines (Figure 1). Leyte province is one of the hugely devastated areas when super typhoon in Eastern Visayas [15] [27]. The occurrence of super typhoons is one of the identified adverse effects of climate change [28]. According to copra buyers and some farm owners, around 50 to 60 percent of coconut farms were damaged due to super typhoon [6]. Leyte shared the highest number of farms with 136.2 thousand, covering 258.6 thousand hectares of agricultural land among the provinces in Eastern Visayas [19]. The total farms in the province accounted for 41.2 percent of the total farms in the region. The agricultural land comprised 39.4 percent of the total land area of the province [19].

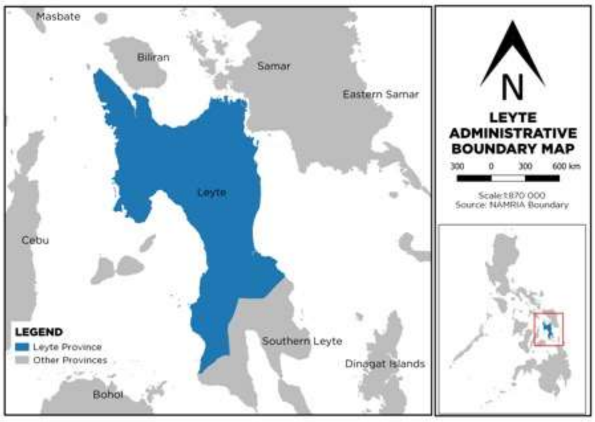

Fig. 1. Map of Leyte province, Philippines
Source: [16].

Data Collection

Primary data was collected through a survey among randomly selected coconut farmers. The survey instrument aims to compare the productivity and profitability of coconut production for farmers who adopted climate smart agricultural practices and those that practiced the conventional farming system. In addition, focus group discussion and key informant interviews were conducted to identify emerging climate smart practices adopted by the coconut farmers.

Cost-benefit Analysis

To estimate the income derived from coconut production, a gross margin was used. The gross margin was computed by subtracting the total variable cost from the total revenue. The total variable cost includes transportation cost, labor cost, and material input cost. Total revenue is obtained from the cash income and non-cash income of the coconut farmer. Cash income simply refers to the cash obtained from the coconut harvests, while non-cash income refers to home consumption, given away products, and others.

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A discounted financial cash flow was used to estimate the benefits and cost of adopting climate smart practices in coconut farming as compared with the usual practice. The cash flow was projected for 10 or 20 years. Project revenue reflects the income generated from coconut farming, particularly copra production. Operating cost is the cost of labor, raw materials and farm inputs.

In valuing the net benefits, this was discounted to obtain the net present value. In doing the cost-benefit analysis, a 10% discount rate was used. The methods used in the financial analysis were based from Harrison and Herbohn (2008) [8]. The net present value (NPV) can be computed as follows:

$$NPV = (\sum B_t - \sum C_t) / (1 + r)^t; \; t = 1, 2,..,n \qquad (1)$$

where:

B_t are the benefits at time t, and C_t are the costs at time t and r is the discount rate. In determining the profitability of the investment, the net present value should be positive, which implies that the benefits exceeds the costs.

Payback period (PP) reflects the number of years in which investment cost is recovered particularly the year when the net cash flow changed from negative to positive. The CSA practice with the shortest payback period is more attractive because the investment cost is recovered faster.

Another financial criterion considered is the internal rate of return (IRR). IRR represents the discount rate where the present value of benefits and the present value of costs are equal. This is where the NPV is equal to zero. This measured the capacity of the net revenue to pay off the investment cost. Mathematically expressed as:

$$(\sum B_t - \sum C_t) / (1 + IRR)^t = 0 \qquad (2)$$

where:

t = 1, 2,…..,n and IRR = internal rate of return. If the computed IRR is greater than the opportunity cost of capital which is the discount rate, then adapting a particular CSA practice is a profitable investment.

RESULTS AND DISCUSSIONS

Socio-demographic profile of the respondents

Table 1 presents the socio-demographic characteristics of farmer respondents. A total of 240 coconut farmers were interviewed. Descriptive analysis shows that the average, the age of coconut farmers is 55 years old. Around half of the respondents are female (49.2%). The majority of them are married (74.6%) and some are widowed (9.2%). The average years in education is around 8.1 years. This implies that on average, coconut farmers have reached 2nd year high school. The average household size is composed of around 4-5 members. The average farm area cultivated is 1.67 hectares. In terms of land ownership, more than half of the respondents (55.4%) are owner cultivators and close to 40% are tenants.

Table 1. Socio-demographic profile of the farmer respondents

Profile of the Respondents	n	%
Age		
Below 35 years	11	6.8%
36 - 45	23	14.2%
46 - 55	43	26.5%
Above 55 years	85	52.5%
Average Age	55	
Sex		
Male	122	50.8%
Female	118	49.2%
Civil Status		
Married	179	74.6%
Widowed	22	9.2%
Single	16	6.7%
Live-in	14	5.8%
Separated	8	3.3%
Refused	1	0.4%
Average Years of Education	8.1	
Average Household Size	4.47	
Average Farm Area (hectare)	1.67	
Land Tenure		
Owner Cultivator	133	55.4%
Share Tenant	89	37.1%
Leaseholder	11	4.6%
Mortgagee	3	1.3%
Free Access/Land Use	2	0.8%
Refused	2	0.8%
n	240	

Source: Authors' own calculation and analysis (2020).

Climate smart agricultural practices for coconut

Climate smart agriculture (CSA) practices in coconut production were identified through focus group discussion, key informant interviews and literature reviews. These identified practices are considered CSA practice because it enhances the productivity and achieves the other two objectives which are climate change mitigation and adaptation option [3] [5]. Table 2 presents the results of the focus group discussions (FGD) among 14 small scale coconut farmers.

Table 2. Description of climate smart agriculture (CSA) practices for coconut

CSA Practice	Description	Climate Related Hazard	Current adaptation rate %
Early Harvesting	Harvest coconut early before the typhoon hits and keep the harvested coconuts in elevated areas	Typhoon	60-100%
Weather forecasting	Be informed with weather updates	Typhoon and drought	60-100%
Intercropping	Utilizing the spaces between coconut with other crops such as banana, vegetables and other crops	Typhoon	less than 30%
Use of improved varieties	Typhoon resistant varieties	Typhoon	less than 30%
Bio-control	Use of bio-control in dealing with pests and diseases	Pest infestation	less than 30%
Sanitation	Cutting of the affected parts due to pest infestation and burning it to avoid the spread of pest	Pest infestation	less than 30%
Watering of seedlings	On normal conditions, farmers do not water the coconut seedlings only during drought	Drought	less than 30%
Three (3) seedlings per hill scheme/ Cropping intensity	Planting scheme wherein three coconut seedlings were planted per hill	Typhoon	less than 30%

Source: Authors' own calculation and analysis (2020).

Table 2 highlights several climate smart agricultural (CSA) practices for coconut production. The occurrence of damaging typhoons was the major climate hazard considered during the FGD but some farmers also mentioned that they experience drought and pest infestation in coconut production. Results show that the most common practice of the farmers in relation to the typhoon as climate hazard is to do early harvesting and check the weather forecast.

Prioritized CSA practices for coconut production

A review of Ranasinghe (2019) [21] in Sri Lanka and Hebbar et al. (2013) [9] in India suggests that the long-term adaption option is on developing resilient and tolerant varieties with high survivability with the effects of climate change. On the other hand, the short-term adaptation option is on doing coconut-based efficient cropping systems with best management practices [9] [13] [21]. Findings of Ranasinghe (2019) [21] is also relevant to the Philippine setting in particular Leyte province. Among the identified climate smart agricultural practices presented in Table 2, we asked the participants to prioritized two CSA in responding to typhoon related climate hazards. After ranking, results show that farmers prioritized intercropping and the use of improved coconut varieties. We discussed in detail and conduct financial analyses of these top two CSA practices selected by coconut farmers.

For intercropping, the farmers indicated that banana can be used as an intercrop. Banana is planted alongside or between the coconut trees. This practice maximizes the unproductive spaces between the coconuts that were left unplanted. Since banana and coconut have similar nutrient and climate requirements, they make a suitable crop for intercropping.

Another prioritized CSA practice for coconut production is the use of improved coconut varieties. Being vulnerable to typhoons, coconut farmers seek to gain knowledge on what varieties of coconut that can withstand during a typhoon. In consultation with the experts or key informants from the National Coconut Research Center, Visayas State

University, Tacunan green dwarf coconut variety is a promising one. Tacunan green dwarf is a dwarf variety of coconut that is early maturing. This variety is often seen bearing nuts touching the ground because it is a dwarf one. The average number of nuts harvested per tree per year is around 48-84 nuts, according to a key informant from the National Coconut Research Center. From the year 1985 to 1993, the average weight of copra per nut is not less than 220 grams. According to the Philippine Coconut Authority (2016) [18], the Tacunan green dwarf was among the identified outstanding dwarf varieties that can withstand strong winds and typhoons. It could be attributed to its physical characteristics with thick and short stem, well-anchored root system and sturdy palm [18].

Financial indicators for prioritized CSA practice for coconut production

To evaluate the profitability of adopting climate smart agricultural practices, a cost benefit analysis was conducted. The CSA practice is compared with the conventional practice in coconut production, which is mono-cropping. The difference between the CSA practice and conventional practice is analysed through its incremental change. Results show that coconut banana intercropping requires an initial investment amounting to PHP 7,890.00 (USD 153.20). The payback period would start four years after adopting the CSA practice, with an annual incremental net benefit of PHP 3,348.9 (USD 65.03) (Table 3).

Table 3. Financial indicator of adopting coconut banana intercropping

Indicator	Value
Initial investment (requirement / hectare)	PHP 7,890 (USD 153.20)
Estimated annual incremental benefits	PHP 3,348.9 (USD 65.03)
Net present value (NPV) at 10%	PHP 148,465.17 (USD 2,882.82)
Payback period	4 years
Internal rate of return (IRR)	80.70%

Source: Authors' own calculation and analysis (2020)
Note: Exchange rate for October 2019 is 1 USD = PHP 51.50. Source: [2].

At 10% discount rate and projected for 10 years, adoption of the coconut banana intercropping is a profitable investment generating a positive net present value of PHP 148,465.17 (USD 2,882.82). The internal rate of return (80.70%) is greater than the opportunity cost of capital suggesting coconut banana intercropping is feasible investment yielding acceptable returns.

In terms of productivity, there is a substantial increase in revenue through the intercropping of banana in areas planted with coconut. Results show that on average, farm revenue of those who adopted the CSA practice is higher by 50% compared to those who used the conventional practice (Table 4).

Table 4. Farm production for conventional practice (mono-cropping) and coconut banana intercropping

Non-CSA Practice		CSA Practice	
Yield/ hectare (kg)	Value (PHP)	Yield/ hectare (kg)	Value (PHP)
Coconut	67,500.00	Coconut	67,500.00
Banana	-	Banana	70,000.00
Revenue (in PHP)	67,500.00	Revenue (in PHP)	137,500.00

Source: Authors' own calculation and analysis (2020).

The minimal-to-none fertilizer and pesticide input requirement of coconut and banana intercropping make this CSA a feasible solution to reduce agricultural emission and food security issues. Although agriculture is least carbon intensive as compared to the industrial sectors [26], Magat (2011) [12] reported that coconut lands and forest ecosystems in the Philippines can mitigate climate change by serving as carbon sinks. This not only reduces carbon dioxide emissions but can also double cash benefits from revenues and carbon sequestration. This will help attain the ambitious target of the Philippine government in reducing carbon emissions [11] [25].

Results of this study is similar to what was reported by Mendoza et al. (2018) [14] in Southern Mindanao, Philippines indicating that coconut production intercropped with banana or fruit trees such as mango, durian, mangosteen, coffee and cacao can generate highest revenues than mono-cropping especially when these products move along the value chain. Similarly, De Guzman et al. (2015) [4] recommended the practice of diversified and integrated farming systems highlighting one of the most productive and profitable cropping system, a coconut-based multi-story system in Cavite, Philippines. This system is coconut-based with a combination of annuals and perennial crops such as papaya, pineapple, taro, ginger and also banana. Besides, Rodriguez et al. (2007) [22] reported that the promotion of intercropping coupled with improved access to credit and technical assistance contributed to better outcomes in coconut farming.

In addition to coconut banana intercropping, we also conducted financial analysis on another CSA practice, which is the use of Tacunan green dwarf coconut variety. Results show that the use of improved coconut variety such as Tacunan green dwarf requires an initial investment of PHP 6,802 (USD 132.08) per hectare (Table 5).

Table 5. Financial indicator of adopting Tacunan green dwarf coconut variety.

Indicator	Value
Initial investment (requirement / hectare)	PHP 6,802 (USD 132.08)
Estimated annual incremental benefits	PHP 62,160 (USD 1,206.99)
Net present value (NPV) at 10%	PHP 171,067.04 (USD 3,321.69)
Payback period (for a period of 20 years)	9 years
Internal rate of return (IRR)	37.01%

Source: Authors' own calculation and analysis (2020)
Note: Exchange rate for October 2019 is 1 USD = PHP 51.50. Source: [2].

This initial cost pertains to the procurement of seedlings for this coconut variety. In a 1-hectare land area, approximately 179 Tacunan dwarf coconut seedlings could be planted with an 8m x 8m planting distance [18]. The period of analysis for this CSA practice is 20 years since the adoption of this CSA would require replanting of coconuts. The investment will be recovered in the 9th year. Over a period of 20 years, farmers can expect a yearly incremental net benefit of around PHP 62,160 (USD 1,206.99).

With a 10% discount rate, replacing the existing coconut variety with Tacunan green dwarf generates a positive net present value of PHP 171,067.04 (USD 3,321.69). The computed internal rate of return (IRR) is 37.01% suggesting that adoption of improved coconut variety is a profitable potential investment that the farmers can pursue (Table 5).

Table 6 shows the comparison between the farm production of using the Tacunan green dwarf variety and the traditional coconut variety. Assuming that a typhoon would hit the coconut farm area on the 9th year, most of the devastated coconuts will be the traditional variety. This is due to its taller and thinner stem characteristics compared to the Tacunan green dwarf which is shorter and thicker [18]. The expected outcome would be that Tacunan green dwarf will still be productive as compared to the existing traditional variety when a damaging typhoon will hit. In a 20-year period analysis, the adoption of Tacunan dwarf variety generates higher income on average compared to the traditional variety by PHP 83,230 (USD 1,616.12) per hectare annually (Table 6). Dwarf coconut varieties are not new to coconut farmers in Leyte province. The factor that limits the adoption of this CSA practice is that farmers are not fully aware of the advantages of growing dwarf coconut varieties. Public and private institutions' support are needed in the adoption of the practice.

Table 6. Coconut production of the use of Tacunan green dwarf variety and use of traditional coconut variety

Non-CSA Practice		CSA Practice	
Coconut (kg/ha)	1,962	Coconut (kg/ha)	2,870
Revenue (in PHP)	54,936	Revenue (in PHP)	83,230

Source: Authors' own calculation and analysis (2020).

CONCLUSIONS

Coconut farming is a very important source of economic activity among small scale farmers in Leyte, Philippines. Climate change can affect coconut production significantly. Among the hazards brought by climate variability and change, the typhoon is the most damaging to coconut production. When super typhoon Haiyan hit Leyte in November 2013, the coconut farms were severely damaged causing reduction in income among small scale farmers. Farmers are facing unprecedented challenges in improving coconut productivity. One of the feasible ways to respond to changing climate and extreme weather events is to adopt climate smart agricultural practices (CSA). CSA is a sustainable development strategy anchored on three pillars such as productivity, mitigation and adaptation to climate change. Investigation of CSA practices and its potential for scaling up was the focus of our study, particularly in Leyte province. Results showed that adapting and mitigating climate variability and change in coconut production requires adoption of typhoon resilient coconut variety coupled with diversified cropping practices. For Leyte, Philippines, the adoption of either coconut banana intercropping or improve coconut variety are feasible options that the farmers can explore. They can maintain or increase productivity and also mitigate the adverse effect of extreme weather events and changing climatic conditions.

Intercropping coconut with banana is an efficient solution to increase farm productivity. With the continuous conversion of agricultural land into commercial and housing purposes, areas of cultivated lands for food production are on the decline which endangers the food security of Filipinos. Thus, coconut farmers must adopt diversified and efficient cropping technologies. Through intercropping banana in areas planted with coconut, farm productivity will increase significantly. On average, farm income of farmers adopting the CSA is higher by 50%. Similarly, the adoption of Tacunan green dwarf coconut variety provides a continued stream of benefits in comparison to the traditional variety when a damaging typhoon will hit the area. Leyte province is likely to experience more frequent and damaging typhoons; thus, the use of improved variety can mitigate this climate hazard.

Small scale coconut farmers face different barriers in adapting these CSA practices. These challenges include financial and technical resources. Hence, support from various institutions, either government or private sector, should prioritize technical and financial support for potential scaling up of these practices. This will enhance the adoption of these prioritized CSA practices and help coconut farmers become more resilient. Various agencies and stakeholders should conduct capacity building activities and trainings related to the adoption of these climate smart agricultural practices but should also consider providing access to technology and markets.

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MODEL OF VINES PRODUCTION VARIATION IN RELATION TO PHYSIOLOGICAL INDICES

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Abstract

The study analyzed the interdependence relationship of the production with the physiological indices in vines, under conditions of differentiated fertilization (organic, mineral and foliar fertilizers). The study was carried out within the Fruit and Vine Research Center of BUSAMV Timisoara, 2011-2012 period. Biological material was represented by the 'Silvania' grape variety. Organic fertilizers (manure), complex fertilizers (NPK, 1:1:1), and foliar fertilizers (Fertitel, Cropmax, Waterfert, Calcium chloride) were used. By applying fertilizing resources, 12 experimental variants (T2 - T13) were obtained, and a control variant T1 (Ct) was used. Physiological indices (leaf area - LA, chlorophyll content - Chl), yield per plant (Ypl) and yield per ha (Yha) were determined. The interdependence relationship between LA and Chl was described by a polynomial relation of degree 2, under conditions of R^2=0.899, p<<0.001. Regression analysis led to obtaining some models of variation of Ypl depending on LA (R^2=0.913, p<<0.001), Ypl according to Chl (R^2=0.929, p<<0.001), Yha depending on LA (R^2=0.907, p<<0.001), and Yha depending on Chl respectively (R^2=0.934, p<<0.001). Multiple regression analysis led to models that described the Ypl and Yha variation depending on the two physiological indices as simultaneous action. Models of the type y = f(x,y) were obtained, under statistical safety conditions (R^2=0.998, p<<0.001 for Ypl, and for Yha). Within PCA, PC1 explained 96.806% of variance, and PC2 explained 1.6334% of variance. Cluster analysis led to the grouping of variants under statistical safety conditions (Coph.corr. = 0.843).

Key words: *grape production, model, PCA, physiological indices, vine*

INTRODUCTION

Vine is a very old crop plant, within the horticultural crops, but of great importance and of great interest worldwide for the vine-wine products and by-products of that it provides [63], [38], [41]. The rich assortment of genotypes makes the vines grown for table grapes, wine grapes, raisins or by-products such as seed oil, food supplements, pharmaceuticals, etc. [40], [31], [8], [12], [74].

The numerous genetic resources of vines, natural and improved genotypes, have led to a series of studies and researches regarding the identification of new resources of valuable germplasm [16], [21]. Vine breeding programs have also been developed to improve the vineyards regarding resistance to pathogens, stressors, the quality of grape production [56], and were produced in new, hybrid forms, as a prospect for sustainable viticulture [15].

In view of the consecrated wine areas and centers for vineyards worldwide, as well as areas that are smaller in size, but important through the specificity and local imprint that they induce on wine products, a number of studies have evaluated the relationship of the vine with the soil and climate factors [59], [22], [11], [25], [68].

Elements of viticulture technology, such as soil works, irrigation, fertigation, maintenance work, integrated protection, etc. have been studied in relation to the vineyard in terms of efficiency, production, quality, sustainable viticulture [5], [47].

In the context and significance of the 'terroir' concept, a series of studies was performed that evaluated the particular relation of the vines with the soil in order to give a specific imprint to the grapevine products [67], [72].

The relation of the horticultural plants to the mineral elements has also been intensively studied, due to the close connection between the quality of the horticultural products in general, and especially of the viticultural ones, and the plants nutritional status [35], [7], [70], [39], [24]. The optimization of the vine nutrition, in relation to the conditions of soil and vegetation, genotype, and the destination of the grape production, represents an important method in ensuring the production and the quality of vine products [46], [36], [75].

Methods based on the image analysis [29], [30] have found applicability also to the vine in evaluating the state of vegetation, nutrition, quality of grapes and optimal harvest time [26], [14], [42], [44], [45]. Also, software applications have been developed for the study of leaf area, and of the attack of pathogens on plants, which can be easily adapted to the vine [19], [20], [9].

Numerous studies in direction of testing different types of fertilizers and application methods in vines have been carried out [18], [62], [61], [69]. As effects of fertilization on vines were evaluated physiological indices [10], [60], [55], productivity elements and yield [4], [19], [13], and quality indices for grapes, must or wine [17], [1], [69].

The present study evaluated the model of grape production variation in relation to physiological indices, under differentiated fertilization conditions.

MATERIALS AND METHODS

The study analyzed the interdependence relationship between physiological indices, and the grape production variation in relation to the physiological indices in vine, under conditions of differentiated fertilization, based on organic, mineral and foliar fertilizers.

The study was carried out within the Fruit and Vine Research Center of USAMVB Timisoara, in 2011 - 2012 period. Biological material was represented by the 'Silvania' grape variety. The planting distance was 2.2 m between rows and 1 m between plants per row, with a density of 4545 plants per ha.

There were used three categories of fertilizers in various doses, which gave the experimental variants (T2-T13); organic fertilizers (manure) in doses of 30 t ha^{-1} (T2), 40 t ha^{-1} (T3), and 50 t ha^{-1} (T4); NPK complex fertilizers (1:1:1) in doses of 50 kg a.s. ha^{-1} (a.s. - active substance) (T5), 100 kg a.s. ha^{-1} (T6), and 150 kg a.s. ha^{-1} (T7); foliar fertilizers, in two treatments, Fertitel (T8), Fertitel + Ca (T9), Cropmax (T10), Cropmax + Ca (T11), Waterfert (T12) and Waterfert + Ca (T13). Calcium was supplemented in two foliar treatments, in the form of calcium chloride ($CaCl_2$). For comparing the results, a variant without fertilizers was considered as control variant (T1 - Ct).

Leaf area (LA) and the chlorophyll content (Chl) as physiological indices, average production per plant (Ypl), average production per ha (Yha), as production parameters, were evaluated. Leaf area (LA) was determined based on the leaf size elements and a correction factor (CF), after a general relation of the type LA=L·W·CF. The chlorophyll content was determined by a non-destructive method, with a portable device SPAD 502 Plus (Konica Minolta), with an accuracy of ± 0.2 SPAD units. Production per plant (Ypl) was determined with a technical balance (accuracy of ± 0.50 g).

The processing and statistical analysis of the experimental data was done with the statistical calculation module in EXCEL and with the PAST software [28]. Wolfram Alpha software was used to produce 3D and isoquants graphics [73]. ANOVA test, correlation analysis, regression analysis, Principal Component Analysis (PCA), and Cluster Analysis (CA) were performed. The parameters p, F-test, standard error (SE), correlation coefficient (r), regression coefficient (R^2), and cophenetic coefficient (Coph.corr.) were used, as safety statistical parameters of the results.

RESULTS AND DISCUSSIONS

Fertilization variants, in the form of organic fertilizers, complex mineral fertilizers and foliar fertilizers, differentially influenced the physiological indices (LA and Chl), and vine production parameters analyzed (Ypl and Yha). Leaf area (LA) recorded values between 108.48±4.07 cm^2 (T1 - Ct) and 159.89±4.07 cm^2 (T7). Chlorophyll content (Chl) recorded values between 31.24±0.77 SPAD units (T1 -

Ct) and 40.72±0.77 SPAD units (T7). Average yield per plant (Ypl) ranged from 1.894±0.086 kg/plt (T1 - Ct) and 2.895±0.086 kg/plt (T7).
In relation to the values of the average production per plant (Ypl), the average production per ha (Yha) varied in the range 8.143 – 12.302±0.363 t ha^{-1}.
The experimental results for physiological indices and vine production parameters are presented in Table 1.

Table 1. Values of physiological indices and production in 'Silvania' grape variety, average values 2011 - 2012

Trial	LA	Chl	Yplt	Yha
	(cm^2)	SPAD units	Kg plt^{-1}	T ha^{-1}
V1 (Ct)	108.48	31.24	1.894	8.143
V2	125.00	33.67	2.183	9.315
V3	140.41	36.03	2.701	11.393
V4	150.03	37.98	2.801	12.047
V5	129.94	35.99	2.413	10.408
V6	148.95	39.47	2.735	11.554
V7	159.89	40.72	2.895	12.302
V8	117.76	32.57	2.083	8.914
V9	124.70	33.70	2.211	9.540
V10	120.06	33.03	2.106	8.922
V11	137.02	34.59	2.265	9.660
V12	126.92	33.15	2.249	9.482
V13	141.50	34.70	2.429	10.333
SE	±4.07	±0.77	±0.086	±0.363

Source: original data, resulted from experiment.

The graphical distribution of the variation interval of the physiological indices and the production parameters, in the form of a box plot, accompanied by the standard error (SE), is presented in figure 1.
Based to the ANOVA test, the presence of the variance in the experimental data set, and the statistical certainty of the data were confirmed, according to p << 0.01, F>Fcrit, for Alpha= 0.001.
High level of variance (215.8961) was recorded in the set of leaf area (LA) physiological index values. At the level of chlorophyll (Chl), the variance was 7.86859. In the case of production per plant (Ypl) the variance had the value of 0.0976, and at the level of production per ha (Yha) the variance had the value of 1.72209.

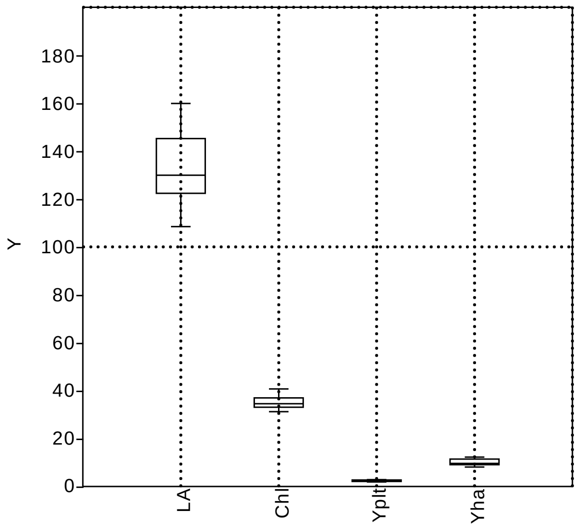

Fig. 1. Box plot graphical distribution of values for experimental parameters, accompanied by SE
Source: original graph based on the experimental data

The correlation analysis showed the existence of very strong correlations between the studied physiological indices, LA and Chl (r=0.937), as well as between production and physiological indices, Ypl and LA (r=0.956), Ypl and Chl (r=0.950), Yha and LA (r=0.952), Yha and Chl respectively (r=0.951).
Regression analysis was used to describe the interdependence relationship between physiological indices (Chl and LA), as a result of differentiated fertilization.
Interdependence relation between the two physiological indices was described by a polynomial equation of degree 2, equation (1) under conditions of R^2=0.899, p<<0.001, F=44.417. The graphical distribution of the Chl variation with respect to LA is presented in Figure 2.

$$Chl = 0.001819 \cdot LA^2 - 0.3102 \cdot LA + 43.84 \quad (1)$$

Based on the levels of correlations found between the physiological indices (LA, Chl) and production (Ypl, Yha), the regression analysis was used to analyze the variation of production according to the two physiological indices.
Regression analysis led to the finding of models in the form of polynomial equations of degree 2, under statistical safety conditions.

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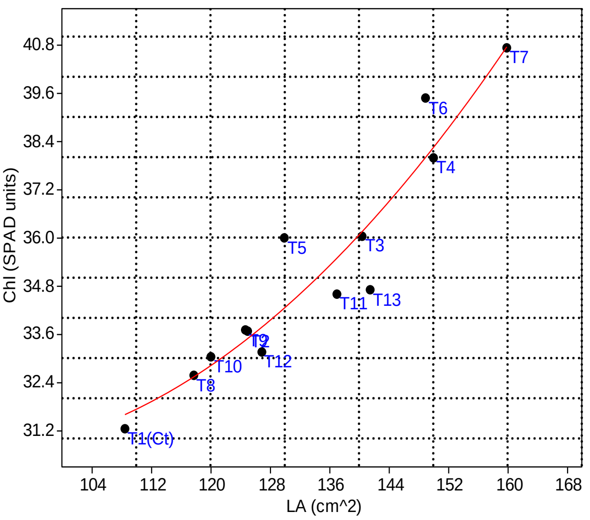

Fig. 2. Graphical distribution of Chl values in relation to LA, 'Silvania' grape variety
Source: original graph, based on the experimental data

Thus, the variation of average production per plant (Ypl) relative to LA was described by equation (2), under conditions of R^2=0.913, p<<0.001, F=52.946. The variation Ypl relative to Chl was described by equation (3) under conditions of R^2=0.929, p<<0.001, F=65.535, and the graphical distribution is presented in Figure 3.

$$\mathrm{Ypl} = 2.197\mathrm{E}-05 \cdot \mathrm{LA}^2 + 0.01441 \cdot \mathrm{LA} + 0.06934 \quad (2)$$

$$\mathrm{Ypl} = -0.006809 \cdot \mathrm{Chl}^2 + 0.5972 \cdot \mathrm{Chl} - 10.15 \quad (3)$$

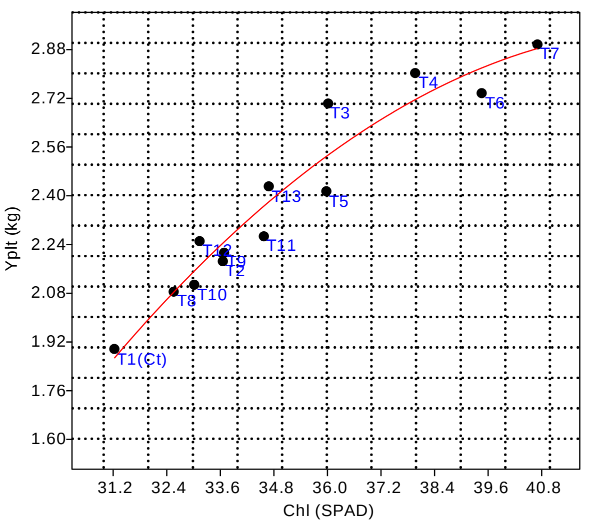

Fig. 3. Graphical distribution of Ypl values in relation to Chl, 'Silvania' grape variety
Source: original graph, based on the experimental data

Grape production per ha (Yha) was described by equation (4) in relation to LA (R^2=0.907, p<<0.001, F=48.793), and by equation (5) in relation to Chl (R^2=0.934, p<<0.001, F=70.934).

$$\mathrm{Yha} = 0.0001295 \cdot \mathrm{LA}^2 + 0.05023 \cdot \mathrm{LA} + 1.148 \quad (4)$$

$$\mathrm{Yha} = -0.0298 \cdot \mathrm{Chl}^2 + 2.596 \cdot \mathrm{Chl} - 44.05 \quad (5)$$

Based on the values of the correlation coefficients (R^2), and on the values of the F-test associated with the regression equations (2), (3), (4) and (5), was identified a stronger relation of Ypl and Yha with chlorophyll content (Chl), compared with the leaf area (LA).

Multiple regression analysis facilitated the finding of some models to describe the production variation (Ypl, Yha), depending on the associated influence of the two physiological indices studied, LA and Chl.

Grape production per plant (Ypl) in relation to Chl and LA, Ypl=f(LA,Chl), was described by equation (6), under general safety statistical conditions, according to R^2=0.998, p<<0.001, F=4264.499. The 3D graphical distribution of Ypl according to the values of Chl and LA is presented in Figure 4.

$$\mathrm{Ypl} = ax^2 + by^2 + cx + dy + exy + f \quad (6)$$

where: x – LA – leaf area (cm^2);
y – Chl – Chlorophyll content, SPAD units;
a, b, c, d, e, f - the equation (6) coefficients;
a= -0.000491140145853946;
b= -0.00705247917163731;
c= 0.00754085620700632;
d= 0.0193940357912801;
e= 0.00387350656446163;
f= 0.

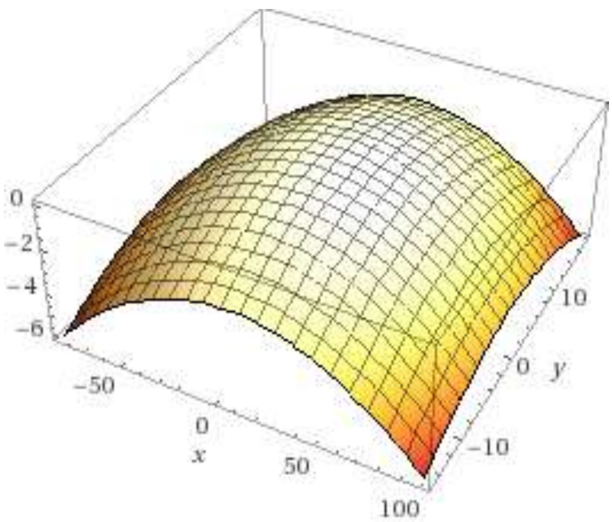

Fig. 4. 3D graphical distribution of Ypl values relative to LA (x-axis), and Chl (y-axis), 'Silvania' grape variety
Source: original graph based on the experimental data

The graphical distribution in the form of isoquants of the Ypl values according to Chl and LA is presented in Figure 5.

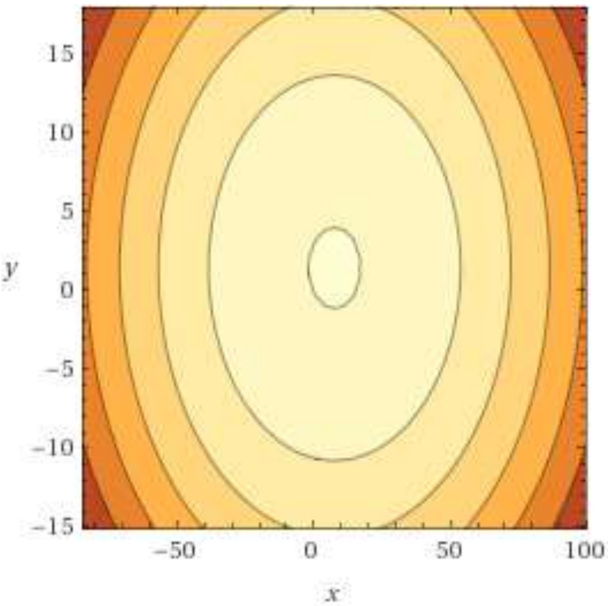

Fig. 5. Graphical distribution in the form of isoquants of Ypl values with respect to LA (x-axis) and Chl (y-axis), 'Silvania' grape variety
Source: original graph based on the experimental data

Grape production per ha (Yha) according to the two physiological indices, as a simultaneous action, Yha=f(LA,Chl) was described by equation (7) under general statistical safety conditions of the equation, according to R^2=0.998, p<<0.001, F=4091.884. The graphical distribution of Yha according to the Chl and LA values, in the form of 3D, is presented in Figure 6.

$$Yha = ax^2 + by^2 + cx + dy + exy + f \qquad (7)$$

where: x – LA – leaf area (cm^2);
y – Chl – Chlorophyll content, SPAD units;
a, b, c, d, e, f - the equation (7) coefficients;
a= -0.00111331775926283;
b= -0.0151247485454284;
c= 0.0337283253687043;
d= 0.0727054170385543;
e= 0.00887831338165124;
f= 0.

Optimal values for *x* (LA) and *y* (Chl), which provide optimal Yha under the study conditions, were found at x_{opt}=145.23 cm^2, respectively y_{opt}=40.22 SPAD units. The graphical distribution of the Yha values according to LA and Chl, in the form of isoquant, is presented in Figure 7.

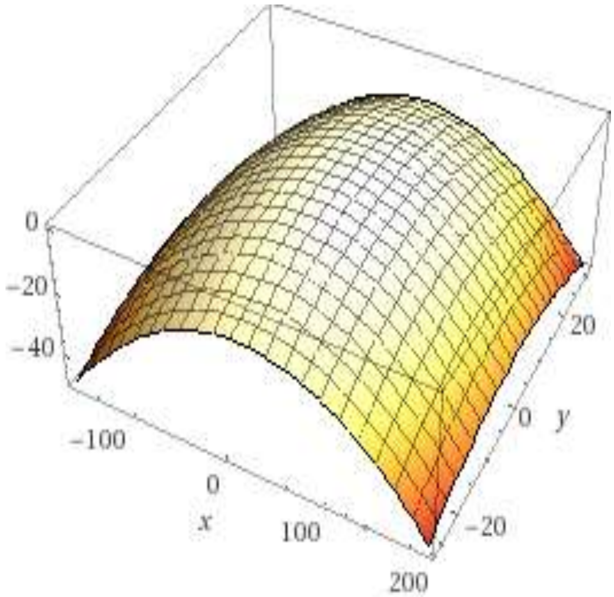

Fig. 6. 3D graphical distribution of Yha values with respect to LA (x-axis) and Chl (y-axis), 'Silvania' grape variety
Source: original graph based on the experimental data

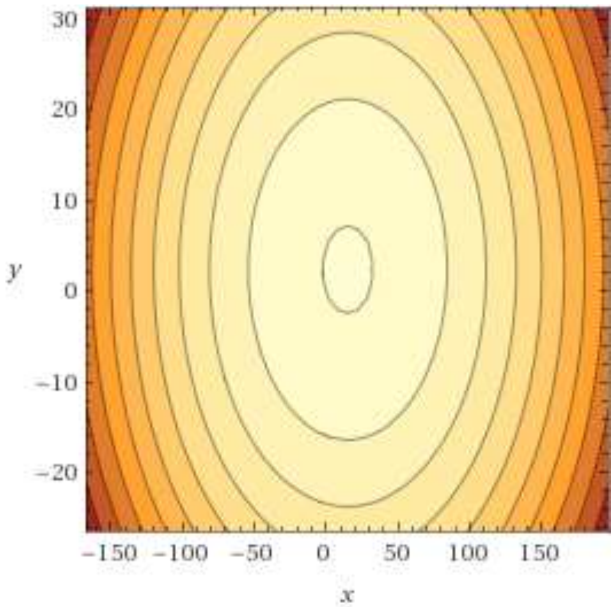

Fig. 7. Graphical distribution in the form of isoquants of Yha values with respect to LA (x-axis) and Chl (y-axis), 'Silvania' grape variety
Source: original graph based on the experimental data

PCA analysis generated the spatial distribution of the variants in relation to the physiological indices (Chl, LA) and production parameters (Ypl, Yha), evaluated in the 'Silvania' grape variety. PC1 explained 96.806% of variance, and PC2 explained 1.6334% of variance, Figure 8.

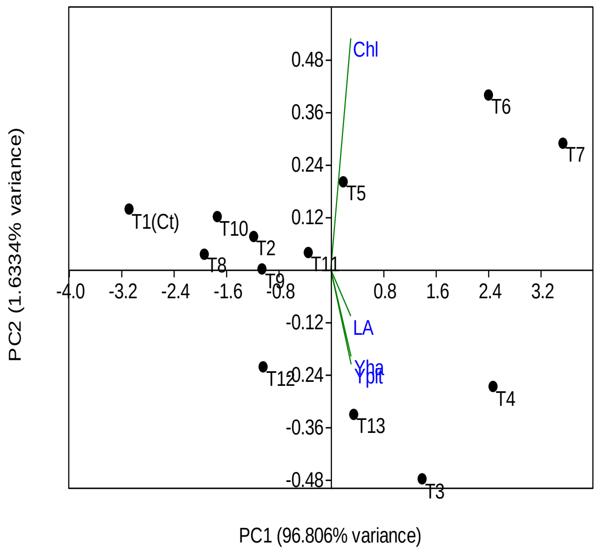

Fig. 8. PCA diagram with the variants (T1-T13) distribution, in relation to LA, Chl, Ypl, Yha, at 'Silvania' grape variety
Source: original graph based on the experimental data

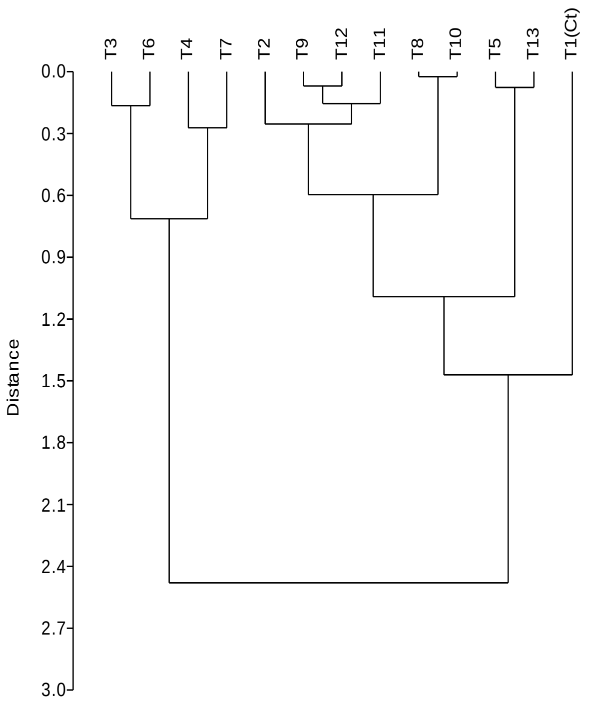

Fig. 9. Clusters diagram in relation to Ypl and Yha, 'Silvania' grape variety
Source: original diagram, based on the experimental data

Cluster analysis generated the grouping of variants based on Euclidean distances, in relation to the values of the production parameters Ypl and Yha (Fig. 9). The statistical safety of the analysis was confirmed by the Cophenetic coefficient (Coph. corr.= 0.843).

The values for similarity distance indices (SDI), related to the experimental variants grouping, are presented in Table 2.

Table 2. Values for Similarity and Distance Indices (SDI) in relation to Ypl and Yha, 'Silvania' grape variety

	T1(Ct)	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
T1(Ct)		1.2069	3.3485	4.0077	2.3235	3.5129	4.2775	0.7936	1.4323	0.8071	1.5615	1.3850	2.2542
T2	1.207		2.1416	2.8010	1.1169	2.3060	3.0707	0.4133	0.2267	0.4005	0.3546	0.1796	1.0473
T3	3.349	2.142		0.6616	1.0262	0.1646	0.9295	2.5549	1.9167	2.5416	1.7870	1.9637	1.0943
T4	4.008	2.801	0.662		1.6843	0.4974	0.2718	3.2142	2.5755	3.2014	2.4464	2.6237	1.7539
T5	2.324	1.117	1.026	1.684		1.1904	1.9544	1.5300	0.8912	1.5174	0.7625	0.9404	0.0767
T6	3.513	2.306	0.165	0.497	1.190		0.7649	2.7193	2.0811	2.7061	1.9514	2.1282	1.2588
T7	4.278	3.071	0.929	0.272	1.954	0.765		3.4839	2.8454	3.4709	2.7161	2.8930	2.0234
T8	0.794	0.413	2.555	3.214	1.530	2.719	3.484		0.6390	0.0244	0.7679	0.5918	1.4606
T9	1.432	0.227	1.917	2.576	0.891	2.081	2.845	0.639		0.6269	0.1316	0.0693	0.8224
T10	0.807	0.400	2.542	3.201	1.517	2.706	3.471	0.024	0.627		0.7549	0.5780	1.4475
T11	1.562	0.355	1.787	2.446	0.763	1.951	2.716	0.768	0.132	0.755		0.1787	0.6927
T12	1.385	0.180	1.964	2.624	0.940	2.128	2.893	0.592	0.069	0.578	0.179		0.8698
T13	2.254	1.047	1.094	1.754	0.077	1.259	2.023	1.461	0.822	1.448	0.693	0.870	

Source: original data calculated based on experimental values (Table 1)

From the analysis of the generated dendrogram, Figure 9, it was found the formation of two distinct clusters. A C1 cluster comprised 9 variants, and a C2 cluster comprised 4 variants. Within the C1 cluster, the T1 variant (Ct) was independently positioned, with the lowest values for production parameters (Ypl, Yha).

The other 8 variants were grouped into several sub-clusters; sub-cluster C1-1, with variants

(T5, T13); sub-cluster C1-2, with variants (T8, T10), sub-cluster C1-3, with variants [((T9, T12), T11), T2], with a common root. Cluster C2 grouped the variants [(T4, T7), (T3, T6)]. The analysis of SDI values (similarity distance indices) in relation to the clusters group, confirmed the highest degree of similarity in the variants T8, T10 (SDI = 0.024), followed by variants T9, T12 (SDI = 0.069), and by variants T5, T13 (SDI = 0.077), table 2. The overall analysis of the SDI values, presented in Table 2, explained the association and grouping of the experimental variants according to the degree of affinity to ensure the production per plant (Ypl) and the production per ha (Yha), under the experimental conditions.

The relationship between the values of the physiological indices (LA, Chl) and the values of the production parameters (Ypl, Yha) was analyzed. Thus, in the case of the ratio LA: Ypl, values between 51.990 and 60.485 units LA/ unit Ypl were found. In the case of the LA:Yha ratio, values between 12.324 and 14.181 LA units / Yha unit were found. From the comparative analysis, with the graphical representation of the values for Ypl and LA / Ypl, it was found the presence of a "scissor" type relationship between the two values categories.

From the analysis of the Chl:Ypl ratio were found values between 13.339 and 16.488 units Chl / Ypl unit, and from the analysis of the Chl:Yha ratio were found values between 3.152 and 3.836 Chl units / one Yha unit.

Leaf area and numerous other aspects of plant leaves have been studied in relation to nutrients [57], [58], with stress factors [34], with production, etc. [71].

Foliar indices such as LAI (leaf area index) have been calculated and used in different studies to evaluate and express the relationship of CO_2 plants, photosynthetic efficiency, response to stress factors, increased production, etc. [23], [43], [50].

Leaf Area Index at vine was also studied in relation to methods of determination [49] but also with elements of productivity, quality and yield [66].

The leaf-fruit ratio presented interest and has been studied in several vine varieties in relation to fruit production and composition [27].

The "scissor" effect identified in the comparative analysis of LA with LA/Ypl leads to the need to control the leaf surface on vine plants in order to balance LA:Ypl.

Vine products represent a special category of horticultural products, and numerous studies have addressed the problem of grape production from the plot to the consumer. In order to optimize the production, numerous studies evaluated the pedoclimatic conditions, the cultivated varieties, the viticulture technologies and the inputs under quantitative and qualitative aspect [18], [3], [16], [47], [25], [72].

Numerous studies have focused on aspects regarding the quality and the typicality of the wine products [17], [2], [48], [2], [64], [67], [14]. There have been studies on economic and trade aspects, specific to the wine sector, especially in relation to the production, consumption and specificity of the wine products [6], [37], [65]. Tourism and wine tourism have also been the subjects of valuable studies aimed at promoting specific values, local, regional or national, on the international market [53], [33], [32] [51], [52], [54].

In the context of the interest for the wine products, highlighted by the specialized literature, the present study communicated models of approach for optimizing the production of grapes, the case study being carried out in the 'Silvania' grape variety.

Of the 12 fertilization variants, the methods of analysis and investigation used highlighted both the best and alternative variants based on similarity. Thus it brought useful information for choosing fertilization variants in relation to the type of plantation (conventional, intensive, ecological), but also with specific aspects of vineyard practices.

CONCLUSIONS

The relationship of interdependence between the physiological studied indices (LA, Chl) and production parameters (Ypl, Yha), under different fertilization conditions, has been described by mathematical models obtained by regression analysis, under statistical safety conditions.

The optimum level of LA and Chl were determined from the equations found, ensuring the optimal values of Ypl and Yha.

Based on Cluster Analysis, similarities of the experimental variants in the assurance of Ypl and Yha values, in statistical safety conditions, were identified.

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FRACTAL ANALYSIS IN ESTIMATING THE FRAGMENTATION DEGREE OF AGRICULTURAL LANDS

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Abstract

Fractal analysis was used to evaluate the degree of agricultural lands fragmentation. An area in the Western Plain, Romania was studied. The image was taken with the RapidEye satellite system. From the basic image, 10 polygons with equal resolution of 735 x 840 pixels were selected. For each studied polygon, the total surface (TS), the number of plots (PN), the average plot area (APA), and the fractal dimension (D) were determined. Fractal analysis was performed using the box counting method. The correlation analysis revealed a moderate, negative, correlation between PN and APA (r=-0.776), strong negative correlation between D and PN (r=-0.871), respectively a very strong, positive, correlation between D and APA (r=0.935). APA variation according to PN was most faithfully described by a smoothing spline model. Variation of fractal dimension D according to PN was described by a polynomial equation of degree 2, in conditions of R^2=0.946, p<< 0.01, and the variation of D according to the APA was described by a polynomial equation of degree 2 in conditions of R^2=0.939, p<< 0.01. Based on fractal dimension (D), regression analysis made it possible to estimate PN under conditions of R^2=0.818, p=0.0025, F=15.782, respectively APA variation under conditions of R^2=0.984, p<< 0.001, F=214.86. Based on PCA, PC1 explained 89.441% of variance, and PC2 explained 10.559% of variance. Cluster analysis led to the grouping of the studied cases, in condition of Coph.corr=0.988.

Key words: *fractal analysis, fragmentation, agricultural land, smoothing spline model*

INTRODUCTION

Land cover and land use are intensely studied in relation to environmental aspects [34], administrative aspects [27], [42], resource assessment [5], [8], environmental aspects and management [11], [22], [28], soil resources management [39], agricultural ecosystems [45] etc. Various satellite systems have been developed (Landsat, MODIS, Sentinel 2 etc.) and new generations of satellites have emerged within the same family (ex. Landsat 1 to Landsat 8), for the purpose of providing better service (image resolution, costs, spectral bands, indices etc.) for the study and analysis of natural, agricultural or urban land areas [36].

Studies were carried out to assess the relations between spectral bands and various vegetation indices [14], [15], [2], [24], regarding the development of new models for land cover and land use studies [21]. The number of indices has also increased and diversified in relation to the new satellite systems facilities and the realities of land, agricultural, urban and rural areas, the categories of use that were intended to be studied [32], [46], [26].

Land cower classification has shown particular interest and has been addressed in many studies for the analysis and characterization of natural and anthropogenic areas [13], of forestry and horticultural species in different areas or culture systems [9], of some National Parks and Protected Areas [12], [6], [31], categories of use and agricultural crops [16]. Some studies have evaluated temporal and spatial changes and variability on land use in relation to various factors [38], [19].

With the introduction of fractal geometry, as a vision and approach to nature [25], fractal analysis developed as a method of study and penetrated into more and more fields such as botany, chemistry, fluid mechanics, material science, medicine, biotechnologies, nanomaterials etc. [7], [40]. At the same time,

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fractal analysis was successfully used in the analysis and characterization of natural, agricultural, forestry, and urban areas etc. [33], [37]. Fractal analysis was used in the study and evaluation of spatial and temporal variability in various approaches, such as soil, vegetable cover, crops etc. [44], [43].
This study used fractal analysis to assess the degree of fragmentation of agricultural land by analyzing fractal geometry expressed in satellite imagery.

MATERIALS AND METHODS

The purpose of the study was to assess the degree of fragmentation of agricultural land by fractal analysis. The area studied is part of the Western Plain, Romania, in a perimeter located at N-V, V from Timisoara Municipality, with the following locations Timisoara, Giarmata-Vii, Murani, Satchinez, Săcălaz (Fig. 1).

Satellite system. The images used were taken using the RapidEye teledetection system, which is composed of 5 satellites and it offers images at 5 m resolution on 5 spectral bands: Red, Green, Blue, RedEdge and NIR. The image used was retrieved on 12.08.2017, figure 1. For fractal analysis was used an image resulting from the combination of spectral bands in false colors, namely the NIR-Red-Green combination.
Polygons studied. In the study there are 10 polygons with resolution 735 x 840 pixels, which have as ground representation an area of 102.1373 ha. The polygons studied have been established to include a variable number of plots (Fig. 2).
Parameters and indices studied. For each polygon studied, there were determined the total surface (TS), the number of plots (PN), the average area per plot (APA), and the fractal dimension (D).

Fig. 1. The studied area, Timis County, Romania
Source: original image, based on RapidEye teledetection system

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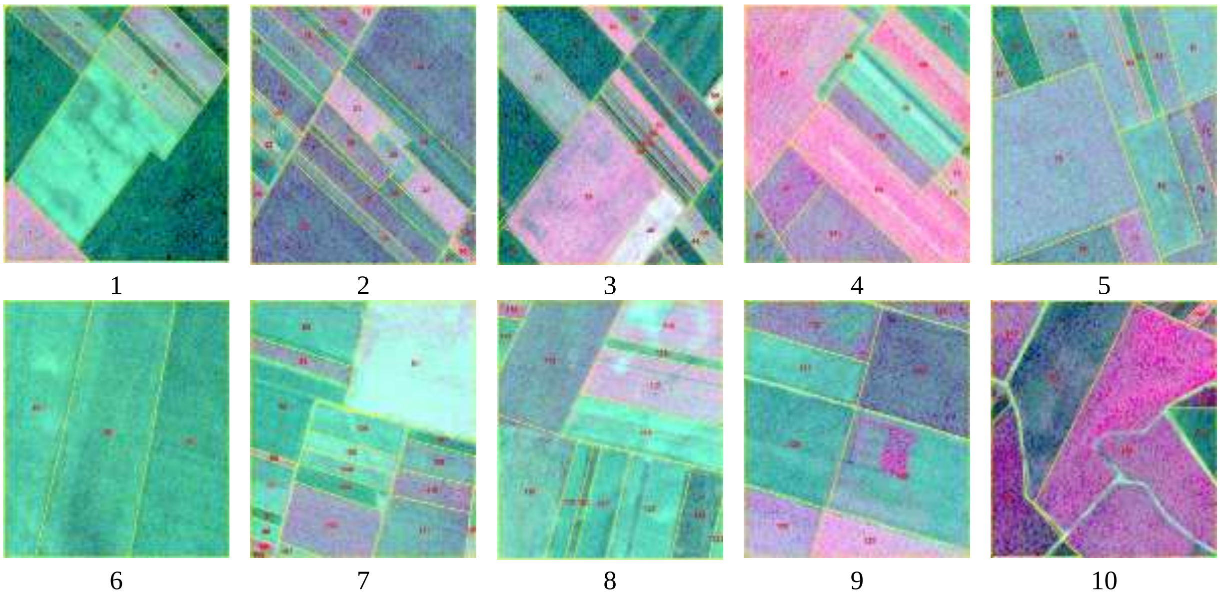

Fig. 2. Perimeters included in the study
Source: original image, extracted by Fig. 1.

Fractal analysis. Fractal analysis was carried out using the box counting method [41], relations (1), (2), (3), [35]. This is the most used method for analyzing fractal geometry on binarized images [20], [22].

$$\mathrm{MeanD} = \sum (D) / \mathrm{GRIDS} \tag{1}$$

$$D = m\left[\frac{\ln(F)}{\ln(\varepsilon)}\right] \tag{2}$$

where: D – fractal dimension; m – slope to regression line, in eq. (3); F – number of new part; ε – scale applied.

$$m = \left(n\sum SC - \sum S \sum C\right) / \left(n\sum S^2 - \left(\sum S\right)^2\right) \tag{3}$$

where: m – slope of regression line; S – log of scale or size; C – log of count; n – number of size;

Statistical analysis of data. The resulting experimental data was analyzed by the ANOVA single factor test, correlation analysis, regression analysis, Principal Component Analysis (PCA) and Cluster Analysis (CA).

For estimation the accuracy of the results was used correlation coefficient (r), regression coefficient (R^2), parameter p, average error ($\bar{\varepsilon}$), and Cophenetic coefficient (Coph.corr), as statistical safety parameters. They were used EXCEL mathematical module, and PAST software [10], for the experimental data analysis and processing.

RESULTS AND DISCUSSIONS

The polygons considered in the study were analyzed in terms of the total area, the number of plots and the average area on the plot. Starting from the working resolution, 735 x 840 pixels per polygon, and the field area of each polygon was 102.1373 ha.

With ArcGIS software, there were determined and marked the number of parcels within each perimeter and the surface of the plots was calculated. Variable number of plots were found, between 3 (polygon 6) and 25 (polygon 2).

Based on the total surface (TS) of a polygon, and the number of plots (PN), the average area was calculated on the each plot (APA). The results obtained are presented in Table 1.

Anova Test, single factor, has confirmed the existence of the variance in the experimental data set, and statistical accuracy of results, F>Fcrit, $p<<0.01$, for Alpha=0.001.

The correlation analysis has revealed a moderate, negative correlation between PN and APA (r=-0.776). Between fractal dimension (D) and PN was recorded a strong, negative correlation (r=-0.871), and between D and APA there was a very strong, positive correlation (r=0.935).

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Table 1. Experimental data on field characterization parameters and fractal size (D)

Perimeters studied	TS	PN	APA	D
1	102.1373	12	8.511	1.763
2	102.1373	25	4.085	1.734
3	102.1373	24	4.256	1.754
4	102.1373	13	7.857	1.778
5	102.1373	13	7.857	1.782
6	102.1373	3	34.046	1.881
7	102.1373	21	4.864	1.729
8	102.1373	14	7.296	1.756
9	102.1373	8	12.767	1.810
10	102.1373	11	9.285	1.795

TS – total surface (ha); PN – plots number; APA – average plots area (ha); D – fractal dimension
Source: original data, resulted from the 10 polygons analysis.

Starting from the correlations identified between the parameters studied (PN, APA, D), different models were analyzed that described interdependence relationships in statistical accuracy conditions.
The variation of the average area per plot (APA) by number of plots (PN) was best described by a model called smoothing spline, and the error of estimation over actual values was given by the equation (4). The smoothing spline model dataset is presented in Table 2.

$$\bar{\varepsilon} = \left(\sum_{i=1}^{n}\varepsilon_i\right)/n = \left(\sum_{i=1}^{n}\left|\frac{ys_i - y_i}{y_i}\right|\right)/n \qquad (4)$$

Table 2. Statistical data for APA variation in relation to PN, in the case of studied perimeters

Trial	x_i	APA			
		y_i	ys_i	ε_i	$I_{i/1}$
6	3	34.046	32.726	1.32	1
9	8	12.767	14.993	2.226	0.458137
10	11	9.285	9.4771	0.1921	0.289589
1	12	8.511	8.4198	0.0912	0.257282
4	13	7.857	7.6071	0.2499	0.232448
5	13	7.857	7.6071	0.2499	0.232448
8	14	7.296	6.957	0.339	0.212583
7	21	4.864	4.7236	0.1404	0.144338
3	24	4.256	4.2355	0.0205	0.129423
2	25	4.085	4.0776	0.0074	0.124598
				$\bar{\varepsilon} = 0.48364$	

Source: original data obtained based on equation (4).

