

THE IMPACT OF THE RESULTS ACHIEVED ON WHEAT CULTIVATION AND THE IMPORTANCE OF EFFECTIVE IRRIGATION SYSTEM ON THE GROSS DOMESTIC PRODUCT PER CAPITA

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Abstract

Romanian agriculture enjoys one of the highest land allocations, with at the level of 2013 the land fund of Romania being made up of about 14.61 million ha of agricultural land (61,30% of the country's surface), each resident returning an area of 0.68 ha of agricultural land and 0,43 ha of arable land. Most of the existing arable land is grown mainly with so-called large crops, namely wheat and maize. In order to emphasize the importance of one of the two crops mentioned, wheat, and of the technological tools used to achieve it on Romania's economy, an analysis of the impact it has on the GDP per capita is carried out. For this purpose, the correlation between the variables considered in an econometric model was determined as follows: Gross domestic product per capita - dependency variable, gross value of wheat production, average wheat yield per hectare and agricultural area actually irrigated. The results obtained show that there is a strong link between the results of agricultural land work and the macroeconomic indicator of gross domestic product per capita.

Key words: agricultural land, GDP, per capita GDP, wheat, production, irrigation

INTRODUCTION

Agriculture is one of the most important branches of the national economy [8] and multiple functions of biological and ecological nature are attributed to it, being considered the main source of the agri-food supply process, while also playing a role in protecting the environment.

In Romania, agriculture has been practiced in various forms since the earliest times, but only since the second half of the 20th century it has been possible to speak of efficient and intensive agriculture [11].

With the continuous action of developing production forces, agriculture has made fundamental changes to the social fabric, to the technical level, to the structure and distribution of land and crop use categories [15].

In the post-communist period, the share of the results of the agricultural sector in the building of the gross domestic product decreased considerably, to the detriment of other economic sectors, at a slower pace in the first years of the transition from the communist to the democratic regime and

much faster after 1997. The transition period was marked by fundamental changes in the agricultural sector, the most important being the shift from cooperative and state ownership to private ownership, based on a number of legislative measures, the most important being: Decree Law 42/1990, Law 18/1991 as amended and supplemented, Law 1/2000.

The post-transition period (2000-present) was and is marked by the influence on the agricultural sector resulting from the adoption and implementation of the common agricultural policies (CAP) [7].

The increased fragmentation of agricultural land, together with subsistence farming, based on the use of low-performing production technologies, has led to a deterioration in soil quality, with direct repercussions on production volume and economic performance.

After 2007, Romania's accession to the European Union and the implementation of the

new common agricultural policies (CAP) [7][14] created a starting point in the process of agricultural development, with numerous non-reimbursable funds being provided to

Romania in the field of agriculture and the sustainable development of the rural environment.

The evolution of the contribution made by the agricultural sector to the building of GDP, compared to trends, for the post-communism period, is as follows:

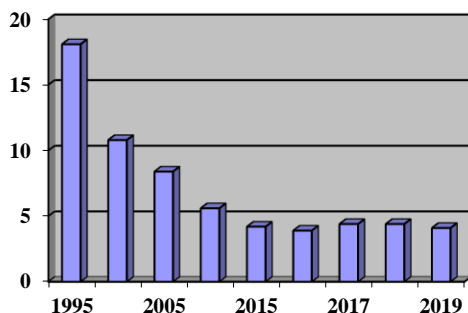


Fig. 1. Evolution of the contribution made by agriculture to the formation of GDP over the period 1995 - 2019

Source: Own representation based on data provided by the World Data Bank (WB), 2021 [13].

It should be noted that, although the contribution of agriculture to GDP formation is decreasing compared to the communist period, or even the period immediately following 90, Romania still has the highest share of the agricultural sector in the GDP structure of all EU Member States, about 3 times higher than the European average [1].

The main branch of agriculture, the one which contributes significantly to achieving economic performance, is the plant one, based mainly on the cultivation of two types of plants: Wheat and maize.

Wheat cultivation is the most important agricultural crop in Romania [3]. It has been known in Romania since the oldest times, with archaeological research showing that this culture dates back to the Bronze age (3000-1000 (before Christ) within the country. The plant is grown on large areas in Romania due to a number of properties including [9]:

- high content of grain in carbohydrates and proteins;
- protein-to-carbohydrate ratio corresponding to the requirements of the human organism;
- long grain preservation;
- convenient storage and transport costs;
- high environmental plasticity,

-the possibility of full mechanization of the crop [12] and the ability to integrate the vast majority of agricultural rotation systems.

During the period 2010-2019, the arable area cultivated with wheat has fluctuated, with relatively low fluctuations, with the values recorded being around 2 million hectares.

The trend in areas under wheat in the period 2010 to 2019 is shown as follows:

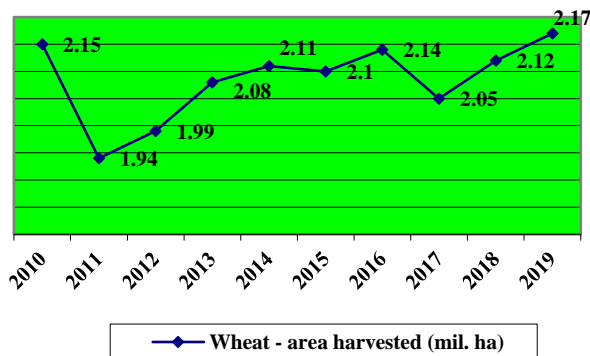


Fig. 2. Development of the area under wheat in Romania in the period 2010-2019

Source: Own representation based on data provided by the Food and Agriculture Organization of the United Nations (FAO), 2021 [6].

A variety of factors are generally involved in wheat production and agricultural production, the most important of which is the climate.

In recent decades, climate change has played an important role in land use, in particular by increasing extreme phenomena (drought, desertification, hail) and the spread of affected areas [10].

Romania presents a considerable risk to climate change, its effects being clearly reflected in changes in temperature and precipitation, mainly. Droughts have a significant impact on the stability of production and national food security, and the lack of adequate infrastructure helps to limit opportunities for economic development despite the potential of agriculture.

The main risks facing Romania in the short and medium term are the significant increase in the average annual temperature, the drop in precipitation and the general occurrence of extreme climate events. The climate change in Romania in recent years, reflected by changes in temperature and rainfall, affects a significant part of the country's agricultural area.

Agriculture is very vulnerable to the impact of climate change when the associated risks are not equally distributed.

Regional differences shall be identified both in terms of the likelihood of extreme events such as drought and episodes with heavy rainfall, and in terms of vulnerability, resilience and adaptive capacity of rural communities to climate change.

The differences are further accentuated by the polarization in the size of farming, typical of Romania. The category most affected is that of subsistence farmers.

Irrigated lands [4] reduce the dependence of agricultural crops on the volume of precipitation and minimizes the risk of drought affecting agricultural production.

At the same time, irrigation can increase the productivity of cropped agricultural land, allowing the spread of cultivated areas in some semi-arid areas.

The drought has a significant impact on the stability of national production and food security, and the lack of adequate irrigation infrastructure helps to limit opportunities for economic development despite the potential of agriculture. Severe soil drought in the southern and eastern areas of Romania, combined with high water consumption between July and August, results in a water supply in the soil most often below the point of wilting on large areas of agriculture. In these areas, complex agricultural drought is a climate hazard phenomenon which has the most serious consequences. The drought can last from a few days to a few months, resulting in a significant drop in agricultural production, especially in those regions with high vulnerability and low adjustment potential, affecting the results of the entire year of agricultural production.

The development of irrigation systems has as its main positive effects