The graphic distribution of APA values according to PN, based on the smoothing spline model, is presented in Fig. 3.

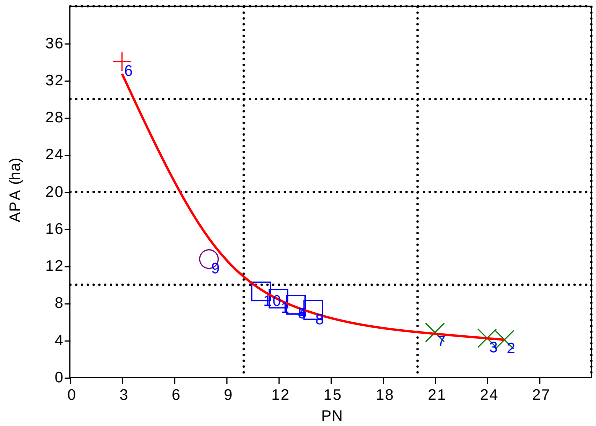

Fig. 3. APA values distribution according to PN, based on the smoothing spline model
Source: original graph based on data from Table 2.

The analysis of the fractal geometry of the perimeters taken in the study led to the obtaining of fractal dimensions (D) that ranged between D=1.729 (perimeter 7) and D=1.881 (perimeter 6).
As the fractal geometry of the images of the studied perimeters was given by the constituent elements, (i.e. plots by shape, surface, and number), consequently was analyzed how the two components of the perimeters (PN and APA) have contributed to the variation of fractal dimension (D).
Variation of D depending on the PN was described using polynomial equation of 2nd degree, relation (5), under conditions of R^2=0.946, p<<0.01. The variation in fractal dimension D depending on APA was described using a polynomial equation of 2nd degree, relation (6), under conditions of R^2=0.939, p<<0.01.

$$D_{PN} = 0.0003932\,x^2 - 0.01732\,x + 1.929 \qquad (5)$$

$$D_{APA} = -0.0001778\,x^2 + 0.01162\,x + 1.692 \qquad (6)$$

The multiple regression analysis on determining the fractal dimension (D) according to PN and APA, analyzed as a simultaneous contribution, led to equation (7), under conditions of R^2=0.927, p<0.01.
The analysis of the statistical parameters resulting from the regression analysis showed

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that the two variables PN and APA had a different contribution to the fractal geometry of the images of the perimeters studied and implicitly to the formation of D value.

Based on the value of the coefficient according to the two variables, the result was that APA had a higher contribution to the generation of D value ($Coef_{APA}$=0.003326), under statistical accuracy conditions (SE=0.000806, p=0.00491), compared to PN whose contribution was lower ($Coef_{PN}$ = 0.00231), under statistical accuracy conditions (SE=0.001016, p=0.05693).

Also parameter p, confirmed a higher degree of statistical accuracy related to variable APA (p=0.00491) compared to the variable PN (p=0.05693).

$$D_{PN,APA} = 1.778714 - 0.00231 \cdot PN + 0.00326 \cdot APA \quad (7)$$

Based on the correlation identified between PN, APA and D, as well as the level of contribution of PN and APA (estimated on the basis of equation coefficients (6) and (7)) when the fractal dimension D is formed, models of estimate of PN and APA were analyzed and tested based on the fractal values D, in order to describe the degree of fragmentation of the land by fractal analysis.

Simple regression analysis for estimating PN according to D has led to the relation (8), under conditions of R^2=0.818, p=0.0025, F=15.782. Simple regression analysis for estimating APA based on fractal dimensions D has led to relation (9), under conditions of R^2=0.984, p<<0.001.

$$PN = 763.8 \cdot D^2 - 2{,}893 \cdot D + 2{,}742 \quad (8)$$

$$APA = 1{,}277 \cdot D^2 - 4{,}419 \cdot D + 3{,}828 \quad (9)$$

PCA led to the distribution of study variants according to the three variables considered, PN, APA and D, according to the graph in Fig. 4. PC1 explained 89.441% of variance, and PC2 explained 10.559% of variance. Cluster analysis led to the grouping of cases studied in high statistical accuracy, Coph.corr=0.988, Fig. 5.

In a separate position got placed polygon 6, with the lowest number of plots (PN=3) and the highest fractal dimension value (D=1.881). The other polygons were grouped into sub-clusters according to the degree of affinity. Polygons 4, 5, 8 were grouped with very high affinity and formed the subcluster ((4, 5), 8), then polygons 2, 3, and 7 formed the subcluster ((2, 3), 7), followed by polygons 1 and 10, subcluster (1, 10), and in a separate position was placed polygon 9.

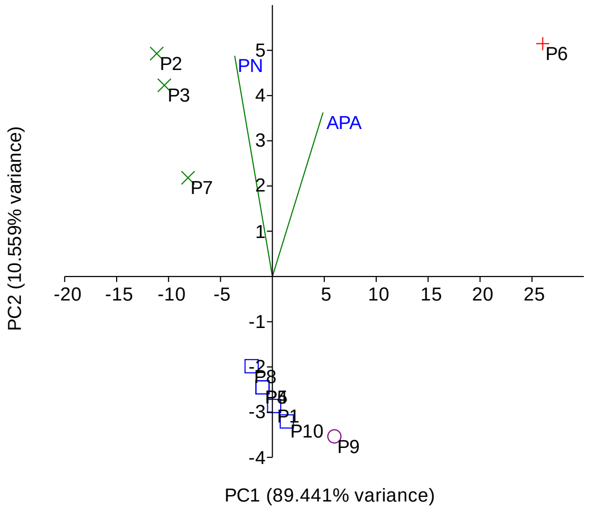

Fig. 4. PCA scatter diagram in relation to PN, APA, and D
Source: original image based on experimental data.

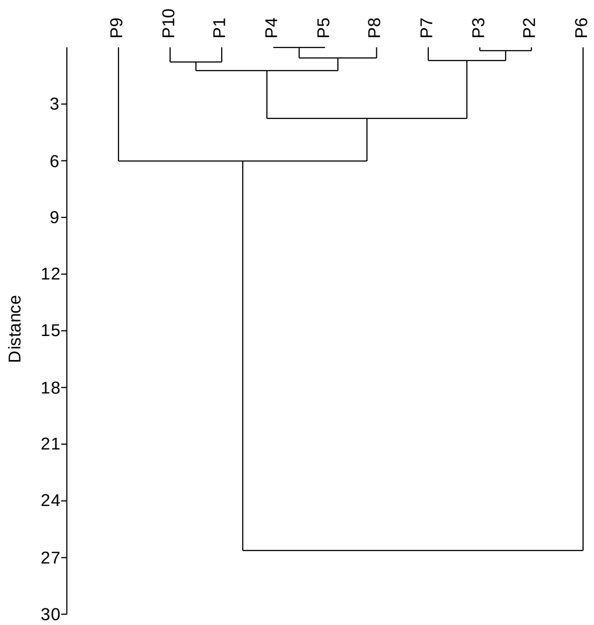

Fig. 5. Dendrogram of cases studied based on Euclidean distances
Source: original image based on experimental data.

Starting from the dendrogram obtained in Fig. 5, the values of Similarity and Distance

Incices (SDI) were analyzed, which confirmed the association and grouping of the 10 cases studied (P1 to P10).

The highest degree of similarity was recorded at the P4 and P5 polygons (SDI = 0.0040), followed by P2 and P3 (SDI = 0.1722), P8 and P4 (SDI = 0.5614), P8 and P5 (SDI = 0.5616), P3 and P7 (SDI = 0.6085) respectively.

An independent position was occupied by the polygon P6 which had the degree of similarity closer to P9 (SDI = 21.2790).

Table 3. SDI values in relation to D and APA values for the studied cases

	P6	P9	P10	P1	P4	P5	P8	P7	P3	P2
P6		21.2790	24.7610	25.5350	26.1890	26.1890	26.7500	29.1820	29.7900	29.9610
P9	21.2790		3.4820	4.2563	4.9101	4.9101	5.4713	7.9034	8.5112	8.6823
P10	24.7610	3.4820		0.7747	1.4281	1.4281	1.9894	4.4215	5.0292	5.2004
P1	25.5350	4.2563	0.7747		0.6542	0.6543	1.2150	3.6472	4.2550	4.4261
P4	26.1890	4.9101	1.4281	0.6542		0.0040	0.5614	2.9934	3.6011	3.7723
P5	26.1890	4.9101	1.4281	0.6543	0.0040		0.5616	2.9935	3.6011	3.7723
P8	26.7500	5.4713	1.9894	1.2150	0.5614	0.5616		2.4321	3.0400	3.2111
P7	29.1820	7.9034	4.4215	3.6472	2.9934	2.9935	2.4321		0.6085	0.7790
P3	29.7900	8.5112	5.0292	4.2550	3.6011	3.6011	3.0400	0.6085		0.1722
P2	29.9610	8.6823	5.2004	4.4261	3.7723	3.7723	3.2111	0.7790	0.1722	

Source: Original data, calculated based on D and APA values obtained from the studied cases.

Fractal analysis has extended to more and more areas as a method and study tool, which ensures a clear decelerating of the reality analyzed and a high degree of accuracy in areas such as nanomaterials [23], biotechnologies [4], medicine [18], and agriculture [1]. Fractal analysis was used in the study and evaluation of the fragmentation degree of green infrastructure in different cities in Romania [30].

Jevric and Romanovich (2016) [17] used fractal analysis as a tool to quantify urban border values for the purpose of space management. Fractal analysis was also used in studies on the evolution and dynamics of forest area fragmentation [3], analysis of cork cambium to some forest arboreal species [29].

The results communicated in this study on the assessment of the degree of fragmentation of agricultural land, are consistent with the studies in which the reporting on the facilities and accuracy provided by fractal analysis was made.

CONCLUSIONS

Fractal analysis facilitated the estimation of the fragmentation degree of the land both in terms of the number of plots (PN) as well as the average area of the parcels (APA), in statistical accuracy conditions.

Polynomial models of 2nd degree described the variation in fractal dimension D depending on the number of plots (PN) and the average area of the plots (APA). Based on the fractal dimension (D) it was possible to estimate the number of plots (PN) and the average area of the parcels (APA) under statistical accuracy conditions. The high degree of fragmentation of agricultural land, expressed by a high number of plots, was associated with low fractal dimension (D=1.734).

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TURKISH AGRICULTURAL EXPORTS TO EURO-MEDITERRANEAN COUNTRIES: A GRAVITY MODEL APPROACH

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Abstract

This paper adopts panel cointegration methods to estimate a gravity model of Turkish agricultural exports to 30 Euro-Mediterranean countries. Results show the conventional variables of economic size and distance to importing markets along with relative factor endowments are significant determinants of agricultural exports. Conversely, similarity of economic size, bilateral free trade agreements with Euro-Mediterranean countries, religious commonality, and the expatriate Turkish population in importing countries are found to be insignificant. Whilst a focus on exporting to large and near neighbouring countries is sensible, Turkey also needs to pay careful attention to the competing demands on its agricultural land from urbanisation and tourism. We speculate that recent changes in Turkey's domestic agricultural policy may impact adversely on exports.

***Key words*:** *Turkey, exports, gravity model, panel cointegration*

INTRODUCTION

Both theory and empiricism suggest that international free trade tends to be advantageous to economic growth, especially for developing countries. As a result, many countries have made great efforts in recent times to liberalise their trade to provide faster economic growth through integration in the global economy. Turkey is one of these countries, with international trade playing a significant role in its economic development.

The liberalisation process for Turkey started with an application for EU membership (then the European Economic Community) in 1959, with an Association Agreement signed four years later. Subsequently, and with the aim of increasing trade, Turkey has established free trade agreements (FTAs) with various Mediterranean area countries which, collectively, form its second largest market after the EU. In 1995, 12 Mediterranean countries - Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, the Palestinian Authority, Syria, Tunisia, and Turkey - and 15 EU member states met in Barcelona to create a common area of "calm, constancy, and shared prosperity" and agreed to establish a Euro-Mediterranean Free Trade Area (EMFTA) by 2010 [25]. The Barcelona declaration constitutes the European Neighbourhood Policy which is directed at neighbour countries of the EU hoping for membership, yet the neighbours are also ambitious to attempt economic and political reformations [46]. Turkey is a good example, but has encountered numerous political and economic difficulties to EU accession. In spite of the delays and slow progress, Turkey features in the Euro-Mediterranean movement of the EU. Also, it has been supporting the Euro-Mediterranean Partnership since its establishment. Within the scope of the membership arrangement, Turkey has a particular location between Northern Mediterranean countries (EU members) and the Southern Mediterranean countries (most of which were colonies of some EU members) [49, 34]. Besides its locational advantage, Turkey has cultural similarities to most of the Mediterranean Partner Countries (MPCs; Albania, Algeria, Bosnia and Herzegovina, Egypt, Israel, Jordan, Lebanon, Mauritania, Monaco, Montenegro, Morocco, Syria, the Palestinian Authority, Tunisia, and Turkey) arising from sharing a common religion. This may affect consumers' preferences for agri-food products in these countries and hence might be expected to increase Turkish agricultural exports to the MPCs. Consequently, Turkey stands to gain from the future trade liberalisation in the Euro-Mediterranean area.

Agricultural trade is a crucial part of the Turkish economy and there has been an upward trend in both agricultural imports and exports for several decades. Turkey has a positive agricultural trade balance in spite of an overall trade deficit. In 2011, agricultural exports were around USD 12.7 billion (in constant 2005 prices) with a contribution of 10.6% to Turkish exports. Agricultural imports were USD 12.3 billion and the total contribution of agricultural imports was 5.5% [27]. There has been an upward trend in both agricultural imports and exports: between 1969-2012, the real value of agricultural imports increased almost thirty-fold while corresponding exports increased by over five-fold. Apart from 2007, there has always been a positive agricultural trade balance, in spite of a deficit in total merchandise trade [27].

Turkey also plays a crucial role in the region in terms of agricultural production. According to [27], Turkey is the largest agricultural commodity exporter among the MPCs. In the Euro-Mediterranean region, Turkey is ranked as the first producer in tomatoes and walnuts, while the second after the EU-27 in olive oils, figs, and potatoes. Turkey provides nearly half of the MPCs' exports of agricultural products to the EU [27], and 40 per cent of its agricultural exports go to countries in the Euro-Mediterranean region [68]. The proportion of total agricultural trade for Turkey is 34 per cent with the region. In short, this region represents the major trading partner of Turkey. Some other countries or country groups are also important partners, such as the USA and BRICS, but the Euro-Mediterranean countries' share is larger and Turkey has signed various free trade agreements with these countries to compete in global trade. Therefore, the Euro-Mediterranean region is chosen in order to analyse the determinants of Turkish agricultural exports.

The increase in free trade agreements in recent years has escalated the discussion on the attraction of them. This study contributes to the existing literature by examining whether the existing trade agreements have resulted in benefits in terms of Turkish agricultural exports. To this end, the paper examines the determinant of Turkish agricultural exports to Euro-Mediterranean countries and employs recently developed econometric methods to estimate a gravity model. Modelling international trade flows has been extensively examined over recent decades. *Ex-ante* analysis has typically employed sector-specific or economy-wide models, and partial equilibrium and computable general equilibrium models have been widely applied. *Ex-post* studies have been based mainly on the gravity model which has been used in numerous applications to explain trade flows. Traditional panel data models are used by many researchers to estimate gravity models but the statistical properties of the variables, especially their likely non-stationarity, has been largely ignored and therefore results may be spurious. Further, endogeneity cannot be accounted for by traditional econometric panel methods, and cross-sectional correlation may be present. We employ recently developed panel cointegration methods to estimate a gravity model to explain Turkish agricultural exports to 30 Euro-Mediterranean countries with annual data for 1969-2010. For comparison, we also estimate fixed and random effects models. The paper is organised as follows: Section 2 provides a selected literature review; Section 3 presents the model to be estimated, details the data, and discusses our empirical method; Section 4 presents the results; and Section 5 concludes.

A selective literature review

The gravity model has been used widely to analyse international trade flows. [22] uses cross-sectional data to study the impediments to Mediterranean countries of access to the EU fruit and vegetable market and show that the region is heterogeneous with some countries benefitting from trade liberalisation and some not. [55] inter alia argues that panel data possess advantages over cross-sectional data in gravity model estimation, particularly identifying connections among variables over time, and monitoring individual impacts between trading partners, and most studies now use panel data. For example, [64] investigates Czech agricultural exports using weighted ordinary least squares (OLS) and economic size is found to be significant. [32] analyses the effects of regional trade agreements (RTAs) on agricultural trade using panel data and fixed effects models, and find that RTAs could promote a larger agricultural trade volume. [62] also examines the effects of RTAs on European agricultural imports and obtain similar results. [37] estimates fixed effects model with panel data to study the key factors affecting Egyptian agricultural exports. The results show that exchange rate volatility and economic size have a positive effect on agricultural exports while domestic growth per se causes a decrease in exports. [54] examines China's agricultural trade flows with its main trading partners and find that economic and market size, regional integration, cultural beliefs and language enhance agricultural exports. [42] uses panel data to show that RTAs increase bilateral agricultural exports.

A number of studies adopt gravity models to examine trade liberalisation in the Euro-Mediterranean area. [57] estimates fixed and random effects models and finds that the EU-Mediterranean Partnership increases exports from Mediterranean countries to the EU. [45] estimates fixed effects models to examine preferential trade agreements in the Euro-Mediterranean area and shows a preference of countries for regionalism over multilateralism. [28] also estimates fixed effects models to investigate economic integration between Euro-Mediterranean countries and finds ambiguous bilateral trade effects for partners in the EMFTA. [47] estimates seemingly unrelated regression equations (SURE) to control for contemporaneous cross-equation error correlation and find that FTAs have a small negative effect on trade flows in the Mediterranean area. By contrast, [12] concludes from random effects models that FTAs have positive and significant effects on exports from Mediterranean countries to the EU.

There are few gravity model applications for Turkey. For total exports, [29] uses panel data and pooled OLS, and [50] uses cross-sectional data and OLS, to examine Turkish accession to the EU and estimate that bilateral trade could rise by a half and a third, respectively. By contrast [3] uses panel data and fixed effects models and find no evidence of supplementary trade between Turkey and the EU, even though a customs union has existed since 1996. On Turkey's agricultural trade, [6] uses random effects models with panel data to examine fruit and vegetable exports to the EU and significant determinants are economic size, the EU population, and the expatriate Turkish population in the EU. [24] also uses random effects models and panel data and obtain similar results for total agricultural exports; additionally, the total arable land in an importing country is significant whereas the existence of a customs union is not. [55] uses SURE and panel data to study the effects of Turkey's full integration into the EU and find that fruit and vegetable exports would increase by a fifth. Finally, [5] uses cross-sectional data and find that economic size and population increase agricultural exports, but distance and protection have negative effects.

The results from these empirical studies may suffer from three problems. First, many economic series are integrated, typically of order one, I(1), and OLS (or maximum likelihood) regressions between such non-stationary series using fixed and random effects models are in general spurious. The exception is where two or more non-stationary series move together and their linear combination is stationary. Here, the series are cointegrated and a meaningful long-run equilibrium exists [31]. Second, endogeneity bias may exist because of correlation between the explanatory variables and the error term [16]. Third, an omitted explanatory variable may also lead to endogeneity bias if correlated with an included regressor [65]. In cross-sectional studies, endogeneity bias is typically resisted by including additional explanatory variables; and in studies that use panel data, it is resisted by including individual (country) effects. Fixed and random effects models however do not control for endogeneity bias arising from the joint determination of exports and the explanatory variables. The dynamic OLS (DOLS) estimator, on the other hand, allows the error term to be correlated with leads and lags of the changes in the nonstationary regressors and therefore accounts for possible bidirectional causality between exports and GDP in particular. To address these estimational issues, [65] uses panel cointegration methods to explain bilateral export flows from 12 EU countries to 20 OECD trading partners. Their method comprises testing for panel unit roots, testing for panel cointegration, and estimating the gravity model by DOLS. We follow this method and are unaware that it has been applied elsewhere to estimate a gravity model of either total or agricultural exports.

MATERIALS AND METHODS

The gravity model stems from Newton's gravity principle in physics that two objects attract each other in proportion to their mass and in inverse proportion to their distance. The attractive force between two objectives i and j is:

$$F_{ij}=G*(M_i*M_j)/(D^2_{ij}) \quad (1)$$

where F_{ij} is the attractive force, M_i and M_j denote masses, D_{ij} is the distance between the two objects, and G is a proportionality constant. [66] adapted (1) to examine bilateral trade flows between countries by substituting the economic size of two trading countries for masses. [51] also incorporated population to measure economic size and this has become the widely applied 'augmented gravity model'. Initially, these models of international trade were *ad hoc* but theoretical underpinnings were later provided *inter alia* by [1], [40] and [13]. [1] stated that the properties of expenditure systems can be used to obtain the gravity equation. In his study, the gravity model is derived by assuming Cobb-Douglas preferences. [13] employed monopolistic competition (according to the approach, products are differentiated among producing firms) to provide a theoretical foundation of the gravity model, while earlier [1] had adopted a ‘product differentiation by place of origin’ approach (it is the Armington assumption [4]). [40] also adopted the monopolistic competition approach by assuming increasing returns to scale.

A variety of gravity models have since been estimated to explain the determinants of trade where export volume between pairs of countries (or country groups) is determined principally by economic size and geographical distance (see for example, [36]; [26]; [2]). A commonly-used proxy for economic size is gross domestic product (GDP) and countries with larger incomes tend to trade more. More specifically, GDP in both exporter and importer country is hypothesised to have a positive effect on bilateral trade flows. Geographical distance is a proxy for transportation costs, and it is hypothesised that the trade volume between partners is inversely related to distance since longer distances typically involve higher transport time, communication and costs, and they also increase product prices and diminish competitiveness.

We hypothesise a gravity model where the conventional determinants of Turkish agricultural export are economic size and geographical distance. Other hypothesised determinants in the literature are similarity in economic size [39, 21, 9, 65, 14], relative factor endowments [40, 24], FTAs [45, 47, 12], religious commonality [30, 20], and the expatriate population in importing countries [6, 24].

The hypotheses, relating to these explanatory variables, are as follows.

A similarity of size index (SGDP) is used as a method to detect intra-industry trade patterns between two trading countries. A similarity in size creates two-way trade for differentiated goods. When there is an increase in the share of differentiated goods, a larger trade volume usually occurs. Therefore, a similarity in country size becomes an important determinant of the trade volume [39]. The expected effect of SGDP on the bilateral trade flows is positive.

The factor proportions (Heckscher-Ohlin) theory states that a country is better off exporting the goods that use its relatively abundant factor (capital, labour, and land) [43]. The differences in the factor endowments determine the comparative advantage. For example, if a country has abundant land, the country produces goods requiring a high ratio of land to capital and labour. Thus, the country has a comparative advantage in land-intensive goods and exports more of these. Accordingly, differences in relative factor endowments (RFE) increase trade between two countries.

One of the main goals of Free Trade Agreements (FTAs) is to positively influence bilateral trade flows. The impact of FTAs has been widely analysed in gravity models but results are ambiguous. Some studies show trade creation and diversion [57, 44] while others do not [23, 8].

A common main religion (RLG) indicates similarity in cultural values and norms which might be expected to increase bilateral trade between partners.

An increase in population results in demand augmentation. The demand for Turkish goods may also be expected to rise when the Turkish population (TP) living in Euro-Mediterranean countries rises because of similar tastes and preferences. More demand for Turkish agri-food products in the Euro-Mediterranean countries may lead to an increase in Turkish exports to this region.

Adopting the commonly-used log-linear function, the gravity model we estimate is:

$$AX_{it} = \beta_0 + \beta_1 TGDP_{it} + \beta_2\, DIS_i + \beta_3\, SGDP_{it} + \beta_4 RFE_{it} + \beta_5 FTA_{it} + \beta_6 RLG_i + \beta_7 TP_i + \varepsilon_{it} \quad (2)$$

where i denotes Euro-Mediterranean country $i=1,\ldots,n$ and time is $t=1,\ldots,T$. Other definitions are as follows. AX_{it} is the (logged) real (2005) value of Turkish agricultural exports to country i ('000 US$); it is non-zero trade values. $TGDP_{it}$ is the (logged) sum of GDPs for Turkey and country i, ('000 US$); it is a proxy for economic size, and we expect that $\beta_1>0$. DIS_i is the (logged) distance between capital cities in Turkey and country i (kilometres); it is a proxy for transport costs, and we expect that $\beta_2<0$. $SGDP_{it}$ is the (logged) similarity of economic size index for each country pair from the GDP shares of Turkey and country i. Following [39], $SGDP_{it}$ is (logged) $SIMIND_{it}=1-[GDP_{Turkey}/(GDP_{Turkey}+GDP_i)]^2-[GDP_i/(GDP_{Turkey}+GDP_i)]^2$, and $0\leq SIMIND_{it}\leq 0.5$. When $SIMIND_{it}=0.5$, there is similarity in economic size, and as $SIMIND_{it}\rightarrow 0$, there is extensive dissimilarity. We expect that $\beta_3>0$. RFE_{it} denotes relative factor endowments. Adapting [40] proxy, $RFE_{it}=|\ln N_{Turkey}-\ln N_i|$ where N is agricultural land *per capita* (1,000 ha), and we expect that $\beta_4>0$. FTA_{it} is a dummy which =1 if country i has an FTA with Turkey, and =0 otherwise, and the sign of β_5 is uncertain. RLG_i is the (logged) percentage of Muslims in the population of country i; it is used to proxy the influence of common religion (in Turkey, 99% of the population is Muslim), and we expect that $\beta_6>0$. TP_i is a dummy for the expatriate Turkish population living in country i. Following [6], $TP_i=1$ if the proportion of Turks in country i is larger than 2% of the total population and =0 otherwise. The proportion of Turks living in other countries is available only for 2010 and is time-invariant. We expect that $\beta_7>0$ due to similar tastes and preferences with the indigenous population in Turkey. Finally, ε_{it} is an error term with the usual properties.

The balanced panel dataset consists of annual observations for 1969-2010 for 30 Euro-Mediterranean countries (n=30, T=42). The total number of observations is 1,260 and the list of countries is as follows; from the EU: Austria, Belgium-Luxemburg, Bulgaria, Cyprus, Czechoslovakia (now Czechia and Slovakia), Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Malta, the Netherlands, Poland, Portugal, Romania, Spain, Sweden and the UK; and from non-EU: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Syria and Tunisia. The data used in the analyses are obtained from the following sources: Nominal values of Turkish agricultural exports to other countries ('000 US$) from [67] and [68], GDP ('000 US$) and deflator from [69], Agricultural land (1,000 ha) from [27], Free trade agreements from [63], Distance between capital cities in Turkey and other countries (km) from [17], Religion from [60] and Turkish population living in other countries from [52]. Our empirical method has three steps: first, we test for panel unit roots; second and conditional on the existence of unit roots, we test for panel cointegration; and third and conditional on finding panel cointegration, we estimate the gravity model in (2).

A number of panel unit roots tests have been developed where the null is a unit root and the alternative is that some series are stationary. 'First-generation' tests such as [41] assume that the cross-sections of the panel are independent, while 'second-generation' tests such as [61], [53], [7] and [19] assume cross-sectional dependency. The effect of cross-sectional dependency depends on various determinants and ignoring it may affect the consistency and efficiency of the estimated parameters. It may also lead to some problems in application of panel unit root tests. Thus, we first test the null of no cross-sectional dependency by adopting [59] bias-adjusted (Breusch-Pagan) LM-test, and rejection implies that second-generation unit root tests are more appropriate. Since panel unit root tests often produce inconsistent results, we use several to seek a consensus. We also use Hadri and Kurozumi's test [35] which reverses the null and alternative hypotheses: the null is that all series are stationary and the alternative is that the panel has a common unit root.

Panel cointegration tests are also divided into first- and second-generation tests depending on whether cross-sectional dependency is admitted or not. Conditional upon finding both unit roots and cross-sectional dependency, second-generation panel cointegration tests are employed, and we implement those of [70]. These four tests are built on structural rather than residual dynamics, and their power does not suffer from restrictions arising from common factors. In a conditional error-correction model, the null in each test is that the error-correction term is zero, that is, the null is non-cointegration. Group mean test statistics are denoted as G_τ and G_α, and there is cointegration for at least one country when the null is rejected. Panel test statistics are denoted as P_τ and P_α, and rejection of the null implies that the panel is cointegrated as a whole. Bootstrapping makes inference possible under general forms of cross-sectional dependence and all tests are normally distributed. G_τ- and P_τ-statistics are calculated using the standard error of the error-correction term which is estimated in a standard way; while G_α- and P_α-statistics are obtained using the Newey-West adjusted standard errors for heteroscedasticity [58].

Conditional on the existence of panel cointegration, we estimate the parameters of the gravity model in (2). [56] examines two panel estimators: DOLS and fully modified ordinary least squares (FMOLS). Both correct for endogeneity and serial correlation to permit standard inferences. DOLS is a parametric method where lags are explicitly estimated, while FMOLS is a non-parametric method which deals with serial correlation using a heteroscedasticity and autocorrelation consistent estimator of the long-run covariance matrix; and both correct for OLS bias induced by endogeneity. Both methods can be used to provide within- or between-group estimates. [56] argues that the between-group (or group mean) estimator is preferred because it has relatively minor size distortions in small samples, the t-statistics permit more flexible alternative hypotheses and in particular the estimated parameters need not be the same for all countries under the alternative, and it allows for heterogeneity across countries. Accordingly, we use the between-group estimator. [10] also shows that DOLS performs better than FMOLS even though both have small sample bias. Time-invariant variables are problematical due to collinearity and a two-stage regression method is applied following [18]: first, the model is estimated using DOLS; and second, the estimated country effects from the first stage are regressed on the time-invariant variables (DIS, RLG, and TP) to obtain their coefficients.

RESULTS AND DISCUSSIONS

To determine whether first- or second-generation unit roots are appropriate, we test the null of no cross-sectional dependence using bias-adjusted test of [58]'s which yields LM=1,792.82 (p-value: 0.00) and the null is rejected. Accordingly, second-generation unit root tests are used and Table 1 presents the results for the continuously time-varying series. For exports, only the PANIC (Panel Analysis of Non-stationarity in Idiosyncratic and Common Components) test shows that AX~I(1) at the 10% significance level whereas Phillips-Sul, Moon-Perron, and Choi tests imply that AX~I(0). TGDP and RFE are I(1) in all tests, as is SGDP except in the Moon-Perron test. Hadri-Kurozumi tests imply that all series are I(1). Overall, there is some evidence that all series are I(1). Panel cointegration techniques appear appropriate, and the case for using fixed or random effects models is weak.

Table 1. Panel Unit Root Tests

	Phillips-Sul Z-test	Moon-Perron t^*_b-test	Choi Z-test	PANIC P^E_C-test	Hadri-Kurozumi Z^{LA}_A-test
AX_{it}	91.28*	-10.87*	-8.67*	-1.12†	6.15*†
	[0.01]	[0.00]	[0.00]	[0.55]	[0.00]
$TGDP_{it}$	16.01†	0.89†	0.66†	-0.45†	14.67*†
	[0.99]	[0.81]	[0.74]	[0.67]	[0.00]
$SGDP_{it}$	15.76†	-5.60*	-4.89*	-0.18†	21.60*†
	[0.99]	[0.00]	[0.00]	[0.43]	[0.00]
RFE_{it}	10.66†	0.34†	3.18†	-3.14†	9.22*†
	[0.99]	[0.63]	[0.99]	[0.99]	[0.00]

Source: Own calculation.
Notes:
1. p-values in square brackets. Asterisks (*) indicate (1%) level of statistical significance.
2. † denotes a unit root at the 10% significance level.
3. Models in Phillips-Sul, Moon-Perron, Choi, and Hadri-Kurozumi tests include a constant and trend; in Phillips-Sul tests, the number of lags is determined by a general-to-specific method; in Choi tests, four lags are used; and in Hadri-Kurozumi tests, the number of lags is $T^{1/2}\approx 7$ following [48].

The results of [70]'s panel cointegration tests are shown in Table 2. The Bartlett kernel window width is $4(T/100)^{2/9}\approx 3$; one lag and one lead are used to resist over-parametrization; and robust critical values are computed using 500 bootstrap replications. In the model that includes a constant as the only deterministic term, and at the 10% significance level, group mean G_τ- and G_α-statistics both reject the null of non-cointegration and there is cointegration for at least one country.

Similarly, panel P_τ- and P_α-statistics both reject the null of non-cointegration and there is evidence of cointegration for the panel as a whole. In the model which also includes a trend, the results are not so clear: the G_τ-statistic rejects the null, whereas G_α-, P_τ- and P_α-statistics fail to reject. Overall, there is evidence of cointegration and we proceed to estimate the gravity model in (2).

Table 2. Panel Cointegration Tests

	Constant Model	Trended Model
G_τ	-3.14*	-3.24*
G_α	-11.96*	-10.90
P_τ	-13.43*	-12.12
P_α	-8.91*	-7.73

Source: Own calculation.
Note:
1. * denotes significance at the 10% level.

Following the two-stage method of [18], we use DOLS to estimate (2). One lead and one lag are used to address serial correlation and endogeneity, and Table 3 shows the results. All estimated coefficients have *a priori* expected signs and three are significant. First, a 1% rise in the sum of GDPs for Turkey and an importer country (TGDP) will increase Turkish agricultural exports to Euro-Mediterranean countries (AX) by 1.6%, which supports the positive relationship identified for Turkey by [24]. Second, a 1% increase in the distance between Turkey and an importing country (DIS) will decrease Turkish agricultural exports by 0.8%. For Turkey, this finding supports [24] and [5], but contrasts with [55]. The decrease in exports due to distance shows that Turkey should pay attention to trade more with geographically close countries. Third, a 1% rise in relative factor endowments (RFE) will increase Turkish agricultural exports by 1.4%, and this also supports the finding of [24]. The significant positive effect of relative factor endowments, measured in our model by agricultural land *per capita*, has some policy implications. In particular and in terms of land-use planning, Turkey's rapidly increasing population and a buoyant tourism industry create greater demands for urbanisation with a commensurate loss of agricultural land especially in the fertile coastal plains, and careful attention needs to be paid to these competing demands on land. Conversely, the similarity of size of the economies of Turkey and an importing country (SGDP) is an insignificant determinant of Turkish agricultural exports. This finding does not support those of [21] who uses general method of moments, [9] who uses fixed and random effects models, or [65] who uses panel cointegration methods. The result may indicate that Turkish agricultural trade is primarily inter-industry rather than intra-industry and that therefore Turkey should focus more on product differentiation strategies. Religious commonality between Turkey and an importing country (RLG) is also insignificant, which does not support the findings of [30] who uses OLS, or of [20] who uses fixed effects models. Turkey has a secular system which is based on modern principles, although 99 per cent of the Turkish population is Muslim. This may show that having a common main religion for Turkey may not fully represent similar cultural values and norms with other Muslim countries in the Euro-Mediterranean region. Similarly, the proportion of expatriate Turks living in the importing country (TP), which is used as a proxy for common tastes and preferences, is also insignificant. This result contrasts with the significant and positive effects found by [6] who uses OLS and a random effects model, and by [24] who uses fixed and random effects models. This result may arise due to data limitations in measuring the Turkish population living in the Euro-Mediterranean country. Further, FTA is insignificant and this finding does not support the notion that FTAs between Turkey and other Euro-Mediterranean countries lead to higher Turkish agricultural exports. This contrasts with [45] and [12] who generally find positive effects from fixed effects models, and with [47] who finds a negative effect from SURE. The insignificant result for FTAs between Turkey and Euro-Mediterranean countries is surprising and may reflect the extent of government intervention in the agricultural sector, both in Turkey and, more particularly, its trading partners. It is well known that government protection of agriculture, including domestic measures, distorts international trade. Such measures are likely to have hindered the development of Turkish agricultural exports, but are unaccounted for in our gravity model. To see the full benefits of free trade agreements, Turkey should reduce high tariffs and remove export subsidies in the hope that trading partners will act likewise. Also, an increase in deficiency payments and the abolition of direct income supports show that agricultural policies applied by Turkey are moving in the opposite direction to the CAP reforms; and the CU agreement between Turkey and the EU exclude agriculture from the treaty. Thus, Turkey should consider implementing the CAP-type reforms, and the EU and Turkey should produce policies towards a free movement of agricultural products. Last, but not least, to gain more from the FTAs in the Euro-Mediterranean region, an imbalance in the distribution of financial resources and high protection levels should be reduced; and the EU and Mediterranean countries should eliminate the obstacles by forthcoming reforms of the agricultural policies to create a freer trade area in the region. These attempts can substantially help Turkey in the process of agricultural liberalisation.

Table 3. Gravity Model Results (Dependent Variable: AX_{it})

	DOLS	Two-way Fixed Effects	Two-way Random Effects
Constant	11.94*	6.91	11.95*
	(2.51)	(6.75)	(2.44)
$TGDP_{it}$	1.56*	1.26	1.92*
	(0.23)	(1.15)	(0.31)
DIS_i	-0.82*	-	-1.23*
	(0.32)		(0.38)
$SGDP_{it}$	0.31	0.20	0.67*
	(0.37)	(0.60)	(0.33)
RFE_{it}	1.40*	1.67	0.43
	(0.60)	(1.16)	(0.33)
FTA_{it}	0.09	0.28	0.27
	(0.14)	(0.28)	(0.26)
RLG_i	0.02	-	0.26*
	(0.83)		(0.09)
TP_i	-0.11	-	-0.16
	(0.37)		(0.35)
R^2	0.37	0.59	0.59

Source: Own calculation.
Notes:
1. Standard errors in parentheses.
2. * denotes significance at the 5% level.
3. The number of observations is 1260.

For comparison, we also estimate both two-way fixed and random effects models [33] which have been used in many previous studies. Preliminary hypothesis tests are as follows. First, the tests of Breusch and Pagan [15] and Baltagi and Li [11] imply that heteroskedasticity and serial correlation are present, and White's [71] robust standard errors are estimated. Second, there are both country and time effects which imply a preference for two-way models. Third, Hausman's [38] test implies that country effects are uncorrelated with other regressors and the more efficient random effects model is preferred. Notwithstanding this preference, Table 3 shows the results from the fixed effects model and all estimated coefficients are insignificant. This is perhaps not surprising: estimated coefficients in fixed effects models tend to be insignificant because individual (country) and time effects dominate. Results from the random effects model in Table 3 show that all estimates have *a priori* expected signs and significant determinants include the conventional gravity variables TGDP and DIS, as in the results from DOLS. In contrast to DOLS results, SGDP and RLG are also significant whereas RFE is not. There are clear differences between the results from DOLS and those from fixed and random effects models. Results from the latter appear spurious because fixed and random effects models are inappropriate in the presence of non-stationary variables.

CONCLUSIONS

This paper explores factors that determine agricultural exports from Turkey to Euro-Mediterranean countries. A gravity model is estimated with annual panel data for 30 Euro-Mediterranean countries for 1969-2010, and we use recent panel cointegration methods to address problems inherent in fixed and random effects models. Hypothesised determinants of Turkish agricultural exports include the conventional gravity model variables of economic size and the distance between Turkey and its export markets. Additional variables include relative factor endowments, FTAs, religious commonality, and the expatriate Turkish population in importing countries.

Panel unit root tests, which are used to test whether time-varying variables are non-stationary under cross-sectional dependency, show evidence that these series contain unit roots. Panel cointegration tests are therefore performed and results show that there is a meaningful long-run relationship between agricultural exports and the time-varying explanatory variables. DOLS is therefore preferred to fixed and random effects models to estimate our gravity model, and results show that the two conventional variables of economic size and distance are significant determinants of Turkish agricultural exports. First, a 1% rise in the sum of Turkey's and an importing country's GDPs will increase Turkish agricultural exports by 1.6%. Second, a 1% decrease in distance between Turkey and its export markets leads to a 0.8% increase in Turkish agricultural exports. In addition, a 1% rise in relative factor endowments will significantly increase Turkish agricultural exports by 1.4%.

By contrast, the similarity of size in the economies of Turkey and an importing country does not significantly affect Turkish agricultural exports. We also find that bilateral FTAs with Euro-Mediterranean countries are insignificant and therefore do not increase Turkish agricultural exports. Religious commonality between Turkey and an importing country is also insignificant. We further find no evidence that a Turkish expatriate population in an importing country is significant.

The significance of the two conventional gravity model variables - economic size and distance - implies that the gravity model framework is appropriate to examine Turkish agricultural exports, and a focus on exporting to large and near neighbouring countries is a sensible policy objective. The significant positive effect of relative factor endowments also shows that differences in agricultural land *per capita* result in a positive effect on bilateral trade flows. Turkey needs to pay careful attention to the competing demands on its agricultural land from urbanisation and tourism. The insignificant result for FTAs with Euro-Mediterranean countries may suggest that reductions in agricultural protectionism would enhance Turkish exports, but our simple dummy variable for FTAs fails to distinguish any nuanced differences.

Finally, most previous empirical studies that estimate gravity models adopt fixed and random effects models. Critically, they do not consider the statistical properties of the variables, namely non-stationarity, and consequently estimated relationships may be spurious. This is the most likely reason why there are differences between our results and those elsewhere. Indeed, a comparison here of estimates from panel cointegration methods using DOLS and those from fixed and random effects models show clear biases in the latter, and heterogeneity appears to be an important problem in the estimation of gravity models, as [65] observe. The choice of method to estimate gravity models matters and inappropriate econometric methods may lead to inappropriate policy implications.

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IMPLEMENTATION OF COMMUNITY – LED LOCAL DEVELOPMENT STRATEGIES - EVIDENCE FROM SOUTHERN BULGARIA

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Abstract

The LEADER approach/ Community Led - Local Development (CLLD) is one of the most effective tools for rural development at EU level. It enables empowerment of the population, involving all stakeholders in the decision-making process. The built trust and the growing role of the Local Action Groups (LAGs), through which the approach is applied, are a prerequisite for LEADER/ CLLD to become a key instrument for tackling the challenges facing the rural areas of Bulgaria. The aim of the study is, based on the analysis of the main factors influencing the results of the implementation of integrated strategies, to outline the opportunities for increasing the number of supported initiatives, as well as to formulate recommendations in the respective field. The study encompasses 34 LAGs operating on the territory of Southern Bulgaria. The results of the regression analysis reveal the following main factors determining the number of supported initiatives under the local development strategies: the experience of the LAGs, the type of strategy (single-fund or multi-fund support) and the ongoing communication with relevant government agencies.

Key words**:** *Community Led - Local Development, LEADER approach, LAGs, entrepreneurship, rural development*

INTRODUCTION

According to the EC, over the past 20 years, from LEADER to CLLD, the approach has helped rural communities to consider the long-term potential of their area, proving to be an effective tool in delivering development policies [3]. The latter is determined by its key characteristics, including capacity building at the local level and on this basis the development of various forms of social capital [13, 17, 18]. Although the main challenges facing the rural population are similar at EU level, each region is characterized by specific needs and opportunities [10]. In this regard, according to Nardole, Sisto and Lopolito (2010) LEADER is concerned with finding innovative solutions to problems by identifying and engaging in the best way endogenous resources [7, 13]. On this account some authors consider it as "a social vehicle to strengthen participation, to foster local governance and even to structure a new social order to changing power relation in rural areas" [15]. Local action groups (LAGs) play a key role in the approach implementation. Furmankiewicz et al. (2016) emphasize that the interaction of representatives of the public, private and non-governmental sectors has an important impact on the processes of this (neo) endogenous and place-based development [5]. The aim of the study is based on the analysis of the main factors influencing the results achieved by the LAGs within the integrated strategies, to outline the opportunities for improving their activities and increasing the number of supported initiatives, as well as to make policy recommendations. The article is structured as follows: First, the materials and methods are presented. Second, the application of CLLD in Bulgaria for the current programming period is reviewed and analysed. Third, a multiple linear regression model is developed and the key factors that have a positive impact on the number of supported initiatives under the community-led local development strategy, are identified. On this basis some conclusions and recommendations are formulated.

MATERIALS AND METHODS

The following methods for collecting, processing and analysing data are applied in the study: document analysis, in-depth interviews with key experts in the field and regression analysis.

Table 1. Variables definition and summary statistics

	Variable definition	Mean	Standard Deviation	Minimum	Maximum
Supported initiatives	Number of contracts signed	5.79	1.28	0.00	28.00
Financial resources	Strategy budget	4,883,369.74	2,414,531.88	399,646.51	11,865,164.44
D=1 Multi-fund Strategy	If the strategy is multi-funded D=1, otherwise D=0	0.59	0.50	0.00	1.00
Experience	Number of years the approach has been applied by the LAG	7.41	3.54	2.00	13.00
Number of municipalities	Number of municipalities whose territory is covered by the LAG / Strategy	1.76	0.78	1.00	3.00
Team	Number of LAG employees	3.79	0.84	2.00	6.00
Communication with GA	Number of official letters / emails to and from representatives of government agencies	189.50	76.03	100.00	407.00

Source: Own research.

The study covers 34 LAGs operating on the territory of Southern Bulgaria. The latter account for 53% of the total number of relevant organisations in the country during the current programming period. The research period is 2016 - 2019.

The following sources of information are used in the study: the database of the Bulgarian Registry Agency [1]; reports, documents and other publications on the official websites of the LAGs. In addition, three experts with a significant experience in the approach implementation were interviewed. The initial research period coincides with the beginning of CLLD's main activities in the country.

The variables were selected based on the theory and results of previous studies [9, 12]. According to Kraner (2014) and Moore et al. (2003) the capacity of non-governmental organizations to support the target group is highly dependent on the material resources they possess, such as financial and human capital [8, 12]. On this basis, the dependent variable of the model is the number of "Supported initiatives", and the explanatory variables are as follows: "Financial resources", "Experience" of the LAG in the implementation of the approach; "Number of municipalities" and the "Team" of the LAG. In the course of the study, the document analysis and interviews revealed that there is a certain delay in the approval of the projects by the Payment Agency under the RDP, which significantly affects the results achieved by the organisations when the strategy is funded only under the EAFRD and it is not multi-funded. Regarding the measures financed by other funds, no such difficulties are identified. Thus, a dichotomous variable is included in the model to reflect the difference between the two distinct groups.

The definition of the variables and the characteristics of the data set are presented in tabular form (Table 1). According to the relevant data, the average number of the supported initiatives within the study period is 5.79. The mean budget of the strategy amounts to BGN 4,883,369.74 with a deviation from these average values of BGN 2,414,531.88. The organization with the longest experience has worked in the field for 13 years. It is important to emphasize that the latter was founded as a result of the implementation of one of the pilot projects carried out in the country during the pre-accession period. This LAG is a good example of the consistency of the activities undertaken to address the challenges of rural areas, the development of local potential and, accordingly, social capital in all its forms.

Several organisations were registered in 2017 and have only a few years of experience in implementing the local development strategy. However, some of them have achieved good results. The average number of people working for the LAG is 3.79 with a minimum of two and a maximum of six employees. The variable revealing the official communication between the LAG and the representatives of government agencies – in this case the Managing Authorities of the RDP and the Operational programmes, State Fund “Agriculture”, Ministry of Finance and others, is of common interest, as the latter could be considered as a measure of the level of the linking social capital. The reports of the LAGs for the implementation of the strategy include detailed information regarding this indicator and the actions taken by each of the parties.

The following tests are applied to the model: (1) Regression Specification Error Test (RESET test); (2) tests for fulfilment of the Classical Linear Regression Model assumptions, including Jarque-Bera Normality Test, Breusch-Pagan test for detecting heteroscedasticity and Durbin-Watson test for autocorrelation [2, 6].

RESULTS AND DISCUSSIONS

During the current programming period, a total of 64 local action groups operate on the territory of the country, which is nearly 55% more compared to the previous period [11]. According to the CLLD department the total budget for multi-fund financing of the implementation of the approach amounts to EUR 304 million, and during the preparatory actions 100 projects were applied, covering 180 municipalities or 74,433 km^2 and 2.3 million population [16]. Regarding the implementation of the CLLD strategy, the approved 64 LAGs include 115 municipalities, 53,796 km^2 and 1,646,588 people, which in turn, according to NSI and Eurostat data [4, 14] is 24% of the total population of the country and 74.49% of that of rural areas for 2019. There are significant differences in the budget of community - led local development strategies for the period under review: from BGN 2,604,000 to BGN 12,843,064. The latter predetermines the inclusion of a corresponding independent variable in the proposed model.

The sub-measure concerning the cooperation among the LAGs and of serious importance for the development of the bridging and linking social capital was not implemented in its full capacity during the study period - preparatory activities were carried out and only few projects for internal territorial cooperation were supported. Therefore, this measure is not thoroughly examined in the present research. The latter is a prerequisite for further examination of the results achieved in the area and their possible inclusion in the model.

The multiple linear regression model (Equation 1) reveals the impact of the available financial resources for socio-economic development, key characteristics of the organisation and communication with government agencies on the results achieved by the LAG within the Strategy, measured by the number of supported initiatives.

The data from the correlation matrix show that all explanatory variables are positively correlated with the number of projects (Table 2). On the other hand, there is an inverse relationship between the experience and the strategy budget. It is possible that some of the LAGs, based on the experience and knowledge gained from the previous period, have focused mainly on the RDP measures, compared to the newly established organizations, which aimed to attract more financial resources.

Regarding the model, a specification test is applied first (Ramsey’s RESET test). The predicted values of the dependent variable are calculated and raised to the second and third degree. The values obtained are included as regressors in an extended model. The formulated null hypothesis states H0: "The additional variables in the extended model are not statistically significant." According to alternative hypothesis H1: "The additional variables in the extended model are statistically significant."

$$Supported\ Initiatives = \beta_1 + \beta_2\, Financial\ Resources + \beta_3\, Strategy\ type + \beta_4 Experience + \beta_5\, Number\ of\ municipalities + \beta_6 Team + \beta_7 Communication\ with\ Government\ Agencies + u_i \text{.........(Equation 1)}$$

Table 2. Correlation matrix

	Supported initiatives	Financial resources	D=1 Multi-fund Strategy	Experience	Number of municipalities	Team	Communication with GA
Supported initiatives	1.0000						
Financial resources	0.5763	1.0000					
D=1 Multi-fund Strategy	0.6002	0.6875	1.0000				
Experience	0.1220	-0.1425	-0.3122	1.0000			
Number of municipalities	0.1469	0.0472	-0.0229	0.1018	1.0000		
Team	0.1176	0.3715	0.1520	0.2316	0.2459	1.0000	
Communication with GA	0.5243	0.4913	0.3580	-0.0171	-0.1357	0.0771	1.0000

Source: Own research.

The critical value of the F-distribution, at significance level $\alpha = 0.05$ and degrees of freedom $df_1 = 2$ and $df_2 = 26$, is 3.37. In this case, F=3.06 is less than 3.37 (Fcrit), which means that the null hypothesis cannot be rejected. On this basis, it can be stated that the model is well-specified.

Regrading Jarque–Bera test of normality, the following null hypothesis was formulated: "The stochastic term of the model is a normally distributed random variable, where S = 0 and K = 3". According to the alternative hypothesis: "The probability distribution of the stochastic term differs significantly from the normal". The calculated JB test statistic = 1.51 is less than the critical value $\chi^2_{crit} = 5.99$ [$\alpha = 0.05$; df = 2]. Thus, null hypothesis cannot be rejected and the disturbance term is normally distributed.

In the model there is a weak to a moderate correlation ($|r|<0.7$) between the variables. In addition, the coefficient of determination does not accept high values.

The results of the Breusch-Pagan test reveal that the CLRM assumption for homoscedasticity of the error term is not violated for this model: Sig. F = 0.18 is greater than $\alpha = 0.05$ and null hypothesis for constant variance of u_i cannot be rejected.

A Durbin-Watson test for serial independence of the disturbances was performed. According to null hypothesis H0 "There is no statistically significant autocorrelation of the error terms". Alternative hypotheses are respectively: H1a "There is a positive first-order autocorrelation" and H1b "There is a negative first-order autocorrelation". The estimated d value is 1.91. The lower critical value dL =1.079 and the upper dU = 1.891 (the number of regressors is 6 and the number of observations N = 34). Thus, dU <d <4-dU, which means that H0 is valid and there is no autocorrelation.

The results of the model evaluation are presented in Table 3. The estimated coefficient of the dichotomous variable, indicating the type of strategy, as well as the coefficients of the explanatory variables "Experience" and "Communication with government agencies" are statistically significant and with the expected positive sign.

Therefore, the multi-fund strategy has a positive impact on supporting a larger number of projects. The experience of the LAG in the application of the approach also has a favourable effect on the number of projects supported. In addition, the results reveal that better communication with representatives of relevant government agencies helps LAGs to expand the number initiatives under the integrated local development strategy. One possible reason is that enhanced communication leads to timely resolution of identified problems.

Table 3. Influence of variables on the number of supported initiatives

	Coefficients	*SE*	*t Stat*	*P-value*
Intercept	-10.0633	5.0048	-2.0108	0.0544
Resources				
Financial resources	0.0000	0.0000	1.0012	0.3256
Strategy type (D=1 Multi-fund)	7.4314	2.5961	2.8625	0.0080
Characteristics of the organisation				
Experience	0.6981	0.2809	2.4848	0.0195
Number of municipalities	1.9169	1.2022	1.5946	0.1225
Team	-1.5773	1.2433	-1.2687	0.2154
Communication linkages				
Communication with GA	0.0294	0.0139	2.1142	0.0439
y= Supported initiatives				
R Square=0.62; F=7.15				

Source: Own research.

As mentioned above, the budget of the strategies varies widely, and greater financial resources should have a positive impact on the number of projects supported. In this case, the estimated coefficient of the respective variable is statistically insignificant, but with the expected positive sign. The latter could be explained by the fact that there is a certain delay in the approval of project proposals and the conclusion of the contracts under the RDP. During the study period no such delays were found for measures under the Operational programmes. In this regard, it is possible that funds have been allocated for a smaller number, but larger initiatives.

The estimated coefficient of the variable "Number of municipalities" is also statistically insignificant, but the sign corresponds to the predicted positive relationship. The larger number of municipalities covering a coherent and homogeneous territory, on the one hand, should expand the number of potential business initiatives and, on the other hand, provide greater opportunities for inclusion in the team of local people with the necessary knowledge, experience and administrative capacity.

However, the survey reveals that several LAGs covering the territory of one municipality have supported a large number of initiatives. Two of these rural municipalities are located in the Plovdiv region near the district centre and are characterized by highly developed industry, business activity and level of social capital.

The estimated coefficient of the variable concerning the number of employees in the LAG team is statistically insignificant and with a negative sign. The data show that the largest number of contracts are concluded with beneficiaries of organizations with fewer employees. These LAGs are located near to the large administrative centres, which in turn provides opportunities for recruitment of highly qualified staff.

In conclusion, it can be pointed out that the number of supported initiatives depends on: (1) the type of strategy - the financing of the strategy by several funds is a prerequisite for supporting a larger number of projects; (2) the experience of the LAG and (3) the communication with the government agencies, which are responsible for the implementation of the respective activities. Although no statistical support has been found on the positive impact of financial resources on the number of beneficiaries reached, according to the theory this impact should not be underestimated.

CONCLUSIONS

Based on the results of the study the following conclusions and recommendations could be highlighted:

- The main factors influencing the results of the application of the community-led local development strategy by the LAGs, operating on the territory of Southern Bulgaria, are: (1) implementation of a multi-fund strategy; (2) the experience of the organization in the respective field and (3) the communication with the institutions.

- In order to support a larger number of initiatives and reach more beneficiaries, it is recommended to diversify the sources of funding for the local development strategy. The latter will reduce the organization's dependence on a single donor and avoid possible problems arising from delays in project approval and contracting with beneficiaries, as identified in the study.
- In order to achieve sustainable results on the territory of the LAG, it is important to ensure a sequence of actions over a longer period of time (within several programming periods), which will help to expand the accumulated capacity at the local level, the number of initiatives and cooperation among the three sectors.
- It is recommended to maintain regular communication with the representatives of the Government agencies managing the respective programme, as the latter will allow increasing the level of linking social capital.

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ECONOMIC EFFICIENCY OF LAND USE BY AGRICULTURAL PRODUCERS IN THE SYSTEM OF THEIR NON–CURRENT ASSETS ANALYSIS: A CASE STUDY OF THE AGRICULTURAL SECTOR OF UKRAINE

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Abstract

The paper substantiates that because the soils ploughing level in Ukraine has not changed for a long time, soil depletion is growing every year. As a result of the formed culture tendencies which grow on such lands, every year will lose productivity, and consequently, the efficiency of managing the agricultural enterprises systematically decreases. Cartogram of Ukrainian regions grouping by the average annual rent for the agricultural land use is given. It was found that that in the current business environment in Ukraine, the amount of rent does not depend on the soil fertility level, because in most western, southern and south–eastern regions of Ukraine, where the most fertile soils are concentrated, the level of rent is relatively low. In addition, it should be noted that the agricultural land of public and private ownership renting cost differs significantly from each other, which we found by comparing the data of the relevant cartograms of Ukraine. We systematized the results of the impact factors assessing on the sale of gross output of agricultural enterprises of Ukraine in 2014 – 2018 by analysing the dynamics of the return rate on their fixed assets and the factors that influenced its formation. The results of the factor analysis will make it possible to identify the quantitative impact of factors on the efficiency of non-current assets of agricultural producers, the significant share of which is directly occupied by land resources. The work is systematized the results of assessing the impact of factors on the return on assets of agricultural producers of Ukraine for 2014 - 2018 by identifying the factors that influenced its formation by determining their quantitative impact through factor analysis methods, including the method of elimination. It is substantiated that having significant and quite high–quality reserves of fertile lands, Ukraine is 2–3 times less productive than developed countries, which is evidence of inefficient use of agricultural land by agricultural enterprises of Ukraine. In our opinion, the main task of the state to rationalize and establish the efficient use of land resources in the agricultural sector is to introduce a number of measures to ensure efficient land use.

Key words**:** *economic efficiency, agricultural producers, land resources, non-current assets, cartogram*

INTRODUCTION

Land and land resources are the basis for the economy of any country, and especially for agriculture.
Land in agriculture performs two important functions, such as the object of labour (when a person`s activity affects it, changing its surface) and tools (when a person uses the physical, mechanical and biological properties of the soil to obtain the desired result). Therefore, land is the main asset for agricultural enterprises.
Since every owner–agricultural producer wants to minimize resource costs, the question arises in choosing the land use method. It is

important for farmers, as well as for the country as a whole, to use efficiently and sparingly the exhaustive and limited resources to which land belongs. Therefore, the issue of economic efficiency of land resources use and management by agricultural enterprises in the Ukrainian agricultural sector does not lose its relevance.

The work of many scientists is devoted to the study of this issue, in particular such as: Andriichuk V. [1, 2], Boiar A. [3], Dobrovolska N. [7], Dziamulych M. [8, 9, 26], Hutorov O. [11], Hordienko V. [10], Lavruk V. [12], Musyka P. [15], Popescu A. [16, 17, 18, 19, 20, 21, 22, 23, 24, 25], Sodoma R. [28], Tofan I. [31], Shulyk Y. [32], Yakubiv V. [34, 35, 36], Zhurakovska I. [37], etc.

The purpose and objectives of this study are to assess the economic efficiency dynamics of land resources use and management by Ukrainian agricultural producers in the factor analysis system of their total non–current assets efficiency and identify factors aimed at improving such efficiency.

MATERIALS AND METHODS

In the study of the land use efficiency by Ukrainian agricultural producers, the official statistical data published by the State Statistics Committee of Ukraine for the relevant period under analysis were used.

To calculate the ploughing level of agricultural land was used the formula:

$$L_p = \frac{S_{al}+S_{pp}}{S_{agl}} * 100\ \%,$$

where: $L_{p.}$ – ploughing level of agricultural land;

S_{al}, S_{pp}, S_{agl} – areas of arable land, perennials and all agricultural land, respectively.

In order to identify factors to improve the efficiency of land use by agricultural enterprises, a factor analysis of the gross output volume and return on assets of agricultural enterprises using a set of elimination methods.

When conducting factor analysis, the method of chain substitutions was used, according to which the calculations were performed using a set of the following formulas:

$$\mathrm{Z} = \frac{\mathrm{X}}{\mathrm{Y}},$$

where: Z – performance indicator;

X, Y – indicators (factors) that affect the performance indicator.

$$\mathrm{Z}_0 = \frac{\mathrm{X}^{\mathrm{p.y.}}}{\mathrm{Y}^{\mathrm{p.y.}}}$$

$$\mathrm{Z}_1 = \frac{\mathrm{X}^{\mathrm{r.y.}}}{\mathrm{Y}^{\mathrm{p.y.}}}$$

$$\mathrm{Z}_2 = \frac{\mathrm{X}^{\mathrm{r.y.}}}{\mathrm{Y}^{\mathrm{r.y.}}},$$

where: $X^{p.y.}$, $Y^{p.y.}$, $X^{r.y.}$, $Y^{r.y.}$ – indicators for the previous and reporting years, respectively.

$$\Delta Z^X = Z_1 - Z_0$$

$$\Delta Z^Y = Z_2 - Z_1,$$

where: ΔZ^X, ΔZ^Y – measure of the factors influence on the performance indicator.

For the successful implementation of the analyzing process the return on assets of agricultural producers used a set of formulas:

$$R/a = \frac{Q}{FA},$$

$$Q = FA * R/a,$$

where: R/a – return on assets;

Q –gross sales volume;

FA –fixed assets value.

In the study of the agricultural producers return on assets and their factor analysis was used the formula:

$$R_{\mathrm{a}} = \frac{P}{FA} * 100\%,$$

where: R_a – return on assets;

P – net profit.

RESULTS AND DISCUSSIONS

According to the Land Code of Ukraine, all lands are divided into categories with different purposes [29]. Land used for agricultural production is agricultural land, which is further divided into agricultural land (arable land, perennials, hayfields, pastures and fallow lands) and non–agricultural land (land under farm buildings and household infrastructure elements).

In the land management process, the main indicator for assessing the land management quality is the land use efficiency. According to the study results, scientists have identified the following land use efficiency types in agriculture (table 1).

Table 1. Land use efficiency types in agriculture

Efficiency type title	Characteristics of the efficiency type
Natural	The effectiveness provided by natural fertility, location in markets, climate, topography, configuration, acquisition of resources.
Structural	The efficiency based on the agricultural land–use intensity.
Technical	The ability of an enterprise to produce a volume of products using a minimum of resources or to produce as many products as possible using a certain amount of resources.
Technological	The result of the production factors interaction, which characterizes the achieved productivity of living organisms used in agriculture as a means of production.
Economic	The ratio between resources and production results, according to which production efficiency cost indicators are obtained.
Expensive	The result obtained due to the existing level and costs structure during production.
Social	The compliance of the economic activity results with the basic social needs and social goals.
Ecological	The ecological environment preservation while increasing production productivity and providing the population with ecologically clean food products.
Energy	The efficiency of the available energy capacity use.
Investment	The effectiveness of resources investing.
Socio–economic	The result of meeting human needs and industrial development.
Ecological and economic	The economic efficiency of environmental costs during agricultural activities.
Production and technical	The comprehensive efficiency of labour resources, a set of material and technical base, technology and production organization, and marketing methods, the interaction of which affects the production cost.
Production and economic	The result of the combined impact of production and technical efficiency and economic policy of the enterprise.

Source: Systematized based on [1, 2, 4, 5, 6, 7, 10, 11, 12, 14, 27, 33].

According to the State Land Agency of Ukraine, as of the beginning of 2020, the total area of agricultural land is 42.79 million hectares, which is 71.0% of the total area of Ukraine (Fig. 1).

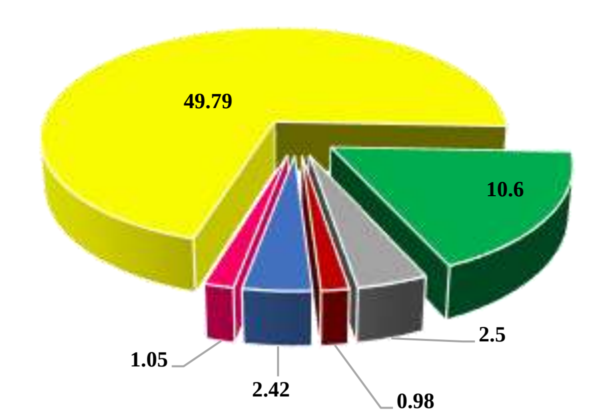

Fig. 1. The land fund of Ukraine structure as of January 1, 2020, million hectares
Source: Developed based on [29].

According to the analysis results dynamics in the study period (2015–2019), a tendency to reduce agricultural land by 0.4% was revealed. In particular, the area of fallow land decreased by 20.4%, while the area of arable land increased by 0.5% (Table 2).

Table 2. Dynamics of agricultural lands of Ukraine for 2015 – 2019, thousand hectares

Land type	Study period, years					2019 in % to 2015
	2015	2016	2017	2018	2019	
Agricultural lands, total: including	41,511.7	41,507.9	41,504.9	41,489.3	41,329.0	99.6
Arable	32,531.1	32,541.3	32,543.4	32,544.3	32,697.1	100.5
Perennial plantings	892.9	892.4	897.1	894.8	864.4	96.8
Fallows	239.4	233.7	230.6	229.3	190.5	79.6
Hayfields	2,407.3	2,406.4	2,402.9	2,399.4	2,294.4	95.3
Pastures	5,441.0	5,434.1	5,430.9	5,421.5	5,282.6	97.1

Source: Generalized based on [29].

It was found that the agricultural land in Ukraine ploughing level in 2015 and in 2019 was 80.5% and 81.2%, respectively, i.e. increased by 0.7%.

According to the study, the highest ploughing level, namely in the range from 70% to 80% in 2019 is observed in four regions of Ukraine – Kirovograd, Mykolaiv, Kherson, Zaporizhia, and the lowest ploughing level, i.e. up to 30% of the territory – in the

Zakarpattia and Ivano–Frankivsk regions (Fig. 2).

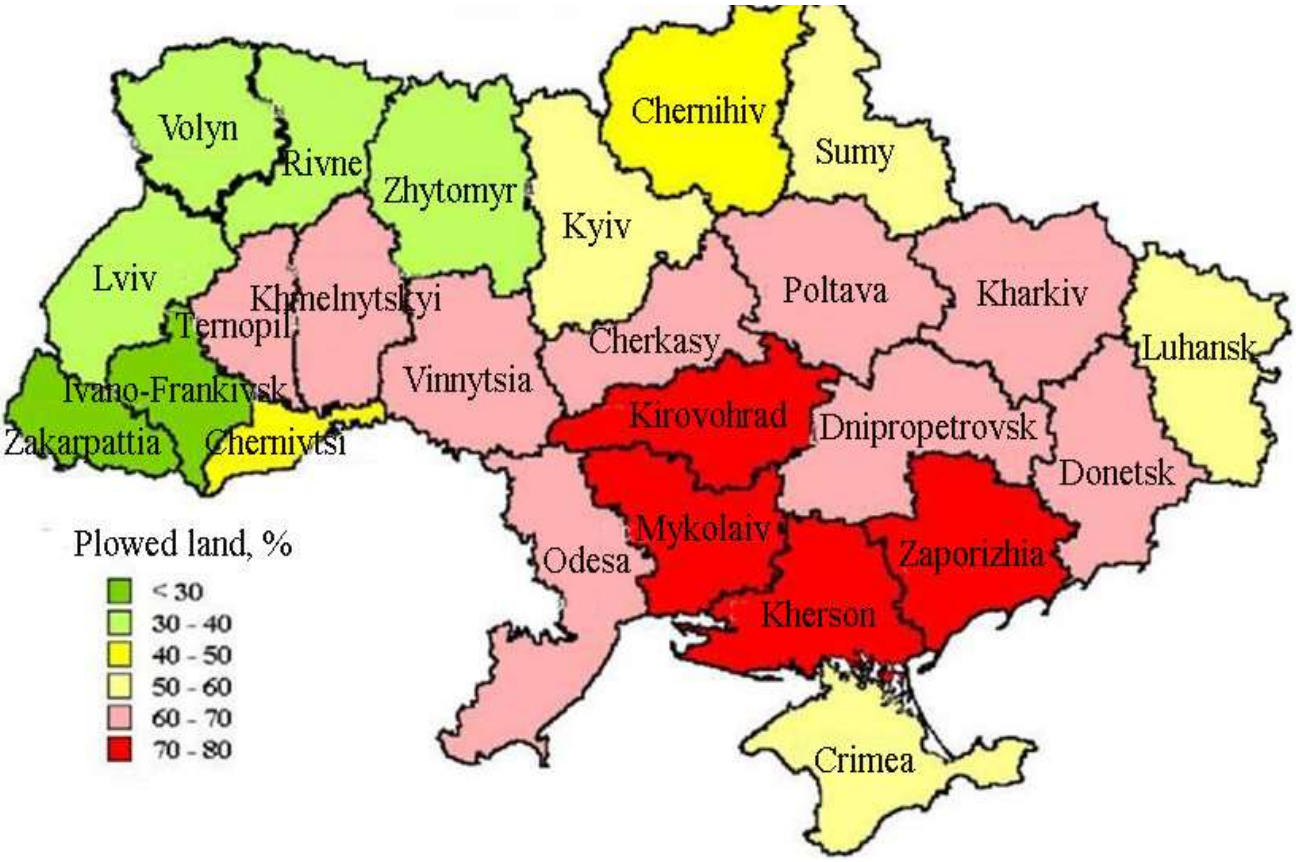

Fig. 2. Cartogram of regions grouping of Ukraine according to the indicator of ploughed agricultural lands, as of 2019.
Source: Developed and systematized based on [29].

As the soils ploughing level in Ukraine has not changed for a long time, soil depletion is growing every year. As a result of the formed culture tendencies which grow on such lands, every year will lose productivity, and consequently, the efficiency of managing the agricultural enterprises systematically decreases.

As of the beginning of 2020, the general ownership structure of the agricultural lands of Ukraine in private hands is concentrated their largest share – 74.95% (Fig. 3).

It should be noted, that in Ukraine is gaining popularity land use type on the rights of emphyteusis, i.e. long–term, alienable and inheritable right to another`s property, which is to provide a person with another`s land for agricultural purposes in order to obtain fruits and income from it with obligation effectively use it in accordance with the intended purpose.

At the same time, the lease relations between business entities are regulated by the Law of Ukraine «On Land Lease», which in fact does not set any significant restrictions. This Law stipulates that the lease agreement must specify the leased object, the term of the agreement and the amount of rent, as well as that such an agreement has legal force, it must be notarized.

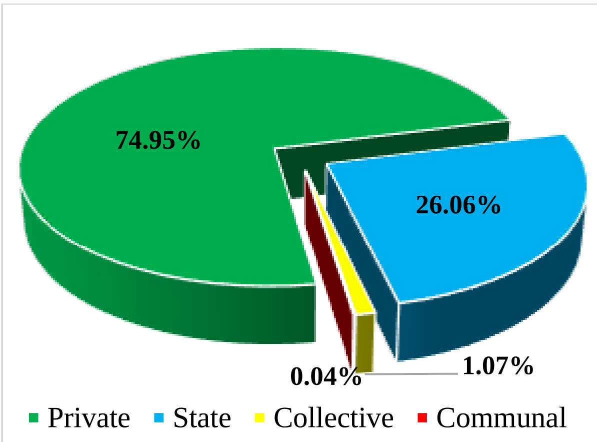

Fig. 3. Ownership structure of agricultural lands in Ukraine as of January 1, 2020, %
Source: Developed based on [29].

There are also deadlines for renting agricultural land, namely the minimum lease term is 7 years, and the maximum – cannot exceed 50 years.

In our opinion, this approach is wrong, because the tenant is not always, or more precisely, almost never worries about the fertility of the land after the lease. Such mismanagement leads to the loss of the earth`s natural fertile properties, which causes total depletion of soils.

We studied the dynamics of the sale of lease rights to state–owned agricultural land in Ukraine for 2015–2019 (Table 3).

Table 3. Lease rights sale dynamics to state–owned agricultural land in Ukraine for 2015 – 2019

Indicators	**2015**	**2016**	**2017**	**2018**	**2019**	**2019 in % to**	
						2015	2018
Area, ha	27,860.09	42,582.39	42,488.26	64,046.77	61,572.62	221.0	96.1
Starting cost of the annual fee, UAH/ha	799.45	1,461.27	1,462.47	1,449.33	1,332.83	166.7	92.0
The cost of the annual fee according to the auction results, UAH/ha	1,377.75	2,249.84	2,793.44	3,431.77	3,431.53	249.1	100.0

Source: Generalized based on [29].

According to Table 3, it is established that for the period of 2015–2019, the area of land plots in respect of which the lease rights sale was carried out increased by 3,712.56 hectares or 121.0%, despite the fact that in 2019 compared to 2018 the volume of such sales decreased by 2,474.15 hectares or by 3.9%. In general, for the analysed period, the starting value of the annual rent increased by 533.38 UAH/ha or 66.7%, and in 2019 compared to 2018 the starting price fell by 166.5 UAH/ha or 8%.

We studied the average rent for the use of agricultural land in Ukraine in terms of its regions as of 2018 (Figs. 4 and 5).

According to the cartogram results analysis (Fig. 4), it is established that the highest level of rent is observed in Cherkasy and Poltava regions, it is slightly lower in Khmelnytskyi and Kharkiv regions. Instead, in most regions of Ukraine, namely – 14 out of 25 the annual rent level is at the lowest value and does not exceed 1,539.7 UAH. Thus, we can conclude that in the current business environment in Ukraine, the amount of rent does not depend on the soil fertility level, because in most western, southern and south–eastern regions of Ukraine, where the most fertile soils are concentrated, the level of rent is relatively low.

In addition, it should be noted that the agricultural land of public and private ownership renting cost differs significantly from each other, which we found by comparing the data of the cartograms shown in Figs. 4 and 5.

In general, the average annual rent in Ukraine for shares is 1,613.4 UAH/ha, and for state–owned land plots leased at land auctions – 3,431.5 UAH/ha. At the same time, it can be concluded that in general the cost of renting state–owned agricultural land is higher in key regions of Ukraine, similarly to the cost of renting privately owned land. In particular, the amount of annual rent of state lands is highest in Khmelnytskyi, Vinnytsia, Kirovohrad and Poltava regions. At the same time, Khmelnytskyi and Poltava regions are also among the four regions with the highest rents for privately owned land. It was found that the low level of rent for land resources of both private and state ownership is typical for all southern and south–eastern regions except Odessa region, where the cost of renting state–owned land is slightly higher, due to high recreational value and potential of this region of Ukraine.

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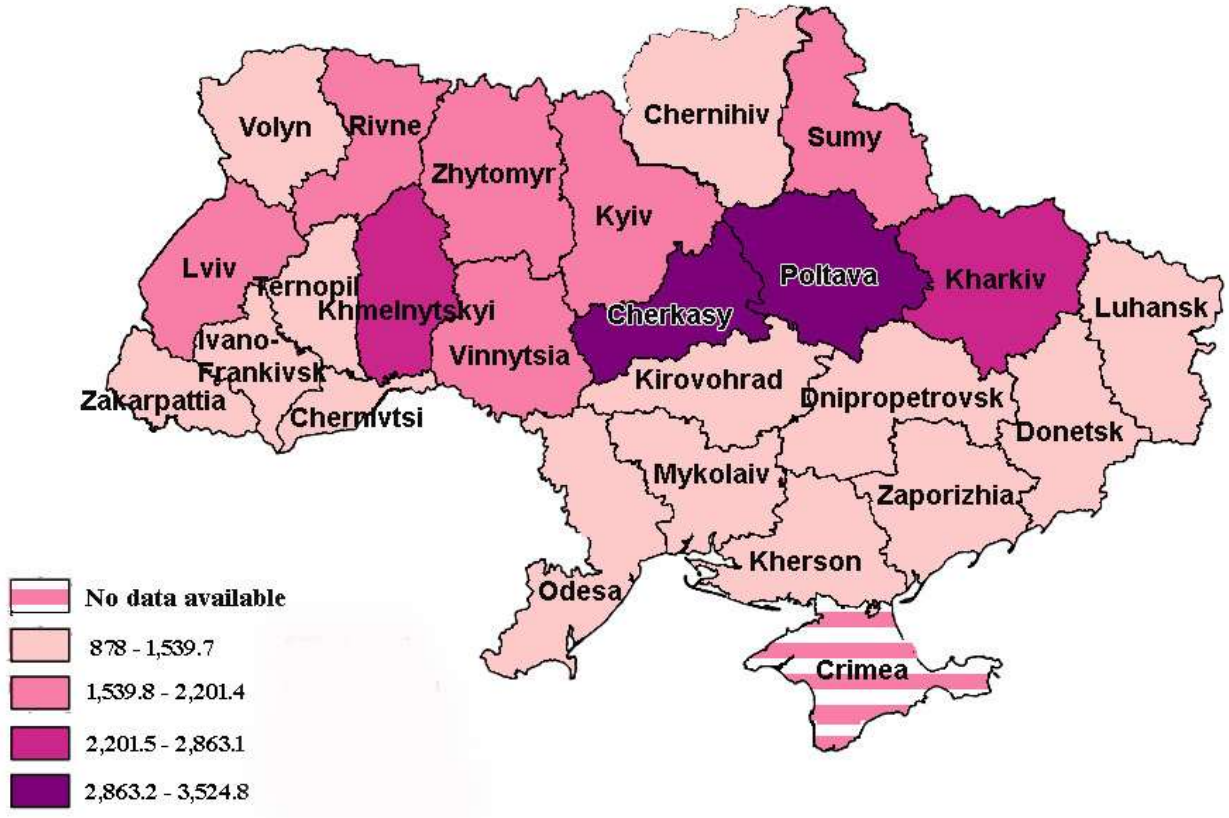

Fig. 4. Cartogram of Ukrainian regions grouping by the average annual rent for the agricultural land use in 2018, UAH/ha
Source: Developed and systematized based on [29].

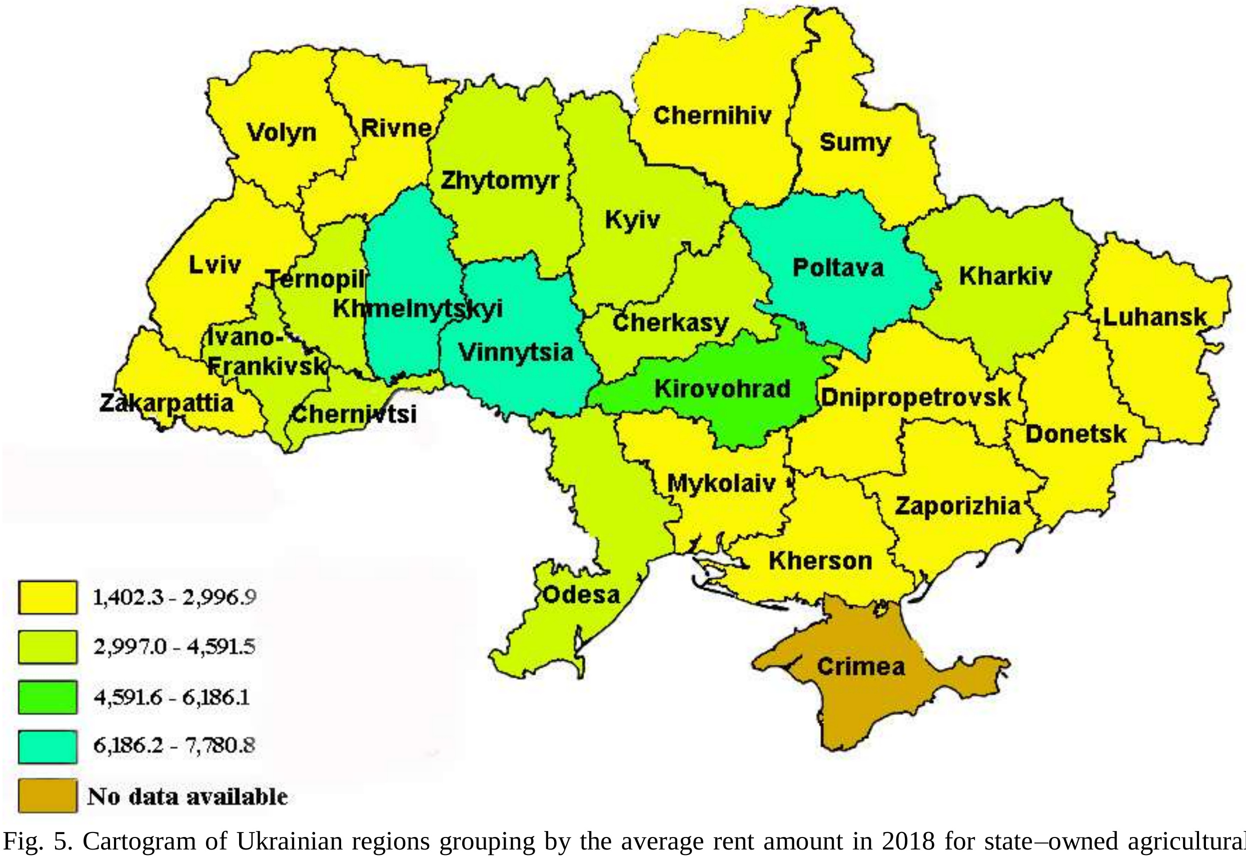

Fig. 5. Cartogram of Ukrainian regions grouping by the average rent amount in 2018 for state–owned agricultural land plots leased at land auctions, UAH / ha
Source: Developed and systematized based on [29].

As is known, until March 31, 2020 in Ukraine there was a moratorium on the sale of agricultural land. However, the Verkhovna Rada of Ukraine later adopted the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on the Conditions of Circulation of Agricultural Land" [13], which defined the peculiarities of the regulatory requirements formation for the organization of the agricultural land market. Thus, it allowed providing conditions for the effective formation of transparent market conditions of purchase and sale and the final acquisition of ownership of agricultural land by citizens of Ukraine. Peculiarities of application of this law determine that the right of agricultural land ownership with an area up to 100 hectares can be acquired only by citizens of Ukraine. Also, from January 1, 2024, such a right will be granted to resident legal entities with an increase in the area of land that can be acquired in the ownership up to 10 thousand hectares.

In our opinion, the specifics of the agricultural land market functioning for legal entities becomes especially relevant in terms of expanding opportunities to attract investors in the agroindustry sector. After all, access to land ownership will result in an increase in the land fund of agricultural enterprises and agricultural holdings and expand their opportunities for planning seasonal changes in sown areas. Accordingly, such planned changes in crops on agricultural lands will result in an overall increase in the efficiency of agricultural land use.

Ukrainian lands are quite fertile and rich in chernozems, which is another important factor that the effectiveness of their use in the case of successful management decisions can reach a sufficient level (Fig. 6).

Thus, the land bank of chernozems of Ukraine is 28 million hectares, which is 28 times more than in Germany and Poland. The area of Ukrainian soils is 60 million hectares, which is 37 million hectares more than in Romania, 29 million hectares more than in Poland and 25 million hectares more than in Germany. The situation is similar with arable land reserves, the volume of which in Ukraine is 32 million hectares, while in Poland this figure is lower by 71.9%, in Germany – by 62.5%, in Romania – by 56.3%. All this is evidence of significant untapped potential and realization of possible prospects for land market development in Ukraine, as the presence of a significant amount of fertile land is the basis for increasing investment in agroindustry sector with increasing efficiency in both short and long term. Such a generous land fund of Ukraine allows them to grow and produce agricultural products in sufficient quantities and at a high–quality level. However, this is only theoretical, but in practice, the situation is somewhat different.

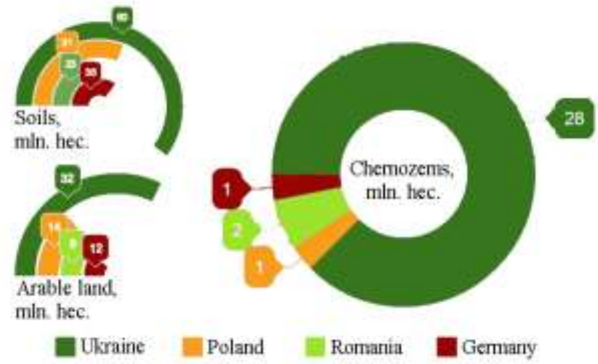

Fig. 6. Reserves of chernozem, soil and arable land in Ukraine, Poland, Romania and Germany, in million hectares, as of 2018 year
Source: Generalized and systematized based on [29].

Having significant and high–quality reserves of fertile lands, Ukraine is 2–3 times less productive than developed countries, which is evidence of inefficient use of agricultural land by agricultural enterprises of Ukraine.

According to Table 4, it is established that the sown and harvested areas in the period 2015–2019 in Ukraine decreased in all types of products, except cereals and legumes and sunflower, given that these crops are very depleting even for Ukrainian chernozems.

The increase in the area sown with industrial crops indicates the desire of their owners to get very high profits, because the profitability of sunflower, soybean, rape is higher than the profitability of wheat, which ultimately leads to agricultural land depletion, and the cost of their restoration is sometimes incomparable.

Table 4. Major crops areas and production dynamics by agricultural enterprises of Ukraine in 2015 – 2019

Product	Years					2019 in % to	
	2015	2016	2017	2018	2019	2015	2018
Sowing area. thousand hectares							
Cereals and legumes	10,719.4	10,461.6	10,573.1	10,785.9	11,202.3	104.5	103.9
Sugar beet factory	213.5	271.5	296.6	258.2	206.0	96.5	79.8
Sunflower	4,155.2	4,981.4	4,980.6	5,068.7	4,855.6	116.9	95.8
Potato	23.0	22.4	18.8	16.2	15.9	68.7	98.8
Vegetable crops	35.8	35.5	30.7	31.6	34.7	96.9	109.8
Fruit and berry crops	74.8	66.6	67.0	68.9	65.9	88.1	95.6
Collected area. thousand hectares							
Cereals and legumes	10,622.9	10,397.6	10,509.7	10,740.6	11,176.1	105.2	104.1
Sugar beet factory	213.1	270.2	294.1	256.7	205.4	96.4	80.0
Sunflower	4,092.6	4,968.1	4,953.6	5,019.3	4,824.3	117.9	96.1
Potato	23.0	21.8	17.8	16.0	15.8	69.1	98.1
Vegetable crops	35.3	34.3	30.6	31.3	34.0	96.3	108.6
Fruit and berry crops	58.2	51.0	51.4	52.2	47.7	82.0	91.4
Production volume. thousand quintals							
Cereals and legumes	465,065.8	520,222.5	479,050.9	560,961.9	599,820.8	129.0	106.9
Sugar beet factory	95,537.6	133,488.6	142,271.8	133,166.3	96,583.1	101.1	72.5
Sunflower	95,492.5	117,300.5	105,967.3	121,935.8	130,886.5	137.1	107.3
Potato	4,559.6	4,681.6	4,294.1	4,163.5	3,734.3	81.9	89.7
Vegetable crops	12,817.0	13,229.3	13,439.3	13,571.1	14,208.5	110.9	104.7
Fruit and berry crops	4,116.8	3,705.4	3,337.7	5,566.1	3,510.5	85.3	63.1
Yield from 1 ha. quintals							
Cereals and legumes	43.8	50.0	45.6	52.2	53.7	122.6	102.9
Sugar beet factory	488.2	494.0	484.1	518.8	470.3	96.3	90.7
Sunflower	23.0	23.5	21.3	24.1	27.0	117.4	112.0
Potato	198.6	212.1	238.4	252.0	230.5	116.1	91.5
Vegetable crops	363.4	382.7	435.3	427.4	415.8	114.4	97.3
Fruit and berry crops	70.8	72.5	64.9	106.2	72.7	102.7	68.5

Source: Generalized and systematized based on [30].

In addition, the analysis data show a constant increase during the analysed period in the volume of agricultural production, except for potatoes and fruits, and berries. This is due to the gradual opening of the European market for Ukrainian producers.

According to the results presented in Table 4, we found the difference between the sown area and the area from which the crop was harvested. It is obvious that the harvested area is smaller than the sown area, which is evidence that agricultural producers have lost some of their products due to the reduction of the harvested area of their land.

In addition, an important element of the land–use efficiency analysis in agricultural production is to take into account the number of crop losses by agricultural enterprises that arose as a result of the difference between sown and harvested agricultural land (Table 5).

In particular, according to Table. 5, we found that the lowest yield losses during the study period are observed for cereals, legumes, and beets, namely – only 0.2% of total production (in 2017 and 2015, respectively). In particular, the largest losses for beets were only – 0.9% of total production (in 2015 and 2017, respectively). At the same time, the most significant yield losses of agricultural producers in the study period are observed for fruit and berry crops, where the lowest loss rate was 28.5% of total production in 2015, and the highest loss rate – 37.7% of total production was observed in 2019. Thus, according to the results of the study in 2015 – 2019, it was found that the difference between sown in the harvested area most significantly affected the yield of fruit and berry crops in agricultural producers of Ukraine.

Table 5. Yield losses of the main agricultural crops by agricultural enterprises of Ukraine in 2015–2019

Product	2015	2016	2017	2018	2019
Yield losses, thousand quintals					
Cereals and legumes	4,226.7	3,200.0	2,891.0	2,364.7	1,406.9
Sugar beet factory	195.3	642.2	1,210.3	778.2	282.2
Sunflower	–	127.3	–	–	–
Potato	181.7	459.2	43.5	128.2	291.1
Vegetable crops	1,175.3	1,131.0	1,012.4	1,773.5	1,323.1
Yield losses in% of total production					
Cereals and legumes	0.9	0.6	0.6	0.4	0.2
Sugar beet factory	0.2	0.5	0.9	0.6	0.3
Sunflower	–	2.7	–	–	–
Potato	1.4	3.5	0.3	0.9	2.0
Vegetable crops	28.5	30.5	30.3	31.9	37.7

Source: Generalized and systematized based on [30].

Table 6. The analysis results of the factors impact on the sales dynamics of gross output of agricultural producers of Ukraine for 2014 – 2018 by factor analysis of the assets return of their fixed assets

Researched indicators	The study period			Deviation				Quantitative influence of factors on the performance indicator, UAH million	
	2014	2017	2018	absolute		relative, %			
				2018 – 2014	2018 – 2017	2018 – 2014	2018 – 2017	2017 – 2018	2014 – 2018
Sales of gross output, UAH million	214,972.5	452,760.1	528,657.8	313,685.3	75,897.7	145.9	16.8	X	X
Fixed assets, UAH million	171,392.0	341,622.0	407,146.0	235,754.0	65,524.0	137.6	19.2	86,830.5	295,710.7
Return on assets, thousand UAH	1,254.3	1,325.3	1,298.4	44.1	–26.9	3.5	–2.0	–10,932.8	17,974.6

Source: Generalized and systematized based on [30].

We systematized the results of the impact factors assessing on the sale of gross output of agricultural enterprises of Ukraine in 2014 – 2018 by analysing the dynamics of the return rate on their fixed assets and the factors that influenced its formation (Table 6). The results of the factor analysis will make it possible to identify the quantitative impact of factors on the efficiency of non-current assets of agricultural producers, the lion's share of which is directly occupied by land resources.

Thus, according to the factor analysis results by the elimination method (Table 6), we found that in 2014 - 2018, the growth of sales by agricultural producers gross output by 145.9% (or 313,685.3 million UAH) was influenced by rising costs fixed assets by 137.6%, which led to an increase in the performance indicator by 295,710.7 million UAH. At the same time, the growth of the return on non-current assets for 2014 - 2018 by 3.5% led to an increase in the performance indicator by 17,974.6 million UAH. Thus, a more significant impact on the sale of gross output by agricultural producers of Ukraine in the study period has a value of their fixed assets, a significant share of which is land resources.

In 2017 - 2018, the growth of the gross sales of agricultural producers by 16.8% (or 75,897.7 million UAH) was influenced by the growth of the value of fixed assets by 19.2%, which led to an increase in the performance indicator by 86,830.5 million UAH. As a result of the study, it was found that the decrease in the return on non-current assets for 2017 - 2018 by 2.0% led to a decrease in the performance indicator by 10,932.8 million UAH.

We systematized the results of assessing the impact of factors on the return on assets of agricultural producers of Ukraine for 2014 -

2018 by identifying the factors that influenced its formation by determining their quantitative impact through factor analysis methods, including the method of elimination (Table 7).

Table 7. The analysing results of the factors impact on the dynamics of assets return of agricultural producers of Ukraine for 2014 – 2018 by conducting a factor analysis by the method of elimination

Researched indicators	The study period			Deviation				Quantitative influence of factors on the performance indicator, %	
	2014	2017	2018	absolute		relative, %			
				2018 – 2014	2018 – 2017	2018 – 2014	2018 – 2017	2017 – 2018	2014 – 2018
Fixed assets, million UAH	171,392.0	341,622.0	407,146.0	235,754.0	65,524.0	137.6	19.2	–3.345	–23.988
Profit, million UAH	21,481.3	68,858.5	71,002.6	49,521.3	2,144.1	230.5	3.1	0.628	28.894
Return on assets, %	12.533	20.156	17.439	4.906	–2.717	X	X	X	X

Spurce: Generalized and systematized based on [30].

Thus, according to the factor analysis results by the elimination method (Table 7) we found that in 2014 - 2018 the dynamics of the return on assets of agricultural producers of Ukraine was affected by an increase in the value of fixed assets (including land resources) by 137.6%, which led to a decrease in performance by 23.9%. At the same time, the increase in the profit of agricultural producers of Ukraine for 2014 – 2018 by 230.5% led to an increase in the return on their assets by 28.8%. As a result, under the influence of all factors for 2014 – 2018, the return on assets of agricultural producers in Ukraine increased by 4.9%.

It is established that in 2017 – 2018, the increase in the value of fixed assets (including land resources) by 19.2% led to a decrease in the return on assets of agricultural producers of Ukraine by 3.34%. At the same time, the increase in the profit of agricultural producers of Ukraine for 2017 – 2018 by 3.1% (i.e. by UAH 2,144.1 million) led to an increase in the return on their assets by only 0.62%. As a result, due to the combination of all factors for 2017 – 2018, the return on assets of agricultural producers in Ukraine decreased by 2.72%.

CONCLUSIONS

According to the study results, it is established that the land resources use by agricultural enterprises of Ukraine is not efficient enough. This is confirmed by the yield loss, as the harvested area for individual crops is significantly smaller than sown. That is, due to a number of reasons related to poor management (flooding, drought, significant frosts, poor pest control) could not be harvested on certain lands.

Summarizing the work results, it is possible to form the main directions and reasons for the reduction of soil fertility and the land fund of Ukraine inefficient use:

1.increase in the volume of agricultural land allocated for technical and oilseeds;
2.impossibility of agricultural lands free circulation;
3.the land lease market insufficient development due to the ineffectiveness of the levers for its regulation, which leads to mismanagement of tenant companies;
4. low level of land reclamation and constant level of ploughing of soils lead to catastrophic depletion and loss of fertility of agricultural areas.

These problematic aspects are certainly signing of agricultural land use insufficient efficiency by agricultural producers in Ukraine.

In our opinion, the main task of the state to rationalize and establish the efficient use of land resources in the agricultural sector is to introduce a number of measures to ensure efficient land use, namely:

– creation of a mechanism for preferential financing of the process of reconstruction of old and construction of new, technically advanced irrigation and drainage systems. Whereas the study has shown that Ukrainian farmers lose their crops due to the impossibility of harvesting from the entire sown area, and modern irrigation and drainage mechanisms will greatly help to avoid such problems in the future;

– improving the economic mechanism of management, which will ensure the implementation of measures to protect natural resources and preserve soil fertility in Ukraine, because in terms of maximizing the profitability of farmers often neglects the issue of rationalization and feasibility of growing certain crops in terms of preserving other useful properties. appointment.

No less important are the state actions in the land regulation legal aspect. The main thing here is to improve land legislation, introduce an efficient and transparent land circulation market, and ensure control over the land resources targeted use by agricultural economic entities.

We believe that the implementation of the proposed measures will provide the prerequisites for the land–use efficient mechanism implementation, which will have a positive impact on the economic situation in agricultural production and the economy as a whole. In our opinion, the successful continuation of the outlined measures set will help increase the efficiency of land use in Ukraine, which will ensure the entry of agricultural production to a new quality level.

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DIVERSITY AND ABUNDANCE INDEX OF ENTOMOPATHOGENIC FUNGI AND THEIR HOSTS IN RICE PLANTATIONS BOLAANG MONGONDOW REGENCY, INDONESIA

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Abstract

Research on the diversity and abundance of entomopathogenic fungi and their hosts in rice plantations in Bolaang Mongondow Regency was an attempt to find potential local biological control agents. Integrated pest management as often employed in agricultural pest control, may be a way to address these issues. The purpose of this study was to determine the diversity and abundance of entomopathogenic fungi and their hosts, to find pest insect species that attack rice plants, and to look for potential host species and entomopathogenic fungi in Bolaang Mongondow. The results showed that entomopathogenic fungi that have been identified through the research are Beauveria bassiana, Hirsutela sp., and Metarhizium anisopliae. Hosts that have been found due to fungal entomopathogenic infections are Nilaparvata lugens, Scotinophara coarctata, Leptocorisa oratorius, and Paraeucosmetus pallicornis. The highest diversity index in Bolaang Mongondow was found in Nilaparvata lugens (1.07) and for entomopathogenic fungi was found in Beauveria bassiana (1.34). The highest abundance index levels in Bolaang Mongondow were found in the same host and fungi.

Key words**:** *Nilaparvata lugens, Beauveria bassiana,* diversity index, abundance index, biological control agents

INTRODUCTION

As a staple food and main source of calories in Indonesia, rice plants (*Oryza sativa* L.) have experienced pest attacks by at least 21 insect species which are categorized as major pests [3; 21]. For these reasons, and many others, we all share the responsibility to ensure that new agricultural technologies will be available continuously. Generally, pest control uses synthetic insecticides because they are easy to use and have a quick killing effect; however, those synthetic insecticides can lead to long term negative effects, such as environmental pollution, the emergence of resistant pest insects, the killing of natural enemies, increased residual yields, and health problems for users [17; 4; 1].

Biological control is expected to inhibit the growth of pest insects by using biological control agents which are natural enemies of target insects, such as parasitoids, nematodes, viruses, fungi, bacteria and other predatory insects [1; 10]. The biological control commonly used is entomopathogenic fungi because it is an eco-friendly alternative; such as soil fungus (rhizosphere) which is able to attack insects by producing extracellular enzymes in the form of chitinase, lipase, and protease, which are important components of fungal infection process into insect bodies [24; 26].

Entomopathogenic fungi have great potential as biological pest control agents, and have been developed throughout the world for controlling a variety of important agricultural insect pests [12; 17]. The diversity of entomopathogenic fungi in a particular land may provide information about the potential of local pest control from entomopathogenic fungi that are naturally present at the site. However, *B. bassiana* isolates have different level of virulence at each host and location [17]; so that the local potentials of entomopathogenic fungi are needed to be known scientifically as a consideration for the supply of biological control agents.

In recent years, Bolaang Mongondow Regency has become the center of rice production and granary in North Sulawesi. This region has experienced pest attacks [18; 15; 13] recently, and to overcome this problem, it is necessary to explore local potential entomopathogenic fungi isolates to control agricultural pests. Based on the description above, the problem of this research is how the diversity and abundance levels optimize the effectiveness of the entomopathogenic fungi and what insect species of pests and host species are potential to be controlled with entomopathogenic fungi, to obtain species of entomopathogenic fungi which are potential to be used as biological control agents in Bolaang Mongondow.

MATERIALS AND METHODS

This research took place from April 2019 to February 2020; including exploratory research using 1 m x 1 m plot size method, which was conducted in three districts of North Dumoga, Central Dumoga and East Dumoga as location samples. Furthermore, as the sampling location of each sub-district sample, three stations in the rice field area were determined with a purposive random sampling method adjusted to the age of rice plants. Sampling areas were chosen by making 10 plots of 1 m x 1 m size. Insects that have been infected with fungi were taken as samples; after being identified at the Laboratory of Ecology and Conservation FMIPA Sam Ratulangi University Manado. The number of entomopathogenic fungi was calculated based on the host species infected by the entomopathogenic fungi species. Diversity of infected host species and fungal species was calculated using the Shannon-Wiener Diversity Index [25].

$$H' = -\sum_{n=1}^{s} pi\ lnpi$$

H' = Shannon-wiener Diversity Index
pi = comparison of the number of i-th individuals (ni) with the total number of individuals (n)
s = Number of i species

The abundance of infected host species and fungal species was calculated using the Abundance Index [7].

$$A = \frac{\text{counts of individuals of i type}}{\text{counts of individuals of all types}} \text{ x } 100\%$$

A = Abundance Index

Identification of entomopathogenic fungi was done by using a combined method of [19, 27, 9, 16, 28, 20, 30, 23].

RESULTS AND DISCUSSIONS

Results

Exploration of Host Insects and Entomopathogenic Fungus

The results of the exploration of host species and entomopathogenic fungi in Bolaang Mongondow District obtained four host insect species, namely *Nilaparvata lugens*, *Scotinophara coarctata*, *Leptocorisa oratorius*, and *Paraeucosmetus pallicornis*; and three entomopathogenic fungi species found, namely *Beauveria bassiana*, *Hirsutela sp.*, and *Metarhizium anisopliae*. The exploration data can be seen in Table 1.

Table 1. Average Number of Entomopathogens in Bolaang Mongondouw Regency

Type of Host (Individual)		**Type of Fungi (Individual)**		**Total**
	B. bassiana	*Hirsutela sp.*	*M. anisopliae*	
N. lugens	1.47	1.31	0.78	3.56
S. coarctata	0.93	0.98	0.49	2.40
L. oratorius	0.81	0.60	0.18	1.59
P. pallicornis	0.81	0.36	0.36	1.43
Total	4.02	3.25	1.72	

Source: Own calculation.

The highest total number of entomopathogenic fungi was found in N. lugens host (3.56) and the least in *P. pallicornis* host (1.43). The *B. bassiana* fungus is the most common host of *N. lugens* (1.47), *L. oratorius* (0.81), and *P. pallicornis* (0.81). Hirsutela mushroom sp. is the fungus that most attacks the host *S. coarctata* (0.98). Based on these data, the type of host that is potential to be controlled with entomopathogenic fungi is the *N. lugens* host because it has the highest total number of attacks on this pest insect compared to the other hosts. The type of entomopathogenic fungus that is potential to control pest insects in Bolaang Mongondow is *B. bassiana* fungus because this fungus has the highest number of attacks against three of the four pest insects found.

Diversity Index (H')

The fungi diversity index was analyzed using the Shannon-wiener diversity index formula [25]. In this study, there are two forms of diversity index calculation. The first form is based on the type of host with a defining value (ni) which is the number of entomopathogenic fungi that attack one type of host and the value (N) is the total number of entomopathogenic fungi that attack one type of host. The second form is based on the type of entomopathogenic fungus with the defining value (ni), namely the number of similar insects infected by one type of entomopathogenic fungus and value (N), namely the total number of individual insects infected by one type of entomopathogenic fungus found.

There are three categories of diversity indexes, namely Low (H' <1), Medium (1 ≤ H' < 3), and High (H' ≥ 3) [2].

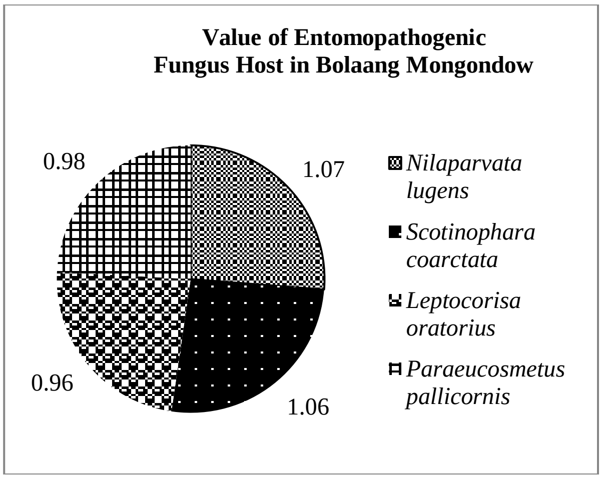

Fig. 1. Entomopatogenic Fungus Host Value in Bolaang Mongondow
Source: Own calculation.

The value of H' host insect pest species can be seen in Figure 1. The highest value was found on host *N. lugens (1.07)*, followed by *S. coarctata* (1.06), *P. pallicornis* (0.98) and *L. oratorius* with the lowest value of 0.96. *N. lugens* and *S. coarctata* hosts are in the moderate category and *L. oratorius* and *P. pallicornis* are in the low category [2]. This shows that *N. lugens* and *S. coarctata* hosts are entomopathogenic fungi that is more diverse than the other two host insect species, so that *N. lugens* is the most potential hosts to be controlled with entomopathogenic fungi.

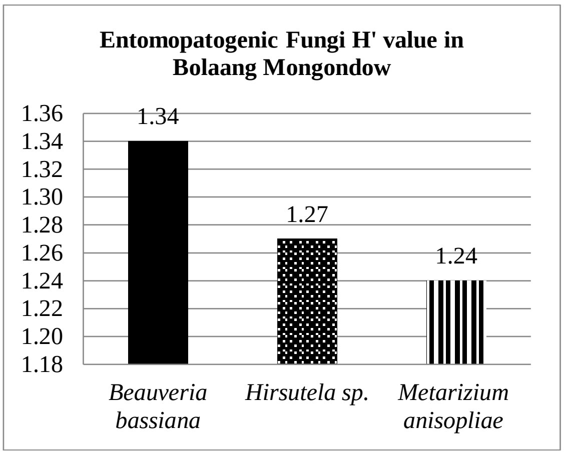

Fig. 2. Entomopatogenic Fungi H' value in Bolaang Mongondow
Source: Own calculation.

The index value of entomopathogenic fungi diversity in Bolaang Mongondow Regency shows that *B. bassiana* (1.34) has the highest index value, followed by *Hirsutela sp.* (1.27), and *M. anisopliae* (1.24) with the lowest index value (Figure 2). Those fungi are classified as the medium category, which means that they have the same diversity of hosts. Based on these data, the type of entomopathogenic fungus that has the potential to control pest insects is *B. bassiana*, based on the highest H' value compared to the other two fungi.

Abundance Index (A)

The entomopathogenic mushroom abundance index was calculated using the formula of abundance index, calculated using two forms of calculation [7]. The first is based on the type of host and the second is based on the type of entomopathogenic fungus. The higher the value of A means the species is more abundant. Based on the host insect species, the results indicated that there were two abundant entomopathogenic fungi in certain species of pest insects. *B. bassiana* fungi were found to be abundant in three host insect species, namely *N. lugens* (41.20%), *L. oratorius* (51.01%), and *P. pallicornis* (56.72%). Meanwhile, *Hirsutella sp.* overflow in *S. coarctata* host (40.74%) (Fig. 3).

The *M. anisopliae* fungus shows the lowest abundance value for all host insects indicated by these values: *N. lugens* (21.85%), *S. coarctata* (20.37%), *L. oratorius* (11.18%), and *P. pallicornis* (18.65%).

Thus, the *B. bassiana* fungus is the most abundant entomopathogenic fungus compared to the other two fungi because it is able to attack three insect pests found; hence, it is the most potential for controlling insect pests.

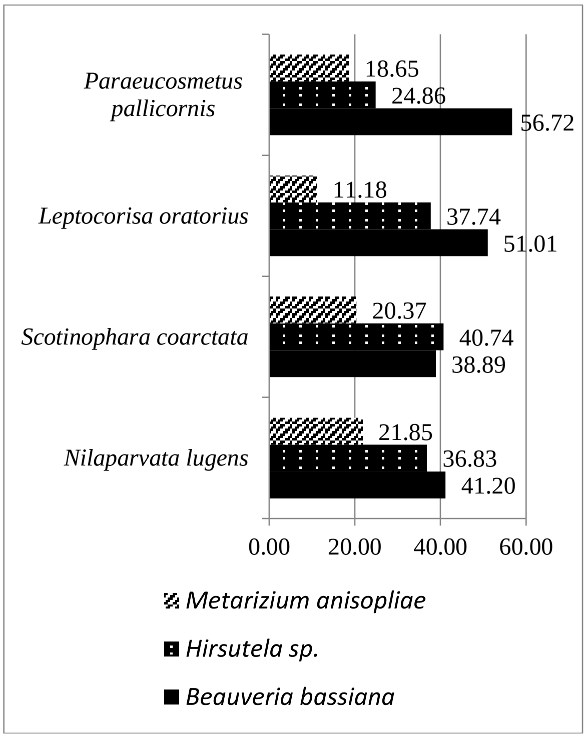

Fig. 3. Abundance index of host infected by entomopathogenic fungi in Bolaang Mongondow
Source: Own calculation.

Based on entomopathogenic fungi species, the results showed that *N. lugens* was the host with the highest index of abundance of entomopathogenic fungi, namely *B. bassiana* (36%), *Hirsutela Sp.* (40%), and *M. anisopliae* (45%) (Fig. 4).

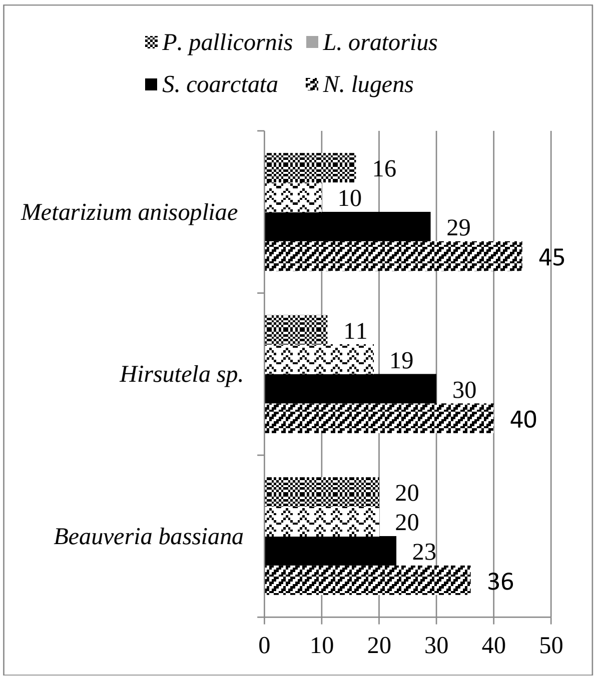

Fig. 4. Entomopathogenic Fungi Abundance index based on Host Type in Bolaang Mongondow (%)
Source: Own calculation.

P. pallicornis hosts showed the lowest index of fungi abundance in the species of *Hirsutela sp.* (19%) and *L. oratorius* host in *M. anisopliae* fungal species (10%); both of them have the lowest abundance index value in *B. bassiana* fungus (20%). This shows that the *N. lugens* pest is an insect that is potential to be controlled with entomopathogenic fungi because of the high abundance index of each entomopathogenic fungus found in this pest.

Discussions

Exploration of insects infected with entomopathogenic fungi in Bolaang Mongondow shows that the insect pests that has the tendency to become host is *N. lugens* insects with entomopathogenic fungus *B. bassiana*. This was influenced by several factors including the use of pesticides [22; 28] and the virulence ability of entomopathogenic fungi [17].

The use of pesticides can affect the ability of entomopathogenic fungi to infect *T. molitor* larvae [28]. It is noted that on certain field area where pesticides are not applied, high percentage of *T. molitor* larvae infection were found. This means that the use of pesticides can affect the ability of entomopathogenic fungal infections, but the level of influence of the use of pesticides on the ability of entomopathogenic fungal infections in Bolaang Mongondow has not been scientifically tested. The use of pesticides that are still massive is suspected to be the cause of the reduced number of infected insect pests because their pathogenicity is disrupted due to pesticide residues. This applies specifically to the *M. anisopliae* fungus because the results show that this fungus has the lowest number of infections of all hosts. The use of imidacloprid-based pesticides can inhibit sporulation of this fungus; but in different strains the opposite effect may occur, so it still needs in-depth investigated [8].

Differences in sampling locations also affect the pathogenicity of entomopathogenic fungi in terms of the mortality rate of host insects. Mortality rate of *L. oratorius* (*walang sangit*) due to infection with *B. bassiana* and *Metarhizium sp.* was different; depending on the location where the entomopathogenic fungi are isolated [6]. This relates to the location of sampling.

There are three sample locations, which are the three districts in Bolaang Mongondow, namely North Dumoga District, Central Dumoga District, and East Dumoga District. The characteristics of these three regions need to be investigated further, whether it affects the virulence differences of the entomopathogenic fungi that exist in each place, where the *B. bassiana* fungus was also reported to have a different virulence due to differences in location and host where the fungus was isolated [17].

The index of abundance of pest insect species shows that all types of hosts in all locations have the highest abundance index due to fungal infection of *B. bassiana*, because *B. bassiana* has a high conidia germination (> 70%) when compared to *Metarhizium sp.* with conidia germination <60% [19], so the ability to infect host insects is increased. *B. bassiana* is known to have a high pathogenicity compared to *Metarhizium sp* [6]. In addition, *B. bassiana* fungi showed the highest mortality rate of *L. oratorius* (walang sangit) (73.3%) compared to *Metarhizium sp.* (70%). In addition, *B. bassiana* is an entomopathogenic with a broad spectrum of attack, so its abundance against various host insects is higher.

Based on the calculation of diversity and abundance index values, the potential host insect to be controlled with local isolate entomopathogenic fungi is brown plant hopper (*N. lugens*). These insects are pests that damage plants by sucking cell fluids and are able to migrate for a long distance [14]. These insects can become more virulent by increasing the expression of genes associated with the digestive system, salivary secretion, detoxification, metabolism of carbohydrates, lipids, and amino acids [5].

Control using synthetic pesticides may give resistant effect on these insects. Extreme resistance occurs with imidacloprid and moderate to high resistance occurs with thiamethoxam [31]. Controlling *N. lugens* with pesticides is feared to have a pesticide-resistant effect on Bolaang Mongondow farm. Another concern is shown by the extraordinary migration tray of *N. lugens.* There was a spike in the population of *N. lugens* in the vicinity of the Yangtze River due to N. lugens immigrants reproducing there [11]. Migration that occurs there comes from *N. lugens* that are around the area, meaning that migration of *N. lugens* can occur between agricultural land. If there is a migration of *N. lugens* that has become pesticide resistant to other agricultural land, then the use of pesticides will not have a good impact to control the pest population and actually harm the soil ecosystem where entomopathogenic fungi are located.

Instead of using synthetic pesticides, the selection of local entomopathogenic fungi is highly recommended. Based on the calculation of diversity and abundance index values, locally isolated entomopathogenic fungi that have the potential to control pests are *B. bassiana*. *B. bassiana* fungi will be hampered by the process of spore formation if there is a fungicide present around it, but imidacloprid-based insecticides can stimulate the growth and sporulation of this fungus [8], so that the use of *B. bassiana* fungi can be applied in fields that have used insecticides. This is also the reason the diversity and abundance index value of *B. bassiana* fungi in Bolaang Mongondow is higher than the other two species of entomopathogenic fungi, if indeed there is a high enough pesticide residue in the area. In addition, the use of *B. bassiana* to overcome insect pests that are resistant to imidacloprid-based insecticides may become a new alternative. Besides being able to play a direct role as a biological control agent, secondary metabolites of the fungus *B. bassiana* can be used as insecticides; because the fungus *B. bassiana* produces toxins from the mycelium which can be used as an insecticide in the process of destroying the stomach tissue of the insect's body. This toxin can be extracted, so that *B. bassiana* in the future can potentially become a biological agent providing N-hexadecanoic acid-based insecticide [29].

CONCLUSIONS

The highest diversity index in Bolaang Mongondow was found in the host *Nilaparvata lugens* (1.07) and for entomopathogenic fungi was found in *Beauveria bassiana* (1.34), while the highest abundance index was also found in the host *Nilaparvata lugens* and for fungi was found in *Beauveria bassiana* fungi. With data examined above, it may be concluded that the most potential host insects to be controlled with entomopathogenic fungi is *Nilaparvata lugens*, with the most potential entomopathogenic fungi to control pests is *Beauveria bassiana*.

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PHYTOMONITORIZATION OF THE INTENSITY OF PHOTOSYNTHESIS, RESPIRATION AND TRANSPIRATION IN HAIR PLANTS

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Abstract

The paper presents the results regarding the phytomonitoring of physiological processes in hair plants. Among the physiological processes that characterize the activity of the production process is photosynthesis, which, like other physiological processes, is influenced by light, temperature and other ecological factors. Based on these considerations, the saturation curve of the light for photosynthesis was monitored. The modern RTM-48A phytomonitor was used, which allowed the measurement of physiological indices in the form of film-phytodiagram in automatic regime that allowed the diagnosis of the properties of the genotype and the physiological state of the plants. The saturation curve of light for photosynthesis in hair trees was determined as a result of assessing the intensity of photosynthesis, sweating, respiration and conductivity of stomata depending on temperature, humidity and CO_2 content in air. The minimum value of the light at which the photosynthesis process is initiated was established. With the increase of the light intensity (to 1/3 of the total light) the intensity of the photosynthesis increases after the essential optimization of the process took place. In hair plants, the intensity of photosynthesis begins with the appearance of light and continues to increase until the illumination of 100-150 micromol / m2 s, decreasing to 500 after maintaining at the same level until the illumination of 1500, then it increases to 1800. It was been established that the effect of temperature influence on photosynthesis in hair plants depended on the intensity of light. Respiration, transpiration and conductivity of the stomata confirmed light saturation curves for photosynthesis. As a result of the research, the positive influence of SBA Reglalg and microelements (B, Zn, Mn, Mo) on the activity of physiological processes in hair plants was established. The more pronounced stimulation of the activity of the physiological processes takes place under the influence of the Reglalg preparation in the presence of microelements.

Key words: *phytomonitoring, phytogram, gross photosynthesis, net photosynthesis, respiration, sweating, stoma conductivity, Republic of Moldova*

INTRODUCTION

It is known that plant productivity is determined by the activity of a complex of physiological and biochemical processes, among which the primary role belongs to photosynthesis. It is necessary to mention that this process is carried out in connection with other processes, first of all the breathing, a process in which a considerable amount of organic substances is consumed and which, in coordination with photosynthesis, ensures the viability of the plant organism. It is also known that the production potential of plants is determined by the genome, but its realization to a considerable extent depends on the ecological factors. Physiological processes, including photosynthesis, are permanently subject to the influence of various factors, such as light, temperature, humidity, which influences the productivity of plants.

Based on these considerations parallel with the monitoring of the functioning of the physiological processes, the saturation curve of the light was recorded for photosynthesis-performance element, photosynthesis (gross and net), perspiration, respiration, conductivity of stomata, weather conditions: temperature, humidity, CO_2 concentration and other factors. We carried out phytomonitoring research for 72 hours in the hairs under the influence of SBA and microelements.

MATERIALS AND METHODS

Fig. 1. Distribution of respondents by districts of the Republic of Moldova.
Source: Mapeurope.ru.

The work was carried out on the terms: 06 - 08. 07. 2018 - 06-08. 07. 2019 in lysimeters
(Institute of Genetics, Physiology and Plant Protection).

As object of study were the hair trees, the late variety Noiabriscaya, the species Pyrus, the family Rozaceae, 4 years old, during the intensive growth of the plants. This variety possesses excellent qualities: the weight of the fruits constituted 600 grams, industrial use: fresh, long storage in the refrigerator, multidirecţional processing on preservation [8]. Currently, there is a special interest regarding the practical application of biologically active substances (SBA) with an ecologically harmless character, the use of which can serve as an effective lever for regulating the growth and development processes in the crop plants. As a SBA, the preparation obtained from algae under the name of Reglalg was used [7]. This preparation stimulates the increase of the crop in different crops. The use of the preparation contributes to the adaptation and formation of plant resistance to ecological changes [7]. The action of the SBA on the photosynthetic activity of the apple plants according to the ecological conditions is poorly elucidated [7; 15]. Phytomonitoring historically emerged as an instrumental section of plant biocibernetics in the 50s of the last century [9; 11; 12]. Phytomonitoring has historically emerged as an instrumental section of plant biocibernetics in the 50s of the last century [9; 11; 12]. The term "phytomonitoring" itself was proposed in 1987 by scientists from the Leningrad Plant Biocibernetics Laboratory [11]. Further development of this direction contributed to the emergence of a phytomonitoring methodology, which was proclaimed by O.L.Lyalin as a new methodology of plant physiology (physiological phytomonitoring) [12]. The set of records of physiological indices (usually in a day or more) can be considered as a description of the functional state of a cultivated plant or as signals about its functional state. This allows us to include the facilities in the production process management based on feedback control. At present, phytomonitoring, as a new methodology of plant physiology, has received universal recognition in Russia, Europe, Australia, Israel, USA, Chile, the Republic of Moldova and other countries.

Fig. 2. PTM-48A phytomonitoring device in operation immediately after rain.
Source: Original photo.

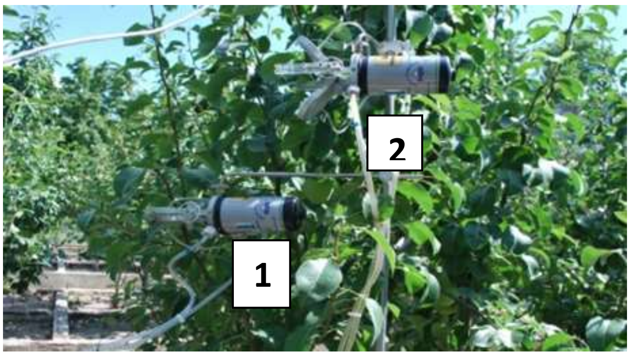

Fig. 3. Measuring chambers; 1, closed – for measurement, 2, open - for calibration.
Source: Original photo.

The task of phytomonitoring, together with physiological and biochemical studies, is to diagnose the properties of the genotype and the physiological state of the plants. The results of the latest researches have made possible the development of scientific and practical technologies for optimizing the cultivation of plants in natural environment and controlled environment in relation to the climatic changes. There are modern gas analyzers that work successfully as a photograph - ADC Bio Scientific Ltd-LGi [2; 6; 13; 14]. The first ISP-2T multichannel phytometric installation was developed in KB "Biopribor" (Chisinau). In the late 90's and early 21st century, based on the latest information technology, foreign companies Bio Instruments SRL, ADC Bio Scientific Ltd-LG gas analyzers and others built small phytomonitoring systems that allow the measurement of environmental parameters. The development of information technologies continues to this day. With the help of the modern PTM-48A phytomonitor, used in parallel with soy [10], we performed the phytomonitoring during 72 hours. We evaluated: photosynthesis (gross, net), perspiration, respiration, conductivity of the stomata under the action of weather conditions: temperature, humidity, CO_2 concentration and other factors, depending on the influence of SBA on the hair, showing - the physio light saturation for photosynthesis [7; 13; 14].

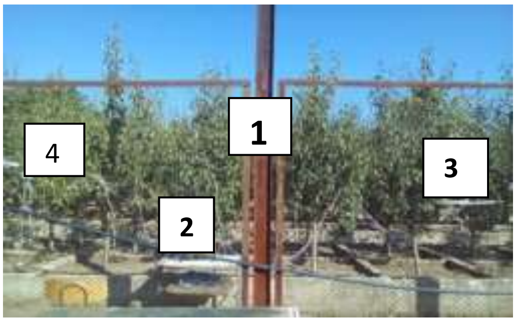

Fig. 4. *Phytomonitoring f*or 72 hours in hair trees.1- general appearance; 2- PTM -48 A apparatus**;** 3- measuring room; 4- RTH-48-weather module + measuring chamber.
Source: Original photo.

The modern PTM-48A phytomonitor (Bioinstruments SRL) [17; 1] has been used, which allows to make measurements in film-phytodiagram format every 15 minutes, for 72 hours, through phytomonitoring in automatic mode (Fig. 1 - 4.). The fitomonitor is compatible with the research drone “Phantom-2” [16; 17] through direct connections and through its own programs for interpreting the recorded information. The phytomonitoring in automatic regime of the indices characteristic of the energy [4, 5] and production processes is ensured [3; 16; 17]. We performed the detection of the basic physiological parameter - Light saturation curve for photosynthesis and crude, net photosynthesis - as a result of evaluating photosynthetic activity, sweating, breathing, conductivity of stomata under the direct action of weather conditions: temperature, humidity, CO_2 concentration in dependence by the influence of SBA (biologically active substances) on hair trees: on intact leaves, located in the middle part of the shoot. Through the tube with Ascarit- [10] (calcium hydroxide Ca(OH) 2 75.5%; Sodium hydroxide - NaOH with water addition 21.0%; Indicator (inorganic salt), as a constructive element of the phytomonitor PTM-48A, in which the calibration of the CO_2 content and the humidity of the air is automatically carried out in 4 measuring chambers, before each measurement, and immediately the measurements were made immediately (Fig. 2.–4.). Automatic phytomonitoring is performed through the analog contact points of the PTM-48A and sensors [13; 17]. The processing of the results allows to obtain the physiological element of performance: the light saturation curve for photosynthesis (micromol CO_2/m2 * s), the gross and net photosynthesis (micromol CO_2)/sq.m * s). Statistical interpretation of the results was performed using the statistical software applications Statistics 10 (Stat software INC, USA) and Microsoft Excel 2010. For the modeling and two-dimensional data, the methods of the smallest squares and the heavily weighted regression at the local level were used. All calculations were performed at significance level $P \leq 0.05$.

RESULTS AND DISCUSSIONS

The main way of researching photosynthesis, whether its mechanisms or biological properties, is based on establishing the reciprocal links of photosynthesis with other metabolic processes of the plant organism. The presence of light, as one of the main exogenous factors, is the main condition for the photosynthesis process to activate, which has determined the study of the influence of this factor on the intensity of photosynthesis, having at hand the possibilities of the automatic monitoring device PTM-48A. The research carried out presents the basic physiological element of the light saturation *curves for photosynthesis* (Fig. 5).

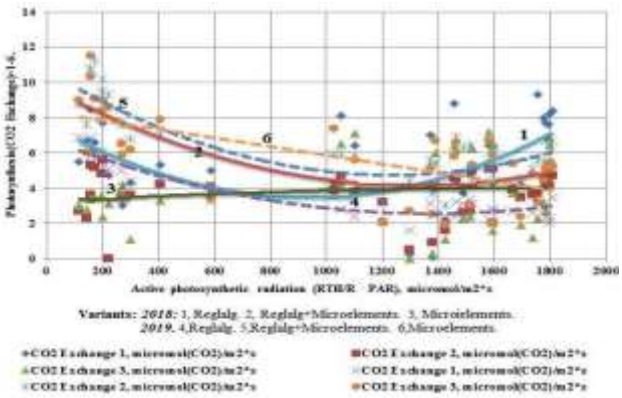

Fig. 5. Light saturation curves for photosynthesis.
Source: Own design reflecting the obtained results (Original).

The minimum values of the light intensity at which the photosynthesis process begins are set. The PTM-48A fitomonitor has the minimum recording capacity, which is very small in hair trees (tables for the years 2018-2019). With the increase of the light (up to 1/3 of the total sunlight) the intensity of the photosynthesis increases after its optimization in comparison with the intensity of the light. With the further increase of light, the process of photosynthesis saturation takes place. Analyzing the data presented, we observe that, in photosynthetic hair plants, the light starts to appear and continues until the illumination of 100-150 micromol/sq.m, gradually decreasing to 500 micromol/sq.m , and stays at the same level until the illumination of about 1,500 micromol/sq.m, then increases to 1,800 micromol/sq.m. The energy base of photosynthesis (Fig. 5.) is represented by the rays absorbed by chlorophyll. As it is known the energy of photosynthetically active radiation represents about 50% of the total energy of solar radiation. It is known that all solar energy does not participate in the photosynthesis process, but only the visible part - the active photosynthetic radiation with wavelengths from 380 to 720 nm (or millimicrons). The good yields correspond to 2-3% of the ROP use. When cultivating varieties of intensive type and optimizing all the processes of growth and development of the plants, the accumulation of 3.5-5% PAR and more predominantly takes place in the harvest. The effect of temperature on the influence of photosynthesis depends on the intensity of the illumination. Consequently, at a low level of illumination (diapazon - 15-25^0C) photosynthesis is performed at the same speed. At high light, the intensity of photosynthesis is determined by the activity of the processes that take place in the dark phase. The temperature of the leaf and the penetration of the leaf by the light depends on its thickness and structure. Thin leaves with lower heat capacity are more responsive to fluctuating light intensity. The following variants were installed in the IGFPP lysimeters with the hair plants: 1-SBA (biologically active substance) Reglalg; 2 – SBA Reglalg + Microelement; 3-Control. *The presented data confirm that the light saturation curves for photosynthesis* in hair plants largely vary depending on the factors in the research (Fig. 5.) is characterized by starting 6 curves in the region of active photosynthetic radiation (RTH / R PAR-100 micromol/sq.m, stable.

It was established that in the research years 2018-2019, stimulation of photosynthesis takes place under the influence of Reglalg preparation and more pronounced in the presence of microelements. *The light saturation curve for photosynthesis* - a performance element, is further confirmed by photosynthesis (gross, net photosynthesis), perspiration, respiration, stoma conductivity. A graphical representation was established depending on the factors studied - the relationship between the intensity of light and photosynthesis, the light penetration of the leaves. Essentially, it is a modification of the Michaelis-Menten equation, which shows a positive correlation between light intensity and photosynthesis intensity. Essentially, it is a modification of the Michaelis-Menten equation, which shows a positive correlation between light intensity and photosynthesis intensity. In the case of evaluating the intensity of photosynthesis, the magnitude of the observed photosynthesis is obtained (net photosynthesis- Fig. 6 and 7). An important indicator of photosynthesis is its intensity, i.e. the amount of CO_2 absorbed per unit time and the respiration of the leaves. In order to evaluate the value of real photosynthesis (gross photosynthesis), a change of breath must be added to the observed photosynthesis.

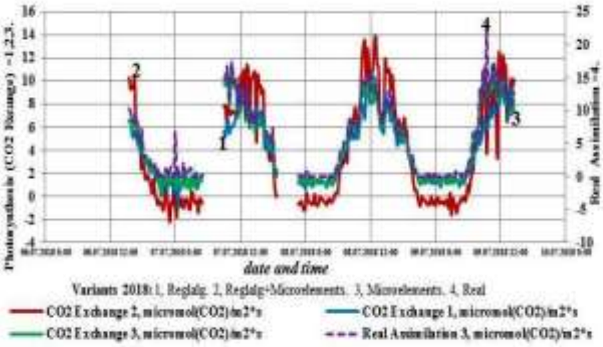

Fig.6. Crude photosynthesis (1,2,3), net photosynthesis (4).
Source: Own design reflecting the obtained results (Original).

The daily weight gain of the dry matter accumulated per unit of leaf area of a whole plant forms the *productivity of photosynthesis*. As the respiration process occurs simultaneously with photosynthesis, in order to obtain the value of a real intensity of photosynthesis (gross photosynthesis) it is necessary to make a respective modification to the intensity of the observed photosynthesis. Thus we obtain the weight increase of the dry substance on a unit of surface of the leaves or of a plant that defines photosynthetic productivity. How the intensity, as well as the photosynthetic productivity in the plants of different species, are essentially different. Hair shafts are very independent of nutritional conditions and especially in low light.

Fig. 8- 10 show results regarding the influence of SBA and air temperature on the intensity of photosynthesis in hair trees.

As you can see the intensity of carbon dioxide absorption essentially depends on the temperature factor. The presented data also confirm the light saturation *curves for photosynthesis.*

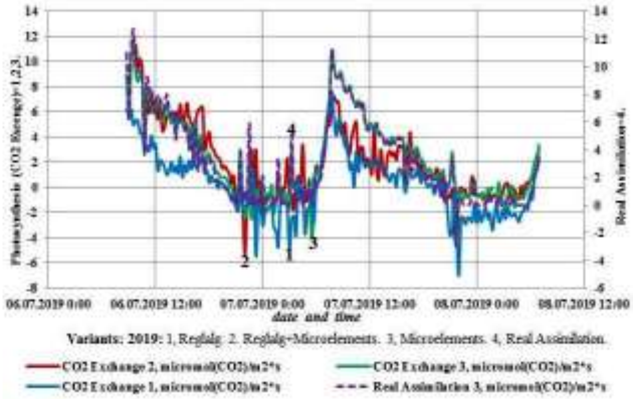

Fig. 7. Crude photosynthesis (1,2,3), net photosynthesis (4).
Source: Source: Own design reflecting the obtained results (Original).

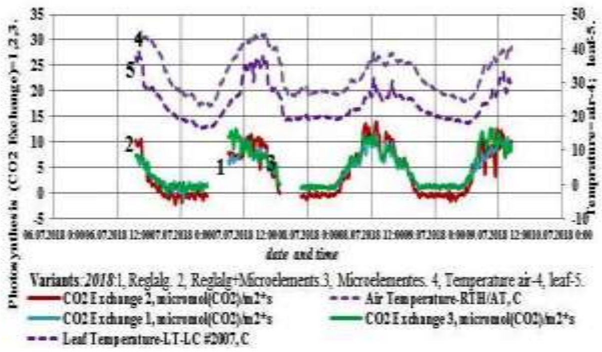

Fig. 8. Photosynthesis (1,2,3); Temperature (4.5).
Source: Source: Own design reflecting the obtained results (Original).

Photosynthesis is possible even at leaf air temperatures (Fig. 8 – 10) at which the growth of plants stops. Particularly low temperatures at night prevent the transport of plastic substances from the leaves to other plant organs, and in the leaf itself there is less room for new photosynthesis products, which artificially restricts its intensity. The activity of the photosynthetic apparatus and the flow of assimilated leaves can be significantly disturbed when the temperature in the root zone drops to 15°C. In turn, the root supply of photosynthetic products of soil and air humidity and air. The temperature limits for photosynthesis activity differ in different plants. The drop in air temperature directly affects photosynthesis, reducing the activity of enzymes involved in dark reactions and

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indirectly due to organ damage. The minimum temperature for plant photosynthesis is about 0°C. The optimum temperature of photosynthesis for most plants is about 20-25 °C. The minimum temperature for plant photosynthesis is approximate 0°C. The optimum temperature of photosynthesis for most plants is about 20-25°C. At temperatures higher than optimum temperatures, the intensity of photosynthesis drops sharply. Thus, increasing the temperature increases the rate of dark responses of photosynthesis. At the same time, at a temperature of 25-30°C, the process of inactivation of chloroplasts takes place. Higher temperature rise may also cause stoma cracks to stop (Fig. 8 - 10). Positive temperatures stimulate the intensity of respiration and in this sense decreases the intensity of visible photosynthesis (the difference between photosynthesis and respiration). Low temperatures reduce the intensity of photosynthesis because enzyme activity is inhibited, the speed of diffusion processes decreases, and the flow of assimilated. The temperature of the leaf depends on its thickness and consistency. In thin leaves, the heat capacity is low and reacts more strongly to the fluctuations of illumination. Sweating (Fig. 10 - 11) represents the process of water movement through plants and its evaporation through its external organs, such as leaves, stems and flowers. Water is needed for the life of the plant, but only a small part of the water that enters through the roots is used directly for the needs of growth processes and metabolism. The rest of over 99% is lost through sweating.

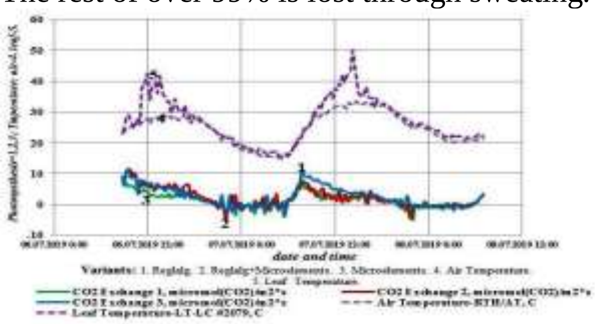

Fig. 9. Photosynthesis (1,2,3); Temperature (4,5).
Source: Source: Own design reflecting the obtained results (Original).

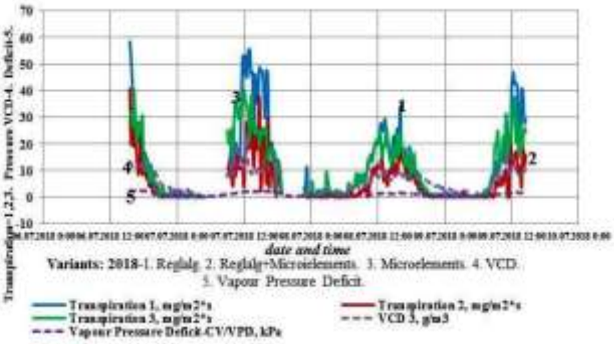

Fig. 10. Sweating (1,2,3); Cellular pressure (4); vapor pressure deficit (5).
Source: Source: Own design reflecting the obtained results (Original).

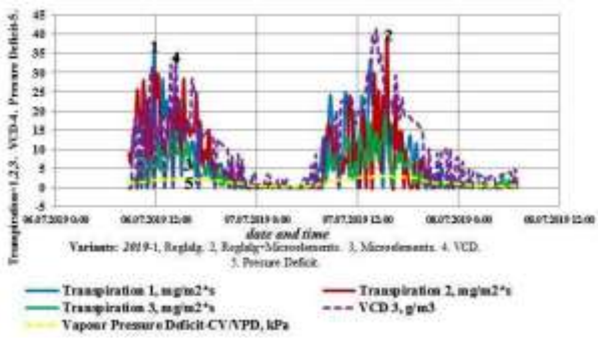

Fig. 11. Sweating (1,2,3); Cellular pressure (4); vapor pressure deficit (5).
Source: Source: Own design reflecting the obtained results (Original).

The surface of the leaf is covered with stomata, which in most fruit plants are located in the lower part of the leaf. Sweat intensity (Fig.10 – 11) confirms the performance. The stomata are limited by the closing cells and the accompanying cells (collectively known as the stomata complex), which open and close the pores.

Sweating occurs through fissures of the stomata through which at the same time they enter the carbon dioxide required for photosynthesis. In the process of sweating, the osmotic pressure in the cells that ensures the movement of water and nutrients from roots to shoots changes. The water is absorbed by the roots of the soil with the help of osmosis and moves into xylem together with dissolved nutrients. Gravity can be overcome only by reducing hydrostatic pressure in the upper parts of the plant, due to the diffusion of water through stomata. Stomach conductivity confirms light *saturation curves for photosynthesis*.

Modern high sensitivity equipment for calculating the conductivity of stomata in the computerized processing of physical indicators of gas exchange is based on the hypothesis of complete saturation of the water vapor cavity [6, 13].

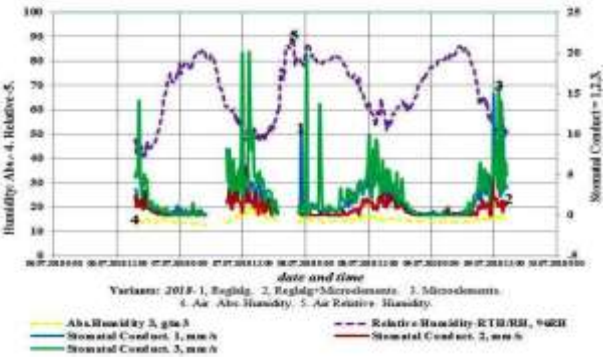

Fig. 12. Conductivity of stomata (1,2,3). Air humidity (4.5).
Source: Source: Own design reflecting the obtained results (Original).

Of particular interest is the evaluation of the quantitative ratio of respiration and photosynthesis (Fig. 13.).
Condensation of water from the surface of the leaves of the plants reduces the temperature of the leaves below the dew point, regardless of the cooling mechanism of the leaves and shoots, shows that all plants can condense the humidity of the air, especially in the absence of direct sunlight, provided that the dew point.
During photosynthesis, there is accumulation of organic substances that in the process of respiration, are mobilized to ensure all vital processes.

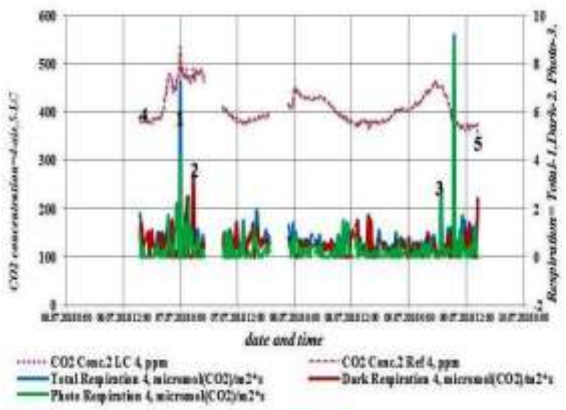

Fig. 13. Breathing (1,2,3). CO2 concentration in air (4) and measuring chamber (5).
Source: Own design reflecting the obtained results (Original).

Breathing provides energy for the biosynthesis, absorption and transport of plastic substances, the realization of the functional energy mechanism (organ movement, internal organ movement), and other activities in the cell. Thus, respiration, like photosynthesis, plays a fundamental role in the vital activity of plants.
As the atmosphere is known, which represents, on average, the main source of CO_2 for plants, it contains 0.03% CO_2. Increasing the CO_2 concentration in air from 0.2 to 0.6% accelerates the photosynthesis process; leads to an increase of the productivity of plants by 12-16% and to the acceleration of the maturation of plants by 7-12 days. When the CO_2 concentration in the air is higher than 0.6%, the growth of plants may slow down. In greenhouses, due to tight spaces, air exchange is difficult, and during the day, when CO_2 is actively absorbed by plants, its content in the air drops sharply. Therefore, in greenhouses, fertilizing plants with carbon dioxid is particularly important. In the measuring chamber the same air flows for a necessary period of time, passing successively through the concentration measuring device and through the measuring chambers. Therefore, photosynthesis occurs with a continuous decreasing concentration of CO_2. Its rate at any time can be evaluated based on the known CO_2 volume of the system and the slope of the light saturation curve, which describes the change in CO_2 concentration over time. Modern equipment requires very precise methods of determining the CO_2 concentration in the air, so that its decrease is slow (and at the same time measurable). In relation to the mentioned, it can be said that in the experiments with the hair plants the concentration of CO_2 was in the norm, which results from the presented information (Fig. 13.).

CONCLUSIONS

The peculiarities of the physiological processes in the hair trees were established based on the phytomonitoring, using the modern phytomonitor PTM-48A.
Photosynthesis (gross, net), just as the breathing, transpiration and conductivity of

the stomata confirm the performance of light saturation curves for photosynthesis.

Based on the phytomonitoring of the physiological processes, it was established that their activity during the vegetation period in the hair trees essentially changes depending on the fluctuation of the factors of light, temperature, humidity and CO_2 content in the atmosphere.

The positive effect of SBA Reglalg and microelents was confirmed based on the phytomonitoring of the intensity of photosynthesis, respiration, sweating, stoma conductivity and weather conditions, the saturation curve of photosynthesis was established in the hair plants.

The positive influence of the Reglalg preparation in the presence of microelements was established in the hair plants.

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ECONOMIC PROFITABILITY AND ECOLOGICAL JUSTIFICATION OF BUCKWHEAT CULTIVATION IN THE REPUBLIC OF SERBIA

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Abstract

The subject of research in this paper is the production of buckwheat on family farms in the Republic of Serbia. The main goal is to look at the situation, assess the economic effects of buckwheat cultivation, as well as the possibilities of improvement and greater representation of this production. Data were collected through a survey / interview with producers, from the websites of farms and institutions. Based on the buckwheat production technology, a calculation was made for one production cycle and important economic indicators were determined: production value, total costs, financial result, cost price, economy, and accumulation rate. These indicators are compared between conventional and organic production. The results show that buckwheat production is economically justified from the producer's point of view, but better effects are achieved by organic production.

Key words: *Buckwheat, organic production, business indicators, economic efficiency*

INTRODUCTION

Buckwheat (lat. *Fagopyrum esculentum Moench*) is a field crop that has been used for human and animal nutrition for more than 7,000 years. According to its nutritional composition, it is one of the very useful plant species [3]. He is originally from Asia. Wild plants can be found in China, and as weeds in Siberia and the Middle East. Diploid buckwheat was produced in Mongolia in the 10th century. Buckwheat has been mentioned in Europe since 1396, while in the United States it was expanded in the 17th century. Grown buckwheat was transported from China and the Himalayas first to Mongolia, Siberia and Japan, and then to Russia. From Europe and Japan, buckwheat has spread to other countries around the world [10]. Today, buckwheat is mostly grown in Eurasia, as well as in North America. Around 4,500 varieties of buckwheat are known in the world, all of which are suitable for growing in certain climatic and production conditions [5].

Buckwheat is suitable for organic production, which, in addition to achieving a more biologically valuable grain yield, contributes to the preservation of natural resources, especially land. There are about 43.1 million ha under organic agricultural production in the world (including the area under conversion). Of these areas in the world, most are located in Oceania, about 17.3 million. ha (40%) and Europe, about 11.5 mil. ha (27%). There are about 6.6 million ha in Latin America (15%) under organic production, in Asia 3.4 million ha (8%), in North America about 3 million ha (7%) and in Africa 1.2 million ha, respectively, 3% [19]. Of the total area of Serbia 8,840,000 ha (about 70%), agricultural land is located on 5,734,000 ha, of which 4,867,000 ha are arable land. Other areas of Serbia (about 30%) are under forests. In Serbian agriculture, the leading place belongs to crop production [17]. About two thirds of agricultural production comes from farming. Cereals, especially corn and wheat, have a dominant place in the structure of production, about 31% [20]. In recent years, there has been a growing interest of agricultural producers in growing buckwheat, as well as economically important and ecologically justified plant species. Precisely, the subject of this paper is the economic analysis of buckwheat production on family farms in the Republic of Serbia. The main goal of this research is to evaluate the economic effects per unit of measure that can be opened by growing buckwheat in different systems of conventional and organic production. The research seeks to answer a number of questions, such as: Is buckwheat production economically justified for the producer? What is the rate of accumulation that can be achieved in conventional and organic buckwheat cultivation systems? Therefore, the aim of the research is to look at the situation and possibilities of improvement from the production of buckwheat on family farms from the economic aspect. In addition to quantitative economic results, the research also analyzed the qualitative ecological effects of buckwheat cultivation.

MATERIALS AND METHODS

The research was conducted on the basis of data from the business practice of family farms in the southwestern part of the Republic of Serbia. Data were collected during the three-year monitoring of inputs and outputs on selected farms where buckwheat is grown as the main source of income. Significant data were collected through a survey and interviews with manufacturers, as well as from the sites of important institutions, associations, associations, etc. Also, data from the databases of the Republic Statistical Office of Serbia (SORS) and the Food and Agriculture Organization (FAO) were used.

Trends and structure of areas under buckwheat production in the world and in Serbia are considered. Then, a calculation of buckwheat production per unit area under conventional and organic conditions was compiled. Important economic indicators have been determined: production quality, production costs, financial result, cost per unit of measure, economy, accumulation rate, etc. By applying the SWOT analysis, the strengths, weaknesses, opportunities and threats of the current situation and further development and improvement of buckwheat production were examined.

RESULTS AND DISCUSSIONS

Areas under buckwheat production in the world and in the Republic of Serbia

According to the database of the Food and Agriculture Organization [2], the total area under buckwheat in the world in the five-year period 2012-2017 ranged from 2,491,909 ha in 2012 to 3,940,526 ha in 2017 (Table 1).

Table 1. Indices of movement of areas under buckwheat production in the world, 2012-2017

Year	Areas under buckwheat in the world (ha)	Index (2012=100)
2012	2,491,909	100.00
2013	2,263,608	90.84
2014	2,002,091	80.34
2015	3,350,253	134.44
2016	2,985,282	119.80
2017	3,940,526	158.13

Source: Calculation according to data www.fao.org [2].

As can be seen in Table 2, looking at the continents the largest areas under buckwheat are found in Europe, Asia and America [2]. Looking at countries in the world, the largest production of buckwheat is in Russia, followed by China, Ukraine, Brazil, America, Japan, France, Poland and Lithuania [7].

Table 2. Volume and structure of buckwheat production by continents, 2012-2017

Continent	Tons	%
Europe	8,724,197.00	53.80
Asia	6,498,013.00	40.10
America	855,786.00	5.30
Africa	138,543.00	0.80
Australia	-	-
World:	*16,216,539.00*	*100.00*

Source: Calculation according to data www.fao.org [2].

Buckwheat is grown on about 300 hectares in the Republic of Serbia, at different altitudes. In the southwestern part of Serbia, buckwheat is grown at an altitude of 1,100 m. The largest number of farms where buckwheat is grown is located in the areas: Zlatar, Zlatibor, Tara, Javor, Rudnik, Pešter, Sjenica, Jastrebac and Čačak. Buckwheat can be successfully produced in Serbia because buckwheat yield was significantly higher than average world yielded of 1,350 kg/ha [13].

Agro technical aspects of buckwheat cultivation

Buckwheat is an herbaceous annual plant and has a very short growing season (60-70 days), which provides the opportunity for two harvests in one year [9]. Fertilization is performed before the basic treatment in quantities of 30-60 kg/ha N, 30-60 kg/ha P_2O_5 and 30-45 kg/ha K_2O. It can be grown on slightly acidic soils, up to 5.5 pH values [16]. Of the buckwheat varieties, the most represented in Serbia are Novi Sad buckwheat and Gray dove, which are characterized by good growth and a solid tree height of 90-100 cm [15]. The plants branch well, is quite tolerant of drought, lodging and shedding of grains, and the lengths of the vegetation period vary from 80 to 110 days. They have a medium-sized grain, and the genetic yield potential is 2.5-3.0 t/ha [1].

About 80-100 kg of seeds per ha are needed for sowing. Crop care and protection measures depend on the sowing method used. Irrigation is applied in the case when buckwheat is grown as a side crop [4]. No chemical protection measures are used against insects. Due to the high content of routine that gives the buckwheat plant a slightly bitter taste, insects do not attack this plant culture. Against pathogens, only preventive measures are applied, such as disinfection of seeds and cultivation of buckwheat in the crop rotation [14]. Grain-eating birds can cause far greater damage to plants. Buckwheat can be grown as a main and as a subsequent crop after mowing winter fodder plants. The time and manner of harvesting depends on the purpose of its cultivation.

Economic importance and nutritional value of buckwheat

It can be used as a fodder plant for making silage. Also, buckwheat can be used as a vegetable fertilizer, by plowing aboveground biomass [6]. This plant culture has good nutritional value. Buckwheat grain contains from 1.50 to 3.70% of lipids, quality and easily digestible proteins from 11 to 15%, which is an equivalent amount as 90% of the protein content of skim milk and more than 80% of egg content [11]. Of the proteins, globulins are the most abundant. The degree of processing of buckwheat grain also depends on the content of nutrients in products or semi-finished products (Table 3).

Table 3. Nutritional value of buckwheat semi-finished products

Product	Contents (%)				
	Prote-ins	Carbo-hydrates	Fats	Fibers	Ash
Grain	12.50	73.30	2.30	10.90	2.10
Porridge	16.80	67.80	3.20	0.60	2.20
Whole wheat flour	14.10	68.60	3.50	8.30	1.80
Semi-white flour	11.70	72.00	2.50	1.60	1.80
White flour	6.40	79.50	1.20	0.50	0.90
Wheat flour for bread	11.80	74.70	1.10	0.30	0.40

Source: [3].

Buckwheat is a cereal of great nutritional value. Hulled buckwheat grains are used in the human diet in several ways. Whole grains are suitable as nutritional supplements for various stews, and flour for making polenta or for making bread with the addition of some other type of flour. From the health aspect of people, buckwheat in the diet brings blood sugar to an optimal level and helps the liver to function better. Young buckwheat grains can be left to germinate. Such sprouted buckwheat seeds are an exceptional source of chlorophyll, vitamins and enzymes.

Economic participants in buckwheat production on a family farm in the Republic of Serbia

Buckwheat production can be economically viable only if the revenues are higher than the total costs, and the main income is obtained by selling the products on the market. The economic viability of buckwheat production on the farm is affected by several factors. Factors that affect costs are different and depend on the volume and structure of production on the farm, market conditions - demand, prices, etc., as well as socio-economic factors [8]. Revenues depend not only on the yield but also on the price at which the products are sold on the market. Producers, on the one hand, cannot influence the selling prices of their products, because they are usually formed on the market under the influence of supply and demand, but on the other hand, they can influence the cost and cost of their own products [18].

Based on the collected data and technological activities from soil preparation and sowing to harvest, calculations of buckwheat production in conventional and organic conditions were compiled (Table 4). Although on the farm in the Republic of Serbia, the production of buckwheat takes place on larger areas, for the purposes of calculation and comparative analysis; all amounts are calculated for an area of 1 ha.

Table 4. Economic indicators of conventional production of buckwheat production in the R. Serbia

Row. Number	Indicators	Conventional production
a.	Yield (kg / ha)	1,800.00
b.	Market price (€ / kg)	1.60
		Amount (€ / ha)
A.	Sales revenue	2,880.00
B.	Costs	
I	Variable costs	
1.	Seeds	170.00
2.	Fertilizer (mineral, etc)	70.00
3.	Chemical preservatives	20.00
4.	Human labor	50.00
5.	Machine operation	110.00
6.	Certification and control	-
7.	Other costs	60.00
	Total (I):	490.00
II	Fixed costs	120.00
III	Total cost (I+II):	610.00
C.	Financial result	2,270.00
D.	Cost price (€ / kg)	0.34
E.	Coefficient of economy	3.72
F.	Profit rate (%)	78.82

Source: According to the data collected by the survey on family holding.

As can be seen in Table 4, in the conditions of conventional buckwheat production, the yield is 1.8 t/ha, and the market price at which the producer sells buckwheat grain is 1.60 €/kg. The total costs amount to 610 €/ha, and from the given calculation it can be seen that in their structure, a larger share consists of seed costs, about 28%, then the costs of mechanical services 18%, fertilizers about 11% and labor, about 8%. Organic production in the Republic of Serbia in recent years, with minor oscillations, has recorded an increase in both the area involved in production and the number of producers. Production took place on a total area of about 15,298 ha (with meadows and pastures), including areas in the status of conversion period. Compared to 2014 (9,547 ha), the total area in 2019 increased by 60% [20]. In the structure of organically grown field crops, buckwheat gained increasing importance. Based on the technology of organic buckwheat cultivation, on the investigated farms in the southwestern part of the Republic of Serbia, a calculation for one production cycle was made and more important economic indicators were determined (Table 5).

Table 5. Economic indicators of organic production of buckwheat in the R. Serbia

Row. Number	Indicators	Organic production
a.	Yield (kg / ha)	1,500.00
b.	Market price (€ / kg)	2.40
		Amount (€ / ha)
A.	Sales revenue	3,600.00
B.	Costs	
I	Variable costs	
1.	Seeds	220.00
2.	Fertilizer (organic, etc)	80.00
3.	Biological protection	30.00
4.	Human labor	90.00
5.	Machine operation	70.00
6.	Certification and control	80.00
7.	Other costs	40.00
	Total (I):	610.00
II	Fixed costs	120.00
III	Total cost (I+II):	730.00
C.	Financial result	2,870.00
D.	Cost price (€ / kg)	0.49
E.	Coefficient of economy	3.93
F.	Profit rate (%)	79.72

Source: According to the data collected by the survey on family holding.

He realized yield of organically produced buckwheat is 1.5 t/ha, and the market price for buckwheat produced in this way is € 2.40/kg, so a higher sales revenue is achieved compared to conventional production (Table 5). The total costs are 730 €/ha. Due to the specifics of organic production, the cost structure differs from the conventional one. The largest share belongs to the costs of seeds (30%), followed by the work of workers (13%), fertilizers (11%) and the costs of certification and control (11%). According to the established economic indicators, the production of buckwheat in both conventional and organic conditions is economically justified, because a positive financial result (profit) is achieved.

The production of buckwheat in organic conditions achieves a financial result in the amount of 2,870 €/ha, which is 26% higher than the financial result achieved by production in conventional conditions (2,270 €/ha). In both conventional and organic production, the cost price of 1 kg of buckwheat is lower than their market (sales) prices, which means that both methods of production are economically justified. Thus, the cost price of buckwheat in conventional conditions is 0.34 €/kg and by 1.26 €/kg is lower than the market price (1.60 €/kg), and in organic production the cost price is 0.49 €/kg and is 1.91 €/kg lower than the market price (2.40 €/kg). The difference between the market price and the cost price per unit of measure is significantly larger for organically produced buckwheat, so this method of production is also economically more profitable.

Observing the coefficient of economy as a ratio of financial result and total costs (3.72 > 1 for conventional and 3.93 > 1 for organic), buckwheat production is economical in both cases, but organic production is more economical. Both conventional and organic buckwheat production achieves a high profit rate, which means that about 80% of the realized sales revenue is made a profit. So, about 20% is enough to cover the total costs. The profit rate in organic production is more favorable compared to conventional (79.72% < 78.82%).

Based on the established economic indicators, it can be concluded that the production of buckwheat per unit area and per unit of yield, is economically justified for the producer, but organic production is economically more efficient than conventional production. How much better the degree of efficiency of organic buckwheat production will be depends on a number of factors, primarily on the applied agricultural techniques, quantity and quality of yield, sales price, etc.

Overall productivity on the farm can be improved by using varieties that give higher yields and that are adapted to local conditions. Yield can be increased by good regulation of plant nutrition and effective control of weeds, pests and diseases. In order to increase the economic production of buckwheat, producers often refine or process grain on the farm. They sell buckwheat flour as final products. Also, as they make and sell ecological pillows that are filled with by-products, i.e. buckwheat flakes.

Economic and ecological determinants of improving buckwheat production in Serbia

Using the SWOT analysis, the strengths, weaknesses, feasibility and dangers that are important for understanding the potential and possibilities of improving buckwheat production in Serbia were identified (Table 6).

Table 6. SWOT analysis of buckwheat production in the Republic of Serbia

Strengths	Weaknesses
• As a crop, buckwheat is suitable for growing on different soils; • Since it is not treated with chemical pesticides, cultivation contributes to the preservation of the soil; • It is economically efficient in both conventional and organic growing conditions; • There is state support for organic production [12]; • As a dietary product, buckwheat is gaining in importance;	Small areas under buckwheat production; • Buckwheat is traditionally known as “food for the poor”, so there is little interest in growing it; • Due to the high costs of certification and control, the share of areas under organic buckwheat production is small; • Insufficient promotion of the nutritional value and importance of buckwheat in human nutrition; • Insufficient investments in grain processing and processing capacities;
Opportunities	**Threats**
• Buckwheat cultivation can use areas that are not adequate for a more intensive plant species; • Investing in processing capacities and creating value-added products; • Available funds from IPARD and other funds; • In combination with bee colonies, higher buckwheat grain yield and quality buckwheat honey are achieved;	• Insufficient control of imports of semi-finished and buckwheat products and "suffocation" of domestic production; • Consumer distrust, because using modern additives and synthetic dyes, wheat and similar flour products are present on the market as buckwheat flour products; • Insufficient incentives for all segments of the value chain for products of organic origin, and thus from organic buckwheat;

Source: Own concept.

In Serbia, there is a noticeable growth in the market of agricultural and food products made of buckwheat, both supply and demand, but it is still very small and underdeveloped. Investments can influence its development due to the multiple advantages it provides to producers and consumers, but also to society in general. There are suitable soil and climatic conditions for growing buckwheat, and it is important to emphasize that the support from the state for organic production is also important. In addition to incentives for organic, there are favorable loans for investment in physical assets on the farm, which provides the opportunity to develop buckwheat production. Today, despite the better understanding of the importance of this plant culture, there are still few areas, producers, as well as yields that could meet domestic demand.

Due to insufficient import control, there is a threat to suppress the existing domestic production of buckwheat. Marketing approach to both the domestic market and exports is important. This includes market research and buckwheat products, which will meet the needs of consumers in terms of quality, range, size and method of packaging, packaging design, sales prices and the like. Opportunities but also obstacles for the development of domestic products on the food market should be recognized. It is also necessary to know and adapt to the standards of the target EU markets in other markets as well. Possibilities in improving economic efficiency and at the same time ecological justification is the organization of organic production of buckwheat, then the use of by-products from the processing of buckwheat grain, and thus the expansion of the range of products for sale on the market. One should strive to create products with added value.

CONCLUSIONS

In the practice of agricultural production in the Republic of Serbia, buckwheat is traditionally known as food for the poor, which has had the consequence of neglecting its cultivation. The technology of growing buckwheat is known in both conventional and organic conditions, and it is only necessary to motivate producers to focus more on this plant culture. Based on the established indicators, in relation to the conventional one, organic buckwheat production is economically more favorable for producers and a significant financial result is achieved both per unit area and per unit grain yield. Growing buckwheat in combination with keeping beehives on the farm, significant economic results are achieved. On the one hand, buckwheat is suitable for grazing bees, and on the other hand, by keeping bees, quality buckwheat honey is obtained. Observing the general interests, buckwheat is also desirable from the ecological aspect, because the technology of cultivation contributes to a more favorable physical structure, preservation of the soil and better biological balance in the environment.

This production also has social effects, because it contributes to the employment of the local population. From processed buckwheat and by-products (flakes), producers on the analyzed farms achieve significant income. The effects of buckwheat cultivation cannot be seen in the short term, but they are achieved only after a long series of years. With the improvement of the quality of final products and processes necessary to meet the needs of consumers, producers manage to create added value of buckwheat products.

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RESEARCH ON THE EVOLUTION OF THE NUMBER OF AGRICULTURAL HOLDINGS IN THE PERIOD 2002 – 2016

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Abstract

Rural space is an important social component for each country. Phenomena such as ageing population and migration of young people to large urban centres or outside Romania's borders have led to the depopulation of these areas. This paper is identify from the point of view of legislation, how to classify holdings according to agricultural activity, but how they are classified according to economic size. The aim of the work is to identify the evolution of the number of holdings influenced by various factors, but also to determine the position that Romania must have with regard to agricultural holdings in relation to other countries of the European Union. The quantitative and qualitative method of data analysis was used in this paper. Also, the analyzed data show that the methods of subsidizing and financing agricultural holdings have contributed to the decrease in the total number of agricultural holdings (mergers) in Romania.

Key words: *agricultural holdings, rural area, rural development*

INTRODUCTION

Agricultural holding is a form of organisation consisting of all the establishments used for agricultural activities and managed by a farmer, situated in the territory of the same Member State of the European Union [3].

According to Law No. 37/2015 on the classification of farms and agricultural holdings, ***by type of agricultural activity***, holdings are classified as follows [10]:

A.Specialized holdings – crops

-holdings specialising in field crops;
-farms specializing in horticulture;
-holdings specialising in permanent crops.

B.Specialized holdings - animal production

-holdings specialising in the rearing of herbivorous animals;
-holdings specialising in the rearing of cranivorous animals.

C. Mixed holdings

-mixed-crop holdings;
-mixed livestock holdings;
-mixed farms of crops and livestock farming;
-unclassified holdings.

Agricultural production has managed to withstand, over time, despite various events and changes, resisting both during the communist period, but also during this period when market competition is fierce [1, 2].

The term "size" indicates the qualitative side, namely the output (production) of the holding, while the size refers to the quantitative side. Also, the notion of "size of a farm" mainly refers to the area of land worked or the livestock. Indicators such as personnel, degree of endowment with agricultural machinery or machines, indirectly compose the size of agricultural holdings [7, 8].

Until 2013, at the level of the European Union, the economic dimension of a farm was expressed in units of economic size, where the value of a unit of economic dimension was 1.200 euros. Starting with 2014, when the second rural development financing program (PNDR) appeared, this indicator was replaced by the SO (standard output) indicator [4].

The size of an agricultural holding is mainly represented by the area of land or the number of animals held and is expressed in physical sizes (hectares, heads of animals) [9, 11, 12].

Depending on the economic dimension, farms and farms shall be classed and defined as follows [10]:

-less than EUR 1,999 - subsistence farms which produce entirely for their own consumption;
-EUR 2,000-7,999 - semi-subsistence farms that provide their own consumption and a small part of the agricultural production that markets it;
-8,000-49,999 euros - small commercial farms that sell more than 50% of their agricultural production;
-EUR 50,000-999,999 - medium-sized commercial farms that market all their agricultural production;
-over EUR 1,000,000 - large agricultural farms/holdings that market all their agricultural production.

MATERIALS AND METHODS

In order to carry out this work, data from the National Statistical Institute were used through the General Agricultural Census (RGA 2002, RGA 2010), the Structural Survey in Agriculture (ASA 2007, ASA 2013, ASA 2016), as well as data provided by European database – EUROSTAT. These data were processed using the qualitative and quantitative method of data, using the Excel program.

RESULTS AND DISCUSSIONS

The evolution of agricultural holdings in Romania, during the period under review, is noted a decrease, so that if in 2002 there were more than 4.48 million farms, in 2013 the number of farms was decreasing by 19%, reaching the threshold of 3.6 million holdings. In 2016 the consolidation process continues as a result of the measures taken in this regard, so that the number reached 3.42 million (Figure 1.).

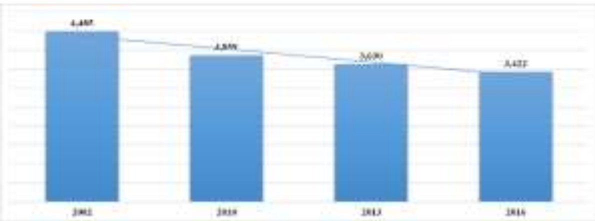

Fig. 1. Evolution of agricultural holdings in the period 2002-2016 (thousand holdings)

Source: INS, RGA 2002, RGA 2010, ASA 2013, ASA 2016 [6].

It is worth noting the trend of declining agricultural holdings among both agricultural holdings without legal personality and those with legal personality.
At 2013 level, more than 73% of all holdings were classified among mixed-type farms.

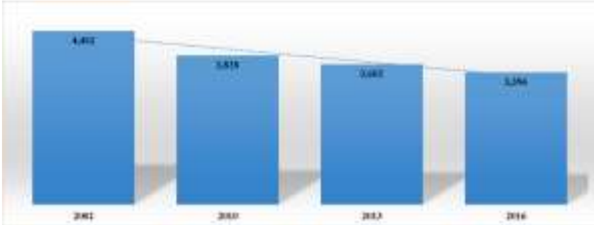

Fig. 2. Evolution of agricultural holdings without legal personality in the period 2002-2016 (thousand holdings)
Source: INS, RGA 2002, RGA 2010, ASA 2013, ASA 2016 [6].

The share of agricultural holdings without legal personality in the total holdings is 99%. It should be noted that farms without legal personality will fell from 4.46 million in 2002 to 3.4 million in 2016, due to an ageing population that was no longer able to deal with agriculture and due to the measures of Romania'a accession to the European Union (Figure 2).

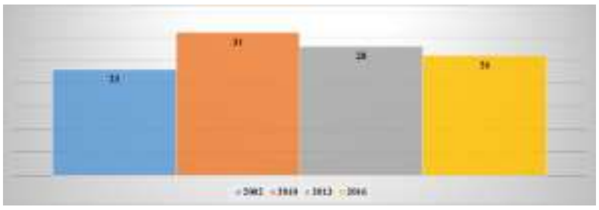

Fig. 3. Evolution of agricultural holdings with legal personality in the period 2002-2013 (thousand holdings)
Source: INS, RGA 2002, RGA 2010, ASA 2013, ASA 2016 [6].

In 2010 there was an increase in the number of agricultural holdings with legal personality, reaching the value of 31 thousand, due to the criteria established for farmers to access European funds through the National Development Programme Rural, but in 2013 there was a decrease of 9.7% due to their inability to adapt to the rules laid down by the European Union, which led either to their closure or were purchased by other

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agricultural holdings in to increase the scores for investments made through the National Rural Development Programme. This phenomenon continued in 2016, when the number was about 26 thousand (Figure 3).

We can see that the number of agricultural holdings using agricultural land shows a decrease by 13.2% in 2013, when the number of farms was 3.56 million, while in 2005 the number of holdings was 4.1 million (Table 1).

Table 1. Evolution of agricultural holdings by size class of agricultural area used (number)

Size classes of agricultural area used (hectares)	Total					
	2005	2007	2010	2013	2016	2016/2005 (%)
Total	**4,103,404**	**3,834,407**	**3,724,332**	**3,563,765**	**3,342,185**	-18.6
under 0.1	414,696	273,525	384,944	408,958	351,894	-15.1
0.1 – 0.3	474,162	522,028	662,122	642,056	555,396	17.1
0.3 – 0.5	283,145	279,085	355,182	330,990	295,765	4.5
0.5 - 1	677,761	609,440	617,198	561,378	567,514	-16.3
1 - 2	868,918	799,143	712,288	646,542	630,361	-27.5
2 - 5	1,011,819	963,453	727,389	691,257	659,997	-34.8
5 - 10	286,987	297,638	182,444	193,871	194,200	-32.3
10 - 20	64,514	68,897	43,609	49,648	50,212	-22.2
20 - 30	9,747	9,156	9,730	10,259	10,992	12.8
30 - 50	5,521	5,988	8,213	8,468	7,531	36.4
50 - 100	3,919	3,587	7,556	7,263	6,013	53.4
over 100	2,215	2,467	13,657	13,075	12,310	455.8

Source: ASA 2005, ASA 2007, RGA 2010, ASA 2013, ASA 2016 [6].

The sharpest decreases were recorded among holdings using an agricultural area between 2-5 hectares and 5-10 hectares. A phenomenon that can be explained by the fact that these holdings have been absorbed by holdings using larger agricultural land areas. Thus, agricultural holdings using agricultural areas of more than 100 hectares registered an increase of 455% in 2016, compared to 2005, from 2,215 holdings to 12,310 (Table 1).

In the case of Bulgaria, Hungary, Poland and Romania, there may be a decrease in the number of agricultural holdings during the period considered, as a result of the measures concerning their consolidation through the various programmes under consideration.

Although the area of the country, including the agricultural area, is larger than in the case of Romania, the number of agricultural holdings in Poland is 1.14 million compared to those seen in Romania in 2016, i.e. 3.42 million (Figure 4).

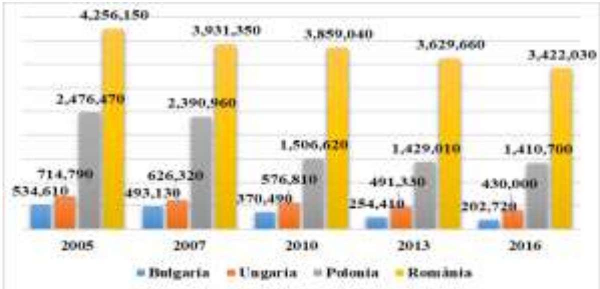

Fig. 4. Evolution of the number of agricultural holdings in Bulgaria, Hungary, Poland and Romania in the period 2005-2016 (number)
Source: processed data Eurostat, Accessed on 15.01.2020 [5].

According to Table 2 There is a sharp decrease in holdings classified as having an economic size of between EUR 2000-7999 and less than EUR 1999 in 2016.

Table 2. Evolution of agricultural holdings classified by economic size (number)

Clasificare	2005	2007	2010	2013	2016	2016/2005 (%) - 100
under 1,999 eur	2,813,340	2,642,490	2,820,360	2,493,430	2,333,210	-17.1
2,000-7,999 eur	1,324,730	1,153,490	916,200	952,920	902,850	-31.8
8,000-49,999 eur	109,170	125,290	109,950	166,930	169,280	55.1
50,000-99,999 eur	4,180	5,130	6,150	7,830	7,730	84.9
100,000-249,999 eur	2,900	3,120	3,990	5,000	5,180	78.6
250,000-499,999 eur	1,100	1,140	1,430	2,100	2,180	98.2
over 500,000 eur	730	700	950	1,470	1,610	120.5

Source: processed data Eurostat, Accessed on 15.03.2020 [5].

This was encouraged by CAP measures on the consolidation of agricultural holdings, but also by the ageing of the rural population, which were no longer able to support the holdings, which were subsequently sold.

There is also a sharp increase in the number of holdings with a standard production value of more than EUR 500,000, which if in 2005 the number was 730, in 2016 they were 1610, up by more than 120% (Table 2.).

CONCLUSIONS

With more than 3.63 million agricultural holdings, Romania register 33.5% of the total number of U.E. farms, but they account for only 7.5% of the U.E. area for Romania, this discrepancy reflects the dominant nature of small-scale farms, this is a very small average area of the agricultural holding.

A structural attribute of agricultural holdings in Romania to be noted is the persistence of a very large concentration of holdings with low standard output values. Farms with legal personality increased significantly in 2010 by around 35%, as a result of the national Rural Development Program, which led farms without legal personality to be authorized to access these non-reimbursable funds. In 2013, there was also a decrease in the number due to the inability to adapt to the rules laid down by the European Union (e.g. animal welfare rules).

In the pooling process, agricultural holdings using an agricultural area between 5-10 hectares and between 2-5 hectares have been shown, while at the same time a significant increase in farms using agricultural areas of more than 100 hectares has been observed.

The downward trend in the number of farms is also recorded in countries such as Bulgaria, Hungary or Poland, against the background of measures developed under the national development programs.

For agricultural holdings classified by economic size, at 2013 level more than 68% of these were subsistence farms with an economic size of less than EUR 2,000 and around 26% had an economic dimension of between EUR 2,000 and EUR 8,000, this shows the predominability of holdings with a low production value.

In order to keep a record as close as possible to reality and, in particular, to draw up a series of decisions on farms, it is necessary to process data as close as possible to reality. According to the National Statistics Institute the data found in the General Agricultural census (RGA 2002, RGA 2010), the structural survey in agriculture (ASA 2007, ASA 2013) are data that centralize the number of agricultural holdings regardless of their ownership. In other words, a holding with leased land from several farmers does not appear as a single holding, although it may, if it so wishes, apply to access European funds as a single holding. Therefore, the land registration process is extremely important in order to have concrete data on the actual number of farms and, in particular, to develop appropriate measures in line with reality.

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ANALYSIS REGARDING THE SITUATION OF THE ROMANIAN VILLAGE - CASE STUDY, TETOIU COMMUNE, VÂLCEA COUNTY, ROMANIA

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Abstract

The Romanian village is facing demographic problems, an ageing population, low birth rates, and a lack of jobs that contribute to the depopulation of villages. The main purpose of the paper is the identification of socio-economic problems, taking as a study the research of the commune of Tetoiu in Vâlcea County. The work is based on official data provided by the town hall of Tetoiu, as well as data provided by the National Statistical Institute, on the basis of which the following statistical indicators were calculated: standard deviation, coefficient of variation, and growth rate. The lack of qualified teachers and interest in education is a major problem in the rural environment, contributing to migration to other countries in order to secure a secure source of income and a decent living. Lack of information on access to European funds leads to a reduction in agricultural activities and a shift towards the urban environment. All these problems form a crisis of the Romanian village and lead to the fall of the villages.

Key words**:** *Romanian village, young people in rural areas, rural area*

INTRODUCTION

"The rural comprises all activities that take place outside the urban and comprises three essential components: administrative communities made up of relatively few members and which have mutual relations; pronounced dispensation of the population and collective services; the special economic role of agriculture and forestry" [3, 5].

The word "rural comes from the Latin *ruris* which represents culture, field, territory occupied and man-made." [6].

In the rural economy, the largest share is "agricultural activity, which is a characteristic of the rural environment and which is followed by other activities such as forestry, tourism, agritourism" [7].

The introduction of elements of the urban, affects agricultural activity and hence the rural economy, and the use of land for cultural development, infrastructure development and land use for purposes other than agricultural purposes has a significant influence on agricultural activities. Rural activities are carried out in agriculture, forestry, fisheries, aquaculture, low population density, the promotion of traditions [9].

The basic function of the rural area is the economic function comprising a number of activities on social implications for maintaining the current workforce and placing it in agricultural activities and obtaining agricultural products and material goods, with the aim of securing a source of income, but also obtaining additional income. In the rural wash economy agriculture is a staple activity, and product processing, the wood industry, artisanal production complements the rural economy. The ecological function of the natural space plays an important role in maintaining the balance of the rural environment. Pollution of the natural environment, of basic resources, is a phenomenon with rapid access, due to the rapid deterioration caused by human activity, general industrialization, deterioration of agricultural and forestry space, reduction of fauna and flora. Measures are needed to reduce the negative factors caused by pollution, such as sustainable management of natural resources, environmental protection, rehabilitation of ecosystems, recording of places of historical and traditional importance, compliance with legislation on environmental protection. The social-cultural function is the observance and transmission of future generations to the customs and traditions for the preservation of the natural heritage of the villages. The exploitation of cultural assets and the transmission of cultural background from the urban environment lead to the development of creativity and civic spirit, and the transmission of the principles of our forefathers completes the idea of the canonical village and maintains the image of the uniqueness of folklore. Beliefs, dates, superstitions, spiritual life influence people's lives preserving the image of the authentic peasant [10, 11]. Industrialization has a strong impact on agriculture, the development of processing industries and the development of trade stimulate production, cultivation on large areas and the creation of competitive environments [8].

"The village is the territory in which the population has adapted to the conditions offered by the natural environment and which is concentrated on specific agricultural activities" [2].

Human capital is a large-scale component and influences and is a defining element in the economic development of villages. Diversification of rural activities can lead to the stabilisation of industries and the practice of smart agriculture, which results in high quality products and high yields, implicitly in high and secure incomes. The structure of the villages influences the socio-economic development of the villages, by ensuring links with the external environment and carrying out activities easily [1, 4].

Vâlcea County is located in Southern Romania and borders Alba, Sibiu, Arges, Olt, Dolj, Gorj and Hunedoara counties, divided into 2 municipalities, 9 towns and 78 communes. Vâlcea County has most of the forms of relief: mountains, hills, plateaus and plain-looking mountains and is crossed over almost the entire county by the Olt River.

Tetoiu is located in the south of Vâlcea County, comprises the villages of Băroiu, Budele, Măneasa, Tetoiu (residence), Nenciulești, Popești and Tepești. The activities of the area-specific inhabitants are agriculture, beekeeping, animal husbandry and trade. Tetoiu is considered one of the most important communes in Romania and even in Europe due to the discoveries made in the Valley of Greuceanu, namely a humanoid skull, Homo Olteniensis, 2,000,000 years old, which is currently on display in Craiova at the Oltenia Museum and remains of hominid (femoral diaphysis and a remnant of a tibia).

The Treasure of Piscul Șasei included the commune of Tetoiu in the list of the oldest settlements in the world. In the 60s of the 20th century, the remains of a Dacian fortress were discovered, which was part of a defensive system of defend of the Sarmizegetusa kings. The cave-in of a shore revealed 140 silver coins and several Byzantine coins, which over to the authorities. were discovered by the tenants and handed.

MATERIALS AND METHODS

The research is based on the analysis of official data requested and received from the municipality of Tetoiu in Vâlcea County, as well as statistical data provided by the National Statistical Institute on the basis of which the following indicators were calculated:

standard deviation $\sigma = \sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}}$, where:

x - sample media;

n - sample size;

coefficient of variation v = $\frac{\sigma}{x}100$ where:

σ - mean deviation;

x - the average level of a variable;

growth rate $\bar{R} = (\bar{I}\ x\ 100) - 100$, where:

$\bar{I}$- average overall growth index.

RESULTS AND DISCUSSIONS

Romania's resident population shows a decrease during the period under review, so in urban areas, the resident population in 2014 was 10.7 million, reaching 10.4 million in 2019, representing a decrease of about 3% in the population over 6 years (Table 1).

In rural areas, the resident population suffered a decrease of 241 thousand inhabitants in 2019 (8.9 million inhabitants) compared to 2014 (9.2 million inhabitants).

Table 1. Situation of the number of inhabitants of Romania according to the environment of residence

Areas of residence	Specification	Year					
		2014	2015	2016	2017	2018	2019
		UM: Number of people					
Urban	TOTAL	10,752,617	10,703,051	10,636,418	10,531,819	10,503,470	10,455,362
	SOUTHWEST OLTENIA region	936,575	929,177	918,765	901,198	900,033	892,200
	Vâlcea	162,934	162,122	160,654	158,518	157,920	156,918
Rural	TOTAL	9,200,472	9,172,491	9,124,167	9,112,130	9,027,161	8,959,096
	SOUTHWEST OLTENIA region	1,097,209	1,086,615	1,074,717	1,071,742	1,049,907	1,034,660
	Vâlcea	202,763	201,148	199,160	198,129	195,268	193,141

Source: processed data INSSE, Accessed on 05.08.2020.

In the case of the county of which Tetoiu commune is a part, it also showed a decrease in the number of inhabitants, so in 2014 the urban population was 163 thousand inhabitants, and in 2019 the number of inhabitants was 157 thousand inhabitants.

The population of the rural environment of Vâlcea County registered a decrease in the period 2014-2019, so that in 2019 the population decreased by 9.6 thousand inhabitants compared to 2014, representing a decrease of about 5% (Table 1.).

Table 2. Analysis of statistical indicators on the number of inhabitants of Romania by residence environment

Areas of residence	Specif.	Min (no)	Max (no)	Aver. (no)	Stand. Dev. (no)	*Coef. of var. %	Growth rate %
Urban	TOTAL	10,455,362	10,752,617	10,597,122	118,384	1.12	-0.56
	SOUTHWEST OLTENIA region	892,200	936,575	912,991	17,836	1.95	-0.97
	Vâlcea	156,918	162,934	159,844	2,425	1.52	-0.75
Rural	TOTAL	8,959,096	9,200,472	9,099,252	90,815	1.00	-0.53
	SOUTHWEST OLTENIA region	1,034,660	1,097,209	1,069,141	23,194	2.17	-1.17
	Vâlcea	193,141	202,763	198,268	3,594	1.81	-0.97

Source: processed data INSSE, Accessed on 05.08.2020, variation coefficient (<10 - small;10-20-medium; >20-high);

In urban areas, Romania's resident population was between 10.4 and 10.7 million. The average period was 10.5 million, with a negative growth rate of 0.56%. In the case of Vâlcea County, the highest number of inhabitants was recorded in 2014, i.e. 162,934, and the lowest in 2019 with 156,918 inhabitants with a negative growth rate of 0.75% (Table 2.)

In the case of rural areas, the population ranged from 8.9 million to 9.2 million, with a coefficient of variation of 1% and a negative growth rate of 0.35. The population of Vâlcea County registered between 193,141 and 202,763 inhabitants, the average period being 198,268 inhabitants, and the growth rate shows a negative value of 0.97 (Table 2).

The number of inhabitants of Tetoiu commune in Vâlcea County is decreasing according to the 2002 population census when there were 3051 inhabitants, the population decreased over 17 years by 605 inhabitants compared to the last year analyzed, representing a decrease of 20%. This downward trend is very common in rural areas, due to population migration and extremely low birth rates, to urban centres or outside the country (Table 3).

Table 3. Evolution of the population of the commune, the number of newborns and the number of deaths in Tetoiu commune, Vâlcea county (number)

Specification	Year						
	2002 *	2014	2015	2016	2017	2018	2019
The population of the commune	3,051	2,683	2,683	2,464	2,464	2,446	2,446
Number of newborns	-	1	2	1	1	1	0
Number of deaths	-	57	43	52	52	48	29

Source: processed data, provided by The Tetoiu commune, Accessed on 30.07.2020.

The number of newborns was on average only one newborn per year, and in the case of deaths, the average period analyzed is 46. These low values for newborns reflect a number of rural issues, whereby the lack or poor development of the right conditions for starting a family in these areas leads to a low birth rate. On the other hand, the high number of deaths reflects the ageing of the rural population (Table 3).

The trend of population evolution in Tetoiu commune, Vâlcea county is a downward one according to the graph above. Although the data presented are data obtained from official sources, we may be raised to question their veracity or, in particular, how to update these data among rural localities, being an essential aspect in the proper management of the activities carried out by the local authorities, since without the most accurate record of the inhabitants , the necessary measures for the development of the locality cannot be taken (Figure 1).

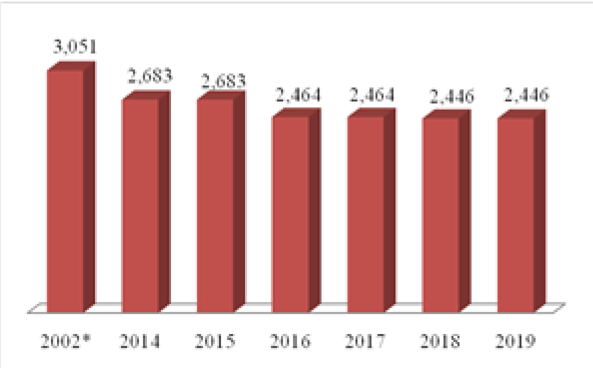

Fig. 1. Evolution of the number of inhabitants of Tetoiu commune, Vâlcea County (number)
Source: processed data, provided by The Tetoiu commune, Accessed on 30.07.2020.

Taking into account the number of newborns and deaths, as well as the population existing in the municipality of Tetoiu at the level of 2019, and the preservation of the current living conditions, the forecast of population evolution in this locality has been determined.
Thus, over the next 12 years, the population of Tetoiu commune will decrease by about 21%, reaching the number of inhabitants in 2030 to be 1929 (Figure 2).

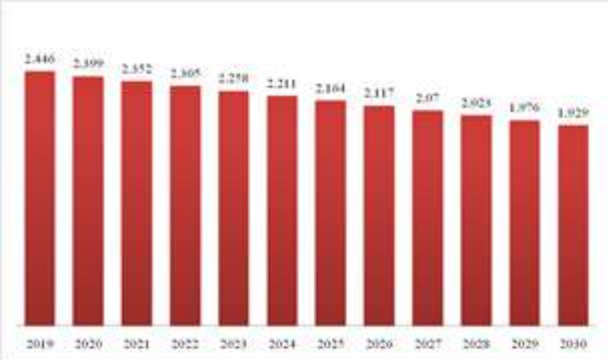

Fig. 2. Forecast of the evolution of the number of inhabitants of Tetoiu commune in Vâlcea County (number)
Source: processed data, provided by The Tetoiu commune, Accessed 30.07.2020.

The number of children enrolled in schools in Tetoiu commune in Vâlcea Country shows a downward trend, in 2014 245 children were enrolled, reaching 223 children in 2019 representing a decrease of about 9% (Figure 3).

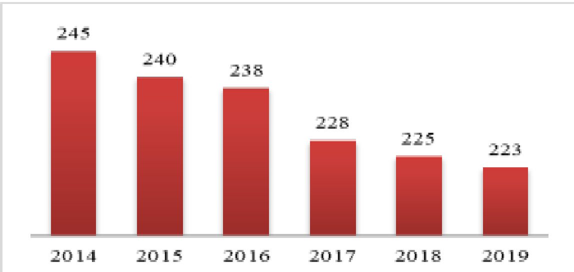

Fig. 3. Evolution of the number of children enrolled in schools in Tetoiu commune, Vâlcea county (number)
Source: processed data, provided by The Tetoiu commune, Accessed on 30.07.2020.

The number of people receiving social assistance in the municipality of Tetoiu shows a decrease in the period under review, 2014-2019. In 2014, the number of welfare recipients was 68, reaching 19 in 2019, representing a decrease of 72% (Table 4.).

Table 4. Situation in terms of social aid and jobs in Tetoiu commune (number)

Specification	2014	2015	2016	2017	2018	2019
Number of people receiving social assistance	68	60	45	32	20	19
Number of jobs	50	48	46	40	40	40

Source: processed data, provided by The Tetoiu commune, Accessed on 30.07.2020.

The number of jobs is also decreasing, in 2014 there were 50 jobs in Tetoiu commune, reaching 40 jobs in 2019 (Table 4).

However, it can be seen that if in the first 2 years analysed, the number of social workers was roughly equal to the number of people receiving jobs, in the last two years the number of social workers has halved by the number of jobs.

The decrease in the number of people receiving social assistance can be attributed to the fact that most of them were elderly people who died and, on the other hand, the measures taken government, which have more closely checked the granting of these aids, have contributed to the decrease in the number of such aid.

CONCLUSIONS

Tetoiu commune in Vâlcea county is facing a depopulation and a low birth rate, illustrating a population decline.

The population of the villages is mostly aged, the average number of retirees in the period 2014-2019 was 725 and the average population was 2,531 inhabitants.

The situation of newborns is not at all favorable, the average of the analyzed period was two newborns, and the number of children in schools is decreasing. School dropout is a major problem in rural areas, it occurs in disorganized families and low-income families, feeling a lack of interest in education and reduced opportunities to support children in school.

The situation of education in rural areas is a major problem, the lack of qualified teachers and interest in educating students both at school and personally is an obstacle in the preparation of future generations.

Cases where parents can not be an educational model for children are increasingly common in rural areas and is represented by divorced parents, aggressive behaviour and alcoholism.

Psycho-pedagogical counselling for teachers and students would be a major solution in case of school dropout. Individual or group counsellor, understanding and adapting the needs of each student, creates teacher-student relationships, but also student-student, thus helping social integration, and also understanding students' thinking about the school environment, teaching system and learning. In-depth knowledge of students and their families, creating a school-family relationship, can be a mandatory measure that helps to train students. By visiting the students at home, one can know the environment in which they live, the parents and thus understanding the family and financial situation.

Regarding the number of jobs in Tetoiu commune, there is a decrease in the period 2014-2019. In 2014, 50 jobs were registered, reaching 40 jobs in 2019, representing a decrease of 10%.

The rural environment is in an accelerated change, the migration of young people has become a worrying phenomenon being influenced by the lack of jobs both in Tetoiu commune and in Vâlcea County.

Young workers, skilled or unskilled, who have completed basic education, high school or university, migrate to cities or abroad. The low standard of living and the lack of jobs cause the rural environment to lose active labour. The idea of a secure job, which provides young people with income that covers their basic expenses and at the same time saves, is the main reason why they choose to leave their place of origin.

The lack of education of farmers on obtaining European funds and the benefits of practicing agriculture is another problem facing the rural environment. Obtaining non-reimbursable funds can be a real motivation to carry out activities in agriculture and can contribute to the economic development of the area, thus representing an opportunity that is not exploited to its true potential.

Accessing European funds for the modernization of the commune, ensuring the basic conditions, improving the infrastructure, modernizing buildings and monuments of historical importance, encouraging tourism can lead to socio-economic development and stopping the depopulation of the commune.

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ECOLOGICAL AND ECONOMIC ESTIMATION OF AGRICULTURAL LAND REPRODUCTION EFFICIENCY IN LVIV REGION

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Abstract

One has proposed to determine the ecological and economic efficiency of the process of land resources reproduction, depending on the yielding capacity of cereals and legumes on the humus stock in soils and the cost of their cultivation due to the use of index method and rating. One has calculated the project indicators of yielding capacity, production costs and minimum profit at 25 % for growing cereals and legumes for the administrative districts of Lviv region based on the range of changes in actual fertility due to humus stock, taking into account the qualitative characteristics. Considering the calculations, we have established that the highest yielding capacity of cereals and legumes at the level of 1.205 will be concentrated in Sokal district of Lviv region, which depends on humus content in soil at the level of 1.159 and the level of socially necessary costs of 1.038. The corresponding project values of the gross production of grain and leguminous crops growing for the researched administrative area are 408.71 million UAH concerning production costs of 286.73 million UAH, which provides a profit of 122 million UAH at 42.5 % of profitability, taking into account the predicted yielding capacity at the level of 45.3 c/ha.

Key words: *agricultural land reproduction, grain and legume yielding capacity, humus content, costs, profit*

INTRODUCTION

Ensuring and increasing cost-effectiveness of the process of land resources use and reproduction presupposes the rational application of ecological mechanisms of the preservation and reproduction of soil and agricultural landscape biological productivity, as the main fundamental of the formation and permanent support of the biological productive potential of crops.
In modern research S. Bohatyrchuk-Kryvko [1], V. Chudovska [2], M. Stupen [8] have different approaches to single out the components of agricultural land use efficiency. O. Dorosh [3], P. Sabluck [6], M. Khvesyk [4], M. Shchuryk [7] include the costs of implementing a set of environmentally-friendly measures of the agricultural system, indicators of the intensity and productivity of the agroecosystem per unit of cost, the orientation of reproduction of soil fertility to the indicators of ecological and economic efficiency. Schemes and methods for their definition are not given. Accordingly, we consider that one should specify the method of calculation and principles for determining the efficiency of land resources reproduction in
agriculture considering the yielding capacity of crops, the cost of their cultivation, depending on the content of humus in the soil.

MATERIALS AND METHODS

One has determined the dependence of the yielding capacity of cereals and legumes on the humus stock in soils and the cost of their production (formula 1). On its basis we have proposed to determine the necessary level of costs, using the index method and rating estimates.

$$\mathrm{PCh} = \frac{\mathrm{Yc}}{\mathrm{Hs} \times \mathrm{GYexp}} \quad (1)$$

where:
PCh – production costs on 1 hundredweight of humus, UAH/cwt;
Yc – yielding capacity of cereals and legumes, cwt/ha;
Hs – humus stock in soil, cwt/ha;

GY_{exp} – grain yield per 1 UAH of expenses, kg/UAH.

RESULTS AND DISCUSSIONS

Considered calculations of profit and loss from humus allow carrying out targeted management of soil fertility wear. Due to humus predicting, we establish optimal ratios, technical and technological standards for land resources use, designing a systematic increase in the yielding capacity of true fertility without reducing the initial potential for soil fertility. One has analyzed grain production by the parameters of humus stock in soils, yielding capacity and production costs per 1 hectare of crops and 1 hundredweight of humus in the regions of Lviv region to identify the level of socially necessary expenditures to support soil fertility as based on the example of grain and leguminous crops production (Table 1) [5].

Table 1. Ecological and economic indicators of efficiency of grain and leguminous crops production in the context of administrative districts of Lviv region for 2018.

District	Humus content		The yielding capacity of grains, cwt/ha	Production costs, UAH/ha	Grain yield per 1 cwt of humus, kg/cwt	Production costs per 1 cwt of humus, UAH/ha	Grain yield per 1 UAH of humus, kg/UAH	
	cwt/ha	%					1 ha	1 cwt
Brody	840	2.8	60.9	10,072.9	7.250	11.99	0.605	0.605
Busk	780	2.6	47.2	7,165.4	6.051	9.19	0.659	0.659
Horodok	780	2.6	40.6	6,232.1	5.205	7.99	0.651	0.651
Drohobych	810	2.7	45.9	4,331.1	5.667	5.35	1.060	1.060
Zhydachiv	780	2.6	49.1	11,395.1	6.295	14.61	0.431	0.431
Zhovkva	780	2.6	33.8	6,085.0	4.333	7.80	0.555	0.555
Zolochiv	1,050	3.5	57.0	11,495.2	5.429	10.95	0.496	0.496
Kamianka-Buzka	750	2.5	47.2	8,597.5	6.293	11.46	0.549	0.549
Mykolaiiv	720	2.4	40.8	6,147.0	5.667	8.54	0.664	0.664
Mostyska	660	2.2	47.3	6,897.3	7.167	10.45	0.686	0.686
Peremyshliany	660	2.2	43.8	6,958.5	6.636	10.54	0.629	0.629
Pustomyty	780	2.6	43.8	8,048.7	5.615	10.32	0.544	0.544
Radekhiv	1,080	3.6	51.3	7,952.5	4.750	7.36	0.645	0.645
Sambir	840	2.8	54.7	7,160.8	6.512	8.52	0.764	0.764
Sokal	600	2.0	45.3	6,553.1	7.550	10.92	0.691	0.691
Staryi Sambir	570	1.9	30.9	8,858.1	5.421	15.54	0.349	0.349
Stryi	660	2.2	46.9	6,326.3	7.106	9.59	0.741	0.741
Yavoriv	480	1.6	35.7	3,964.1	7.438	8.26	0.901	0.901
Lviv region	750	2.5	47.0	7891.3	6.267	10.52	0.596	0.596

Source: on the basis of data [5].

Table 2. Ecological and economic indicators of efficiency of cereals and legumes production in the context of administrative districts of Lviv region for 2018 on the basis of index method of estimation

District	Humus stock, cwt/ha	The yielding capacity of grains, cwt/ha	Grain yield per 1 cwt of humus, kg/cwt	Production costs per 1 cwt of humus, UAH/ha	Grain yield per 1 UAH of humus, kg/UAH	
					from 1 ha of sowing	from 1 ha of humus
Brody	1.12	1.296	1.157	1.140	1.015	1.015
Busk	1.04	1.004	0.966	0.874	1.106	1.106
Horodok	1.04	0.864	0.831	0.760	1.092	1.092
Drohobych	1.08	0.977	0.904	0.509	1.779	1.779
Zhydachiv	1.04	1.045	1.004	1.389	0.723	0.723
Zhovkva	1.04	0.719	0.691	0.741	0.931	0.931
Zolochiv	1.40	1.213	0.866	1.041	0.832	0.832
Kamianka-Buzka	1.00	1.004	1.004	1.089	0.921	0.921
Mykolaiiv	0.96	0.868	0.904	0.812	1.114	1.114
Mostyska	0.88	1.006	1.144	0.993	1.151	1.151
Peremyshliany	0.88	0.932	1.059	1.002	1.055	1.055
Pustomyty	1.04	0.932	0.896	0.981	0.913	0.913
Radekhiv	1.44	1.091	0.758	0.700	1.082	1.082
Sambir	1.12	1.164	1.039	0.810	1.282	1.282
Sokal	0.80	0.964	1.205	1.038	1.159	1.159
Staryi Sambir	0.76	0.657	0.865	1.477	0.586	0.586
Stryi	0.88	0.998	1.134	0.912	1.243	1.243
Yavoriv	0.64	0.760	1.187	0.785	1.512	1.512
Lviv region	1.00	1.00	1.00	1.00	1.00	1.00

Source: on the basis of data [5].

We have made the calculation of the corresponding indices in each administrative district (Table 2) due to formula (1), taking the investigated parameters from Table 1 as a unit in Lviv region.

It allows establishing the dependence of the level of costs per 1 cwt of humus and yields of cereals and legumes, acceptable for each of the regions of Lviv region considering the actual state of land fertility.

Thus, one has proposed methods of for determining the level of socially necessary costs and the minimum amount of profit by differentiation of soil quality as based on the application of formula (1) on the dependence of the yielding capacity indicators of cereals and legumes on humus stock in soils and financial investments in production.

Closer inspection of the obtained calculations in Table. 2 shows that the rate of grain yield per 1 hundredweight of humus is interdependent with the indicator of humus stock in soils and not related to the number of costs in agricultural production. Considering the index of potential fertility (humus stock in soils) for constant value and realizing the range of change of real fertility due to the yielding capacity of cereals and legumes for each district of Lviv region, one can calculate the corresponding project yielding capacity indicators. Using the project values of grain yield per 1 hundredweight of humus or 1 UAH of costs, we can calculate and substantiate the cost range per 1 hectare of sowing, which will ensure that the predicted yielding capacity values for each district of the region. According to the researches, the value of grain yield per 1 UAH of expenses is characteristic for each district of Lviv region in a certain interval considering soil quality, humus stock in them, degree of development of rural territories and arable land for the needs of the agrarian branch, the level of agriculture, observance technological discipline in agricultural production processes. Another significant aspect is that the production cost indices, which are based on the proposed approaches, firstly, per 1 hundredweight of humus or 1 hectare, and then the overall gross yielding capacity of cereals and legumes in the districts of Lviv region, are the foundation for calculating the value of profit due to the provided methodology (Table 3).

Table 3. Actual and project indicators of gross production, production costs and profit on the basis of differentiation of soil quality in the context of districts according to the actual content of humus and grain yield per 1 UAH of costs

Districts	Sowing areas, ha	Gross output, t	The yielding capacity, cwt/ha	Indices on gross yielding capacity of cereals and legumes							
				Gross products, mln. UAH		Production costs, mln. UAH		Profit/ Loss, mln. UAH		Profitability, %	
				actual	project	actual	project	actual	project	actual	project
Brody	20,615	125,169	60.9	134.09	314.61	207.65	252.13	-73.56	+62.5	-35.42	+24.8
Busk	17,762	83,791	47.2	87.84	219.78	127.27	161.68	-39.43	+58.1	-30.98	+35.9
Horodok	17,068	69,216	40.6	75.14	193.60	106.37	144.18	-31.23	+49.4	-29.36	+34.3
Drohobych	8,858	40,690	45.9	42.50	113.26	38.36	51.80	+4.14	+61.5	+10.80	+118.7
Zhydachiv	19,832	96,731	49.1	101.19	245.40	225.99	276.12	-124.81	-30.7	-55.23	-11.1
Zhovkva	18,867	63,567	33.8	68.00	171.20	114.81	149.52	-46.81	+21.7	-40.77	+14.5
Zolochiv	27,088	154,221	57.0	161.73	385.46	311.38	376.86	-149.65	+8.6	-48.06	+2.3
Kamianka-Buzka	17,225	80,974	47.2	85.53	213.14	148.09	188.23	-62.57	+24.9	-42.25	+13.2
Mykolaiiv	9,200	37,529	40.8	39.18	106.25	56.55	77.57	-17.37	+28.7	-30.72	+37.0
Mostyska	14,944	70,615	47.3	73.28	169.50	103.07	119.84	-29.79	+49.7	-28.90	+41.5
Peremyshliany	12,353	54,015	43.8	56.20	129.93	85.96	100.20	-29.76	+29.7	-34.62	+29.6
Pustomyty	14,691	63,662	43.8	66.63	175.72	118.24	156.64	-51.62	+19.1	-43.66	+12.2
Radekhiv	27,294	140,085	51.3	148.64	394.02	217.06	296.25	-68.42	+97.8	-31.52	+33.0
Sambir	12,846	69,931	54.7	73.87	182.80	91.99	116.00	-18.12	+66.8	-19.70	+57.6
Sokal	37,393	169,178	45.3	177.26	408.71	245.04	286.73	-67.78	+122.0	-27.66	+42.5
Staryi Sambir	6,215	19,009	30.9	20.31	46.14	55.05	64.12	-34.74	-18.0	-63.11	-28.1
Stryi	8,691	39,233	46.9	41.44	98.58	54.98	64.53	-13.54	+34.1	-24.63	+52.8
Yavoriv	11,027	39,320	35.7	41.70	90.96	43.71	48.96	-2.01	+42.0	-4.60	+85.8
Lviv region	303,679	1,421,892	47.0	1499.72	3659.06	2396.42	2931.36	-896.70	+727.7	-37.42	+25.0

Source: on the basis of data [2].

The level of minimum profit is 25 % of the average cost of production per 1 ton of cereals and legumes since profitability indicators at such a level will ensure minimal requests for simple reproduction. Setting the profitability level of more than 30 % is impractical because of the large gap in formulated profit, as, on one hand, they will receive excessively high rates of profitability on the best lands, on the others hand, they will not get any profit on the worse ones at all. Similarly, setting a profitability level below 25 % will not guarantee a profit on poor quality land at all.

CONCLUSIONS

In summary, one has proposed to calculate the production costs and the minimum amount of profit on the example of growing cereals and legumes in Lviv region considering the qualitative characteristics of soils and natural regional features.

At the same time, the increase of crop yielding capacity should be accompanied by the improvement of soil quality characteristics and environmental sustainability of agro-landscapes due to the consistent environmentalization of the production process, the increase in gross agricultural production, simultaneously with increasing the yielding capacity in terms of value and the reduction of production costs.

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AGRO-CLIMATIC SUBSTANTIATION OF GROWING AGRICULTURAL CROPS IN CROP ROTATION

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Abstract

The paper studied the methodical foundations of the organization of dynamic crop rotations in economic formations with narrow specialization of production in the article. Taking into account the suitability of agricultural production groups of soils for growing crops, one has developed agro-climatic substantiation of their location on the studied land plots of LLC "LUHY-2", located in the Forest-Steppe zone. It was proposed to develop and implement in the production of crop rotation for rapeseed cultivation on the territory of the studied farm to increase the gross yielding capacity. There were presented schemes of soil-protective crop rotations for different ecological and technological groups of lands of the Forest-Steppe zone, where the object of research is located, taking into account the suitability of land for growing crops, soil and climatic conditions and production specialization on the example of model economy.

Key words: *agro-climatic substantiation, agricultural crop cultivation, crop rotation, ecological suitability of lands*

INTRODUCTION

In modern agriculture, the role of crop rotation is growing due to the improvement of the processes of specialization and concentration of production. After all, increasing soil fertility is a necessary condition for the introduction of advanced agricultural technologies with the local soil and climatic resources rational use, means of intensification and crop rotation system [1]. It is because neither fertilizers nor irrigation and pesticides used in the cultivation of crops, provide an opportunity to get rid of weeds, pests, and diseases completely. Moreover, the better one uses fertilizers and irrigation on lands, the more favorable conditions are created for the development of weeds or diseases.

Yielding capacity reduction of plenty of crops concerning the absence of crop rotations are the result of unilateral soil nutrient application, accumulation of pests and pathogenic organisms, as well as various toxic substances – products of the plant life cycle and soil microorganisms. One can violate the determined requirements for the crop sequence in crop rotations or even permanent sowings because of the market situation of agricultural products, which dictates the production, primarily of "profitable" crops.

Having analyzed the above-mentioned information, one should pay attention to considerable research of D. Dobriak [2; 3], P. Kazmir [4], V. Kryvov [5], M. Stupen [9] concerning the organization of crop rotations in different economic formations with a narrow specialization of production in diverse areas of land use with short rotations.

MATERIALS AND METHODS

It was applied the method of more flexible crop rotations (dynamic) due to the dynamism of the production situation, which we observe nowadays, in the transition to diversified management forms, the annual search for a suitable structure of sown areas, the need to increase land use with less energy consumption [4]. Their major agronomic value is the correct consistency of crop sequence in each field. Concerning such a sequence, each crop, located in the best conditions for growth and development, has a beneficial effect on the growing conditions of the next crop and thus helps to increase crop productivity. The proper sequence is multivariate. Therefore, crop rotation has a dynamic character with the prospect of applying the best techniques of agricultural technology, the implementation of new varieties and crops, as well as changes, if necessary, the previously adopted order of crop sequence, the area they occupy. This is due to the dynamic economic situation, weather conditions, and so on.

According to the method, it was adapted the dynamic crop rotation to the prevailing conditions, in particular economic ones, which allows taking into account the soil and climatic, biological conditions of each land plot. Simultaneously, it does not contradict the principles of building agro-technically correct crop rotation with scientifically sound and consistent crop sequence over the years. However, according to the method, there is no single correct sequence of crop rotation. There is a very wide range of good, medium, and bad (unacceptable) precursors for each culture [2]. Therefore, it is possible to provide agro-technically correct schemes of crop sequence on each ecologically homogeneous field, which is formed at the introduction of a dynamic crop rotation system.

This is the basis of the second methodological approach in the organization of crop rotations, in which one considers the field unit as its initial unit, which is formed taking into account constant factors, in particular the conditions of the territory, the requirements of cultivation technology and soil protection. The number and area of fields do not depend on the structure of sown areas and the period of crop rotation but on natural and territorial conditions.

RESULTS AND DISCUSSIONS

We have applied the method of organizing dynamic crop rotations on the example of land plots in LLC “LUHY-2”. Taking into consideration the suitability of agricultural groups of soils in the crop cultivation, one has developed agro-climatic substantiation of their location on the studied land plots.

In Table 1, there were provided detailed proposals for the development of dynamic crop rotations [5].

Table 1. Recommendations for the introduction of dynamic crop rotations for the object of study

Area, ha	Suitability class	Crop rotation system
1.2557	I	Field crop rotation
1.2557		
0.7501		
0.2130	II	Field crop rotation
0.2390		
0.1718		
0.1635	III	Soil-protective crop rotation: Grass and grain
1.2601	IV	I version - soil-protective crop rotation, three-course rotation II version – prairie restoration
0.7859		

Source: it is done by the author on the basis of data [5].

The specialization of LLC “LUHY-2” is crop production, where a small list of crops, including rapeseed, barley, wheat, and soybeans is set up. Appropriate crops are sufficient to introduce field crop rotations, but not to protect soils from disposal and erosion, which requires the sowing of perennial grasses.

The current market is in demand for the sale of oilseeds, where rapeseed occupies one of the first places in this group. Ukrainian agro-climatic resources fully meet the biological needs of rapeseed, and therefore its productivity is quite stable. At the same time, one maintains an interest in rapeseed at a high level due to good liquidity of products and low level of production costs, which today average is 520–560 UAH/ha [6], which is significantly less than for other crops. The consequence was an expansion of sown areas, an increase in gross rapeseed yielding capacity. However, its yielding capacity remains low and is 14 kg/ha. This is a rather modest achievement, considering that in Western Europe the average yielding capacity exceeds 30 hundredweight per hectare [10]. The reason for this situation is primarily the imperfection of technology and the imbalance of rapeseed in the structure of sown areas.

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In recent years, a lot of researchers have improved the technology of rapeseed cultivation, and one should note that this work has been effective [2; 3]. In particular, the one has studied existing varietal hybrid composition as well as worked out the system of tillage, fertilizers, and elements of the sowing complex, features of crop care, and plant protection. Even experts in the technology of storage and processing of rapeseed products have not ignored it. Nevertheless, rapeseed production has not become stable, as it is sporadic and random [8].

It is advisable to develop and implement new crop rotations with rapeseed on the territory of the studied farm to achieve certain stability. Due to modern conditions, the average area of agricultural enterprises has mostly decreased, so we recommend introducing crop rotation with a short rotation of 3-5 years. Analyzing the work of the most profitable farms in Lviv region, we concluded that we can recommend such crop rotations with winter oilseed rape, which is shown in Table 2 [7].

Table 2. Proposals of field crop rotations with winter rapeseed for the studied farm

The number of fields in crop rotation	Crop sequence		
	The Ist suitability class		The IInd suitability class
3	Pea	Winter barley	
	Winter rape	Winter rape	
	Winter wheat	Winter wheat	
4	Soybean	Winter wheat mixture	Perennial grasses
	Winter barley	Winter wheat	Winter cereals
	Winter rape	Winter barley	Soybean
	Winter wheat	Winter rape	Spring cereals with sowing of perennial grasses
5	Black fallow	Pea, soybean	Meadow clover
	Winter wheat	Winter wheat	Winter wheat + post-harvest sowing
	Pea, soybean	Winter barley	Pea, soybean
	Winter rape	Winter rape	Barley + winter crops between crop
	Winter wheat	Winter wheat	Annual grasses with sowing of annual ryegrass and meadow clover

Source: it is done by the author on the basis of data [5].

We propose to focus on growing the most common crops today, which are the foundation of an agrarian business. In all cases, in crop rotation, winter rape is either after pea (soybeans) or after winter barley. Both crops are harvested early, so there is a possibility of high-quality soil preparation.

It is clear that pea (soybean) for winter rape is the best precursor, but not all growers have it in the structure of their sown areas.

Its presence in crop rotations significantly improves the composition of precursors and increases protein output.

Table 3 shows the schemes of soil-protective crop rotations for different ecological and technological groups of lands in the Forest-Steppe zone, where the object of study is located.

Table 3. Schemes of soil-protective grain-grass crop rotations for the second (slopes 3-5°) ecological-technological group (III class of suitability) of the lands of the Forest-Steppe zone (I version).

The IInd suitability class	
Alfalfa	Еспарцет
Alfalfa	Winter wheat
Пшениця озима	Pea (soybean), гречка
Pea (soybean), гречка	Winter wheat
Winter cereals for green fodder + summer sowing of slafalfa	Oats, barley with sowing of sainfoin
The IInd suitability class	
Alfalfa	Sainfoin
Alfalfa	Winter wheat
Winter wheat	Barley and pea mixture for fodder
Winter wheat	Winter wheat
Pea (soybean)	Oats, barley with sowing of sainfoin
Oats, barley with sowing of alfalfa	

Source: it is done by the author on the basis of data [5].

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Table 4. Schemes of soil-protective grain-grass crop rotations for the second (slopes 3-5˚) ecological and technological group (III class of suitability) of the lands of the Forest-Steppe zone (II version).

The IInd suitability class	
Alfalfa or clover	Alfalfa + cereals, буркун + cereals
Alfalfa or clover	Alfalfa + cereals
Alfalfa or clover	Alfalfa + cereals
Oats, barley with sowing of grasses	Winter cereals for green fodder with summer sowing of alfalfa and cereals
The IIIrd suitability class	
Mixtures of perennial grasses	
Mixtures of perennial grasses	
Mixtures of perennial grasses	
Mixtures of perennial grasses	
Winter cereals for green fodder + summer sowing of perennial cereals or annual grasses with over complementary seeding of perennial grasses	

Source: it is done by the author on the basis of data [5].

In addition, one can withdraw the lands of the IIIrd ecological and technological group from cultivation and from the composition of arable land with the subsequent siltation, including natural one, or afforestation.

CONCLUSIONS

Insufficient amount of information and scientifically substantiated explanation of the reasons for the negative consequences of crop rotation, which leads not only to reduced yield capacity but also to the deterioration of agricultural products, caused the preparation of scientific proposals to justify the suitability of land for growing crops. It was taken into account the soil and climatic zone of Ukraine and specialization on the example of the model farm of LLC “LUHY-2”.

These developments will be useful for use in agricultural enterprises, which focus on the latest technologies for growing cereals, including winter wheat, corn, barley, and oilseeds (sunflower, soybeans, winter, and spring rapeseed), etc.

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RECIPROCATION OF SOCIO-ECONOMIC ATTRIBUTES OF THE RESOURCE-POOR RICE GROWERS: IMPLICATIONS FOR OUTREACH ORGANIZATIONS IN PAKISTAN

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Abstract

Pakistan is blessed with different seasons making it favorable for production of variety of crops, fruits and vegetables. Globally, it has a considerable share in crop production especially in quality rice and cotton production. It has been many years that country is experiencing decline in rice and cotton production due to natural and farmers associated factors. Therefore, the present study has been designed to identify damages caused by environmental degradation and what strategies have been used by farmers to cope these damages. Two well known districts having maximum rice and cotton growers were selected as a study population. The respondents of the research were limited to 120 (60 from each district) due to unavailability of sufficient funds. Interview and Focus Group Discussion were used for data collection from the selected respondents. The collected data were then analyzed using Statistical Package for Social Sciences (SPSS). Findings indicate that majority of the farmers were lacking information in appropriate seed selection followed by maintenance of plant populations of selected crops. Meanwhile, a positive relationship was found among farming experience and annual income of the respondents.

Key words: *reciprocation, socio-economic attributes, resource-poor, rice growers, implications,*

INTRODUCTION

Rice is the largest staple food as well as the most cultivated cereal after wheat in the world. Two-thirds of global impoverished population lives in Asia and intakes 80% of the daily calories from rice [6]. It provides 21 and 15% of global human per capita energy and protein, respectively. In addition to dietary energy (1,527 KJ/100g) and protein (7.9 g/100g), it is a rich source of minerals (K, Ca, P, Fe, Zn), amino acids and vitamins (thiamine, riboflavin, niacin) which protect the human being against neural sickness and ensures healthy growth during pregnancy and childhood. It is very useful against anemic diseases due to its iron contents (1.5mg/100g) [15, 16].

Pakistan is the 4th largest rice producer followed by China, India and Indonesia. Rice is the country's 2nd agricultural export commodity after cotton. The country earns about 13% annual foreign exchange. Pakistan's share in world rice trade is 10 and 25% in trade of the Basmati rice. Rice is grown over 10% of the total agricultural land in Kharif (summer) season while Basmati rice covers almost 52% of rice cultivated area in Pakistan. It adds 6.7% value in agricultural commodities and contributes 1.3-1.6% in economy of Pakistan. The rice industry absorbs 9% of the national labor force. It also shares on an average 2 billion national foreign exchange annually along-with bilateral trade with other countries [7]. According to Trade Development Authority of Pakistan (2016) [13] rice trade is the most significant bond among cultural, democratic, Islamic and continental ties behind the close relation of Saudi Arabia, United Arab Emirates, Iran and Sri Lanka with Pakistan.

Pakistan produces almost 6 million tons of rice annually. It adds two million tons in national food requirements. There was 2.3

million hectare (1.05 Basmati, 0.58 IRRI, 0.66 others) area under rice cultivation and 5.5 million tons production (1.86 Basmati, 1.82 IRRI, 1.85 others) with 1.7 tons per hectare during 2013 which is 10% less than previous year [11]. The Punjab is the leading province in rice cultivation with 0.99 million hectare under rice crop and 3.4 million tons production annually. It is 58% of total national rice cultivation followed by 29, 13 and 10% by Sindh, Baluchistan and KPK respectively in the country. The contribution of the Punjab in production of Basmati rice is also very significant. Gujranwala is the predominant district out of Lahore, Sargodha, Multan, Bahawalpur districts of the province regarding rice cultivation and production. The crop is cultivated on an area of about 0.25 million hectares with a production of 0.55 million tons, which is the highest in the Punjab province [7, 3].

In the comity of developed nations outreach services like farmers' education reciprocate the demographic characteristics i.e. crop production, income etc. of smallholder farmers [10]. Ironically, in developing countries, like, Pakistan the farmers' education doesn't reciprocate like developed world [8]. The research question arises here is why the outreach services don't reciprocate in developing countries like Pakistan? Therefore, the study was planned to investigate reciprocation among socio-economic attributes of resource-poor rice growers and propose implications for outreach organizations. This study will explore the theoretical relationships of demographic attributes of smallholder rice growers. Practically this study will be very helpful for policy makers in designing a policy for outreach organizations.

Research objectives

Reciprocation of socio-economic attributes of the resource-poor rice growers: implications for outreach organizations.

The specific objectives were to:

(i)To find the correlation between Age and Education of resource-poor rice growers;

(ii)To examine the correlation between Education and Annual Income from Rice;

(iii)To determine the correlation between Age and Annual Income from Rice;

(iv)To explore the correlation between Farming Experience and Annual Income from Rice;

(v)To propose implications for outreach organizations.

MATERIALS AND METHODS

The model and research methodology

The aim of outreach services is to improve the socio-economic attributes of resource-poor farmers. Ultimately, the characteristics of farming community reciprocate by improving education and farming experience. Pakistan is an agrarian country with almost 80% smallholder farmers [1]. These are small landholders with farm sizes averaging 2 hectares (5 acres) or less [14]. Therefore, Pakistan can't develop without strengthening the community. So, after independence of Pakistan since 1947, various programs i.e. Village-AID (1952-1958), Basic Democracy System (1960-1970), Integrated Rural Development Program (1970-1978), T&V System (1978-1998) etc. have been launched under public sector to update the resource-poor farming community with advance agricultural practices [12, 2]. The government included private organizations since 1980s to enhance the effectiveness of outreach services in the country. Unfortunately, the socio-economic condition of smallholder farmers has not been reciprocating to all of these public and private outreach services [9]. Therefore, it is urgent need to study why not socio-economic attributes are reciprocating?

Research Methodology

A survey research methodology was applied to conduct the study. The study was conducted in Gujranwala, Pakistan, the largest rice-producing district in the country. The population or sampling frame was made up of rice growers registered with the Department of Agriculture (Extension Unit) and the largest private extension unit, a pesticide company. The largest private unit in the district was Syngenta Agrochemicals. A sample size of 342 farmers was drawn out of 2,365 rice growers from the four tehsils of the

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district: Gujranwala, Wazirabad, Kamoky and Noshehra Virkan [4]. The respondents from each tehsil were selected on the basis of number of farmers in the tehsil. There was: 103 respondents selected from tehsil Gujranwala; 97 respondents from tehsil Kamoky; 83 respondents from tehsil Wazirabad; and 59 respondents from tehsil Noshehra Virkan. An interview schedule was prepared in English but ad-libbed in vernacular (Punjabi) to facilitate the respondents [5]. Its validity and reliability was checked through pre-testing. Data collection was carried out by the lead author through face-to-face interviews. Of 342,289 respondents were interviewed on their farms locally known as Deras while rest of them was at their homes or shops. Data analysis was done using the SPSS 24 (Statistical Package for Social Sciences).
This study was limited to responses of 342 smallholder rice growers of district Gujranwala. Although it cannot be generalized to whole country and even to whole province but it will help the agricultural policy makers in situation analysis to designing the farmers' education policy for outreach organizations.

RESULTS AND DISCUSSIONS

Correlation studies portray the association among variables by cross-tabulation and correlation coefficient. It was performed to find strength and direction of association between various socio-economic variables.

Correlation between Age and Education

To determine strength and direction of association between age and education of the respondents, Pearson correlation coefficient (R) test was performed. Age (independent variable) was taken on X axis and education (dependent variable) on Y axis. According to the results,(Correlation Coefficient (R) = -0.131; Coefficient of Determination (R^2) = 0.017) with increase in age the education level decreased.
This scattered diagram (Fig. 1) indicates that initially, with increase in age the education level was also increasing, and then education level decreases with increase in age. It was concluded there was moderate negative association between age and education of the respondents. A young farmer was more educated than old ones.

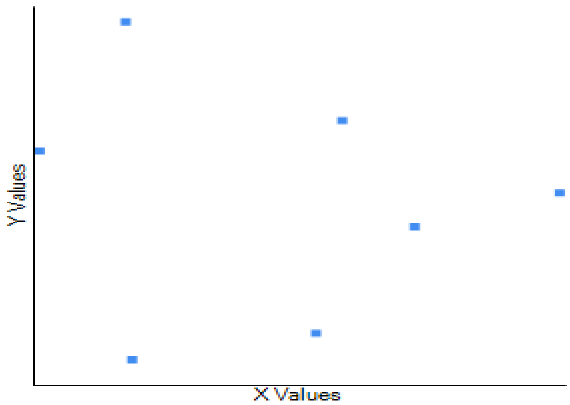

Fig 1. Correlation between Age and Education
Source: Primary Data.

Education and Annual Income from Rice

To find strength and direction of education effect on rice production in terms of annual income, a bivariate correlation test was performed between education and annual income from rice of the respondents. Education (independent variable) was taken on X axis and annual income from rice (dependent variable) on Y axis. The values (Correlation Coefficient (R) = 0.8079;

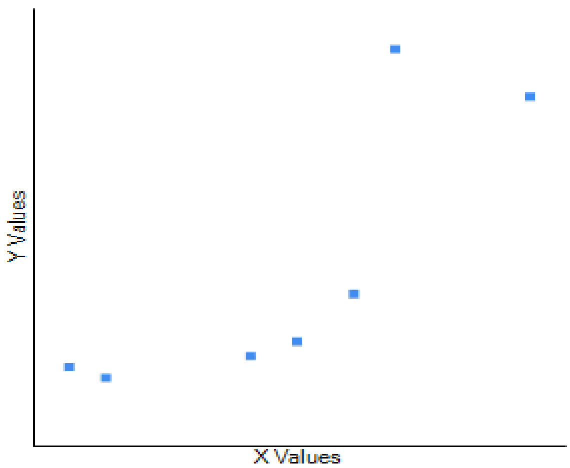

Fig 2. Correlation between Education and Annual Income from Rice
Source: Primary Data.

Coefficient of Determination (R^2) = 0.6527) indicate that there was strong positive relationship between education and annual income from rice. These values showed that with increase in education the annual income from rice also increased.

This scattered diagram (Fig. 2) portrayed that with increase in schooling years, the annual income was also ascended. It was concluded that education had strong positive effect on rice production. An educated farmer was more rich than uneducated.

Age and Annual Income from Rice

To measure strength and direction of age impact on rice production in terms of annual income, a bivariate Pearson correlation test was performed between age and annual income from rice. Age (independent variable) was taken on X axis and annual income from rice (dependent variable) on Y axis. The values (Correlation Coefficient (R) = 0.3567; Coefficient of Determination (R^2) = 0.1272) show that there was a weak positive relationship between age and annual income from rice. These values showed that initially with increase in age, the annual income from rice appeared to be increasing.

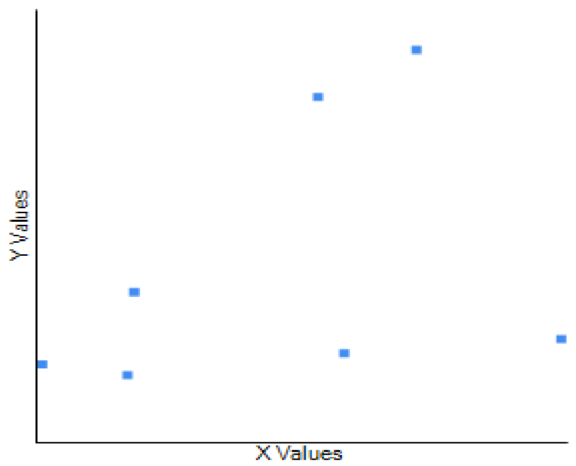

Fig 3. Correlation between Age and Annual Income from Rice
Source: Primary Data.

This scattered diagram (Fig. 3) described that initially with increase age, the annual income was also increasing but later on with increase in age, the income was decreasing. It was concluded that age had very weak impact on rice production. For example, an educated farmer could get more production (more income) than uneducated.

Farming Experience and Annual Income from Rice

To measure strength and direction of farming experience effect on rice production in terms of annual income, a bivariate Pearson correlation test was performed between age and annual income from rice of the respondents. Farming experience was taken on X axis and annual income from rice on Y axis. The results (Correlation Coefficient (R) = 0.4987; Coefficient of Determination (R^2) = 0.2784) reveal that there was a weak positive relationship between farming experience and annual income. These values showed that with increase in farming experience, there was very little increase in annual income from rice.

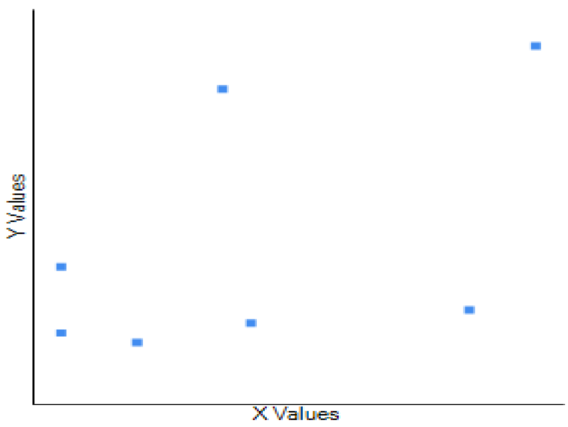

Fig 4. Correlation between Farming Experience and Annual Income from Rice
Source: Primary Data.

This scattered diagram (Fig. 4) described that initially with increase farming experience, there was no increase in annual income but later on with increase in farming experience, there was little increase in the income. It was concluded that farming experience had weak impact on rice production. For example, an experienced grower could get a little more production (more money) than un-experienced grower.

CONCLUSIONS

It is evident from the present study that there was moderate negative association between age and education of the respondents i.e. a young farmer was more educated than old ones. The education also had strong positive effect on rice production i.e. an educated farmer was more rich than uneducated. It was concluded that age had very weak impact on rice production. For example, an educated farmer could get more production (more income) than uneducated. It was concluded that farming experience had weak impact on rice production. For example, an experienced grower could get a little more production (more money) than un-experienced grower.

Implications for Outreach Organizations

On the basis of results, it is proposed that:

Outreach organizations should non-formally educate the young resource-poor farmers instead of just disseminating the information. As shown by the results of study, the young farmer were cultivating their ideas rather the information disseminated by the outreach organizations about rice production.

Outreach organization focuses education not only to enhance the knowledge level of growers but also improve the crop production in the country. It was also found that education has strong positive correlation with crop production.

Outreach organization should work hard with old farmers to encounter food-insecurity in Pakistan because study revealed that age has no impact on crop production.

Outreach organizations should equally treat resource-poor growers to improve agricultural contribution in gross domestic production (GDP) of the country because results revealed that farming experience have very weak impact on crop production.

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ECONOMIC SUSTAINABILITY – A BASIC FACTOR FOR INCREASING THE QUALITY OF LIFE OF THE POPULATION

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Abstract

In this paper, the authors revealed the concepts of development and economic growth, economic sustainability and quality of life. The authors determined and analyzed in dynamics the period 2010-2018, the trend of changing indicators, development and economic growth at the macroeconomic level such as: the value of Gross Domestic Product (GDP), GDP per capita, and the dynamics of the average monthly nominal salary of an employee per economy, disposable incomes per person, their structure and socio-economic indicators that characterize the quality level of the age of the population in the Republic of Moldova. Although there are modest increases in the number of nominated indicators, the authors consider that there are still a number of issues that need to be addressed, solved and complied with EU and other international standards. The research contains data that will surely be of interest to those concerned with the quality of life of the population. In essence, research in the field of quality of life aims at creating a complex image of quality of life, by analyzing different components of population's life. The following research procedures and methods have been applied in the research process: observation method, comparison, graphical method, table method, chronological series method, etc.

Key words: *economic development, economic sustainability, economic growth, quality of life, disposable income.*

INTRODUCTION

From an economic, social and environmental point of view, sustainable development deals with the concept of quality of life as a whole. The notion of sustainable or durable development is studied during the research process in the same context or with some deviations.
The concept of sustainable development has been promoted in the United Nations forums since 1986, which have set up the Committee on Environment and Development, with reference to:
•balanced and equitable economic development;
• coherent, transparent policies;
• at the level of social cohesion and inclusion;
• responsibility for the rational use of natural resources and protection of the environment;
• ensuring food security;
• international cooperation to promote sustainable development at the global level, etc.

Economic sustainability represents an agreed concept, as well as economic activity, ensures financial and operational stability and contributes to the social development of the team, given the dynamic development of both, external and internal environment.
Economic development is a concept that characterizes direct or indirect economic effects at the level of the national economy, or of a sector as a result of the quantitative, qualitative and structural transformation that exists in economic activity, at macroeconomic or microeconomic level, under the influence of dynamic factors.
According to A. Smith, the sources of economic growth are: increase of labour force and capital stock, increase of the efficiency with which capital is used due to the division of labour and technological process; foreign trade that expands the market and establishes the other two sources of economic growth [5].
In our opinion, economic growth in the sectors of the national economy is necessary to be

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supported by state and private investments, including foreign investments, as well as the implementation of the achievements of modern science and technology.

We further support the vision that “economic growth is a long-term process of increasing the production activity in quantity and quality aspects and maximizing their results, through the efficient capitalization of intensive factors and boosting investment processes with the condition to maintain ecological balance” [8].

MATERIALS AND METHODS

The research has been focused on studying the materials of authors from the country and abroad concerned with the field of economic development and growth, economic sustainability and quality of life of the population. The materials of the National Development Strategy “Moldova 2020” and the Draft Law for the approval of the NDS “Moldova 2030” have been used.

The methods of observation, comparison, tables and graphs, the method of time series have been used in the research. The analysis was performed based on the data of the Statistical Yearbook of the NBS from the Republic of Moldova and electronic resources. To determine the average rate of increase (decrease) in the time series was used geometric mean formula $\overline{R}_c$

In the paper were calculated and analyzed some basic indicators that characterize the level of quality of life of the population as: the average monthly nominal salary of an employee, the average size of the established monthly pension, minimum monthly average per person.

Exchange rate for one US dollar set by the NBM: 2017-18.49 lei; for 2018-16,802 lei

RESULTS AND DISCUSSIONS

By approving the Law no. 166 of 11.07.2012 of the National Development Strategy "Moldova 2020", the purpose was to change the paradigm of economic development based on consumption fuelled by remittances in favor of a dynamic model based on attracting investment, and on the development of industries exporting goods in services.

Unlike previous national development strategies, the general objective of the NDS "Moldova2020" was to ensure qualitative economic development and, implicitly, poverty reduction [3].

By the Government Decision no. 1083 of 08.11.2018, the draft Law for the approval of the National Development Strategy “Moldova2030” was approved – a strategic reference document for all policy documents at national, regional and local level. The goal of NDS "Moldova 2030" is to increase the quality of life, based on four pillars of sustainable development, with 10 corresponding long-term objectives:

-sustainable and inclusive economy;
-human and robust capital;
-honest and efficient institutions;
-healthy environment [4].

NDS "Moldova 2030" indicates the direction of development of the country and society for the next decade, based on the principle of human life cycle, rights and quality of life.

For the national economy, the stability of the mentioned processes has an important significance given the fact that the activity of the basic branches, including agriculture, is the factor, which ensures a high-performance sustainability at macroeconomic level. Gross Domestic Product (GDP) represents the indicator of economic growth at the country level.

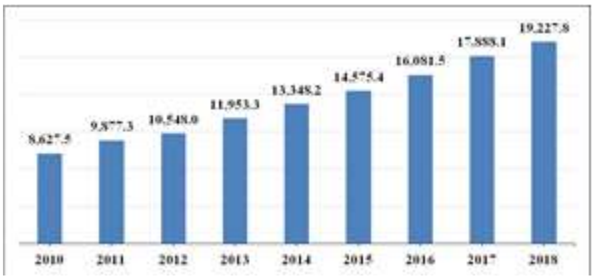

Fig. 1. Dynamics of the value of the Gross Domestic Product (GDP) in the Republic of Moldova in the period 2010-2018, million lei [7]

Source: Developed by authors based on the data of the NBS Statistical Yearbook of the Republic of Moldova, 2019, p. 246.

The data analysis (Fig.1) shows an essential GDP growth in 2018 compared to 2010 by 2.2 times, and in the dynamics of 2010-2018 (average growth rate determined using the geometric mean:

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$$\overline{R}_c = \sqrt[n-1]{\frac{N_n}{N_1}} = \sqrt[8]{\frac{192{,}278}{86{,}275}} = 1.105$$

indicates that the value of GDP has increased on average annually with 10.5%.

(N_n and N_1 - the last and first level of the series, n- number of years).

For the Republic of Moldova, this growth demonstrates a relaunch of economic stability and balance at the macroeconomic level.

It should be mentioned that the analysis of the GDP structure by resources shows that "other services" during the researched years account for 39-42%, trade services – 12-15%. Cumulatively, these two branches constituted 54.5% in 2018, followed by the industrial sector, which includes the extractive industry, processing and the energy sector, the share of which is 13-14%. Such a low level is explained by the limited capacity of the economy to produce marketable goods on the domestic and foreign markets.

Currently, about a third of the labour force is employed in the agricultural sector, but the share of its value in the GDP structure in 2018 was 10.3% which is equivalent to the share of 2012. This situation is explained by low levels of productivity of agricultural crops, such as: wheat, corn, vines, vegetables, technical and fodder crops, as well as the productivity of the livestock sector, which are the main factors influencing the decrease in labour productivity.

According to the basic scenario of the draft Law for the approval of the National Development Strategy "Moldova 2030" [4], the economy of the Republic of Moldova until 2030 will continue to grow at a more modest pace – annually by 3.5%. Due to the development of new branches in the machine building sector, the role of industry will increase, however, the food and beverage industry, which directly depends on raw materials in the agricultural sector will advance more slowly, as agriculture will likely suffer due to lack of necessary investments, qualified human capital and due to climate change, especially the impact of drought, as the average frequency of droughts is 1-2 episodes over a decade in the Northern region, 2-3 – in the Central region and 5-6 – in Southern region [4].

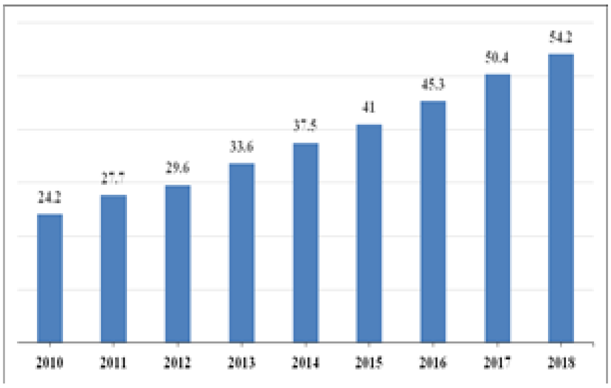

Fig. 2. GDP dynamics per capita in the Republic of Moldova, period 2010-2018, thousand lei
Source: NBS Statistical Yearbook of the Republic of Moldova, 2019, p. 233 [7].

The data (Fig. 2) show that the GDP per capita in the Republic of Moldova since 2010 has a significant growth trend from 24.2 thousand lei to 54.2 thousand lei or by 2.2 times. This situation has had a positive influence on the improvement of the basic socio-economic indicators of the population, but such a level and pace of economic growth is insufficient for the convergence of incomes to the standards of Central and Eastern European countries during the life of current generations [2].

Starting with 2020, the new methodology of the National System of Accounts, version 2010 will be used to calculate per capita incomes. The new methodology "raises" the country to a higher per capita income level, at the same time the reference base will be not the population of 3.5 million people, but 2.8 million people (according to the results of the 2014 census).

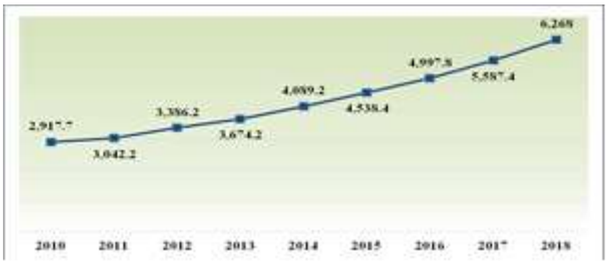

Fig. 3. Dynamics of the average monthly nominal salary of an employee by economy in the Republic of Moldova, in the period 2010-2018, lei
Source: Developed by authors based on the data of the NBS Statistical Yearbook of the Republic of Moldova, 2019, p. 91 [7].

As a result, the Republic of Moldova will promote the group of inferior-middle income countries and will enter the group of superior-middle income countries, according to the World Bank classification [2].

The data (Fig.3) show that the level of the average monthly salary of an employee on the economy in dynamics increased from 2,971.7 lei in 2010 to 6,268.0 lei in 2018, i.e. by 2.1 times. It should be mentioned that at higher rates the increase of the average salary of an employee in the economy is observed since 2014 and coincides with the year of GDP growth (Fig.1).

On average, during the researched period, the salary of an employee increased by 9.8% ($\overline{R}_c = 1.098$), but, on economic activities, the average is as follows: information and communications - 13.6 thousand lei; financial and insurance activities - 12.1 thousand lei; industry - 4.1 thousand lei; agriculture, forestry and fishing -4.2 thousand lei; education - 5.2 thousand lei; health and social assistance - 5.2 thousand lei, etc. At first glance, it seems that the increase in the average monthly nominal salary of a dynamic employee is a positive situation. The authors of this research consider that the salary level compared to the salaries of employees of other countries is lower. For example: in Estonia it accounts to 1,379 US dollars, Belgium - 4,127 US dollars, Romania - 819 US dollars, Hungary - 1,045 US dollars, Moldova - 302 US dollars and only Ukraine and Kazakhstan have less than 300 US dollars [7].

The main cause of this situation is a decrease in the efficiency of the labour market. The “labour market efficiency” indicator calculated by the World Economic Fund decreased in the period 2010-2017 from 4.4 to 3.5 points out of the 7 possible maximums.

In order to change the trend on the labour market, it is necessary not only to adjust the labour legislation, but also the policy to stimulate competition and reduce the shadow economy. Without efforts to stimulate investment in the Republic of Moldova, labour productivity and the value of wages will remain at the current level of only 20-23% of the corresponding averages of the Central and Eastern European member countries of the EU [2].

The data analysis (Fig.4) shows that in dynamics, the total disposable income per person has a change towards growth, for example in 2019 compared to 2014 it advanced with 4,576.4 lei, or by 66%, which is positively appreciated.

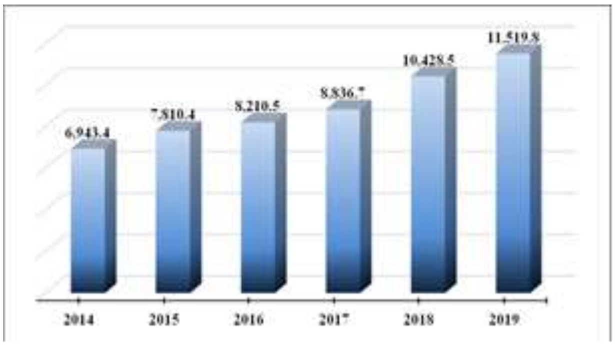

Fig. 4. Disposable income per person in the Republic of Moldova, lei

Source: The number of the population with habitual residence was used as the basis for estimating the indicators [6, 1].

Analysis of the structure of disposable income per person (Table 1) indicates that the income from salary activity has the highest share of over 40-50%, followed by social benefits 16-18% - and other incomes mainly composed of remittances, which are decreasing by 2019 with 7.34 p.p.

Table 1. Analysis of the types and structure of disposable income per person in the Republic of Moldova, period 2014-2019, lei

Types of income	2014	Share,%	2019	Share, %	Deviation2019 compared to 2014 (±) p.p.
Available income, lei	6,943.4	100	11,519.8	100	-
Inclusive:					
Salary activity	3,033.6	43.69	5,780.5	50.17	+6.48
Individual agricultural activity	663.4	9.55	1,023.5	8.88	-0.67
Individual non-agricultural activity	506.4	7.29	723.2	6.29	-1.00
Property income	6.9	0.1	34.4	0.29	+0.19
Social benefits	1,136.0	16.36	2,154.7	18.7	+2.34
Other incomes	1,597.1	23.01	1,803.5	15.67	-7.34

Source: Authors' calculations based on data from [6, 1].

In 2019, the incomes from the salary activity are increasing by 6.48 p.p. and social benefits (increase of pensions, child allowances, social assistance, etc., by 2.34 p.p.). These positive changes are due to the economic policy

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undertaken by the Government of the Republic of Moldova in recent years.

The data (Table 2) show that in dynamics, both, the nominal salary and the average size of the pension and the minimum monthly subsistence per person tend to increase, but the size of these indicators are of a lower level. It should be mentioned that the minimum average monthly subsistence per person increased from 1,373.1 lei to 1,891.0 lei, i.e. by 517 lei during 9 years.

The average size of the established monthly pension is lower, for example, in 2018 by 182 lei, or accounts for 90.4%, compared to the subsistence minimum.

Table 2. Some socio-economic indicators that characterize the level of quality of life of the population in the Republic of Moldova, in the period 2010-2018

Indicators	Year								
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
The average monthly nominal salary of an employee in the economy, lei	2,917.7	3,042.2	3,386.2	3,674.2	4,089.7	4,538.4	4,997.8	5,587.4	6,268.0
The average size of the established monthly pension (at the end of the year), lei	810.9	879	957.6	1,020.6	1,087.6	1,165.2	1,275.2	1,527.9	1,709.2
Subsistence minimum (monthly average per person), lei	1,373.4	1,503.0	1,507.5	1,612.3	1,627.1	1,734.1	1,799.2	1,862.4	1,891.0
In relation to the subsistence minimum, %: - average monthly nominal salary	216.4	202.4	224.6	227.9	251.4	261.7	277.8	300.0	331.5
- average size of the established monthly pension	59.0	58.2	63.5	63.3	66.8	67.2	70.9	82.0	90.4

Source: Calculated based on the data of the Statistical Yearbook of the Republic of Moldova, 2019, p. 91 [7].

We consider that it is strictly necessary that the bodies empowered to determine the minimum average monthly subsistence level for a person, already starting with 2020, to review this indicator taking into account the real data, the needs of the population for a decent living, the prices that are increasing and other important factors.

The poverty rate at the national threshold has decreased in the period 2010-2015, from 21.9% to 9.6%, reaching the final target for 2020. This progress must be treated with caution, due to the fact that the indicator measures only monetary poverty. Progress can be driven by a relatively low level of poverty and increased social benefits – sources that may be unsustainable in the long run, and which largely depend on: urban or rural residence of the population, age, gender, education, disability, etc. People in individual, small and medium households are exposed to the risk of poverty, where managerial functions and their composition are elderly, have an advanced share of retired elderly women and families with adult members with disabilities.

Among the measures to improve living conditions, the most frequently mentioned by the population is related to the financial aspect (increase of income, salary, pension, allowances, decrease of taxes and prices), increase of employment of the able-bodied persons, stop of corruption, compliance with applicable laws, improving the health care system and changing the mentality.

CONCLUSIONS

The analysis of GDP dynamics as the main indicator for assessing economic growth at the macroeconomic level, shows an increase from 2010 to 2018 from 86,275.0 million. lei up to 192,278 million lei, i.e. with 106,003 million lei.

The GDP per capita at the level of 54.2 thousand lei in 2018 is insufficient for the convergence of incomes (more than 4,000 USD) to the standards of the countries of Central and Eastern Europe. Our country is currently in the group of inferior-middle income countries according to the World Bank classification.

The increase in the average monthly nominal salary, in dynamics, of an employee by 9.8% is a positive situation, but the authors consider that the level and pace of growth compared to other countries is low. One of the basic causes is the diminution of the efficiency of the labour market. Without the effort to stimulate investments in the Republic of Moldova, labour productivity and the value of wages will remain at the current level of only 20-23% of the levels of the Central and Eastern European member countries of the EU.

The analysis of the structure of disposable income per person indicates that the income from the salary activity has the highest weight of 40-50%, followed by the social benefits – 16-18% and other incomes mainly composed of remittances. The increase of incomes is necessary to be done by boosting the accumulation of incomes from sustainable sources – the salary and the economic activity based on the achievements of the professional aspirations that will lead to the development of a robust economy.

In dynamics, both the nominal salary and the average size of the pension and the monthly subsistence minimum for a person tend to increase, but the level of these indicators, which characterize the quality of life of the population, have a low degree. Moreover, the average size of the established monthly pension is 59.0-90.4% in relation to the average monthly subsistence minimum per person. We consider that it is strictly necessary for the bodies empowered to determine the subsistence minimum, the monthly average per person, already starting with 2020, to review this indicator taking into account the real data, the needs of the population for a decent living, changes in food product prices and some industrial, communal, medical services, etc., which are growing.

Smart country development, increasing internal and external competitiveness, ensuring economic inclusion through equity of distribution and reducing economic inequalities, etc., are the basic factors of increasing income, reducing poverty, their risks and increasing the quality of life of the population.

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NON-CONVENTIONAL AGRICULTURAL LAND USE IS THE BASIC FOUNDATION FOR ITS CAPITALIZATION AND SOCIALIZATION IN RURAL AREAS

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Abstract

The article is devoted to the study of non-traditional agricultural land use, as the basis for rural development due to increased capitalization and socialization of land use. As a result, we analyzed the efficiency of agricultural land use in selected European countries and in Ukraine. A comparison of the added value created per area unit with the value of agricultural land is also presented, which noted that the capitalization and socialization of agricultural land use depends on the proportion of high-margin crops in the structure of crops production area. The authors present indicators of the effectiveness of the use of agricultural lands of Ukraine by agricultural enterprises, farms and households in monetary value. This allowed us to state that it is important for farmers and households to cultivate high margin crops, including niche ones. Since such crops, as a rule, are quite resource-intensive in cultivation and their production for large-scale farms is costly, and for small farms it is profitable, because it not only increases the profitability of land use, but also its value.

Key words: *non-conventional agricultural land use, added value, high margin crops, crop yield.*

INTRODUCTION

Increasing instability of land productivity, declining soil fertility on the planet with the growing demand for greening of the agricultural sector in accordance with new approaches to land use necessitate the change of the whole agricultural land use paradigm in rural areas.

It is known that in the countries of Eastern Europe for over 25 years, and in Ukraine over the last decade, more and more attention is paid to non-conventional farming, and in particular to organic farming. This comes in response not only to a concern for the state of the environment (in particular, improvement of the ecological stability coefficient of the land use) and profit of land users, but also by concern for people's health and improving global food security in general.

Today, when organizing agricultural land use, it is necessary to rely on fundamentally new innovative solutions that provide not only a mandatory increase in soil fertility, but also provide capitalization (increasing the value) of land use. Such measures come as a direct consequence of the scientific and technological progress in intensifying land use and serve as a solution to the efficiency of agricultural production in rural areas, the development of rural territories and, in general, to increase the national economy and human health.

A successful solution to the posed problems of greening and capitalization of land use, in our opinion, is possible only on the basis of a change in the old paradigm based on intensification of agricultural production with use of broad chemicalization for growing traditional crops, to a new land use paradigm of growing non- traditional, more profitable and environmentally friendly crops.

Today, society pays great attention to environmentally friendly and cost-effective land use. Moreover, each of the authors reveals the essence of this issue through the prism of such well-known concepts as «environmental land use planning» [1; 9; 15], «organic farming» [2; 7; 11; 17; 18; 27], «alternative system of agricultural production» [3; 6; 8], «biological farming» [5; 18; 25] etc. Thus, the aim of the study is to substantiate a new paradigm of land use with the cultivation of non-traditional more profitable and environmentally safe crops as a basic basis for the development of rural areas through the prism of capitalization and socialization.

MATERIALS AND METHODS

To reveal the importance of capitalization and socialization, an analysis of the growth of agricultural land use efficiency in some European countries was conducted. As well as the added values created per 1 hectare of agricultural land and the total value of arable land.

To calculate the monetary value of the indicators of the effectiveness of the use of agricultural lands of Ukraine by agricultural enterprises, farms, households, official statistical materials of the State Statistics of Ukraine were used and the share of these enterprises and farms by the area of agricultural land was presented.

The information and statistical base for the study are official materials and reports of FAOSTAT, the State Service of Ukraine for Geodesy, Cartography and Cadastre (State Geocadastre of Ukraine), the State Statistics Service of Ukraine (State Statistics Service of Ukraine), World Data Atlas data, and legislative documents of Ukraine.

In addition, the study materials were scientific foreign and domestic publications devoted to the subject of non-conventional agricultural land use in rural areas.

RESULTS AND DISCUSSIONS

In 2018, the number of people suffering from hunger every day exceeded 821 million, the number of people who are victims of moderate or high food danger is 2 billion [4]. That is, today the price of fertile land, state control over its use and independence from food imports has become the price of food security (and hence the price of life and death) for the population of many countries. Therefore, the issue of agricultural land use in countries is a matter of national security.

According to FAO Production, the planet's land fund is 13 billion 435 million hectares, of which 36.2% is agricultural land (4 billion 868 million hectares in 1994). Agricultural lands of Ukraine occupy most of the land - 68.8% (41 511.7 thousand ha), of which arable land (ploughland) - 78.4% or 54% of the country, while for Europe this figure is on average is 35%. Ukraine in terms of agricultural land is one of the largest countries in the world.

Studying the trends in the efficiency of agricultural land use in European countries and in Ukraine, it can be stated that they are similar to Ukrainian ones in terms of crop yield growth (Table 1).

It should be noted that as the data in Table 1 show, the presence in Ukraine of a moratorium on the purchase and sale of land shares did not have a significant impact on the efficiency of agricultural land use. In addition, according to some studies, Ukrainian agricultural enterprises and farmers use on average 4 times less fertilizer per 1 hectare of agricultural land than in EU countries [13].

Agricultural land use, based on the cultivation of grain and oilseeds and the avoiding of growing perennial crops, which bring greater profitability, does not allow increasing the value of these land plots, which is an indicator of land use capitalization, to the level of European countries. For example, in comparison with European countries, the share of high-margin crops in the overall structure of production is several times smaller in Ukraine (Fig. 1) [13].

Since high-margin crops, for the most part, are highly costly, a larger number of the rural population is involved in their cultivation, and the level of provision of the population with work is an indicator of the socialization of land use.

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Table 1. Characterization of growth trends in agricultural land use efficiency in Europe

Period	Average grain yield, c / ha								
	Bulgaria	Romania	Czech Republic	Poland	Slovakia	Hungary	Germany	France	Ukraine
2003			39.4	28.6	31.3	30.4	57.5		
2004			54.4	35.4	46.4	55.9	73.6		
2005			47.4	32.3	45.1	55.3	67.2		26.0
2006	35.7	31.0	41.6	26.0	39.7	51.0	64.9	68.0	24.1
2007	25.2	16.4	45.2	32.5	35.6	34.9	61.8	65.2	21.8
2008	41.0	32.5	53.6	32.2	51.8	58.0	71.2	72.5	34.6
2009	34.2	28.2	50.7	34.8	43.3	47.2	72.0	74.1	29.8
2010	40.2	33.3	47.0	33.9	37.4	47.2	67.2	70.7	26.9
2011	42.5	39.9	55.9	34.3	50.1	51.0	64.6	69.2	37.0
2012	36.7	23.6	45.3	37.1	38.3	37.6	69.6	72.6	31.2
2013	45.6	38.6	53.1	38.0	44.9	48.3	73.2	70.8	39.9
2014	48.6	40.7	62.2	42.7	60.4	59.0	80.5	75.6	43.7
2015	46.7	35.44	58.81	37.28	50.8	52.43	74.98	75.7	41.41
2016	48.2	39.71	63.17	40.34	64.3	64.87	71.82	56.87	46.52
2017	54.8	52.23	54.98	42.00	48.56	57.79	72.7	68.75	43.16

Source: generated by the authors using sources [6; 19; 20; 21; 28].

Accordingly, the level of capitalization and socialization of agricultural land use in Ukraine is much lower than in EU countries.

Comparison of added value created per area unit, which directly affects the value of agricultural land (Fig. 2) [16], for example, in Germany is almost 7 times higher than in Ukraine and in France - 6 times higher. Accordingly, the value of agricultural land in Ukraine is much lower than in France and Germany [16]. That is, the value of agricultural land is determined by the level of added value, which depends on the labour intensity and profitability of crops grown, rather than the purchase and sale of land shares.

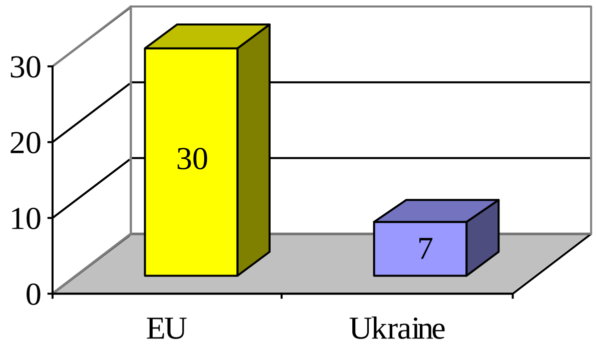

Fig. 1. Comparison of the share of high-margin crops in the structure of sown areas of Ukraine and EU countries, in %
Source: [13].

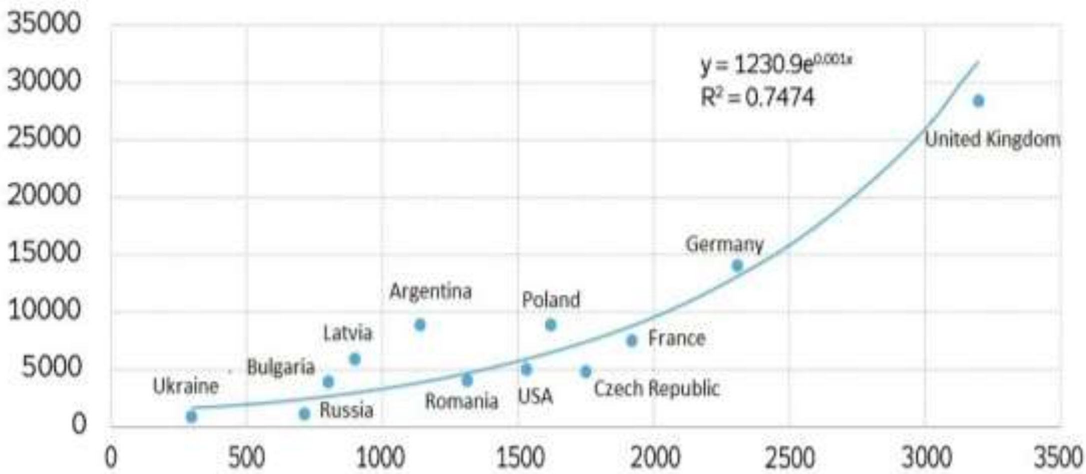

Fig. 2. Comparison of the added value created per 1 ha of agricultural land of agricultural land use value, in USA dollars.
Source: [16].

A comparison of the level of added value created per 1 ha of arable land with the value of this hectare shows that the price of Ukrainian agricultural land is almost justified (Fig. 3). At the same time, it should be noted that in official documents it is underestimated, as the data of the normative monetary valuation of lands are taken. In particular, we conducted studies of comparative productivity and value of agricultural land in Ukraine [23, p. 165] which show that their real value was 3744 US dollars, as of 2015.

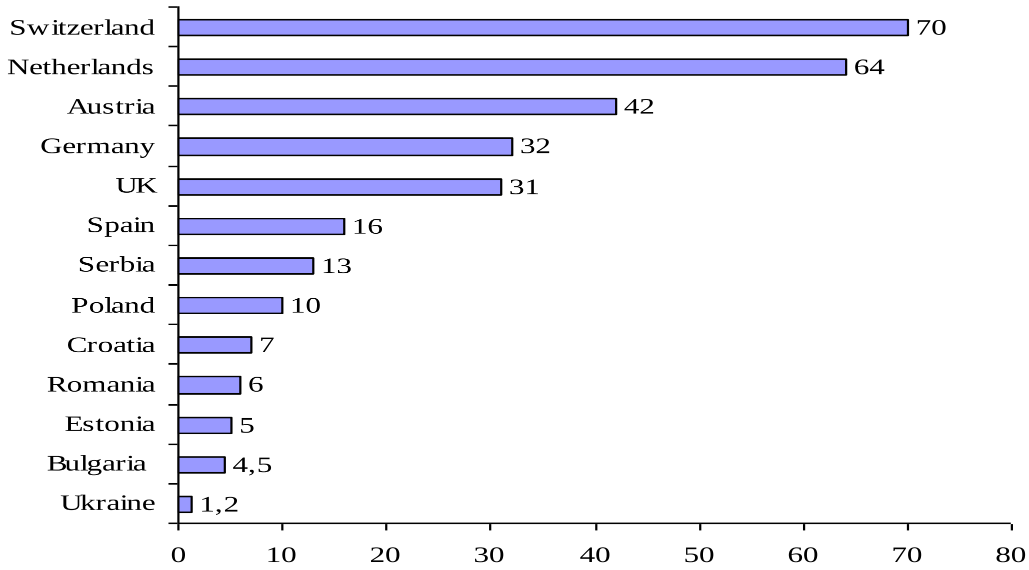

Fig. 3. The average value of arable lands in different countries, thousand US dollars.
Source: [22].

Summarizing the above, it can be stated that the capitalization and socialization of agricultural land use depends on the share of high-margin crops in the structure of sown areas.

Table 2. Dynamics of efficiency of agricultural land use by yield of main crops, c / ha

Crop	Year					Average value	± 2018 till 2000
	2000	2005	2010	2015	2018		
Agricultural enterprises							
Cereals and legumes	18.3	25.9	27.6	43.8	52.2	33.56	64.9
Sugar beet	171.0	255.4	281.5	448.2	518.8	334.98	67.0
Sunflower	11.8	12.8	15.4	23.0	24.1	17.42	51.0
Potato	109.1	147.8	171.0	198.6	252.0	175.7	56.7
Vegetables	88.3	154.5	207.0	363.4	427.4	248.12	79.3
Fruits and berries	10.9	16.0	38.2	70.8	106.2	48.42	89.7
Farms							
Cereals and legumes	15.8	22.0	21.9	33.4	41.1	26.84	61.6
Sugar beet	186.3	238.1	250.8	422.3	538.5	327.2	65.4
Sunflower	10.2	11.1	13.4	20.8	21.9	15.48	53.4
Potato	128.9	150.8	159.5	163.2	207.0	161.88	37.7
Vegetables	78.2	136.5	159.2	316.3	330.9	204.22	76.4
Fruits and berries	11.5	17.3	49.7	69.8	112.9	52.24	89.8
Households							
Cereals and legumes	26.9	26.4	25.0	33.9	34.4	29.32	21.8
Sugar beet	232.3	224.8	257.3	325.3	361.9	280.32	35.8
Sunflower	16.0	12.6	13.1	16.1	18.0	15.16	11.1
Potato	121.8	128.2	131.7	160.8	169.4	142.38	28.1
Vegetables	118.9	157.4	169.9	192.6	197.7	167.3	39.9
Fruits and berries	88.3	105.9	98.5	117.8	136.4	109.38	35.3

Source: [19; 20; 21].

In particular, the capitalization of land use depends on the profitability of crops grown, and socialization on the resulting added value. Consider the trends of efficient use of agricultural land in Ukraine by different forms of land use depending on the crops grown in the structure of sown areas, in particular the presence of high-margin crops in it (Table 2).
The data in Table 2 show that crop yields are growing both in agriculture as a whole and in all forms of land use.
However, in monetary terms, the most effective is the cultivation of sugar beets and vegetables for all forms of land use (Fig. 4-6).

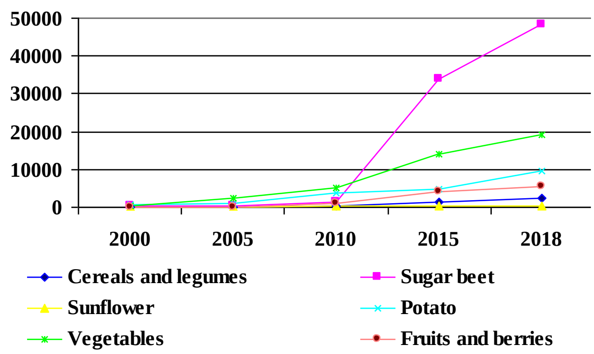

Fig. 4. Dynamics of indicators of efficiency of lands use by agricultural enterprises, thousand UAH / ha
Source: calculated according to the data of the State Statistics Service of Ukraine.

At the same time, it is necessary to pay attention to the prospect of growing fruits and berries, which are becoming increasingly popular in European countries.

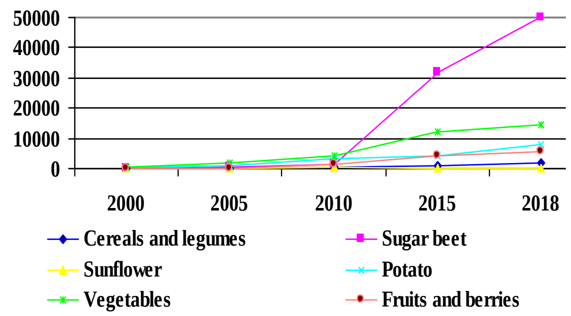

Fig. 5. Dynamics of indicators of land use efficiency by farms, thousand UAH / ha
Source: calculated according to the data of the State Statistics Service of Ukraine.

The cultivation of high-margin crops is especially important for farms and households in terms of creating jobs in rural areas for rural development.

After all, almost 56% of enterprises have a size of land in use of 10 to 500 hectares, of which more than 70% are farms (Table 3).

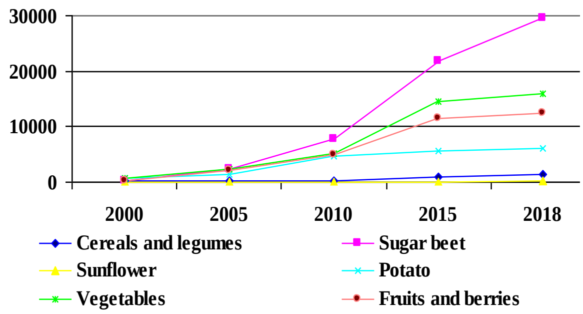

Fig. 6. Dynamics of indicators of efficiency of land use by households, thousand UAH / ha
Source: calculated according to the data of the State Statistics Service of Ukraine.

Thus, the indicator from a social point of view is the employment of the population, and from an economic point of view - the profitability of growing high-margin (incl. niche) crops.
At the same time, farms and households are the fastest to increase the capitalization and socialization of land use, respectively, and the market value of agricultural land.
In the market, niche crops are crops for which there is a situational or constant increased commercial or social demand, or products that cover a narrow segment of consumers [26].
For the conditions of Ukraine to niche crops we can include: flax, garlic, berries, and exotic or traditional but uncommon cereals (millet, sorghum, dinkel, rye, etc.), legumes, organic products.
An important feature of niche crops is that they are usually quite resource-intensive in cultivation (production) and their production in large farms is difficult, and at small farms is profitable.
In the world agri-food market the fastest growing niche crops are: kidney beans, peas, garlic, chickpeas, honey, asparagus (Table 4) [24].
Experts call tomatoes and grapes the most profitable crops, due to their widespread use in cooking. From 1 ha of vineyards one can earn $ 6,250, and from 1 ha of planted tomatoes - more than 14.0 thousand dollars. It is tomatoes and grapes that experts call the most profitable crops for farmers around the world [14]..

Table 3. The share of enterprises and farms in the area of agricultural land in 2018

	Number of enterprises		Area of agricultural land	
	units	percentage to total enterprises	thsd.ha	percentage to total area of agricultural land
Enterprises				
Enterprises, which had agricultural land including of land, ha	40,333	82.0	20,005.2	100.0
no more than 5.0	2,972	6.0	9.5	0.0
5.1 – 10.0	2,496	5.1	19.5	0.1
10.1 – 20.0	3,811	7.7	59.1	0.3
20.1 – 50.0	11,076	22.5	417.3	2.1
50.1 – 100.0	4,909	10.0	354.5	1.8
100.1 – 500.0	7,573	15.4	1,851.1	9.3
500.1 – 1,000.0	2,704	5.5	1,932.9	9.7
1,000.1 – 2,000.0	2,447	5.0	3,513.0	17.5
2,000.1 – 3,000.0	1,063	2.2	2,594.0	12.9
3,000.1 – 4,000.0	467	0.9	1,612.4	8.1
4,000.1 – 5,000.0	250	0.5	1,109.8	5.5
5,000.1 – 7,000.0	258	0.5	1,497.0	7.5
7,000.1 – 10,000.0	127	0.3	1,057.5	5.3
more than 10,000.0	180	0.4	3,977.6	19.9
Enterprises, which did not have agricultural land	8,875	18.0	x	x
of which private farms				
Farms which had agricultural land	30,441	91.8	4,707.2	100.0
including of land, ha				
no more than 1,0	147	0.4	0.1	0.0
1.1–3.0	1,195	3.6	2.7	0.1
3.1–5.0	1,430	4.3	6.1	0.1
5.1 – 10.0	2,301	6.9	18.1	0.4
10.1–20.0	3,498	10.6	54.4	1.2
20.1–50.0	10,432	31.5	394.8	8.3
50.1–100.0	4,160	12.6	298.4	6.3
100.1–500.0	5,111	15.4	1,193.3	25.4
500.1–1,000.0	1,216	3.7	855.6	18.2
1,000.1–2,000.0	670	2.0	925.1	19.7
2,000.1–3,000.0	167	0.5	406.9	8.6
3,000.1– 4,000.0	49	0.1	165.7	3.5
more than 4,000.0	65	0.2	386.0	8.2
Farms which did not have agricultural land	2723	8.2	x	x

Source: [21, p. 168].

Table 4. Trends in exports of niche agricultural products in the world, thousand tons

Crop	2000	2010	2016	± 2016 till 2000
Peas	3,384.7	4,481.4	6,264.8	185.1
Kidney beans	2,623.2	3,698.6	3,706.3	141.3
Oat	2,727.9	2,759.2	2,871.8	105.3
Chickpeas	753.1	1,188.1	2,395.2	318.0
Garlic	735.5	1,675.9	1,962.1	266.8
Sorghum	8,498.1	6,318.3	8,673.4	102.1
Rye	2,296.4	1,385.3	1,009.5	44.0
Honey	373.6	468.7	650.5	174.1
Asparagus	184.8	310.8	379.9	205.6
Millet	249.2	383.0	350.1	140.3
Mustard	265.6	249.1	267.1	100.6
Buckwheat	158.2	124.7	153.3	96.9

Source: [10].

Also, in recent years it has become very popular to grow raw materials (roots, leaves, flowers) of dandelion, one of the most common plants in our country.

The purchase price for dried dandelion flowers is 46 UAH / kg, dry leaves are estimated at 45-60 UAH / kg, and the most expensive was dried root: from 92 to 125 UAH / kg (Table 5) [12].

Thus, non-conventional agricultural land use is interpreted as a socio-economic category that exemplifies the relationship in the production of those crops which not only meet the needs of the population in food, but also provide jobs in rural areas, restore natural soil fertility, increase productive potential of land resources and the level of their environmental friendliness.

Table 5. The most profitable medicinal plants in Ukraine

Plant	Part of plant used	Purchase price, $ / kg
Rhodiola rosea (golden root)	Rhizome	180
Orchis maculata	Tubers	50
Astragálus dasyánthus	Root	45
Potentilla alba	Root	25
Milkweed	Root	20
Potentilla alba	Leaves	18
Centaurea cyanus	Flowers	17.5
Rosemary	Leaves	10

Source: [12].

In this case, non-conventional agricultural land use should be considered in a five-dimensional coordinate system:
- economic (economic needs of land and soil use, the nature of land use, market of products and land lease, location of production, infrastructure development);
- technological (level of agricultural land use, the main criterion of which is the capitalization and greening of land use);
- social (social institutions of land use and land tenure, in particular, land system, land ownership, economic structure, reduction of unemployment, social infrastructure);
- environmental (natural resource potential, agroecological features of soil use, ecological condition of land, environmental restrictions);
- investment (aggregate investment resources per agricultural land area).

The main factors of non-conventional agricultural land use: knowledge and rational use of the laws of nature; soil fertility recovery, improvement of agronomic and biological properties, mainly due to non-traditional understanding of crop rotation (because the saturation of crop structure with marginal crops requires a new understanding of crop rotation); application of all types of organic fertilizers, limited use of mineral fertilizers taking into account the optimization of plant nutrition; ecological system of plant protection, differentiated soil treatment system, taking into account the requirements of crops, soil and climatic conditions.

In addition, non-traditional agricultural land use contributes not only to increase the profitability of land use, but also its value, which, accordingly, leads to an increase in revenues from land tax to local budgets and job creation in rural areas.

CONCLUSIONS

Ukrainian rural regions have significant land potential for increasing non-conventional agricultural production. As a non-traditional agricultural land use is the basic basis for rural development through capitalization and socialization of land use, in Ukraine this area of organization of efficient use of agricultural land with state support can be developed by farms and households.. Since it is they who are typical in the Ukrainian realities of growing crops with high added value, and accordingly they can accelerate the process of capitalization and socialization of agricultural machinery and land use in rural areas. However, the development of non-traditional agricultural land use requires the application of a new paradigm for the formation of market-oriented levers to regulate land ownership relations in the production of high-margin, including niche crops. In addition, specially selected crops for existing and emerging, natural and climatic conditions which are based on following principles:

taking into account positive changes (preservation of land fertility, improvement of biodiversity conditions, ensuring ecological stability of land use); comparative efficiency of land use before and after changing the type (subtype) of land use, in particular, on specialization in the production of niche crops by socio-ecological and economic indicators (increase jobs, environmental stability and increase capitalization of land use);

evaluation of indicators over time with the aim of positive consequences in the systemic nature management.

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FACTORS AFFECTING THE TURKSIH FARMERS' DECISION TO QUIT FARMING

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Abstract

Agriculture contributes to Turkish economic development by manufacturing essential agricultural products, utilizing a huge portion of the population, trading of agricultural products, making intermediate goods for the other sectors. However, poverty along with deepening gap between input and output prices caused by Turkish agricultural policies implemented in the recent years has pushed farmers to quit farming. As a matter of fact, in 2017 5.4 million worked in agricultural sector, which were 7.7 million people in 2000. Therefore, object of this study was to investigate the factors affecting farmers' likelihood to quit agriculture. The data was collected by a questionnaire conducted in the selected districts of Izmir and totally 195 farmers are calculated as sample size. Logit regression model was used to determine the factors affecting quitting agriculture. The results show that agricultural subsidy, tenure, education and the size of the farm are the important factors for quitting decision. The question of who will make agricultural production in the future will be on the agenda as long as agriculture loses attractiveness for young people. The situation is no different in a country with a high young population country like Turkey. Hence, agriculture should be encouraged especially for young people with high education and entrepreneurship ability.

Key words: *exit intention, employment, choice models, rural development*

INTRODUCTION

In each country, agriculture has different conditions, but still contributes to the economies of countries. While the resources are gradually decreasing, supply of healthy and cheap food for the coming generations becomes more important. Therefore, whether it is a developed or a developing country, it is necessary for agriculture and agricultural enterprises to be sustainable. Despite this importance, farmers around the world are aging and young people move away from agriculture. The average age of farmers in Japan is 67 years and 58 years in the USA. More than one third of European farmers are older than 65. All OECD countries have ageing farmers [9].

The situation is similar also in Turkey. In 2000, 4.9 million people aged between 20 and 39 were employed in agriculture. This figure decreased to 3.4 million in 2010 and to 1.5 million in 2016. These figures show us that Turkish farmers are aging and that young people do not prefer to participate in agriculture. Over the last 20 years, rural areas of Turkey are reshaped by an unbroken loss of both farm and nonfarm rural residents. Between 1991 and 2001, a number of 890,173 active farms in Turkey exited from farming. As a result the average farm size raised to 6.1 hectares from 5.9 hectares [6].

After the year 2000, expanding divergence among input and output prices has added to the extending of poverty in rural of Turkey. This was joined by a decline in agricultural lands. Over the most recent 10 years, around 2 million hectares of agricultural land are dropped from cultivation. Likewise, the total agricultural land and plantation areas have diminished.

When examining the number of agricultural holdings, as per the outcomes of the 1980, 1991 and 2001 General Agricultural Census, there was an expansion of 25.6% in 1991 regarding 1980 and 8.3% expansion in 2001 contrasted with 1991. While there has dependably been an expansion in absolute number of agricultural holdings in the majority of the three censuses, the quantity of agricultural holdings occupied with agricultural activity has expanded by 19.1% from 1980 to 1991, and diminished by 9.6% from 1991 to 2001. As the quantity of agricultural holdings not occupied with farming is analyzed, it is seen that there has been an expansion of 86.7% from 1980 to 1991, and an increment of 117.5% from 1991 to 2001 [18]. The most noteworthy increment number of agricultural holdings occupied with farming in 1991 contrasted with 1980 was seen in the Mediterranean Region with rate 43.5% while the quantity of agricultural holdings drew in agriculture has diminished in all regions from 1991 to 2001. The most elevated amount of decline has been seen in the Aegean Region with rate 14.8% [18].

On the other hand, 413 thousand hectares land has been diversified from agricultural land to different usage types. Most of this land has been switched to constructional and tourism land. 30.10% of agricultural land changed to constructional and tourism land, 29.34% is unused, or undeveloped potentially productive land, 40.56% is other types [18].

Other than all these, structural problems in Turkish agriculture drive the farmers to stop cultivating. The movement of the youth from rural to urban territories additionally causes challenges in providing agricultural workers. As a result, the political decision makers decided in March 2016 to provide rural development grant support for young farmers in order to encourage them to continue their production in the countryside or to return to the village.

The changing structure of the rural area influences equity, profitability and efficiency of agriculture, and the welfare of rural. While numerous studies recommend that adjustments in profitability result from modifications made on individual farms, a great part of the change might be the outcome of the entry and leave process [3]. Hence, the entry and leave process keeps on being a factor in maintaining competitiveness, and in assigning resources between agriculture and the other sectors.

The basis of farm exit has been an issue of interest for researchers for quite a while. The majority of the contribution to the literature has originated from works done on the USA farms. The farmers who choose to stop cultivating look at the utility they get from cultivating versus they got from stopping. The majority of the studies done on this topic rest on this assumption. Transaction costs associated with this displacement (including relocation) are also an important determinant [5]. As long as the costs are lower, the propensity to quit farming will be higher. Most studies focus on a few variables, particularly on the off-farm employment [1], [2], [10], [5], [4]. There has been very little empirical work analyzing these problems, notably at the farm level [19], [5], [14], [7], [3], [15], [8], [11], [17].

Current studies address a number of factors that affect the farmer's ability to continue (or leave) agriculture mostly for developed countries. This leaves crucial gaps for developing countries. Therefore, this paper estimates the factors that have effects on farm exits using Turkish farm-level data. A logit regression model was applied to the data to analyze factors affecting farm exits decisions. Knowing which types of farms are more probably to exit may be helpful to policy makers about the consequences of exits on the exiting, the remaining farmers, and rural.

This paper is divided into four sections. Section II specifies how the data are treated for the purpose of implementing the farm exit model and a framework for analyzing probability of farm exit as a function of conditioning variables. Section III discusses the factors influencing farm exit and then provides results. Section IV concludes.

MATERIALS AND METHODS

This paper uses the data that were collected in a farm survey. The survey observed individual Turkish farms across ten districts of İzmir. The survey on which this analysis is relied on consists of 195 randomly selected farmers. The sample size was determined with the finite population proportional sample size method [12]. 7% standard error and 95% confidence interval was accepted. The questionnaire that was used for this study contained inquiries to capture farming activities, attitudes toward farm and non-farm activities, policy support and plans for future farming.

To examine the characteristics of farms leaving Turkish agriculture, the probability of farm exit is estimated as a function of affecting variables. The logit model is constructed for the empirical analysis. With farm exit being observed in pairs of adjacent years, a farmer is assumed to have a discrete choice at the end of each year – exit or stay- and this decision show up in the following year.

From this model, the log likelihood function for estimation is:

$$\ln L = \sum_{t=2}^{T} \{EXIT_{it-1,it} lnF(X_{it-1}\beta) + (1 - EXIT_{it-1,it}) ln[1 - F(X_{it-1}\beta)]\}$$

The marginal effect of a parameter on farm exit is denoted as,

$$\frac{\delta E(y|x)}{\delta_{x_k}} = F(\acute{\beta}x)[1 - F(\acute{\beta}x)]\beta_k$$

The variables used in the analysis are summarized in Table 1. The dependent variable EXIT reflects the response to the question, ‘‘Are you planning to continue farming in the future?’’ The variable was coded ‘‘1’’ if the respondent answered ‘‘No’’ and ‘‘0’’ otherwise. The independent variables (regressors) include farm size, farmer’s age, education, family size, and experience in farming, agricultural support, rent and credit, all of which are expected to affect exit decision, X_{it} (Table 1).

Table 1. Description of Variables

Variable	Description and Units
EXIT	1=plan to exit from farming, 0=otherwise
SIZE	Land, in decars
AGE	Age, in years
EDU	Education, in years
MEMB	Household members, count
EXP	Farmer’s experience in farming activity, years
SUB	1=having agricultural subsidy, otherwise=0
TENURE	1=being tenure, otherwise=0
CREDIT	1=having loan, otherwise=0

Source: Own calculations.

The farm size is measured by the variable SIZE. The variable SIZE reflects the total amount of arable land used by the farmer. The variable size is expected to have a negative effect on the likelihood of exiting from farming.

Farmers’ characteristics are represented by age (AGE), education (EDU), farming experience (EXP) and the number of family members working on the farm (MEMB). Farmers are more likely to quit farming as they approach retirement age. The variable EDU represents the availability of alternative employment options in the model. We consider that farmers with some education are progressively competitive in the off-farm employment and, are bound to get new skills required for alternative employment. In addition, it is expected to positively affect the likelihood to exit from farming. When the farmer is less experienced in agricultural activities, it is expected that farmer prefers not to stay in agricultural sector.

It is normal that farmers with a moderately high number of family members working on the farm prefer to continue farming. [13], [16], [4], and [3] proposed that the quantity of family members living or working on the farm essentially affects the succession of farm and subsequently the choice to stay or to exit from cultivating.

In the model, agricultural subsidy (SUB) represents the agricultural policy conditions for Turkey. The more subsidies farmers have, the less likely they are to leave farming. The variable TENURE reflects whether the farmer has owned or leased land. The variable was coded “1” if the farmer has leased land and “0” otherwise. Tenure is predicted to be positively affecting likelihood of leaving from cultivating. When the farmer has a bigger share of owned land, it is expected that farmer prefers to stay in the agricultural sector.

The variable CREDIT reflects whether the farmer use loans or not. The variable was coded “1” if the farmer has used loans and “0” otherwise. CREDIT is expected to have a positive effect on likelihood of exiting from farming because for farmers with larger loans, farm exit rates are higher.

RESULTS AND DISCUSSIONS

The logit model estimates a farmer's propensity to exit from farming on explanatory variables. This is accomplished by maximizing the log likelihood function, given in the equation (1). Table 2 shows the estimates of the logit regression. A negative value indicates that the factor reduces the likelihood for exit, whereas a positive value works within the other way.

Before referring to the results of the model, it is better to look at whether the model is statistically significant or not. The model is significant at the one percent, as indicated by LR chi-square statistics. Regarding the accuracy of the model, 154 out of 195 farmers were predicted properly, that is an accuracy of 79.0%.

The Chi^2 test of linear restriction was used to test for overall model fit. The null hypothesis is that the joint coefficients of the independent variables are equal to zero. The null hypothesis is rejected at 1% significance level. The results show that at least one of the independent variables is different from zero.

When the results of the model are examined, it is seen that four factors affect the probability of quitting farming. These are agricultural subsidies, tenancy status, education and the farm size. If the results of the model are considered, it is seen that the agricultural subsidies and the size of the farm decrease the possibility of quitting farming. However, education and having rented agricultural land increases the chances of leaving farming.

Obviously, the agricultural subsidy (SUB) negatively affects the likelihood of exit and is significant at 5% significance level. It is frequently discussed that high agricultural supports and agricultural product prices minimize structural change in agriculture because they lead to enlarged profitability. Therefore, discourage farmers from exiting [3]. Contrarily, [1] proposes that subsidy payments do not really influence changes in the number of farms and farmers' decisions. However, according to Table 2, farmers who have high agricultural supports are less likely to quit farming in Turkish agriculture. This result is compatible with [5] 's findings.

Table 2. Results of Logit Model

Dependent Variable: EXIT *(1) plan to exit from farming (0)otherwise*					
Independent Variable	**Coefficient**	**Standart Error**	**z**	**p- value**	**Mean of X**
Constant	-2.73	1.47	-1.85	**0.0637***	----
EXP	0.03	0.02	1.52	0.1285	25.06
SUB	-1.04	0.47	-2.21	**0.0269****	0.83
TENURE	0.99	0.40	2.45	**0.0143****	0.57
AGE	0.001	0.02	0.05	0.9570	49.22
EDU	0.15	0.08	1.79	**0.0731***	6.22
SIZE	-0.003	0.002	-1.67	**0.0947***	10.09
MEMB	-0.06	0.13	-0.46	0.6388	3.69
CREDIT	0.67	0.41	1.62	0.1047	0.65
Log-likelihood		-97.52097	**LR**		Chi-square(8) = 20.339 [0.0091]
McFadden R-squared		0.094433	**S.D. depended var**		0.428807
AIC		213.0419	**BIC**		242.4989
Number of cases correctly predicted		79.0%	**Linear restrictions**		chi^2(8) = 16.7265, p-value = 0.0330859

* Significance level 0.1; ** significance level 0.05; *** significance level 0.01.
Source: Own calculations

As the farmer owns more arable land, the likelihood of the farm exit reduces. We found similar result like [5]. Farm exit probability is lower for Turkish farmers whose owned land share is high. As expected, the variable TENURE has a positive effect on the likelihood of exit decision and is significant at 5% significance level. On the other hand, [3] stated that the farmers could establish an emotional link with their own lands and hence their willingness to quit farming could be low. In addition, the high proportion of owned land in the property will allow a farmer to reach the loans more easily and have a high credit capacity [3].

As indicated in Table 2 we found that the farm size (SIZE) is adversely related to the likelihood of farm exit. Farm exit probability is lower for larger farms rather than small farms. [10] recommended that farm size would positively help succession of farms because larger farms are more likely to support the farmer and his family with a modest and sustainable income. Therefore, opportunity costs of leaving farming for larger farms are higher.

Education variable positively and significantly affect the likelihood of exit from farming. This verifies the hypothesis that farmers with some education may easily enter to alternative employment options. This will make it easier for farmers with high levels of education to quit farming.

It is also important to measure the marginal effects as well as the direction of the factors that affect the likelihood of quitting farming. According to the obtained marginal effects, one unit increase in the agricultural subsidies and farm size will cause the likelihood of existing farming to decrease by 20.48% and 0.06% respectively. These variables affect farm exit decision in a decreasing way. The other two variables, namely tenure and education have positive effects on existing farming decision. One-unit increase in rented arable land and education increases the existing rate by 15.85% and 2.58%, respectively (Table 3).

Table 3. Marginal effects of the logit model

Variable	dy/dx	Std. Err.	Z	P>|z|	[95% C.I.]		Mean of X
EXP	.005742	.0037	1.53	0.127	-.00163	.01311	25.06
SUB*	-.204843	.1032	-1.98	0.047	-.40725	-.00243	0.83
TENURE*	.158470	.0604	2.62	0.009	.04000	.27693	0.57
AGE	.000229	.0042	0.05	0.957	-.00811	.00857	49.22
EDU*	.025810	.0142	1.81	0.071	-.00216	.05379	6.22
SIZE*	-.000633	.0003	-1.72	0.085	-.00135	.00009	100.90
MEMB	-.010622	.0226	-0.47	0.639	-.05498	.03374	3.69
CREDIT*	.105945	.0606	1.75	0.081	-.01291	.22480	0.65

* dy/dx is for discrete change of dummy variable from 0 to 1
Source: Own calculations.

Lastly, the results implied that the farm exit decision of the surveyed sample of Turkish farmers are influenced by the factors identified in the literature: agricultural subsidy, tenancy status, farm size and education level of farmers. The effect of farm size and education variables are less important compared to the agricultural subsidy and tenancy status variables. These two variables (agricultural subsidy and tenancy status) seems to be dominant factors for the Turkish farmers in deciding to leave or stay in agriculture sector.

CONCLUSIONS

Agriculture is a sector with low income and abundant labor. Therefore, the number of people who want to deal with farming in developed countries is decreasing. However, the food needs of people need to be met. In other words, agricultural production should be maintained. Therefore, the aim of this study is to determine the factors affecting the probability of quitting.

This study estimates the possibility of farm exits in Izmir province of Turkey and the factors affecting this decision. The factors identified as farm, family characteristics and agricultural subsidy policy. The results show that likelihood of farm exit is fully influenced by agricultural subsidy and tenancy status. The most important results is that an increase in agricultural subsidy significantly reduces the likelihood of farm exit by %20.48. In addition, we found the other two significant variables effecting the likelihood of farm exit are farm size and farmers education level. Small farms prefer to quit farming. Also farmers with high education level may easily quit farming due alternatives in employment.

According to the Agriculture and Forestry Ministry records, there is a serious decline in the number of farmers. The number of registered farmers decreased from 2.588 million in 2002 to 2.132 million in 2017. In the same period, the agricultural area cultivated by these farmers decreased from 164.96 million decares to 148.79 million decares. These reductions are the result of the agricultural policies incentives as well as the increasing gap between input and product prices. The structural problems of Turkish agriculture also have an effect on this decline.

The decline in agricultural areas and the withdrawal of thousands of farmers from agriculture are alarming for the future of the country's agriculture. Therefore the Turkish government is fostering a program targeting individuals, under age 40, to become farmers since 2016.

The changing structure of Turkish agriculture has important results for productivity and efficiency. The gradual decrease in the number of farmers will affect the redistribution of resources in the agricultural sector. The low level of welfare of farmers is also effective in likelihood of farm exit. Therefore, it is necessary to take the measures to increase the welfare of farmers living in rural areas.

In addition to the support given by the Young Farmer Project, which has been implemented since 2016, additional subsidies should be given to the creation of jobs in rural areas. Especially for younger farmers, targeted programs to educate them about alternative on-farm activities should be implemented. Policy-makers also should provide programs that help farmers to integrate into the new markets easily and to promote vertical integration.

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SUBSIDIES AS A FACTOR AFFECTING ECONOMIC PERFORMANCE OF FARMS IN THE SLOVAK REPUBLIC

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Abstract

The Common Agricultural Policy (CAP) is one of the most important policies of the European Union. It affects the economic performance of farms to a large extent. The objective of the paper was to analyse the relationship of subsidies and several economic indicators of Slovak farms. We have focused on the analysis of five economic indicators - total assets, revenues from the sale of own products and services, economic result, the number of employees and the volume of investments spent on the acquisition of tangible fixed assets. The Spearman's rank correlation coefficient was used to analyse the dependence between economic indicators and the amount of received subsidies. The results show that the level of all types of subsidies was in positive relation to the area of agricultural land and partly with a large majority of economic indicators expressed in absolute terms. When analysing intensity indicators, the situation was less clear.

Key words: *agricultural farms, subsidies, economic performance, Spearman's rank correlation coefficient*

INTRODUCTION

According to [12] "the Common Agricultural Policy of the EU is one of the oldest European policies. It is characterized by large and diversified groups of beneficiaries, diversity of objectives, multi-level decision-making and an important budget". The European Union's agricultural sector is currently highly subsidized. The EU Common Agricultural Policy, through various mechanisms, affects a wide range of societal issues, including agricultural production, as well as rural development, employment and environmental protection [3]. [10] states that „agricultural subsidies have been criticized for distorting agricultural markets and labour allocation in the economy by constraining or preventing structural change that is essential for economic growth and development. At the same time, proponents of agricultural subsidies have argued that such policies are crucial to support incomes of farmers and to sustain rural communities by creating jobs and preventing out-migration from rural areas".

Subsidy policy also affects the economic performance of farms to a large extent and is an essential factor that plays a significant role in making optimal decisions for farmers themselves [9]. Therefore, the CAP is a subject of interest to political leaders across the European Union [1].

Most subsidies in the first and partly also in the second pillar of the CAP aim to support the income situation in agricultural sector [5]. The impact of such subsidies on farmers' income and farm profitability is obvious and many farms would generate a loss without subsidies [6]. According to [8] "it is not only this indicator that the subsidy policy has a significant impact on. Subsidies also affect production volume, amount of costs and production efficiency." The study of CAP effects becomes an important issue for the development of future subsidy policy instruments [7].

Several authors have analysed the impact of subsidy policies on the economic performance of farms. [2] examined the impact of subsidies on profitability and the level of inputs / outputs of Russian dairy farms. The authors found that subsidies had a significant impact on the increase in farm profits, but on the other hand they caused distortions in the level of their costs and production. [11] analysed the effect of two types of subsidies - coupled to production and fully decoupled from production. The results showed that coupled payments had a significant impact on the use of inputs and the amount of production, while in case of decoupled payments these effects were negligible. Similar conclusions have also been reached by [4], when they found a negative impact of subsidies on the level of production of Swiss farms.

[15] examined the effect of subsidy payments on economic indicators of Czech livestock farms. The authors found that direct payments caused a decline in the economic performance of agricultural holdings, as subsidy recipients achieved lower output levels and incurred higher input volumes than agricultural holding which did not receive subsidies. Direct payments thus did not encourage farms to produce more and contributed to waste of resources. [14] analysed the effect of subsidy payments on three types of Czech farms in the period 2007-2012. They found that subsidies had a statistically significant effect on the profitability of conventional farms, but on the other hand they had a negative impact on sales. In the case of organic and biodynamic farms, the effect of subsidies on their economic situation was negligible. In Slovak republic [13] dealt with this topic, they revealed the existence of a strong correlation between the volume of gross agricultural production and the volume of agricultural subsidies paid in individual regions of Slovakia.

The aim of the paper is to analyse the relationship of subsidies and several economic indicators of Slovak farms.

MATERIALS AND METHODS

The data source was the Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic (IL MARD SR) for the year 2018.

In this year the database consisted of 1,576 legal entities. We have excluded firms with a different legal form than cooperatives and trading companies, so the final set consisted of 1,503 legal entities.

We put emphasis on the analysis of five economic indicators - total assets, revenues from the sale of own products and services, economic result, the number of employees and the volume of investments spent on the acquisition of tangible fixed assets. In addition to the analyses that we conducted on a sample of all legal entities together, we have also examined relationships in various subgroups of legal entities.

We have analysed the dependence between economic indicators of Slovak farms (in absolute and relative terms) and the amount of received support (total, non-investment and investment) using Spearman's rank correlation coefficient.

Its calculation is as follows:

$$\rho = 1 - \frac{6\sum d_j^2}{n(n^2-1)}$$

where dj represents the difference between the rank of values of the variables examined in the j observation and n is the number of observations.

The Spearman correlation coefficient can take values within <-1, 1>. The closer is its absolute value to 1, the stronger the relationship between variables is, and vice versa, the closer is the absolute value of the coefficient to 0, the weaker association between variables is. Positive coefficient values indicate positive, negative values indicate negative dependence.

The hypotheses verifying statistical significance of the Spearman coefficient are as follows:

- H_0: ρ=0
- H_1: $\rho \neq 0$

Whether the dependence between variables is statistically significant or not, was found by comparing the test statistics t with the table critical value of Student's distribution t_{tab} at the significance level α = 0.05 at the degree of freedom n-2.

$$t = \frac{\rho}{\sqrt{\frac{1-\rho}{n-2}}}$$

If t < t_{tab}, the null hypothesis was not rejected, the dependence between variables is not statistically significant. Vice versa, if t > t_{tab}, the hypothesis H_0 was rejected and the alternative hypothesis H_1 was accepted, the dependence is statistically significant.

We have also examined the differences in values of economic indicators between farms operating in production areas (Nitra and Trnava regions) and in areas with less-favoured natural conditions (Prešov and Žilina regions) using the non-parametric Wilcoxon-Mann-Whitney U test. It is a method that works with ranks of data in the so-called merged sample.

We had two independent samples from a cumulative distribution - X with observations $x_1, x_2, ..., x_{n1}$ and Y with observations $y_1, y_2, ..., y_{n2}$. The mathematical definition of hypotheses is as follows:

H_0: P(X>Y) = P(Y>X)
H_1: P(X>Y)≠P(Y>X)

The calculation of U test statistics was as follows:

$$U = \min U_i = R_i - \frac{n_i\,(n_i+1)}{2} \quad i = 1,2$$

where n_i is the number of observations of the i-th sample, R_i is the sum of ranks of the i-th sample, and Ui is the value of test statistics of the i-th sample.

During testing we calculated separately the value of U_1 for the first and the value of U_2 for the second sample. We have chosen min (U_1, U_2) as the test criterion U.

Then we compared the U value with the table critical value of the Wilcoxon-Mann-Whitney test for n_1 and n_2 at significance level $\alpha = 0.05$, U (α, n_1, n_2).

If the calculated value was less than or equal to the critical value, the null hypothesis was rejected, indicating a statistically significant effect of the investigated factor on the given variable. Otherwise, if the calculated value was greater than the table critical value, the null hypothesis was not rejected, the influence of external factor on examined variable could not be demonstrated.

In the case of Spearman correlation coefficient as well as Wilcoxon-Mann-Whitney test for validation of hypotheses, the SAS 9.3 statistical software, in which we performed the calculations, offers calculation of the so-called P-value. We compared its value to 0.05. If the P-value was greater than 0.05, the null hypothesis was not rejected. Vice versa, if the P-value is less than or equal to 0.05, we have accepted the alternative hypothesis.

RESULTS AND DISCUSSIONS

In the first part of our research we have focused on the relationship between total, non-investment and investment subsidies in relative terms (in relation to the number of hectares of agricultural land) and indicators of economic performance of Slovak farms.

In the case of legal entities, we can see a positive correlation between the area of agricultural land and the intensity of total, non-investment and investment subsidies, which means that with the increase in farm size the amount of subsidies received per hectare has also increased (Table 1).

This may have partly affected the fact that the intensity of all subsidies has positively correlated with almost all economic indicators. The only exceptions were the economic result of farms which did not depend on the intensity of total, non-investment or investment subsidies, added value that was positively related only to the intensity of investment subsidies, and revenue from the sale of own products and services which were demonstrably related only to the intensity of total and investment support. In the case of non-investment subsidies, the number of employees appears to be a significant factor related to their intensity per hectare, while in the case of investment payments it is the volume of assets and investments for its acquisition. Regarding the dependence of intensity values, the situation is more diverse. Non-investment subsidies were in the strongest positive relation with the number of employees. The intensity of assets, investments spent on its acquisition and equity also positively correlated with non-investment subsidies. On the other hand indicators with a significantly negative relationship to the intensity of non-investment support were revenues from sales of own products and added value of farms.

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Table 1. Correlation matrix of Spearman coefficients and corresponding P-values for economic indicators and received subsidies of Slovak farms

Variable	Unit	Total subsidies		Non-investment subsidies		Investment subsidies	
		€/ha		€/ha		€/ha	
		Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Agricultural land	ha	0.163	0.000	0.156	0.000	0.211	0.000
Assets	€	0.238	0.000	0.173	0.000	0.328	0.000
Equity	€	0.264	0.000	0.221	0.000	0.271	0.000
Liabilities	€	0.138	0.000	0.090	0,001	0.261	0.000
Total revenues	€	0.180	0.000	0.134	0.000	0.276	0.000
Sales of own products and services	€	0.096	0.000	0.039	0.133	0.276	0.000
Total costs	€	0.184	0.000	0.139	0.000	0.286	0.000
Economic result	€	-0.010	0.696	-0.033	0.196	0.046	0.072
Added value	€	0.039	0.135	-0.029	0.263	0.216	0.000
Number of employees	number	0.336	0.000	0.309	0.000	0.288	0.000
Acquisition of tangible fixed assets	€	0.255	0.000	0.149	0.000	0.393	0.000
Assets / ha	€/ha	0.151	0.000	0.065	0.012	0.241	0.000
Equity / ha	€/ha	0.226	0.000	0.183	0.000	0.191	0.000
Liabilities / ha	€/ha	0.036	0.159	-0.019	0.451	0.151	0.000
Total revenues / ha	€/ha	0.062	0.016	-0.007	0.794	0.191	0.000
Sales of own products and services / ha	€/ha	-0.050	0.052	-0.125	0.000	0.000	0.000
Total costs / ha	€/ha	0.066	0.010	-0.004	0.886	0.199	0.000
Economic result / ha	€/ha	-0.029	0.259	-0.047	0.068	-0.019	0.453
Added value / ha	€/ha	0.003	0.916	-0.075	0.004	0.182	0.000
Number of employees / 100 ha	n/100ha	0.331	0.000	0.301	0.000	0.185	0.000
Acquisition of tangible fixed assets / ha	€/ha	0.204	0.000	0.089	0.001	0.317	0.000

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

Investment subsidies had a positive correlation with the intensity of acquisition of tangible fixed assets, which is not due to their focus surprising. The volume of these supports was also in positive correlation with assets of farms, which can be explained by the fact that mainly farms with larger capital equipment used the Slovakia - Rural Development Programme. The only indicator not related to the amount of investment subsidies was the economic result.

The volume of total subsidies positively correlated with the number of employees, which was probably supported mainly by non-investment subsidies and with assets, equity and investments in the acquisition of tangible fixed assets, which in turn was more related to receiving investment payments.

We have also analysed relationships in separate subgroups of legal entities. The results are presented in Table 2 - Table 6 through Spearman correlation coefficient values.

Volume of assets and investments spend on its acquisition was demonstrably related to the intensity of investment subsidies in cooperatives and also in trading companies (Table 2). Moreover, the assets and investments of companies correlated positively with the intensity of both total and non-investment payments. Revenues from the sale of own products and services were in a positive relationship with the intensity of investment subsidies in both types of farms, but in cooperatives they showed a negative dependence on the intensity of total and non-investment payments.

Only the intensity of investment subsidies in trading companies was in a positive relationship with the economic result, in remaining cases the dependence was not proven. On the other hand, the number of employees correlated positively with the intensity of all subsidies in both types of farms.

Table 2. Correlation matrix of Spearman coefficients for economic indicators and received subsidies of Slovak farms classified by legal form

Variable	Unit	Cooperative farms			Trading companies		
		Total subsidies	Non-investment subsidies	Investment subsidies	Total subsidies	Non-investment subsidies	Investment subsidies
		€/ha	€/ha	€/ha	€/ha	€/ha	€/ha
Assets	€	0.064	-0.023	0.293	0.204	0.140	0.306
Sales of own products and services	€	-0.150	-0.230	0.223	0.068	0.012	0.252
Economic result	€	-0.029	-0.054	0.027	0.073	0.055	0.097
Number of employees	z	0.138	0.100	0.229	0.286	0.255	0.253
Acquisition of tangible fixed assets	€	0.085	-0.066	0.398	0.236	0.138	0.372
Assets / ha	€/ha	0.196	0.106	0.309	0.110	0.026	0.218
Sales of own products and services /	€/ha	-0.131	-0.207	0.206	-0.052	-0.126	0.153
Economic result / ha	€/ha	0.018	-0.005	0.033	0.036	0.021	0.012
Number of employees / 100 ha	n/100ha	0.406	0.402	0.160	0.251	0.214	0.161
Acquisition of tangible fixed assets /	€/ha	0.185	0.020	0.414	0.192	0.089	0.299

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

As regards the economic indicators in intensity form, the amount of assets and investments for its acquisition per hectare was in a demonstrable positive relation with the intensity of investment and thus also of the total support. Non-investment subsidies correlated positively with assets in the case of cooperatives and with investments in its acquisition in the case of trading companies. In both types of farms, sales per hectare were in a demonstrably negative relationship with non-investment and in a significantly positive relationship with investment payments per hectare. Conclusions for the other two indicators are also similar for both types of farms - as long as the economic result did not correlate with either type of payments, the number of employees was demonstrably positive with all.

Assets and investments for the acquisition of tangible fixed assets (both in absolute and intensive terms) in case of crop and livestock farms related mainly to investment and thus to total subsidies (Table 3). Positive dependence of these indicators with the intensity of non-investment subsidies has been demonstrated only in farms mainly focused on crop production. Sales of own products and services in absolute terms correlated positively with the intensity of all types of subsidies in crop farms and the intensity of investment subsidies in livestock farms.

In the case of sales per hectare, we found a positive correlation only with the intensity of investment support (both types of farms), which in the case of crop farms also resulted in a positive correlation with the intensity of total support. While the number of employees (in absolute and relative terms) was in a positive relationship with all types of subsidies in both types of farms, only the intensity of total support of farms focused on livestock production correlated with the amount of economic result (in absolute and intensity terms).

Furthermore, we divided farms according to the area of farmed land into smaller (up to 1,000 ha) and larger (over 1,000 ha) farms (Table 4). Assets and acquisition of tangible fixed assets (in absolute and intensity terms) correlated in smaller and larger farms with the intensity of investment and total subsidies.

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Table 3. Correlation matrix of Spearman coefficients for economic indicators and received subsidies of Slovak farms classified by production specialization

Variable	Unit	Crop production farms			Livestock production farms		
		Total subsidies	Non-investment subsidies	Investment subsidies	Total subsidies	Non-investment subsidies	Investment subsidies
		€/ha	€/ha	€/ha	€/ha	€/ha	€/ha
Assets	€	0.331	0.253	0.348	0.094	0.03	0.291
Sales of own products and services	€	0.232	0.173	0.28	0.004	-0.059	0.27
Economic result	€	-0.002	-0.022	0.04	0.091	0.062	0.061
Number of employees	z	0.366	0.328	0.287	0.152	0.118	0.252
Acquisition of tangible fixed assets	€	0.335	0.208	0.427	0.106	-0.004	0.348
Assets / ha	€/ha	0.249	0.162	0.238	0.158	0.063	0.265
Sales of own products and services /	€/ha	0.091	0.03	0.134	0.016	-0.07	0.24
Economic result / ha	€/ha	-0.041	-0.062	-0.03	0.104	0.081	0.012
Number of employees / 100 ha	n/100ha	0.319	0.295	0.177	0.3	0.251	0.169
Acquisition of tangible fixed assets /	€/ha	0.29	0.161	0.346	0.133	0.011	0.29

Source: Database of Information Sheets of Ministry of Agriculture and Rural Development of Slovak Republic, own calculations.

The intensity of non-investment support was positively linked to the indicator of assets and investments for its acquisition (in absolute and relative terms) in the case of small farms and with the intensity of assets in case of large farms. Sales of own products and services (in absolute and relative terms) were demonstrably positively related to the intensity of investment subsidies in both smaller and larger farms, while their relationship to the intensity of non-investment subsidies was demonstrably negative in three out of four cases. The economic result was negatively related only to the intensity of non-investment subsidies in larger farms and in remaining cases its relationship with the intensity of payments was not proved.

Table 4. Correlation matrix of Spearman coefficients for economic indicators and received subsidies of Slovak farms classified by area of cultivated land

Variable	Unit	Farms up to 1000 hectares			Farms with an area of over 1,000 hectares		
		Total subsidies	Non-investment subsidies	Investment subsidies	Total subsidies	Non-investment subsidies	Investment subsidies
		€/ha	€/ha	€/ha	€/ha	€/ha	€/ha
Assets	€	0.253	0.187	0.306	0.162	0.087	0.196
Sales of own products and services	€	0.067	0.016	0.226	-0.046	-0.115	0.135
Economic result	€	0.023	0.01	0.038	-0.064	-0.114	0.042
Number of employees	z	0.336	0.314	0.226	0.362	0.357	0.171
Acquisition of tangible fixed assets	€	0.254	0.158	0.325	0.172	0.01	0.374
Assets / ha	€/ha	0.11	0.028	0.255	0.228	0.147	0.198
Sales of own products and services /	€/ha	-0.08	-0.152	0.174	-0.025	-0.093	0.113
Economic result / ha	€/ha	0.001	-0.01	0.001	-0.059	-0.112	0.04
Number of employees / 100 ha	n/100ha	0.266	0.23	0.189	0.474	0.493	0.139
Acquisition of tangible fixed assets /	€/ha	0.199	0.1	0.292	0.204	0.032	0.378

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

The number of employees correlated positively with all types of payments in both small and large farms, and in particular the relationship of total and non-investment subsidies to the number of employees per hectare in large farms was very significant.

The fourth criterion according to which we have divided legal entities was their profitability (Table 5). Assets and investments for acquisition of tangible fixed assets in absolute terms were demonstrably positively related to the intensity of all types of subsidies regardless of farm profitability. Relative indicators were in demonstrably positive relationship, especially with the intensity of investment and thus also with total subsidies, whether it was profitable or loss-making farm. On the other hand, neither the assets nor the investments for its acquisition correlated with the amount of non-investment subsidies per hectare of profitable farms.

In terms of sales, those in absolute and relative amounts correlated positively with the intensity of investment support in profitable and loss-making farms. On the other hand, there was a negative relationship between sales per hectare and the intensity of non-investment subsidies of profitable enterprises. The economic result in absolute amounts correlated negatively with the intensity of all types of subsidies in the case of loss-making farms.

The higher the intensity of all types of subsidies (especially non-investment and thus also the total), the higher the average number of employees in absolute and relative amounts, on loss-making and profitable farms. Especially in the case of loss-making farms, the positive correlations of employment and non-investment subsidies were relatively strong.

Table 5. Correlation matrix of Spearman coefficients for economic indicators and received subsidies of Slovak farms classified by profitability

Variable	Unit	Loss-making farms			Profitable farms		
		Total subsidies	**Non-investment subsidies**	**Investment subsidies**	**Total subsidies**	**Non-investment subsidies**	**Investment subsidies**
		€/ha	€/ha	€/ha	€/ha	€/ha	€/ha
Assets	€	0.343	0.307	0.322	0.191	0.111	0.331
Sales of own products and services	€	0.242	0.219	0.267	0.026	-0.048	0.28
Economic result	€	-0.164	-0.156	-0.18	0.018	-0.005	0.139
Number of employees	z	0.467	0.461	0.279	0.278	0.234	0.296
Acquisition of tangible fixed assets	€	0.333	0.253	0.373	0.219	0.101	0.402
Assets / ha	€/ha	0.163	0.101	0.247	0.146	0.049	0.238
Sales of own products and services	€/ha	0.072	0.027	0.178	-0.102	-0.19	0.165
Economic result / ha	€/ha	0.109	0.135	-0.042	-0.073	-0.094	-0.025
Number of employees / 100 ha	n/100ha	0.389	0.365	0.216	0.308	0.271	0.174
Acquisition of tangible fixed assets	€/ha	0.25	0.156	0.318	0.181	0.06	0.318

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

The last criterion for the classification of farms were natural conditions (Table 6). The production area was represented by the Nitra and Trnava regions; the less-favoured area (LFA) was represented by the Žilina and Prešov regions. Assets and investments for acquisition of tangible fixed assets (in absolute and relative terms) correlated positively in both areas with the intensity of all types of subsidies (the only exceptions were non-investment subsidies and asset acquisition that did not correlate in the LFA area). Particularly strong were the dependencies of investments and the intensity of investment subsidies, as well as the assets and intensity of total subsidies in production areas.

Interesting are the results of sales correlation, which in both natural areas were positively related not only to the intensity of investment and total subsidies, but also to non-investment subsidies (with the exception of relative sales in LFA areas). This suggests that previous findings about the negative relationship between the intensity of non-investment subsidies and sales might have been due to the fact that farms in LFA areas receive higher non-investment subsidies, but largely due to natural conditions, lower sales are achieved. Even in this case, the relationship between the economic result in absolute terms and the intensity of subsidies was not proved.

The economic result per hectare in the LFA areas also did not correlate with the intensity of subsidies, but on the other hand, its negative relationship with subsidies in production areas has been demonstrated. As in previous cases, the absolute and relative number of employees correlated positively with the intensity of all types of subsidies, especially in terms of non-investment and total subsidies in production areas.

Table 6. Correlation matrix of Spearman coefficients for economic indicators and received subsidies of farms classified by natural conditions

Variable	Unit	Farms of production area			Farms of LFA area		
		Total subsidies	Non-investment subsidies	Investment subsidies	Total subsidies	Non-investment subsidies	Investment subsidies
		€/ha	€/ha	€/ha	€/ha	€/ha	€/ha
Assets	€	0.4	0.377	0.299	0.26	0.206	0.282
Sales of own products and services	€	0.368	0.374	0.274	0.164	0.115	0.234
Economic result	€	-0.069	-0.056	-0.065	0.076	0.069	0.03
Number of employees	z	0.474	0.479	0.306	0.278	0.266	0.172
Acquisition of tangible fixed assets	€	0.33	0.237	0.406	0.234	0.144	0.31
Assets / ha	€/ha	0.326	0.273	0.188	0.282	0.198	0.298
Sales of own products and services /	€/ha	0.338	0.334	0.154	0.145	0.076	0.221
Economic result / ha	€/ha	-0.113	-0.107	-0.11	0.086	0.083	-0.015
Number of employees / 100 ha	n/100ha	0.442	0.437	0.213	0.4	0.383	0.12
Acquisition of tangible fixed assets /	€/ha	0.25	0.134	0.327	0.186	0.09	0.268

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

Analysis of differences in indicators between farms in production and LFA areas

We have also compared economic indicators of legal entities in Slovak agriculture, which in 2018 operated in regions with prevailing production area (Nitra and Trnava regions) with legal entities that were operating in regions with predominantly less-favoured natural conditions (Prešov and Žilina regions). Farms operating in less-favoured natural conditions received significantly higher non-investment subsidies thanks to LFA payments, which could be another factor that had an impact on the economic indicators of agricultural companies, in addition to different natural conditions.

To test the significance of differences in economic indicators between farms in production and LFA areas, we used the non-parametric Wilcoxon-Mann-Whitney test. The test results are summarized in Table 7. The data in the “Area” columns indicate which farm group had on average higher values of the given economic indicator. The “PRO” value refers to farms operating in regions with a predominant production area, while the “LFA” value refers to farms located in regions with predominantly less-favoured natural conditions.

Despite significantly lower total and non-investment subsidies, as well as slightly lower area of agricultural land, in almost all economic indicators, farms operating in Trnava and Nitra regions have achieved better results compared to farms located in Žilina and Prešov regions. Their assets, liabilities, revenues, sales of own products and services, total costs, economic result, added value and acquisition of tangible fixed assets were statistically significantly higher, both in absolute and intensive form, as well as equity expressed in € / ha. The only indicator where significant differences between regions with different natural conditions has not occurred, was the absolute and relative number of employees. These results indicate that farms in LFA regions, despite the higher subsidies received, were not able to cope economically with farms in production areas due to worse natural conditions. On the other hand, subsidies could have contributed to maintaining employment in these regions.

Table 7. Results of Wilcoxon-Mann-Whitney tests of the compliance of economic indicators of farms operating in production and LFA areas

Variable	Unit	Area	P-value	Unit	Area	P-value
Agricultural land	ha	LFA	0.213			
Assets	€	PRO	0.001	€/ha	PRO	0.000
Equity	€	PRO	0.068	€/ha	PRO	0.000
Liabilities	€	PRO	0.000	€/ha	PRO	0.000
Total revenues	€	PRO	0.000	€/ha	PRO	0.000
Sales of own products and services	€	PRO	0.000	€/ha	PRO	0.000
Total costs	€	PRO	0.000	€/ha	PRO	0.000
Economic result	€	PRO	0.000	€/ha	PRO	0.000
Added value	€	PRO	0.000	€/ha	PRO	0.000
Number of employees	number	LFA	0.203	n/100ha	PRO	0.691
Acquisition of tangible fixed assets	€	PRO	0.018	€/ha	PRO	0.000
Total subsidies	€	LFA	0.001	€/ha	LFA	0.000
Non-investment subsidies	€	LFA	0.000	€/ha	LFA	0.000
Investment subsidies	€	PRO	0.741	€/ha	PRO	0.757

Source: Database of Information Letters of the Ministry of Agriculture and Rural Development of the Slovak Republic, own calculations.

CONCLUSIONS

The results of analysing the dependence of total, non-investment and investment subsidies per hectare with the amount and intensity of selected economic indicators, using the Spearman correlation coefficient, show that the level of all types of subsidies was in positive relation to the area of agricultural land and partly with a large majority of economic indicators expressed in absolute terms. When analysing intensity indicators, the situation was less clear.

Non-investment subsidies per hectare were in the strongest positive relationship with the number of employees and this support contributed to maintaining employment in the agricultural sector. When analysing subgroups of legal entities, this relationship was particularly visible in cooperative farms, larger farms, loss-making farms and farms operating in regions with prevailing favourable natural conditions. The intensity of assets, equity and investments also positively correlated with non-investment subsidies. On the other hand, sales and value added of legal entities per hectare were negatively related to the intensity of these payments.

This indicates that farms receiving higher non-investment subsidies were not so compelled to increase their sales and generate higher added value, because subsidies were a substantial source of their income. However, a positive correlation between the intensity of non-investment subsidies and sales per hectare in a separate analysis of farms operating in regions with prevailing favourable and in regions with prevailing less-favoured conditions shows that different negative environmental conditions could be the cause of the negative relationship. Non-investment subsidies were significantly higher because of LFA payments in regions with unfavourable conditions, but farms naturally achieved lower sales.

Investment-related subsidies positively correlated with almost all intensive economic indicators, especially with investments in the acquisition of tangible fixed assets. In separate analyses this relationship was mainly reflected in cooperatives and farms with predominant crop production.

Using the Wilcoxon-Mann-Whitney test, we examined the existence of differences in values of economic indicators between farms in regions with prevailing favourable and disadvantaged conditions. Despite substantially lower total and non-investment subsidies, as well as slightly smaller area of agricultural land, farms operating in Trnava and Nitra regions achieved better results in almost all economic indicators. Compared to farms in Žilina and Prešov regions, their assets, liabilities, revenues, sales, costs, profit, equity, added value and investments for the acquisition of tangible fixed assets were significantly higher, both in absolute and intensity terms.

Significant differences between regions with different natural conditions did not occur only in absolute and relative numbers of employees. These results indicate that farms in LFA regions, despite the higher subsidies received, were not able to compete economically farms located in production areas due to worse natural conditions. On the other hand, this support payments probably contributed to maintaining employment in these regions.

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RURAL DEVELOPMENT IN THE CONTEXT OF SOCIAL WEALTH: ASPECTS OF THE REGIONAL LABOR MARKET

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Abstract

In this paper, we study the regional aspects of the differentiation of wages of agricultural workers. In the prevailing market conditions, funding for agricultural workers is inadequate. In most cases, wage differentiation in neighboring countries is two or more times higher, which causes uncontrolled processes of labor migration from rural areas. The conditions of dependence of wages and production results in agriculture on the basis of a participatory approach are studied. We found that the payroll should be formed taking into account the observance of fundamental economic principles. In particular, while in the reference countries the basis of production activities is the observance of social guarantees and a decent level of remuneration, in the developing economies neighboring the region workers are poor, and as a result satisfaction of social justice is impossible. Moreover, the classical approach to the formation of a wage fund in modern market conditions may not be feasible and the author's concept of wage ranking is preferable.

Key words: *regional agribusiness, wages, labor market, Russian Federation*

INTRODUCTION

The article examines the current state and trends of the labor market in terms of wages of agricultural workers of the analyzed countries of the post-Soviet space and Europe, reveals the reference conditions of social wealth, its economic parameters. The article argues that in order to fully and comprehensively take into account the social and economic interests of workers, it is necessary to comply with the developed system for ranking wages and stimulating highly productive labor.

These studies are based on previous studies by Fisher and Knutson (2013) [8], Mackel (1975) [19], Melichar (1982) [20], Lee (1982) [17], Newman and Jarvis (1999) [27] and other leading global scientists involved in agricultural labor market issues.

These previous studies show that the widespread observance of social justice in the formation of remuneration for labor in agriculture provides benefits from production in comparison with traditional forms of remuneration due to the specifics of production and terms of trade, which in turn reduce efficiency and economic benefits. This study takes another step to assess the importance of improving the efficiency of financing agricultural workers taking into account regional and industry specifics based on compliance with key provisions of the International Labor Organization. The material for the study was the results of the activities of agricultural enterprises of the post-Soviet countries (Tajikistan, Turkmenistan, Uzbekistan, Moldova, Kyrgyzstan, Georgia, Armenia, Azerbaijan, Belarus, Russia, Ukraine, Kazakhstan), as well as European countries neighboring Russia (Bulgaria, Poland, Lithuania, Slovakia, Hungary, Romania, Czech Republic, Latvia, Estonia, Slovenia, Norway, Finland, Sweden) for the period 2017-2019.

The research concept was the basic model of the involvement process - "ladder of participation", created in 1987 and then expanded, which contains the following levels: access to information, consultation, joint decision-making, initiation and control by those who receive the result from social changes. Subsequently, this model was supplemented and refined by introducing extreme elements of the range, such as passive participation and self-motivation for actions (Wellbrock, Roep, … Farrell, 2013) [49].

Using a qualitative methodology based on the use of documentary analysis and the use of various methods of collecting information, Davila, Vargas, et al. (2018) [5] analyze two demographic trends that have influenced the definition of the economy of solidarity. The first is the Latin American current, and the second is the current social and solidary economy, on the basis of which they examined the regulatory framework and proposed some theoretical elements that are the core of the study.

According to Wellbrook, Roep, et al. (2013) [49], differences in the implementation of joint forms of governance can be partially explained by different political dynamics, the economic and demographic situation, as well as a common sense of place. The effective formation of collective management requires a peer review and restructuring of the separation of roles and tasks between facilities, including public administration.

Tegegne, Penker and Wurzinger (2016) [45] noted that working together on demographic change factors between science and society provided valuable space for social learning so that regional stakeholders can determine the need and scope of local mitigation or adaptation measures demographic transformation.

During the development of the organizational and economic mechanism for regulating the financing of agricultural workers on the basis of a participatory approach using the research conducted by Ivashinenko (2012) [15] and a number of authors of the Institute of Socio-Economic Population Problems of the Russian Academy of Sciences, groups of low-income, middle-income and most wealthy segments of the population were determined by the level of minimum wage using the method of statistical summary and structural attributive grouping by countries entering in the post-Soviet and Europe.

In this work, convincing evidence was found that the optimization of the principles of formation of the wage fund in agriculture increases the level of satisfaction with the labor of the rural population, reduces migration sentiment and, using the example of reference economies, increases the efficiency of regional agribusiness as a whole [9]. This conclusion is important for the management of agricultural organizations: an increase in the well-being of workers should attract highly qualified specialists to work and stabilize the reproduction of the rural population as a self-sustaining structure, as well as the potential of the national agribusiness to reduce the outflow of the local population and reduce the need for hired immigrant labor [29].

The rest of this document is organized as follows: in the second section, empirical data on the development of labor markets in the region's agriculture are considered, the third section introduces the methodology of the mechanism for regulating wages, and the fourth describes the proposed decision-making model to increase the income of agricultural workers.

MATERIALS AND METHODS

The most important stage in the study of socio-economic phenomena and processes is the systematization of primary data and obtaining, on this basis, a summary characteristic of the entire object using generalizing indicators, which is achieved by observing the statistical summary method by grouping the primary statistical material [47]. The qualification category of the tariff system of remuneration depends on the tariff rate of the agricultural worker, his qualifications [44]. Working conditions are also taken into account - accruals are made in the form of various surcharges (for irregular working hours, coefficients for the complexity of work in agricultural sectors) [16]. Legal regulation of remuneration is represented by national legislation. Local acts of enterprises determine the wage system, the size of the salary, rates, allowances, surcharges, increase in wages in conditions that deviate from the norm, the bonus system [18].

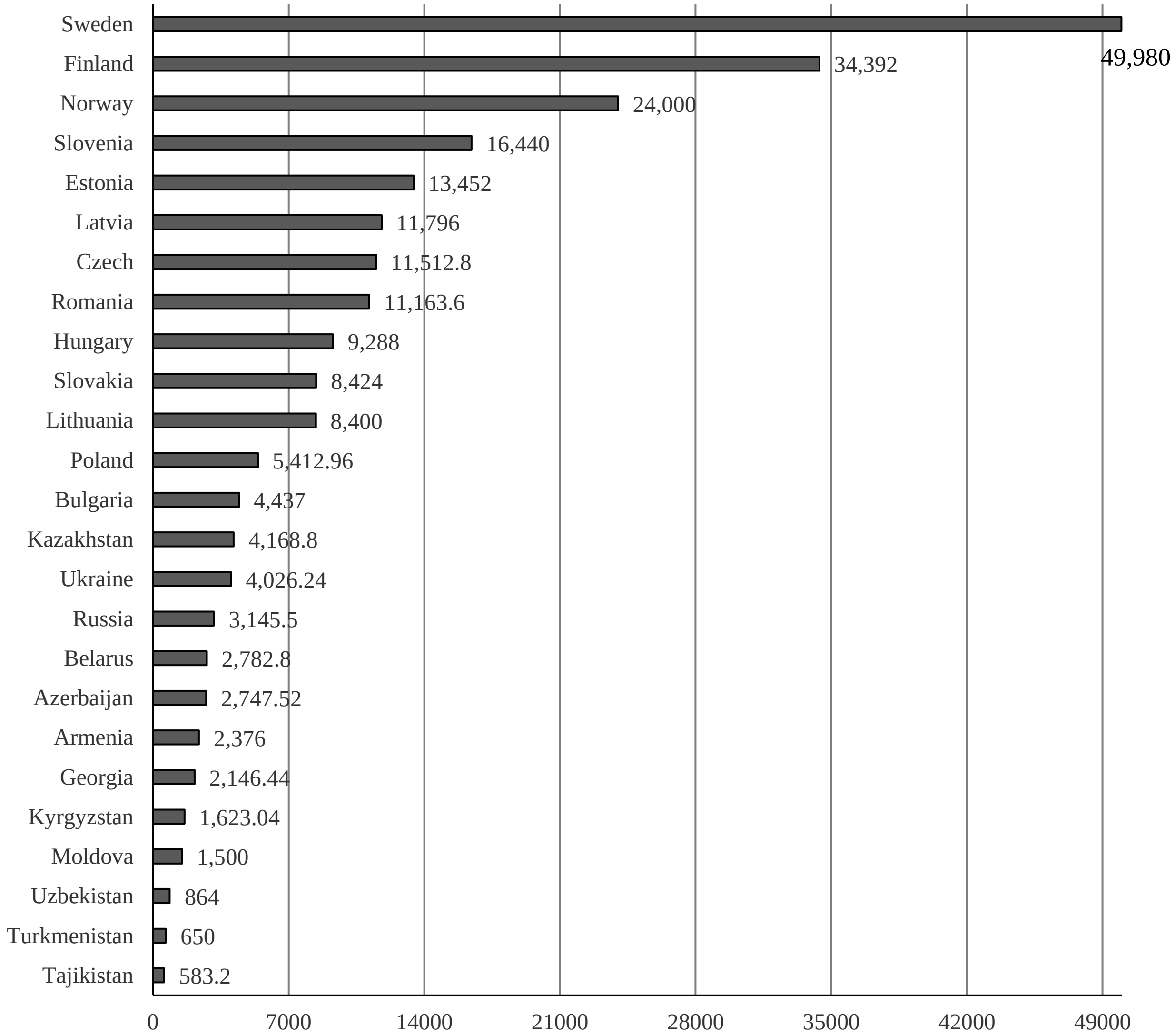

Fig. 1. Differentiation of remuneration in the studied region, euro per year.
Source: calculated by the authors.

To date, the following trends have been identified in the regional wage system:
- the level of remuneration in individual countries and the volume of gross production weakly correlate with each other and rely solely on the economic interests of agribusiness entities;
- the differentiation of average monthly and average annual wages is more than 5 orders, even within individual groups;
- the net profit of agricultural enterprises of the states of the studied region is formed largely due to national systems of support and subsidization of agriculture;
- there are no national programs for the formation and development of the social welfare of agricultural workers;
- there is no single approach to determining the minimum wage for agricultural workers, which contributes to an increase in the outflow of the able-bodied population to more economically developed countries;
- the reluctance of most agribusiness entities to offer a fair price for agricultural labor;
- poor efficiency of the statistical services of the countries of the post-Soviet space, lack of access to analytical information, distortion of official statistical information for the sake of the national interests of individual states (Tajikistan, Turkmenistan, Uzbekistan).

Thus, the current differentiation of regional volumes of wages in agriculture is presented in Fig. 1.

The current situation in agricultural remuneration clearly demonstrates its own imperfection, which is further complicated by the lack of managerial initiative on the part of the management of key enterprises in the region to form and then use a fair wage system.

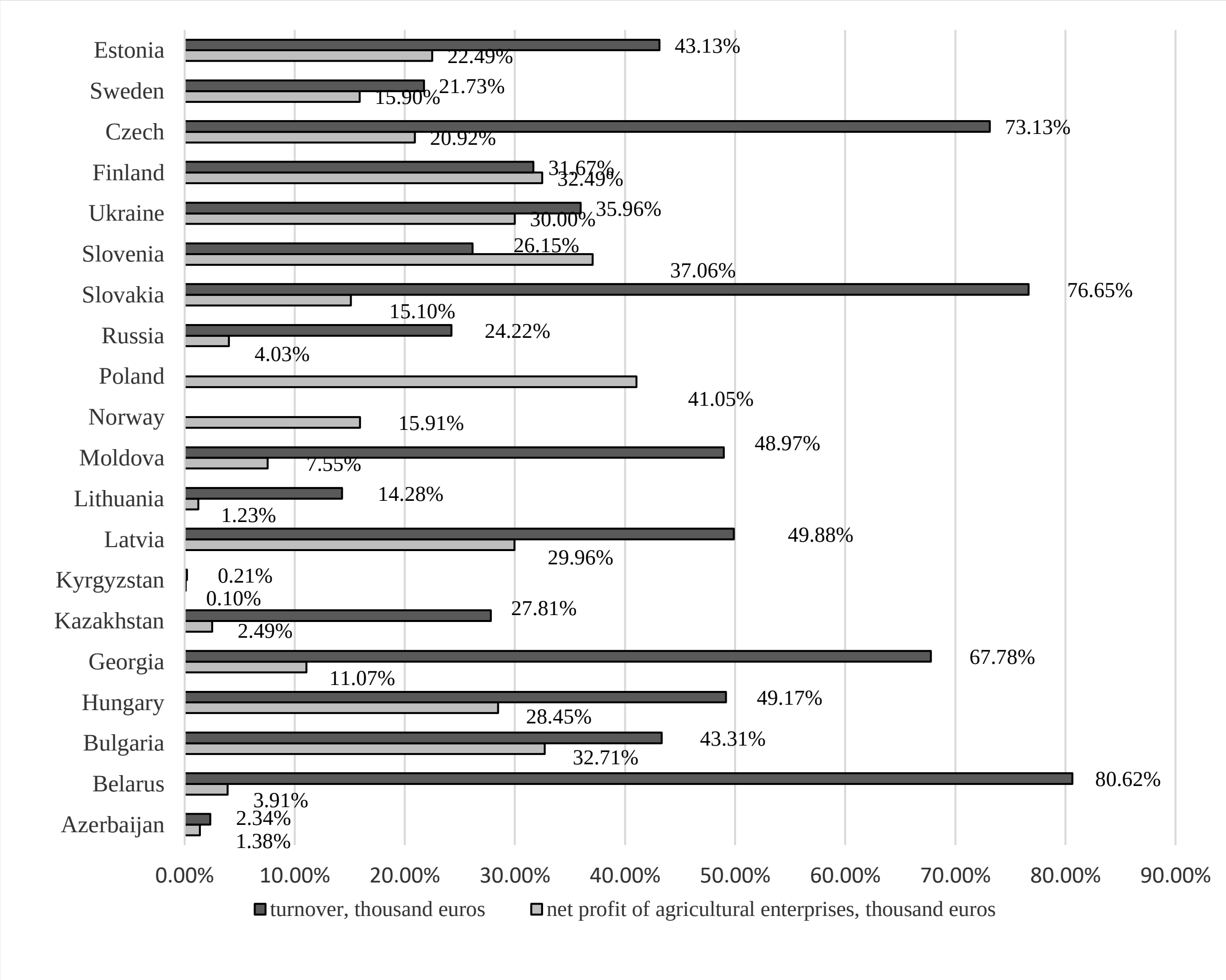

Fig. 2. Absolute ratio of gross outputs, turnover and net income in agriculture in the region
Source: calculated by the authors.

One of the reasons for this passivity is the objective negative aspects of the agricultural industry:
- submission of their own organizational and commercial interests to the interests of the national agricultural policy [7];
- the sufficiency of unskilled manual labor in many sectors of agricultural production [14];
- lack of a full-fledged system of national control of actual employment, formalization of the provision of financial statements [3];
- the general poverty of the rural population and the forced consent to unfair working conditions [48].

At the same time, business entities represented by management underestimate the clear advantages of optimizing the wage system:
- organization and improvement of the effectiveness of interaction between agricultural workers;
- attracting qualified personnel to the industry [10];
- organization of training, retraining, advanced training and internships of employees at their own expense, interest in career growth [30];
- the ability to choose personnel as a result of increasing the attractiveness of agricultural labor;
- reducing the risks of criminalizing the illegal use of migrant and unskilled cheap labor [34];
- organizational, informational and legal support from the national agricultural authorities and labor ministries in order to further improve national indicators of the social efficiency of agriculture [11].

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In the process of research, the structure of the formation of added value of agriculture was analyzed and a significant bias was revealed in the volumes of revenue from sales of agricultural products and the levels of net profit of agribusiness, which indicates an insufficiently effective construction of national agro-industrial complexes and the absence of full-fledged market mechanisms for regulating the industry, Fig. 2.

RESULTS AND DISCUSSIONS

The study used the method of statistical summary - this is a set of sequential operations to generalize specific individual factors. identify typical features and patterns inherent in the studied phenomenon as a whole, which allows us to calculate the tariff schedule for three options in our study, depending on the size of the actual wage and the subsistence minimum established for the Russian Federation on 01.01.2019, 163.48 euros per month for the able-bodied population.

A statistical summary includes the following steps:

- determination of the formation of groups according to Sturges' rule;
- the choice of a grouping characteristic and a system of statistical indicators to characterize groups and the object as a whole.

Definition of the formation of groups

We determined which feature underlies the grouping (quantitative, qualitative, discrete, continuous). In this case, a quantitative continuous attribute.

We calculate the number of units of the population - N. In this study, we get N = 22.

We determine the maximum (x_{max}) and minimum (x_{min}) value in the given data.

We get: x_{max} = 49,980; x_{min} = 583.2.

The Sturges' rule is an empirical rule for determining the optimal number of intervals into which the observed range of variation of a random variable is divided when constructing a histogram of the density of its distribution.

The optimal number of groups corresponding to a certain number of observations, according to the Sturges' rule, can be represented as follows:

$$n = 1 + [\log_2 N] = 1 + [3.332 \log N]$$

where:

N is the total number of observations of the quantity

$\log_2 N$ - base 2 logarithm,

$$n = 1 + [\log_2 N] = 5.459$$

$$n = 1 + [3.332 \log N] = 5.473$$

n ≈ 5.459 ≈ 5.473 ≈ 5

We get n = 5

We calculate the interval by the following formula:

$$h = \frac{R}{n} = \frac{Xmax - Xmin}{n}$$

$$h = \frac{49{,}980 - 583.2}{5} = 3{,}171.4$$

We round the interval to i = 3,171.4 euros. If the value of the last boundary of the interval of the final group with x_{max} is not observed, it is necessary to take a more accurate value of the interval.

Table 1. The boundaries of the average monthly wage interval for employees

Group number	The boundaries of the interval of countries on wages per year, Euro., X	Number of countries, discrete variation series of indicators, f	Particular, W	The accumulated frequency, S
1	583 - 3754.4	10	10/22=0.45	
2	3,754.5 – 6,925.8	4	4/22=0.18	10+4=14
3	6,925.9- 10,967.2	3	3/22=0.14	14+3=17
4	10,967.3- 13,268.6	3	3/22=0.14	17+63=20
5	13,268.7- 16,440	2	2/22=0.09	20+2=22
Summ		22		

Source: calculated by the authors.

We calculate the interval for each group, with the condition that the interval is closed (has an upper and lower boundary).
For this, for the first group, the lower boundary will be x_{min}.
In our study, the groups were determined by the size of the average annual wage per worker in agricultural enterprises by countries of the post-Soviet space and elected countries of Europe, Table 1.
Applying the G. Sturges' rule to calculate the optimal number of intervals, we received 5 groups with the largest and lowest average salaries at agricultural enterprises (583 and 16,440 euros, respectively), with an interval between them of 3,171.4. And one separate group, which in our study is a benchmark in terms of social welfare and the effectiveness of financing agricultural workers.

The choice of a grouping characteristic and a system of statistical indicators to characterize groups and the whole object

The dynamics and nature of changes in the abundance of any territory are determined by its natural (birth rate, mortality) and mechanical (migration) movement. The constant renewal of the population on the basis of natural movement, migration processes, as well as the transition of the population from one social group to another is called population reproduction.
Then the first group will include countries where the average annual salary of all employees will be from 583 to 583 + 3,171.4 = 3,754.4 euros per year. There will be 10 such countries (Tajikistan, Turkmenistan, Uzbekistan, Moldova, Kyrgyzstan, Georgia, Armenia, Azerbaijan, Belarus, Russia) (Table 2).

Table 2. The impact of wages on key indicators of social welfare of the studied countries

Groups of countries by salary in agricultural sectors		**Tajikistan, Turkmenistan, Uzbekistan, Moldova, Kyrgyzstan, Georgia, Armenia, Azerbaijan, Belarus, Russia**	**Ukraine, Kazakhstan, Bulgaria, Poland**	**Lithuania, Slovakia, Hungary**	**Romania, Czech Republic, Latvia**	**Estonia, Slovenia**	**Norway, Finland, Sweden**
The interval of wages in agriculture per year, euro		583 - 3,754.4	3,754.5 - 6,925,8	6,925.9-10,097.2	10,967.3-13,268.6	13,268.7-16,440	24,000 - 49,980
On average in the group	Average wages to wages in agriculture, Euro,%	48.54	65.75	62.69	83.41	79.69	94.19
	The number of deaths per born, people	0.67	1.02	1.27	1.31	1.05	0.81
	Birth rate,%	1.66	1.18	0.95	0.94	0.99	1.15
	Immigration,%	5.0	8.42	4.24	6.23	13.31	11.89
	Natural increase (decrease) in the entire population,%	227.13	118.74	81.44	77.79	95.07	125.37
	Residents of the countryside,%	53.86	65.48	64.27	65.3	61.7	85.0
	The decline in the rural population, including due to migration, person / year	202,787.4	255,573.75	14,379.33	19,116.33	5,959	856.33

Source: calculated by the authors according to the [1, 2, 4, 6, 12, 13, 21, 22, 23, 24, 25, 26, 28, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46]

The second group will include enterprises with an average annual salary of 3,754 to 3,754.4 + 3,171.4 = 6,925.8 euros per year. There will be 4 such countries (Ukraine, Kazakhstan, Bulgaria, Poland). Similarly, we find the number of countries in the third group (Lithuania, Slovakia, Hungary), the fourth group also includes 3 countries (Romania, Czech Republic, Latvia), the fifth group is completed by Slovenia and Norway. A separate reference group is represented by Norway, Finland, Sweden. Salaries in the agriculture of these countries per year are 24,000, 34,392, 49,980 euros, respectively, Table 2.

This kind of socio-economic factor, such as the size of wages, has one of the decisive effects on the demographic processes in the region. The grouping of wages showed a directly proportional dependence on the demography of different countries in terms of fertility, mortality, migration processes, and natural population growth. Natural growth serves as a characteristic of the growth rate of population reproduction. In the first and second study groups, there is a natural population growth due to the high birth rate in most countries included in it (Tajikistan, Turkmenistan, Uzbekistan, Moldova, Kyrgyzstan, Kazakhstan, etc.) due to religious and national cultural traditions. Depopulation takes place in countries belonging to the 3, 4, 5 groups, which speaks of a narrowed process of population reproduction and leads to a demographic crisis. A prosperous economy in the fourth, fifth, and sixth groups with a high level of average wages helps to reduce the outflow of the working population (the average annual wage to wage in agriculture is from 83 to 95%).

Justification of a decision-making strategy to improve the material situation of households in a rural settlement

The study identified two social groups (wage earners and employers (agricultural enterprises and farms)) and, separately, administrative (managing) bodies. All these entities have a certain impact on decision-making to improve the social welfare of agricultural workers.

The first social group - wage earners - is divided into three social and property subgroups with respect to wages to living wages per working family member: 1.48-1.85 - high risk of poverty (minimum wage); 2.10-2.40 - on the threshold of poverty (average wage); 2.68-2.93 - an attempt to go beyond the poverty line (maximum wage) (Table 3).

Table 3. Decision strategies for improving the material situation of rural households

Minimum wage to the cost of living	**Middle wage to the cost of living**	**Maximum wage to the cost of living**
Wage-earners		
1.37-1.58	2.01-2.19	2.59-2.78
1.70-1.93	2.28-2.48	2.86-3.13
The average value of wages to a living wage		
1.48-1.85 (155.36 - 221.33 Euro)	2.10-2.40. (221.35 - 287.30 Euro)	2.68-2.93 (287.32 - 353.28 Euro)
The choice of a strategy for the behavior of a rural settlement of various social levels and authorities		
1-st Social group (employees)		
minimize costs	creation of volunteer groups	public attention
2-nd Social group (employers - agricultural enterprises and farms)		
-provision of permanent housing, with subsequent acquisition of ownership; -allocation of funds for the repair of schools, kindergartens, libraries, stimulating the labor market in “critical zones” - creating new jobs through the implementation of investment projects		
Authorities		
-attraction of social and informational ties -compliance with the provisions of the International Labor Organization (conventions 129, 144, 95, 131) and national labor codes (improving the legal framework in the field of labor and forms of employment and monitoring the implementation of the accounting policy adopted in the accounting policy in accordance with the tariff qualification grid and adjusted rates for the main part of remuneration, taking into account the implementation of established norms and standards)		

Source: developed by the authors.

The improvement of social wealth should primarily be associated with an increase in the material well-being of the rural population, therefore, the behavior strategy of families with different levels of income is different.

The population with the lowest income (1 subgroup) has the most pronounced strategy of minimizing all expenses (emergency savings), including for food and basic necessities. They rely primarily on the help of the state, as well as relatives and parents. In addition, they are characterized by educational and labor activity (in the summer they are engaged in growing vegetables in their own plots, etc.). In order to improve the living conditions of this group, it is necessary to draw public attention to the problem of poverty.

The middle-income sections of the rural population take a passive position (2 subgroups), supporting the family at the expense of economy, preferring to endure temporary difficulties. They can also be proactive in providing financial assistance to low-income families.

The most affluent families activate and mobilize their internal reserves (3 subgroups). The presence of social ties and the possession of information, distinguishes them from other segments of the population and is a determining element of well-being, allows to engage in alternative activities such as farming or small business.

The second social group - employers (agricultural enterprises and peasant farms) will provide additional jobs due to investments in production.

In the second and third groups, economic instability affected the state of the budgets of municipalities and in the long term, the search for ways to stabilize finances and ensure the sustainability of local budgets of the district's settlements is still important.

Employers as a socially responsible group can influence the welfare of their workers, in particular, rural households, providing housing on preferential terms, a social package of corporate (within collective) benefits. Due to favorable investment characteristics, enterprises can attract investors with the aim of creating additional and new jobs in specific territories, implement projects under special contracts with the district administration with tax holidays for a certain period, as well as free sites requiring reconstruction, additional equipment or for new construction.

Administrative bodies influence demographic processes and behavior strategies of households and employers of the agro-industrial complex.

The reduction of significant differentiation in the level of remuneration between sectors of the economy is a prerequisite for improving the regulatory framework in the field of labor and forms of employment, which controls the implementation of the accrual methodology adopted in the accounting policy in accordance with the tariff qualification grid and adjusted rates for the main part of payment labor, taking into account the implementation of established norms and standards. All this will contribute to increasing the social responsibility of the business, as well as the legalization of wages.

Studies have shown that it is necessary to minimize the existing significant differentiation in levels of remuneration between sectors of the economy and to fix in the accounting policy a detailed methodology for calculating remuneration in agricultural organizations, in accordance with the tariff qualification grid and adjusted rates for the main part of remuneration, taking into account the implementation of established standards and requirements.

The choice of a grouping criterion by the size of wages and main economic indicators in the context of post-Soviet countries and Europe

A selection and study of the main economic indicators of the countries of the post-Soviet space and Europe (and their grouping depending on the size of wages) showed that the first group of countries with the lowest level of wages is the largest. It includes 10 countries, including Russia. An analysis of these countries shows that in the reference group where the highest labor productivity (production), the wage intensity is 1.51, that is, one euro in the organization's income accounts for 1.51 euro of wages.

One of the key indicators that determine the effectiveness of the use of cash to pay for labor is wage mass or the profitability of the labor process. It indicates how many times the employer's income received as a result of the employee's work is greater than the total wage fund.

Wage mass indicator allows you to assess the impact of the wage fund on the growth of production. Wage mass equal to the quotient of the financial results of the enterprise and the cost of labor for the period of time. It shows what revenue is received per euro of salary costs. The results of the organization's work include: profit; value added; volume of sales.

Formulas for calculating wage mass are:

Wage mass= (Gross output)/(Wage fund)

To identify the effectiveness of spending money on wages, we carried out a comparison of wage mass with the indicator of wage intensity in dynamics for six groups in the context of selected countries. Wage intensity - an indicator, opposite wage mass. It determines how much wage is contained in 1 euro of production. The higher the value of the indicator, the more efficiently the organization's labor resources are used (Table 4).

Table 4. Grouping of the studied countries by main economic indicators (grouping indicator - wages)

Indicators	**Average group of countries wages per year, Euro**					
	1-st group 1,841.85	2-nd group 4,511.2	3-rd group 8,704	4-th group 11,490.8	5-th group 14,946	6-th group 36,124
Production, million euros / thousand people	12.03	30.13	28.55	14.21	32.05	95.05
Capital-labor ratio, euro / euro	6.20	2.46	6.07	1.02	6.36	22.75
Wage mass, Euro / Euro	16.21	1.95	1.56	0.50	0.70	0.66
Wage intensity, Euro / Euro	0.06	0.51	0.64	2.00	1.42	1.51
Personnel efficiency, Euro	572.71	10,284.01	5,895.34	1,756.46	10,064.48	19,065.36
Wage Efficiency, Euro	0.31	2.28	0.68	0.15	0.67	0.53

Source: calculated by the authors according to the [1, 2, 4, 6, 12, 13, 21, 22, 23, 24, 25, 26, 28, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46].

A decrease in wage intensity and an increase in wage mass ratio speaks of competent management of salary costs. Otherwise, the efficiency of labor costs decreases. In studies we observe the reverse process. An increase in these indicators indicates an increase in the social and economic significance of labor costs. In countries 5 and 6 of the groups with the highest level of pay per capita, wage mass is 0.7 and 0.66 euros, respectively, of the profit per one euro of labor costs. For further calculation of the tariff grid, it is most advisable to accept the minimum wage for the first category of the second group of countries, 4,511.25 euros per year or 375.93 euros / month, focusing on basic economic indicators, including wage intensity, which exceeds its size by 0.45 points compared to the first group.

The method of ranking tariff coefficients by rank (minimum, average, maximum) and the calculation of the tariff grid of remuneration

The ranking method is used to evaluate personnel, according to which the results of the work of employees, qualifications, positions held are compared, and then the sizes of tariff coefficients for the categories are determined. This method makes it possible to compare workers with each other, and not only with the established standard or norm (Table 5).

Table 5. Ranking the coefficients of the tariff grid depending on the income of agricultural workers

Tariff category number	Tariff coefficients			Absolute increase in range	Relative increase in range	Range width	Overlap
	Minimum rank step value	Middle rank step value	Maximum rank step value				
1	1.0	1.3	1.6	-	-	0.6	0.2
2	1.4	1.7	2.0	0.4	23.5	0.6	0.2
3	1.8	2.1	2.4	0.4	19.0	0.6	0.2
4	2.2	2.5	2.8	0.4	16.0	0.6	0.2
5	2.6	2.9	3.2	0.4	3.8	0.6	0.2
6	3.0	3.3	3.6	0.4	12.1	0.6	0.2
7	3.4	3.7	4.0	0.4	10.8	0.6	0.2
8	3.8	4.1	4.4	0.4	9.8	0.6	0.2
9	4.2	4.5	4.8	0.4	8.9	0.6	0.2
10	4.6	4.9	5.2	0.4	8.2	0.6	0.2

Source: calculated by the authors.

In this case, it is taken into account that:
- the minimum, average, maximum values of the rank step are calculated depending on the income of the families of the rural settlement and are ranked according to the categories of the inter-qualification tariff grid;
- absolute growth is taken equal for all categories, on its basis the minimum, average, maximum tariff coefficients are determined on an accrual basis;
- the relative increase in the range characterizes the growth rate of the tariff coefficient in relation to the previous one;
- the width of the range is calculated as the difference between the minimum and maximum values of the ranks and with the help of overlapping they allow to cover the deficit of funds when the employee moves from the lowest to the highest level.

In socio-economic policy, any state in improving the demographic situation of a rural settlement should rely on the provisions of the International Labor Organization in the framework of recommendations and ratified conventions to strengthen social protection. State authorities should promote the protection of the right to work through an emphasis on the globalization of labor markets, characterized on the one hand by an excess of labor, and on the other by a lack of highly qualified personnel for agricultural enterprises. The labor market at the legal level should provide national regulatory systems of safety and health at work. This concept includes the creation of a basic model of social protection, which allows assisting families in the most difficult situations who have lost their jobs or have been employed part-time.

In our studies, the calculation of tariff networks is based on the concept of poverty - the cost of living. The cost of living in the Russian Federation and, accordingly, the minimum wage is determined at 163.48 euros for the working-age population, 124.39 euros for pensioners, 150.58 euros for children.

For comparison, the second option of the tariff grid is calculated based on an analysis of the main economic indicators and their grouping in the context of elected countries (Table 6, and 7).

We have proposed an adapted 10-digit tariff grid and coefficients, which are determined depending on the ability of the enterprise to ensure the level of wages of its employees at the minimum, average or maximum levels.

From the analysis of payroll, salary intensity and profitability of labor, it follows that material remuneration is not associated with effective performance indicators of the enterprise.

Having identified the shortcomings of the existing unified system of labor rating, we examined the problem from the point of view of socio-economic significance. With a minimum value of the tariff coefficient, a person can provide only his primary needs, with an average of simple reproduction, with a maximum - expanded.

Table 6. Adaptation of the tariff grid for three options depending on the income of a rural settlement with a minimum size, average and maximum income on the example of the Russian Federation

Tariff category number	Tariff coefficients			Tariff Rates		
	Minimum 1.37 - 1.93	Middle 2.01 - 2.48	Maximum 2.59 - 3.13	Minimum 1.37 - 1.93	Middle 2.01 - 2.48	Maximum 2.59 - 3.13
1	1	1.3	1.6	163.48	212.52	261.57
2	1.4	1.7	2	228.8	361.29	523.14
3	1.8	2.1	2.4	294.26	446.30	627.76
4	2.2	2.5	2.8	359.66	531.31	732.39
5	2.6	2.9	3.2	425.05	616.32	837.02
6	3	3.3	3.6	490.44	701.33	941.64
7	3.4	3.7	4	555.83	786.34	1,046.27
8	3.8	4.1	4.4	621.22	871.35	1,150.90
9	4.2	4.5	4.8	686.62	956.36	1,255.53
10	4.6	4.9	5.2	752.01	1,041.37	1,360.15

Source: calculated by the authors.

Table 7. Adaptation of the tariff grid for three options depending on the income of a rural settlement with a minimum size, an average and a maximum level of income for the analyzed countries, based on the minimum rate of the second group - 375.93 euros / month

Tariff category number	Tariff coefficients			Tariff Rates		
	Minimum	Middle	Maximum	Minimum	Middle	Maximum
1	1	1.3	1.6	375.93	488.71	601.49
2	1.4	1.7	2	526.30	830.81	1,202.98
3	1.8	2.1	2.4	676.67	1,026.29	1,443.57
4	2.2	2.5	2.8	827.05	1,221.77	1,684.17
5	2.6	2.9	3.2	977.42	1,417.26	1,924.76
6	3	3.3	3.6	1,127.79	1,612.74	2,165.36
7	3.4	3.7	4	1,278.16	1,808.22	2,405.95
8	3.8	4.1	4.4	1,428.53	2,003.71	2,646.55
9	4.2	4.5	4.8	1,578.91	2,199.19	2,887.14
10	4.6	4.9	5.2	1,729.28	2,394.67	3,127.74

Source: calculated by the authors.

CONCLUSIONS

The organizational and economic model that we developed for regulating the social welfare of agricultural workers on the basis of a participatory approach made it possible to single out a system of demographic factors (birth rate, mortality, migration, natural increase) and based on them to justify the influence of the size of wages on the decision-making strategy and determine three socio-property groups in relation to the living wage for one working family member: 1.48-1.85 - high risk of poverty (minimum wage); 2.10-2.40 - on the threshold of poverty (average wage); 2.68-2.93 - an attempt to go beyond the poverty line (maximum wage).

The method proposed by the model for calculating the adapted tariff grid based on ranking according to three options depending on the income of the agricultural worker in the future should serve as the basis for calculating the prices of products in crop production and animal husbandry when the employer determines the main part of wages. Additional wages based on the rating of the labor contribution of workers and the calculation of the percentage of performance indicators of the performance criterion will allow for an increase in payroll by 42.79% to provoke a 2.4-fold increase in staff profitability in crop production, and in livestock farming a decrease in payroll by 59.9% will lead to an increase profitability of personnel by 2.75%, while the profitability of wages will increase.

Increasing the social welfare of agricultural workers in the countries of the first group will help to stop the growing flow of emigration of agricultural labor resources, increase the national attractiveness of agribusiness for local labor markets and stabilize migration processes in the region.

Within the framework of this model, the modern system of labor incentives was adapted based on analytical factors with the aim of developing specific recommendations to local authorities on increasing the efficiency of financing agricultural workers by legalizing basic and additional wages.

In the future, the study of the issue of optimizing the remuneration of agricultural workers will be framed in the form of a methodological manual for the national governing bodies and heads of enterprises of the agro-industrial complex on standardizing wage policies taking into account the developed model.

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INTERACTION OF ASSET TANGIBILITY ON THE RELATIONSHIP BETWEEN LEVERAGE STRUCTURE AND FINANCIAL DISTRESS IN AGRICULTURE-LINKED NON-FINANCIAL FIRMS

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Abstract

This study aims at investigating, from a perspective of agriculture linked firms, the impact of leverage structure on the probability of corporate financial distress with the moderating role of asset tangibility. A panel data logit regression model used to estimate the relationship between capital structure, debt maturity structure, and financial distress while controlling the effects of acclaimed variables like firm size, taxes, and profitability. The data set consists of 187 agriculture linked non-financial firms listed on the Pakistan Stock Exchange (PSX) over five years (2013-2017). The results reveal that asset tangibility negatively moderates the relationship between debt maturity structure and the probability of financial distress, but no such evidence found for the relationship between capital structure and financial fragility. Results suggest lessening the reliance on short term debt in the leverage structure. This research implies that policymakers at managerial levels should have less reliance on short term debt to abate rollover risk. Productive fixed assets can act as collateral without a considerable rise in associated fixed costs. The current study evaluated the moderating role of tangible assets on the relationship of debt maturity structure and the possibility of financial distress along with the previously addressed link of capital structure and the chances of financial distress. A sample of agriculture-linked corporate entities is also unexplored in previous literature.

Key words**:** *capital structure, debt maturity structure, financial distress, logit regression, agri-linked firms*

INTRODUCTION

Financial distress, if not addressed, may cease the application of going concern assumption. In this situation, firms find it challenging to honor the lender's claims. It is an alarm that alerts to initiate repair work. This situation often, leads to firm failure, prevalent phenomena nowadays, especially in the developing world. There are many factors studied in the past literature that contribute to such a disliked outcome. Researchers used several micro and firm-specific attributes that lead to financial distress [28, 30, 12]. Some studies link financial distress with macro and external factors [9, 19, 25]. Financial distress deals with the inability of organizations to meet their obligations both short term and long term and also continuous obligations like interest payments and other financial expenses. Choice of financial resources is crucial in this regard as it will have future implications on performance vulnerability. The literature on preference for financial resources is grounded in pecking order theory proposed by [31]. This theory explains the order of financial preference and ranks retained earnings, debt and equity as first, second and third choice respectively.

Inclusion of asset tangibility in this debate is a scarcely addressed link in prior literature in that abundance of fixed assets puts a firm in a position to negotiate its loans better. A higher volume of tangible assets serves as collateral in accessing mortgage loans and vice versa. Small firms have a lower number of assets in place and find it challenging to acquire new loans [13] which further hinders their growth potential. A non-growing firm cannot pull itself towards the maturity, and instead, it diminishes its chances of existence. The firm life cycle theory divides the life of firms into various stages, and each step has a varied level of financing requirements. This study takes an ex-post approach to determine what impact financing choices have on the financial distress considering the existing tangible assets. We also focus on the interacting effects of tangible assets on the pecking order theory. We base our research on the proposition that there can be reversals to the pecking order theory depending upon the volume of tangible assets possessed. Prior studies also support this argument in that such firms are more in line with the trade-off theory rather than following any distinct pattern in funds acquisition. In this setting, an immature firm needs external resources to pursue its growth but might not avail them due to scarcity of existing tangible assets in place and forced to rely on equity. Similarly, a mature firm can have adequate fixed assets in place that can serve as collateral, but it may not require external resources due to fewer growth potentials. Older firms are more concerned about sustaining their market position rather than pursuing more growth as they already expanded to maximum potential. Past researches have established a positive link between financial leverage and risk. It is not always accurate as firms with negotiating power can use debt in their favor—this argument supported by information asymmetry theory. Debt maturity is another crucial decision that can lead to risk differentials. The short-term loan thought to be riskier as compared to the long-term loan. However, firms with better assets in place and more information can better negotiate their loans and circumvent the rollover risk associated with short-term financing. One way to avoid this risk is to acquire long term loan as it will postpone this risk for the time being. However, a maturity matching approach is desirable to tackle the risks associated with debt maturity.

Motivation: Why Agriculture-Linked Firms?

Pakistan is an agriculture-based economy as agriculture is one of the most important sectors contributing to the economic wellbeing of the country. According to the latest stats published in the economic survey of Pakistan by the ministry of finance, there is an 18.5% contribution of agriculture in the Gross Domestic Product (GDP) of the country and 38.5% of the labor force is engaged in this sector. Most of the listed firms in the corporate area are also dependent on agriculture. The performance of listed firms contributes to the direction of the stock index, which in turn, is an indicator of financial development in a country. This research focuses on this established relationship between financial leverage and financial distress and that too on the economic plight of listed firms that directly or indirectly link to the agriculture sector in Pakistan. Many of the developing nations base their economy on agriculture and their corporate sector is also tightly connected to either agricultural input or the agricultural output. For example, in the case of Pakistan, the most important industry of firms is textile that is dependent on agriculture.

Similarly, other industries like leather, poultry, pesticides, agricultural machinery, tobacco goods, fertilizers, sugar, etc., are also reliant on agriculture. So, the most significant chunk of the corporate sector is related to agriculture, and it serves as a source of motivation for this study. Another essential reason for analyzing agriculture linked firms is that their performance will have an impact on the agriculturist income as well. If there are frequent firm failures, suppose in the textile sector, the demand for cotton should decline with each failure which will affect a farmer’s income who produces cotton. The following figure 1 explains the distribution of firms into agriculture linked and non-agriculture linked firms. It based on the data extracted from the financial statement analysis (FSA) published by the State Bank of Pakistan (SBP) for non-financial firms. Three consecutive publications by SBP on FSA of non-financial firms for six years in each case used i.e., 2008-2013, 2010-2015 and 2012-2017.

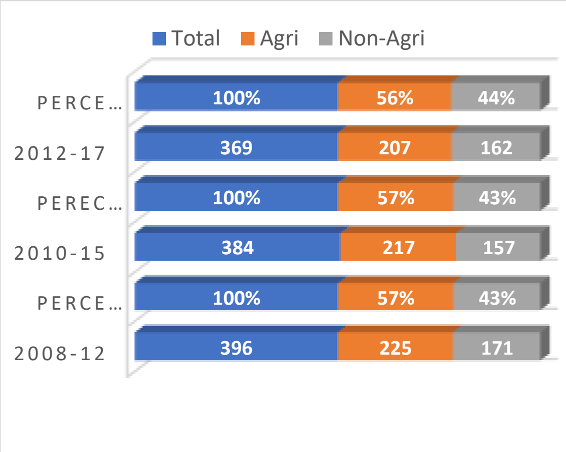

Fig. 1. Distribution of Firms as Agriculture and Non-Agriculture Linked
Source: Author's calculation based on the data from FSA published by State Bank of Pakistan.

Figure 1 clearly states that agriculture-linked firms are more in number than non-agriculture related firms. The FSA for 2008-13 includes 396 listed firms, out of which 225related to agriculture which constitutes 57% of the total firms. The State Bank of Pakistan performed FSA for 384 firms from 2010 to 2015, and 217 firms belong to the agriculture sector with a similar percentage of 57%. The latest FSA published by SBP for the years 2012 to 2017 includes 369 firms, and 56% of firms belong to agriculture, which consists of 207 firms. These stats indicate that the stock index is also highly dependent on agriculture in Pakistan. The criteria for assuming a firm as agriculture linked is that the particular firm is using the agricultural output as their raw material/input or the output of such a firm is used in agricultural operations e.g. agricultural machinery, fertilizers, pesticides, etc. This paper is structured as next section 2 cites the literature supporting the study, part 3 deals with data and methodological issues, section 4 portrays the results of this study, results discussed in part 5 and finally, papers concluded along with future implications and limitations of the research in part 6.

Review of literature and hypothesis development

Capital structure, debt maturity, and financial distress

Past literature suggests that firms with a higher proportion of debt in their capital structure are riskier and have more probability of being financially distressed [7, 21, 37]. A distressed firm is risky, the past literature also relates the financing choices to risk. There is a scarcity of researches that links leverage structure to financial distress. We will also discuss the association in risk perspective due to insufficient theoretical evidence on the link between leverage structure and financial distress. Recently, [8] found that an increase in leverage causes more risk-taking in financial firms. Dierker, *et al.* [15] proved that firms issue equity (debt) in case of an increase (decrease) in risk. el Alaoui, *et al.* [16] detected a change in the sample firm's returns and volatility as the capital structure changes. Mselmi, Lahiani and Hamza [30] revealed that financially distressed firms are small in size, possess more leverage in their capital structure, and have a lower tendency to repay loans. They also maintain more inferior liquidity, solvency and profitability ratios. Charalambakis and Garrett [12] analyzed 31,000 private Greek firms by using a multi-period logit model. They found multiple determinants of financial distress including assets, profitability, liquidity, leverage, dividend payout, exports and GDP growth.

There are two justifications in the literature that support the direction of linkage between debt maturity and financial distress based on the rollover risk hypothesis and asset substitution hypothesis as posited by [40]. He and Xiong [20] interpreted the role of rollover risk by putting the argument that shareholders are supposed to bear the negative consequences of rollover risk, whereas creditors are free of any such charge. Therefore, shareholders file for early bankruptcy, being the only victims in this conflicted situation [38]. Whereas, the proponents of the asset substitution hypothesis take the lead through monitoring hypothesis and state that short term leverage arrangements require acute monitoring due to continuous debt renewal and the asset substitution problem fades away, resultantly a decrease in default risk [39]. Recently, Adachi-Sato and Vithessonthi [1] elaborated that debt maturity has a negative association with operating performance volatility and no association with the value of firm volatility in the future. Wang and Chiu [40] claimed that firms with higher rollover risk have more probability of default. Rollover risk is tied to short term debt. Conversely, Brancati and Macchiavelli [10] inferred that short term debt has an insignificant impact on default risk and has nothing to do with rollover risk. It only becomes severe if the firm has limited access to new loans. Javadi and Mollagholamali [23] reported that higher debt market illiquidity, specifically for short term debt causes more default risk. Keeping in view the above studies we propose the following hypothesis:

H1: Use of debt in capital structure makes agriculture-linked firms financially distressed.

H2: Use of debt with longer maturity makes agriculture-linked firms financially less distressed.

The moderating role of asset tangibility

The resource dependency theory claims that firms tend to acquire resources, both internal and external, to roll their operational wheels and make profits through this process. Acquisition of new finances especially borrowed ones are subject to the presence of tangible assets that can be used as collateral [5, 27]. Firms with more fixed assets can get loans quickly and at lucrative terms. This scenario brings a positive association between firm assets and financial leverage [3]. Mota and Moreira [29] investigated the determinants of the capital structure of Portuguese firms investing in Angola and found that firm age, asset tangibility and return on assets influence capital structure positively whereas, liquidity and non-debt tax shields affect the leverage ratio negatively in such firms. The static trade-off theory purports that an optimal structure is desired and firm profitability, asset tangibility and firm size have a positive impact on financial leverage. At the same time, past literature has developed a negative association between tangible assets and financial distress[6]. Similarly, Daskalakis and Psillaki [14] analyzed the capital structure of SMEs from France, Greece, Italy and Portugal. They inferred that the firms which invest more in tangible assets like property, plant and equipment as compared to the intangible assets face lower financial distress costs.

The impact of leverage on financial distress is positive in various studies which explain that a more levered firm will have more risk exposure as compared to the equity-based entities. This association is stronger for firms with more short-term debt if they find it difficult to refinance their operations regularly. Organizations issue more debt if they are facing lower levels of risk and rely on equity if facing higher levels of risk. Based on these relationships, we can infer that a firm with more tangible assets can get superior loans without putting firms in acute financial distress. Recently, Alfaro, *et al.* [2] determined the importance of total assets in defining the association between financial leverage and financial fragility in emerging markets. They further insisted that large firms are more fragile and equally crucial for economic growth. Lee *et al.* [26] studied the relationship between leverage and financial distress in the U.S. based restaurant industry. This study detected a positive moderating role of the capital intensity measured through fixed assets to total assets ratio on the relationship between financial leverage and distress. So, the positive association between leverage and financial trouble may be moderated by the volume of tangible assets possessed by firms keeping other things constant. Joshi [24] reported that firms with better risk management systems issue more debt and acquire more tangible assets. Increased debt causes more risk but neutralized through better risk management practices. Such firms also exhibit better cash flows with stability in sales and profits.

H3: Impact of capital structure and debt maturity on financial distress is moderated by asset tangibility in agriculture-linked firms.

MATERIALS AND METHODS

Data sample

The data extracted from Financial Statement Analysis (FSA) for non-financial firms listed on the Pakistan Stock Exchange (PSX) published by the State Bank of Pakistan (SBP) formed the primary sample. The data period of five years ranging from 2013 to 2017, is considered. A panel data set is generated for this study period — only those firms selected in the final sample which fulfill the following criteria.

*(i)*Those firms included which linked to the agriculture sector.

*(ii)*The firms that were in operation continuously during the study period.

*(iii)*The firms with missing data are excluded from the sample.

Those firms included in the sample that had data for five years before the study period to calculate the standard deviation of assets. It is required to classify the data into subsamples of low-risk and high-risk firms.

According to the FSA, there are 369 firms listed on PSX, out of which 207 firms linked to the agriculture sector. The complete data set is available for 187 firms based on the criteria mentioned above. There are 124 firms from the textile sector, 27 firms from the sugar industry, 13 firms from the food sector and 23 firms from other industries that secured their position in the final sample. Among these last 23 firms, 05 belong to chemicals and pharmaceuticals, 07 from the manufacturing sector, 03 from motor vehicles, trailers & auto parts and 08 relate to paper, paper board & products according to the economic groups defined by SBP. Firms less than ten from any sector are cumulatively placed under a single head of other industries instead of being separately identified due to lesser representation. We have further divided the primary sample into two sub-samples based upon their risk levels named as high risk and low-risk firms. We have calculated the standard deviation of return on assets for each firm and divided the firms into these two categories after calculating the median value of the standard deviation of return on assets. Firms with lesser value than the median of the standard deviation of return on assets are regarded as low-risk firms and remaining as high-risk firms. To avoid confusion and make data easily divisible we have considered the last year's value for this classification as each firm may have different values for standard deviation each year during the study period.

Statistical analysis

Variables and their operational definition

Before we proceed to the statistical analysis, it is essential to identify the variables involved in this study, their relevant proxies, and the methods of their computation (Table 1).

Table 1. Operational definition of variables

Variable	Notation	Measurement
Dependent Variable: Financial Distress (Altman, 2005 EM Z-score)	EMZ-Score	$6.56X_1+3.26X_2+6.72X_3+1.05X_4+3.25$
Independent Variable: Capital Structure Debt Maturity Ratio	D/E DMR	Total debt scaled by total equity Long term debt scaled by total debt
Moderating Variable: Asset Tangibility	AT	Fixed assets scaled by total assets
Control Variable: Profitability Firm Size Tax Expenses	ROA SIZE TAX	EBIT scaled by total assets Natural log of total assets Natural log of tax expenses

Source: Proxies based on past literature.

This study focuses on the impact of capital structure and debt maturity structure on financial distress. So, financial distress is the dependent variable in the current study. We used the emerging market Z-score model proposed by [4]. It involves three accounting ratios X_1, X_2, $X_3$and X_4 as working capital/total assets, retained earnings/total assets, current operating income/total assets and the book value of equity/total liabilities, respectively. The decision criteria is a cutoff point, i.e., if EMZ Score >4.15 then the firm is safe and the EMZ Score <=4.15 indicates that the firm is either facing financial distress or is vulnerable to distress in the respective year as per the firms are assigned binary values of 0 and 1.

The debt-equity (D/E) ratio used as a proxy for the capital structure similar to the other studies like [32]. We employed a debt maturity ratio (DMR), which is a ratio of long term debt to total debt as a proxy for debt maturity following [17]. This study also captures the moderating effect of asset tangibility represented by notation AT and measured similarly as to [29]. We have used three control variables in this study namely firm size (SIZE), taxes (TAX) and profitability (ROA) similar to the researches of [17, 33, 34], respectively.

Logistic Regression

Logistic regression is appropriate where the dependent variable is in binary numbers [11]. We will assign number '1' to the firms in financial distress, and '0' otherwise based on the emerging market Z-score discussed in the above section.

So,

$$Y = \begin{cases} 1, & distressed \\ 0, & undistressed \end{cases} \quad \text{......................} (1)$$

We will use binary logit models for panel data analysis, including and excluding moderators. Logistic distribution of the error terms assumed under logit analysis or logistic regression models. The logit analysis is a preferred approach over discriminant analysis. Based on the target estimation of financial distress the logit analysis model is reported as

$$P_{(FD)} = \frac{\exp(\beta o + \beta 1X1 + ...+ \beta mXm)}{1+\exp(\beta o + \beta 1X1 + ...+ \beta mXm)} \quad ....(2)$$

Where '$P_{(FD)}$' denotes the probability of financial distress in agri-linked firms

'Xi' represent the predictor variables, i equals 1 to m variables

'βo' is the intercept of the regression equation

'βi' capture coefficients of the predictor variables

The resultant odds equation defines the probability of being distressed as P and scaled by the chance of not being financially distressed as ($1 - P$) and can be re-written as

$$Ln(Odds) = \frac{P}{1-P} = \beta o + \beta 1X1 + \cdots + \beta mXm \quad ....(3)$$

The general logit regression models for the study given in the following equations:

$$EMZ - Score = \alpha + \beta 1\left(\frac{D}{E}\right) + \beta 2(DMR) + \beta 3(AT) + \beta 4(SIZE) + \beta 5(TAX) + \beta 6(ROA) + \epsilon \quad ....(4)$$

The equation (4) specifies the impact of capital structure, leverage structure, asset tangibility, and controls on financial distress without considering the interacting effect of asset tangibility. Control variables include firm size measured as the natural log of total assets and taxes measured as the natural log of annual tax expenses and return on assets as the ratio of earnings before interest and tax to total assets.

$$EMZ - Score = \alpha + \beta 1\left(\frac{D}{E}\right) + \beta 2(DMR) + \beta 3(AT) + \beta 4\left(\frac{D}{E}\right) \times (AT) + \beta 5(DMR) \times (AT) + \beta 6(SIZE) + \beta 7(TAX) + \beta 8(ROA) + \epsilon t \quad ....(5)$$

The equation (5) incorporates the interacting impact of asset tangibility and all other things being the same as in the equation (4). Where the dependent variable EMZ-score is a proxy for financial distress. Capital structure is proxied by D/E ratio, the debt maturity structure has a proxy denoted by DMR that represents long term debt ratio computed as the ratio of long term debt to total debt. Asset tangibility is represented by (AT). The interacting effects of assets tangibility are captured by notations (D/E)×(AT) and (DMR)×(AT). The control variables firm size, taxes and return on assets are denoted by SIZE, TAX and ROA, respectively.

RESULTS AND DISCUSSIONS

Table 2 presents the descriptive statistics of the study variables. The proxy for financial vulnerability presented by EMZ-score has a mean value of 0.43 with a standard variation of 0.49. We coded it as a binary number; therefore, minimum and maximum values are within a range of 0 and 1. The current study used the debt-equity ratio (D/E) as a measurement of capital structure, averaging 2.08, and having a standard deviation of 39.35.

Its minimum and maximum values lie at -941.27 and 337.8 respectively. The second independent variable of interest is the debt maturity ratio (DMR), with a mean value of 0.29 and 0.22 degrees of variation.

It involves firms with almost no long-term debt as minimum value accounts for 0 and also the firms with long term debt proportion as high as 99% of total debt.

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Table 2. Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max
Panel A-Overall Firms					
Z-Score	935	0.431	0.495	0	1
D/E	935	2.081	39.359	-941.272	337.808
DMR	935	0.292	0.216	0	0.999
AT	935	0.596	0.215	0	0.999
lnTAX	935	13.743	0.507	1.386	16.391
lnSIZE	935	14.619	1.842	7.045	18.763
ROA	935	0.456	18.654	-241.64	139.37
Panel B- High-Risk Firms					
Z-Score	390	.4897436	.5005369	0	1
D/E	390	2.357184	20.6805	-88.43332	337.8081
DMR	390	.2756544	.2284976	0	.9985459
AT	390	.5697841	.2416452	.0000558	.9997464
lnTAX	390	13.76632	.3568962	13.32332	16.39085
lnSIZE	390	14.15512	1.853395	7.044905	18.76264
ROA	390	-1.478256	27.34055	-241.64	139.37
Panel C- Low-Risk Firms					
Z-Score	545	.3889908	.4879691	0	1
D/E	545	1.882644	48.51533	-941.2717	309.6904
DMR	545	.3042311	.206655	0	.9477246
AT	545	.6145041	.191562	.0008426	.9996196
lnTAX	545	13.72552	.5907616	1.386294	15.78902
lnSIZE	545	14.95262	1.761909	8.197264	18.71674
ROA	545	1.840165	7.634875	-22.64	32.31

Note: EMZ-Score represents emerging market Z-score, D/E describes the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. Size means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets.
Source: Author's calculations.

This study has a particular focus on the moderating effects of asset tangibility (AT), with an average value of 0.60 and a variation of 0.22. The minimum value for this variable is 0 and the maximum accounts for 0.99. We have used three control variables termed as lnTAX, lnSIZE, and ROA; each has average values of 13.74, 14.61 and 0.45, respectively.

The subsamples based on the median value of the standard deviation of return on assets, regarded as high-risk and low-risk firms also reported to understand the nature of data. The high-risk firms are more vulnerable as expected to have a mean value of 0.49 as compared to low-risk firms with a mean value of 0.38 for Z-score. Variation in means of two samples is 0.50 and 0.48, respectively. High-risk firms on average, used more debt as specified by the debt-equity ratio of 2.35 in comparison to 1.88 for low-risk firms. However, low-risk firms are volatile in debt consumption as their standard deviation approaches 48.51, much higher as compared to the high-risk firms represented by 20.68 variations in their debt usage. Average debt maturity of the two sub-samples is somewhat similar, represented by 0.27 and 0.30 with 0.23 and 0.20 standard deviation of debt maturity levels for high risk and low-risk firms. The mean of the proportion of tangible assets is 0.57 and 0.61 for high risk and low-risk firms, deviating up to 0.24 and 0.19, respectively.

Table 3. Correlations

	Z-Score	**D/E**	**DMR**	**AT**	**TAX**	**SIZE**	**ROA**
Z-Score	1						
D/E	0.02	1					
DMR	0.01	0.01	1				
AT	0.32*	0.00	0.23*	1			
TAX	-0.18*	-0.00	-0.04	-0.10*	1		
SIZE	-0.31*	-0.02	-0.05	0.00	0.21*	1	
ROA	-0.40*	-0.01	0.06	-0.16*	0.14*	0.37*	1

Note: EMZ-Score represents emerging market Z-score, D/E describes the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. Size means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets.
Source: Author's calculations.

Table 4. Variance Inflation Factor (VIF)

Sr#	**Variable**	**VIF**	**1/VIF**
1	D/E	1.00	0.999
2	DMR	1.08	0.925
3	AT	1.11	0.897
4	lnTAX	1.06	0.940
5	lnSIZE	1.22	0.820
6	ROA	1.23	0.816
7	Mean VIF	1.12	

Note: D/E represents the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. Size means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets.
Source: Author's calculations.

Table 3 represents correlations among the study variables. The debt-equity ratio and debt maturity ratios have an insignificant positive relationship with z-score. Asset tangibility has a significant positive correlation to EMZ-Score and DMR whereas it has an insignificant positive correlation with the debt-equity ratio. Moreover, the DMR is a proportion of long-term debt to total debt, and it signifies that the rate of short term debt to total debt should have a negative association with z-score and asset tangibility. None of the selected variables has a correlation value of more than 0.5 which rejects the possibility of a multicollinearity problem among these variables. We are using logit regression in our analysis which relaxes many post estimation assumptions but is highly sensitive to multicollinearity. However, to further investigate this issue, we calculated the Variance Inflation Factor (VIF) which affirms our inferences regarding multicollinearity as all the study variables have values much less than the cutoff value of 10 as described by [36] (Table 4).

Main findings

The following Table 5 is designed to report the logit regression results based on the overall sample of firms containing 935 observations for each variable. The moderating role of asset tangibility is studied in two separate regression models termed as model 2 and model 3. Model 1 represents the results without assuming the moderating role of asset tangibility. Whereas model 2 assumes this role for the relationship of leverage and the probability of financial distress and model 3 for the relationship of debt maturity and the likelihood of financial distress.

This study employed logit regression models with and without the interaction of asset tangibility. Table-5 reports the results for non-financial agriculture linked firms using logit regression. The regression results without taking into account the moderator as shown under model-1 specify that debt-equity ratio (D/E) has a negative but insignificant impact on the probability of being financially distressed as its coefficient value is negative and p-value equals 0.84 which is much high than the critical level of 0.05 at 95% level of significance. Similar results reported for the debt maturity ratio (DMR) in this case. The beta coefficient for debt maturity stands at -0.49 depicting a negative association with the probability of financial distress but its p-value is also higher than the critical value i.e. p-value = 0.22 > 0.05.

Table 5. Logit Regression Results for Overall Sample

Variable	Without Interaction	With Interaction	
	Model 1	**Model 2**	**Model 3**
D/E	-0.00(0.84)	-0.02(0.12)	-0.00(0.88)
DMR	-0.49(0.22)	-0.55(0.18)	2.28**(0.03)
AT	2.59***(0.00)	2.63*** (0.00)	3.93***(0.00)
D/E×AT		0.03(0.12)	
DMR×AT			-4.37***(0.00)
lnSIZE	-0.20***(0.00)	-0.20***(0.00)	-0.19***(0.00)
lnTAX	-1.37*(0.08)	-1.49*(0.06)	-1.36*(0.09)
ROA	-0.16***(0.00)	-0.16***(0.00)	-0.16***(0.00)
Log Likelihood	-415.35	-413.99	-410.80
LR Statistics	447.62***(0.00)	450.34***(0.00)	456.74***(0.00)
Pseudo R^2	0.35	0.35	0.36

Note: D/E represents the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long-term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. SIZE means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets. Coefficients followed by ***, **, and * are significant at the 1%, 5%, and 10% level of significance respectively

Source: Author's calculations.

Debt maturity ratio measured as a ratio of long term debt to total debt which specifies a negative association with the possible occurrence of default and the results will become opposite if we use the ratio of short term debt to total debt in this analysis. This association is insignificant but yet it can be inferred that long-term loans are less deteriorating as compared to the short term loans in case of financial vulnerability. However, asset tangibility proved to be a strong predictor of the financial vulnerability with a coefficient value of 2.59 and a p-value of much less than 0.05 i.e. p-value = 0.00 in this case. All the control variables had a negative influence on a possible default, but it was insignificant for the log value of tax expense at a 5% level of significance but significant at a level of 10%. The coefficient values for SIZE, TAX and ROA are -0.20, -1.37 and -0.16 respectively and p-values are less than 0.05 except taxes.

The second stage of analysis involves the interaction of asset tangibility as a moderator in this study. The results showing the moderating role of asset tangibility are reported in columns under model 2 & 3 in this table. Model-2 captures the moderating role of asset tangibility on the relationship between the debt-equity ratio and the probability of financial distress. The negative and insignificant impact of debt-equity and debt maturity ratio persists in this model as previously (beta = -0.02 & p-value = 0.12 i.e. p-value > 0.05 for D/E and beta = -0.55 & p-value = 0.18 i.e. p-value > 0.05 for DMR). Asset tangibility still reveals a positive and significant role with a beta value of 2.63 and a p-value of 0.00. Unlike Lee, Koh and Kang [26], there is a positive impact of tangible assets on financial distress. The positive relationship between the proportion of tangible assets to total assets and the probability of financial distress can also be narrated as the existence of unproductive fixed assets which are unnecessarily accumulated and are also not utilized properly as collateral for leveraged acquisition and as a result causing an increase in distress. The primary variable of interest is the moderating role of asset tangibility in this study in that the interaction term D/E×AT showed positive but insignificant moderating effect as coefficient value is 0.03 at 0.12 level of significance. The controlling power of the control variables remains unaffected even after the introduction of the interacting role of asset tangibility in model-2. All of them have a negative and significant impact on possible corporate distress. However, taxes are significant at 10% where, p-value = 0.06 i.e. 0.05 < p-value < 0.10.

The second interaction term denoted by DMR×AT captured in model-3 given in Table 5. The results for D/E ratio are similar to the previous two models but the DMR reveals a positive and significant role in predicting probable financial distress in this case showing a regression coefficient value of 2.28 and a p-value less than 0.05 i.e. 0.03. The standalone impact of asset tangibility is further strengthened in this model showing a beta value of 3.93 and a p-value of 0.00. Asset tangibility negatively moderates the relationship between debt maturity ratio and the probability of financial distress, as evidenced by the significant negative coefficient value of -4.37. It can be inferred that firms with more tangible assets and debt with longer maturities cause a reduction in possible financial distress and confirm our third hypothesis using logit regression only in case of long term debt usage which means if we take into account the debt with short maturities this interacting effect will reverse which can be a possible reason for a positive moderating role of asset tangibility on total leverage usage as specified by the interacting function of asset tangibility and debt-equity ratio. Agriculture linked firm need to worry less about long term leverage decisions if it possesses a higher concentration of assets as tangibles, but short-term financing decisions are a matter of concern . However, no such advantage captured for total leverage including a combination of short term and long-term debt in this study. The three control variables once again were significantly and negatively associated with possible financial distress, but the only taxes were insignificant at 5% level of significance.

Further checks for high-risk and low-risk firms

As discussed earlier, we have divided the primary sample of firms into two subsamples of high risk and low-risk firms based on the median value of the standard deviation of return on assets to put more rigor in our analysis. The following Tables 6 & 7 report the logit regression results of the two subsamples.

The result for model-1 without adding moderators report a positive impact on the outcome variable, but this impact is again insignificant for debt-equity and debt maturity ratio as reported in Table 6. Asset tangibility predicts a 3.03 per unit change in outcome variable and is again significant with a p-value of 0.00. Results for control variables reaffirm a negative change as firm size, taxes and return on assets have a negative influence, but it is significant for size and returns on assets as the p-values lie within the 5% range. However, in model-2, after adding moderators, the capital structure causes an insignificant negative change in probability of default, whereas debt maturity results in an insignificant but positive change in the dependent variable, as evidenced in model-1. The first moderating term D/E×AT is insignificant and positive as shown under heading model-2 (beta = 0.18 and p = 0.16 i.e. $p > 0.05$)and the model-3 exhibit that second moderating term DMR×AT causes a negative and insignificant change in high risk firms (beta = -1.48 and p = 0.48 i.e. $p > 0.05$).

Table 6. Logit regression results for high-risk sample

Variable	Without Interaction	With Interaction	
	Model 1	Model 2	Model 3
D/E	0.00(0.36)	-0.08 (0.20)	0.01(0.36)
DMR	0.49(0.43)	0.41(0.52)	1.30(0.32)
AT	3.03***(0.00)	3.02***(0.00)	3.39***(0.00)
D/E×AT		0.18(0.16)	
DMR×AT			-1.48(0.48)
lnSIZE	-0.42***(0.00)	-0.41***(0.00)	-0.42***(0.00)
lnTAX	-0.82(0.56)	-0.83(0.56)	-0.78(0.58)
ROA	-0.09***(0.00)	-0.10***(0.00)	-0.10***(0.00)
Log Likelihood	-170.70	-169.61	-170.45
LR Statistics	199.09***(0.00)	201.27***(0.00)	199.60***(0.00)
Pseudo R^2	0.37	0.37	0.37

Note: D/E represents the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. SIZE means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets. Coefficients followed by ***, **, and * are significant at the 1%, 5%, and 10% level of significance, respectively

Source: Author's calculations.

The impact of the proportion of tangible assets remains positive and significant in all the three models with slight variation in beta coefficients. These results prove that high-risk firms are unable to utilize the available tangible assets in attracting favorable financial leverage and their leverage acquisition is further adding to the possibility of default. However, the results for this sample once again confirms that the three control variable including firm size, taxes and profitability brace the financial soundness of the agriculture linked non-financial firms but taxes found to be having an insignificant role in doing so as portrayed by their insignificant p-values in the three models.

Table 7 is designed to report the logit regression results for low-risk firms with and without moderators. As shown in model-1 debt-equity ratio (D/E) has a negative but insignificant role in predicting financial distress without adding moderator. The debt maturity ratio (DMR) has a negative and significant role in defining possible distress in low-risk firms. Asset tangibility, in this case, has once again the positive and significant role (beta = 3.06 and p-value = 0.00).

Table 7. Logit regression results for low-risk sample

Variable	Without Interaction	With Interaction	
	Model 1	Model 2	Model 3
D/E	-0.00 (0.47)	-0.02*(0.08)	-0.000.52
DMR	-1.73***(0.00)	-1.82***(0.00)	1.86(0.31)
AT	3.06***(0.00)	3.18***(0.00)	4.85***(0.00)
D/E×AT		0.03(0.10)	
DMR×AT			-5.12**(
lnSIZE	0.02(0.74)	0.04 (0.64)	0.06(0.48)
lnTAX	-1.49(0.20)	-1.73(0.14)	-1.610.16
ROA	-0.32***(0.00)	-0.32***(0.00)	-0.32***(0.00)
Log Likelihood	-209.10	-207.74	-206.80
LR Statistics	310.23***(0.00)	312.96***(0.00)	314.85***(0.00)
Pseudo R^2	0.43	0.43	0.43

Note: D/E represents the debt to equity ratio, a proxy used for capital structure, DMR is a notation for debt maturity ratio measured as a percentage of long-term debt to total debt used as a proxy for debt maturity. AT means asset tangibility, a ratio of fixed assets to total assets. SIZE means natural log of total assets. The TAX represents the natural log of yearly tax expenses, and ROA is a proxy for profitability measured as a ratio of earnings before interest and tax to total assets. Coefficients followed by ***, **, and * are significant at the 1%, 5%, and 10% level of significance respectively

Source: Author's calculations.

In the case of control variables, only return on assets has substantial power to explain possible distress with significance values of 0.00 as reported in model-1.

After introducing the proportion of tangible assets to total assets as moderator, the debt equity ratio (D/E) shows a negative but significant change in outcome variable at 10% level of significance, the debt maturity ratio (DMR) also contributes positively to the financial stability of the agriculture linked firms (beta = -0.02 & p-value = 0.08 for D/E and beta = -1.82 & p-value = 0.00 for DMR as reported for model-2). Asset tangibility constantly reports significant positive results for all the three regression models (beta = 3.01 & p-value = 0.00 for model-1, beta = 3.18 & p-value = 0.00 for model-2 and beta = 4.85 & p-value = 0.00 for model-3). The first moderating term D/E×AT has insignificant but positive role in describing the chances of financial fragility (beta = 0.03 and p = 0.10).

The moel-3 reaffirms the negative role of debt-equity ratio (D/E) but the positive role of debt maturity ratio (DMR) but insignificant in both cases. The second moderating term

DMR×AT reduce the chances of financial vulnerability as a negative and significant value is reported (beta = -5.12 and p = 0.04, i.e., $p < 0.05$). These results confirm the significant moderating role of asset tangibility on the relationship between debt maturity ratio and financial distress. More importantly, these results are consistent with the overall sample of firms unlike the high-risk firms. So, the high-risk firms need to see their leverage decisions more keenly as compared to low-risk firms.

Agriculture linked firms are greater in number than non-agriculture related firms in Pakistan being an agriculture-based economy. These firms use agricultural produce as raw materials or produce goods used in agricultural operations. Farmers do not grow less rewarding crops subject to their demand. Thus, the inferior contribution of agriculture linked corporations will force them to other crops that are more rewarding or are in demand. This statement refers to the dependence of corporations on agriculture and vice versa. The current study examines the moderating role of asset tangibility on the relationship of capital structure and debt maturity structure with the possible financial vulnerability of the agriculture linked firms. Results portray an insignificant impact of debt usage on the probability of financial distress in these firms. The proportion of fixed assets in total assets is positively linked to financial distress. There is a scarcity of research that establishes this link. However, there is an abundance of research that relates asset tangibility to firm risk [22]. Literature also builds an active link between firm risk and financial suffering. So, we can relate the asset tangibility to financial distress in this sense. The current study establishes a significant positive role of asset tangibility on the chances of being financially distressed. A firm's fixed assets typically serve as a source of operating leverage and thus tend to increase the firm risk. It can be inferred that a firm with a higher value of fixed assets in its asset structure is exposed to higher fixed costs that are not proportionate to its revenue generation [35].

Asset tangibility does not moderate the relationship of debt usage measured through debt-equity ratio with financial distress being statistically insignificant. The analysis of the relationship between debt maturity ratio measured as a ratio of long term debt to short term is negatively moderated by asset tangibility. It means that a firm using long term debt with a high level of fixed assets will have fewer chances of being financially distressed. This result supports the information asymmetry theory for firms with increased tangible assets in the structure of their assets. It is also proved that these results will be the opposite if we use the ratio of short-term debt to total debt as a proxy for debt maturity structure. Thus, we validate the argument that short term leverage is riskier in comparison to long term debt as also posited by [40] in the Pakistani context for agriculture linked non-financial firms. It is also evident that the average proportion of long term debt in agriculture-related non-financial is less than 30% and therefore, it is 70% for short term debt in Pakistani context confirming the inferences of [18] claim that nations with weaker laws and more corruption use more short term debt. Robustness checks were made to study these relationships in high-risk and low-risk firms. The empirical findings show that asset tangibility has no significant moderating role in the case of high-risk firms. However, in the case of low-risk firms, there is a significant moderating role of asset tangibility on the relationship of debt maturity and the probability of financial distress only confirming the results obtained for the overall sample. This evidence suggests that high-risk firms need to increase the proportion of long-term debt in their debt maturity structure to reduce the impact of rollover risk and also reduce the financial distress consequently.

CONCLUSIONS

Conclusions

The stock markets are mostly dependent on the agriculture sector in many emerging economies like Pakistan. A large number of firms are dependent on agriculture which makes it a fascinating area of study. In this paper, we studied the impact of leverage and debt maturity structure on the probability of being financially distressed. Further, we analyzed the moderating role of asset tangibility on the relationship between capital structure and financial distress and the relationship between debt maturity and financial distress. The debt maturity structure has a negative impact on the probability of distress. The debt maturity is measured as a percentage of long term debt to total debt and it can be inferred that long term debt causes a reduction in financial distress which supports the notion that short term debt is risky that causes more chances of distress. The availability of tangible assets serves as collateral while acquiring loans and allows us to get credits on better terms. The empirical findings suggest a positive impact of fixed assets on the probability of financial distress which is a contradiction to the common knowledge. Asset tangibility also moderates the relationship positively between leverage and likelihood of financial distress and negatively between leverage maturity and the probability of financial distress. Past studies like [26] have also studied similar phenomena in U.S. based restaurant industry and regarded that firms that have more fixed assets should be less concerned about leverage but this study states such results for debt maturity ratio rather than overall debt position.

Policy Implications

This research has multiple implications for financial managers and policymakers at the organizational and governmental levels. First, it is observed that the leverage mix contains a much higher proportion of short-term debt in comparison to long term debt which adds to more risk and the higher probability of financial distress in agriculture-linked non-financial firms. Debt with longer maturities postpones the firm risks whereas short term loans enhance the current obligations, so, the firms facing huge risk should avoid short term loans and should try to finance itself through long term debt. Second, high-risk firms have a low proportion of fixed assets in their asset structure or are unable to use them productively. So, they must utilize their fixed assets properly in business operations to take advantage of them as collaterals. It is also observed that possible financial distress is insensitive to the overall debt levels and also insignificant for debt maturity. However, the interaction with the proportion of intangible assets in the asset structure makes long term debt risk inhibitor. Third, on a comparative basis, low-risk firms are highly sensitive to debt maturity, which predicts a reduction in distress, but the results are not confirmed for high-risk firms. On this basis, managers are advised to borrow on a long-term basis following less risky firms to avoid financial distress while devising their borrowing strategies. Fourth, governments are advised to make policies targeting subsidized lending rates to these firms and easy access to external financing. In Pakistan, usually very high markup rates are charged by lenders which makes borrowing unattractive adding more risk. The government acquires funding to handle the budget deficit from international agencies and sets the domestic lending rate much above the rate charged by these creditors. We recommend considering such a macro factor in future research and regard it as a limitation of this study. Moreover, the asset base of each sector of firms is different but this study considers them as equal. Therefore, it accounts for a limitation and further research may deal with various sectors separately for analyzing the role of tangible assets.

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INFLUENCE OF MARKETING INSTRUMENTS ON THE FORMATION AND USE OF MARKETING POTENTIAL OF AGRICULTURAL ENTERPRISES

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Abstract

The article presents the results of research of theoretical, methodological and practical aspects of marketing mechanism formation of agricultural enterprises development. The essence of the notion «marketing mechanism of agricultural enterprises development» is defined. This mechanism is considered as a set of management levers of economic, organizational, analytical and diagnostic aspiration, means, principles, methods and marketing tools, which are used in the activity management, directed to the transformation of enterprise potential into the concrete production results, capable to satisfy the consumers' needs at the market, providing the agricultural producers with the weighty levers in competitive fight. The suggestions concerning the methodical approaches to the evaluation of the marketing mechanism efficiency of agricultural enterprises development are formulated. They provide for the complex analysis of application efficiency of structural components of this mechanism, which are: market segmentation and choice of target segments; positioning of agricultural enterprise production; formation of effective assortment policy; formation and realization of strategy of bringing new products to the market; differentiation of price policy; optimization of sales system; construction of effective communication policy. The assessment of these components will make it possible to identify potential opportunities for the improvement of some of them. Methodical approaches to the estimation of marketing instruments influence and intangible assets on the formation and use of marketing potential of agricultural enterprises are worked out in the article. With the help of correlation-regression analysis a number of interdependencies between the investigated features has been revealed. The proposals regarding the allocation of agricultural enterprises with high, medium, satisfactory and low level of marketing potential use are formulated. The proposed gradation and its implementation methodology makes it possible to assess the impact of marketing potential on the market position of agricultural enterprises.

Key words**:** *agricultural enterprises, cluster, competitiveness, marketing, marketing mechanism, marketing potential*

INTRODUCTION

The priority of development of the agricultural sector is determined by the exceptional importance of agricultural production both for human activity and for the society as a whole [10]. In the current crisis, it is the agrarian sector that has been recognized as a strategic priority for the development of the domestic economy in the short term, since the effective operation of the agroindustrial complex provides a significant share of revenues to the state budget through export operations [11, 5, 6]. Agriculture is the resource base of many sectors of the national economy, the key to food security of the state [13]. It is extremely important to ensure the efficient operation of agricultural enterprises, which is largely determined by the results of their activities in the sale of their products [1, 3].

Today, it is difficult for agricultural companies to compete in the market. This situation is caused by a high level of instability due to imperfection of the economic mechanism, underdevelopment of market infrastructure, lack of necessary information about market state and practical experience in a dynamic competitive environment [4]. The driving force in resolving of the most of these issues may become the formation of a marketing mechanism for agricultural enterprise development based on the elements of integration and innovation, which will allow to use the opportunities in orer to prevent the crisis processes impact on their effectiveness [9].

MATERIALS AND METHODS

The theoretical and methodological basis of the research was the situation in the domestic and foreign economic science as for the issues of formation and development of marketing mechanism, the marketing activities of agricultural enterprises. To accomplish the article tasks such scientific and special research methods are used: scientific induction and deduction – with justification of the essential characteristics and determination of the economic nature of marketing mechanism" concept; the historical and logical – to study the evolution of the marketing mechanism essence; abstract and logical – for theoretical generalizations and conclusions formation; comparison and synthesis – to identify the features of formation marketing mechanism in the agricultural enterprises; correlation and regression analysis – to identify and assess the impact of factors on the marketing mechanism of agricultural enterprises; monographic – in the assessment of the marketing capacity of selected typical agricultural enterprises and the efficiency of its use; an expert survey - to assess marketing potential of selected agricultural enterprises; integrated assessment for integrated diagnostics efficiency of organizational measures on creation of the agricultural cluster according to process and indicators developed by the authors.

Sources of information which were used by authors include legislative acts of the Verkhovna Rada of Ukraine; the official data of the State statistics service of Ukraine, Main Department of statistics in Lviv oblast, information of agricultural enterprises; domestic and foreign scholars investigations of the problem, personal observations of the authors.

RESULTS AND DISCUSSIONS

The formation and use of marketing mechanisms is important for the solution of complex problems related to ensuring effective management of agricultural enterprises. The concept of «marketing mechanism» is a system of management levers, combined with the marketing tools, resources, principles, methods, marketing principles, used by agricultural enterprises in the business management aimed at transforming potential of an enterprise in specific performance are able to meet the needs of consumers on the market.

Detailed functions of the marketing mechanism can be allocated to three groups: the analytical (separation of the market into segments and study of the behavior of consumers in these segments, the market research, study of the behavior of competitors), strategic (creation of strategies, market selection, market development, market stimulation, market promotion); resulting (implementation of marketing plans, marketing programs, marketing projects) [14].

Taking into account the specificity of agricultural enterprises activity, it is appropriate to consider their competitiveness which is interrelated of the competitive advantages of products offered by them. Competitiveness of agricultural products reflects its ability to meet the needs of consumers more fully in comparison with similar products, available in the consumer market. It is defined by the following competitive advantages: quality and its technical characteristics, price characteristics, a purchase incentive system [7].

Competitiveness is the ability of enterprises to carry out their development using the tools of the marketing mechanism to preserve existing and forming new competitive advantages. For an integrated estimation of agricultural enterprises competitiveness it is advisable to consider such characteristics as the competitiveness of the product of the enterprise on the market, logistics of product distribution, marketing communications, product differentiation [2].

There are three directions of efficiency assessment of the agricultural enterprises marketing mechanism development: strategic, tactical, operational [12]. Taking into account the principles of the system approach, a complex approach to the evaluation of the effectiveness of this mechanism to implement based on the analysis of its components, which are actions with: market segmentation and selection of target segments; agricultural enterprises products positioning; formation of effective assortment policy and implementation of launchin new products to market; differentiation of price policy; sales system optimization; building of an effective communication policy.

During the study, regional peculiarities and agricultural enterprises development regularities as an object of study have been identified. Analysis of the processes of their development over the last decade indicates instability with a tendency of agricultural production development decrease in medium and large agricultural enterprises, reduction of their number.

The analysis of the Carpathian region and Lviv oblast agricultural enterprises gross output production volumes dynamics (in constant 2015 prices), indicates a significant increase during 2000-2015. Livestock production increased at a higher rate due to the development of poultry and pig breeding in the agricultural enterprises. However, the high proportion of unprofitable agricultural enterprises in Lviv oblast indicates the need for the business entities to look for new tools in order to improve the efficiency of their operations. One of the factors, that affects the achieving of enterprise certain goals, is its potential, part of which is marketing.

Taking into account the results of the study, the theoretical foundations of the concept of «marketing potential of agricultural enterprises» have been developed, which is defined as potential own resources of enterprises, which ensure its costant competitiveness to occupy broad competitive advantages market niche, form a development strategy for the future based on such marketing tools as quality management; strategic planning and product, competitors and consumers behavior control; strategic planning and conducting effective marketing activities in the sphere of demand study, commodity, price, communication and sales policy.

The marketing potential of agricultural enterprises is based on the resource marketing potential, the total potential of marketing tools and potential of intangible assets. The activities of the entity on the market is determined by complex of factors of influence of external and internal environment. The main factors of influence which determine the character of formation process of agricultural enterprises marketing potential of include: the level of staff qualifications (professionalism of marketers), the logistics system, which is built on the basis of long-term relationships, marketing information system, the level of correlation "price-quality", positioning system, pricing, market share, consumer awareness of a brand, under which the company operates, the structure of the assortment policy, the availability of own distribution network, consumer value for the consumer from the consumption of the product, the level of innovative technologies use in the production process, the duration of the production process, the level of labor productivity [13].

Taking into account certain facts, the ranking of agricultural enterprises by level of marketing intensity that allowed identifying industries with high, medium, satisfactory and low level, was made.

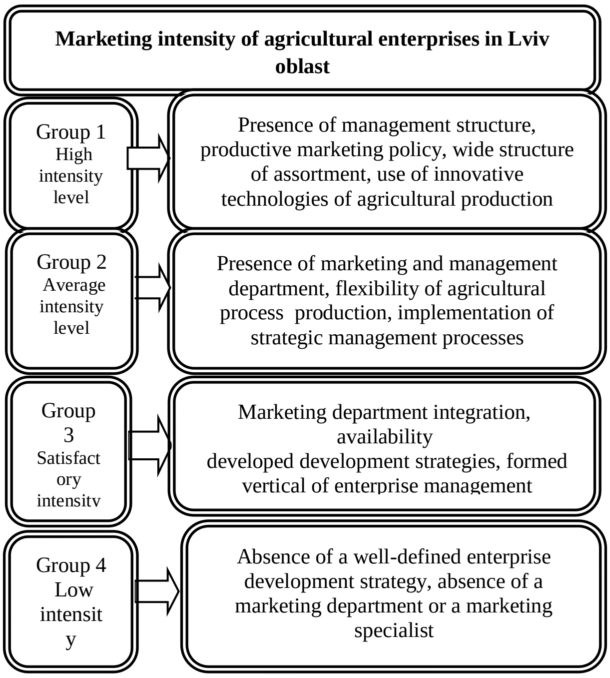

Fig. 1. Ranking of agricultural enterprises by feature marketing intensity
Source: Generalized by authors based on [3, 5, 6].

The characteristics of marketing activity management of the enterprises for each of the selected groups are generalized. Enterprises with low levels of marketing potential operate in an unattractive market for themselves. The reasons for such problems may be the low level of specialists-marketers qualification, the discrepancy of management organizational structure to modern market requirements, the inadequacy of the marketing-management system, the unjustified ambitious views of enterprises management.

The characteristics of agricultural enterprises marketing potential using were investigated on the example of three enterprises, identified as model ones - Apogey Agro LLC, Privat-Agro-Lviv LLC, Agro-Progress PE. The weighting factors of of these enterprises marketing potential components were determined on the basis of a questionnaire. Respondents, when completing the proposed questionnaire, had to indicate the degree of their agreement with the proposed statement on the following scale: 0 - completely ineffective; 0.25 - not effective; 0.5 - ineffective; 0.75 - more effective; 1.0 is quite effective. The results of components evaluation of resorce marketing potential of these enterprises are given in Table 1.

According to a similar methodology, the model agricultural enterprises marketing tools potential and the potential of their intangible assets were evaluated. In marketing tools potential the main components were pointed out, namely: analitical (displays technology of sales, processing and storage of data), production (relates to the procedures of market segmentation, the assortment study, pricing), sales (development of sales strategy, forecasting, preparation and implementation of operational plans and marketing activities) and communication (organization of promotional activities). In the composition of potential intangible assets potential image of the enterprise and technological intangible assets are allocated and evaluated [6].

Evaluation of model efficiency of agricultural enterprises of marketing activity was made. It takes into account the market share of enterprises, includes comparison of marketing expenses with revenues from sales and net profit, determining the share of these costs in the gross expenditure of the entity.

Table 1. Results of marketing potential resource components estimation of Lviv oblast model agricultural enterprises

Factor	Indicator	Weigh-ting Criteria	Enterprise			Overall score
			1	2	3	
The potential of real resources	Marketing automation tools (computers, IP telephony, etc.)	0.36	0	0.57	0.34	0.66
	Local area network for computer communications	0.32	0.89	0.72	0.32	0.68
	WEB-directory	0.22	0.79	0.61	0.1	0.3
	WEB server	0.1	0.81	0.62	0.0	0.14
	Total weight / rating	1.00	0.81	0.62	0.24	0.44
The potential of financial resources	Volume of own marketing financial resources	0.19	0.76	0.71	0.44	0.43
	Financing of marketing logistics	0.14	0.66	0.62	0.39	0.25
	Financing of marketing research	0.1	0.73	0.54	0.12	0.!4
	Financing of new products development	0.15	0.76	0.69	0.29	0.28
	Financing of branding and image support	0.2	0.62	0.53	0.27	0.3
	Financing of sales	0.23	0.8	0.58	0.11	0.37
	Financing of marketing service	0.13	0.60	0.52	0.21	0.18
	Financing of staff training	0.06	0.59	0.53	0.19	0.08
	Total weight / rating	1.00	0.84	0.71	0.29	0.27
Labor resources potential	Personnel policy of the enterprise in the sphere of marketing	0.2	0.79	0.61	0.27	0.4
	Sales staff planning	0.15	0.49	0.48	0.18	0.36
	Staff training and qualification	0.1	0.67	0.59	0.21	0.36
	Remuneration of staff	0.18	0.79	0.74	0.31	0.55
	Level of professional competence	0.1	0.72	0.69	0.57	0.64
	Staff's ability to adapt professionally	0.07	0.71	0.65	0.48	0.57
	The reputation of managers	0.06	0.76	0.71	0.39	0.51
	Availability of staff experience in marketing	0.14	0.67	0.59	0.44	0.54
	Total weight / rating	1.00	0.74	0.67	0.29	0.49

Source: Generalized by authors based on [1, 7, 9].

The profitability of marketing expenses in the investigated enterprises which is an integrated assessment of marketing activities effectiveness.

A distinctive feature of the modern market environment is the variety of integrated structures, which are widespread in the agricultural sector, providing a significant impact on the activities of many farmers. System management of the marketing mechanism of agricultural enterprises, which is based on the concept of integration is defined as a set of principles, functions, administrative relationships and mechanism of production distribution and income distribution based on marketing tools, as to result of the interaction leads to the development of agricultural enterprises and the implementation of their mission - to meet the market needs and demands of consumers in the quality agro-food products [8].

One of the most appropriate forms of integrated units in agricultural production are clusters and association established in their framework. A leading, pivotal role in shaping of agro-industrial cluster plays the main sector, which includes agricultural producers, processing enterprises which ensure uninterrupted processing of agricultural raw materials and production of finished products, as well as a network of branded stores. The clustering process gives the possibility for a small size and interconnected small enterprises to complement activities of each other, increase productivity, innovate, improve product quality, form relationships of trust, exchange the ideas and information, work together to coordinate actions, stimulate products sales, strengthen the competitiveness of economic entities [13].

It is determined that the tools of marketing, that are primarily associated with the process of business entity internal system adaptation to external and internal factors of the business processes with the aim to capture target markets, are targeted on search of prospects for the agricultural enterprises development. An important task in the activities of agricultural enterprises is the effective analysis and forecasting of the marketing environment and economic situation on agricultural markets with the aim of creating competitive positions, synchronization of own management decisions with objective changes in the environment. Agricultural enterprise can not control all factors and influence them. Thus, improving the efficiency of marketing activities in agricultural enterprises on the basis of marketing action mechanism and the effect of marketing environment factors is essential [6].

Studies show the necesity to consider the marketing environment of agricultural enterprises functioning from the standpoint of its internal and external components, with the latter distributed on microexternal and macroexternal environment. The internal factors are those, which are directly involved in the activities of agricultural enterprises, and which are under their control [7]. External marketing environment of the agricultural enterprises are factors that act outside of such enterprisess and they can not be influenced by them. External marketing environment includes economic, demographic, political-legal, socio-cultural, natural, geographical, and technological factors. The micro-external environment includes entities that can be influenced by an agricultural enterprise in a particular way: consumers, customers, buyers, competitors, suppliers, intermediaries, contact audiences.

Evaluation of competitiveness level of model agricultural enterprises of Lviv oblast according to integrated indicators of economic activity efficiency and the effectiveness of the marketing mechanism development were made (Table. 2). Figures showed a close relationship between the relevant integral metrics.

Table 2. Evaluation of model agricultural enterprises competitiveness of by integrated performance indicators

Enterprise	2016	2017	2018
Integral indicator of economic activity efficiency			
Apogee Agro Ltd.	1.45	1.75	1.87
Privat-Agro-Lviv LLC	0.79	1.25	1.2
PE "Agro-Progress"	0.78	0.74	0.79
Integral indicator of development marketing mechanism effectiveness			
Apogee Agro Ltd.	0.85	1.1	1.2
Privat-Agro-Lviv LLC	0.58	0.7	0.83
PE "Agro-Progress"	0.4	0.46	0.6

Source: Generalized by authors based on [3, 6].

According to analysis results a set of recommendations aimed at the development of agricultural producers through the improvement of their marketing activities has been developed [10]. They provide for the formation of competitive integrated organizational structure of agricultural enterprise marketing activity management on the basis of efficient information system with the involvement of a complex of marketing instruments.

CONCLUSIONS

Scientific results gave reasons for such theoretical, methodological and applied nature conclusions:

-Marketing mechanism of agricultural enterprises development is a set of managerial levers of economic, organizational, analytical and diagnostic areas, facilities, principles, methods and marketing tools which are used in the management of activities aimed at transforming potential of an enterprise in specific production results that meet the needs of consumers in the market, giving farmers the most important levers in competitive fight.

-Principles of marketing mechanism are formed on the basis of an integrated system of marketing tools interaction, systematic management of which is implemented through the analytical, strategic and productive functions. Methodical bases of agricultural enterprises marketing mechanism formation are in a certain order of actions to achieve the goals set by enterprise and are implemented based on the model, which contains the following structural components: market research to determine threats and opportunities for the development of the enterprise, internal planning, operational activities, motivation system, control of marketing activities.

-Competitiveness is defined as the ability of the enterprise to carry out development in certain areas, using the marketing mechanism tools, taking into account the changing conditions of the external environment for the maintenance of existing and the formation of new and better competitive advantages that will help to achieve the desired economic results in the process of certain strategies implementention.

-The application marketing is important not only mechanism in the activities of agricultural enterprises but also created with their participation of integrated units. Participation in the cluster gives the opportunity for agricultural enterprises to improve product quality, improve assortment policy, to encourage sales with marketing tools.

-An important task in the activities of agricultural enterprises is the analysis and forecast of the marketing environment and economic situation on agricultural markets with the objective of creating competitive positions, synchronization of its own management decisions with objective changes in the environment. It is necessary to consider the marketing environment of agricultural enterprises functioning through the prism internal and external environment factors.

-The application of the competition map will help to form the tactics of production and enterprises marketing activities. Positioning of the entity in a competitive map is used to assess the level of competitiveness of integral indicators economic efficiency and marketing mechanism development.

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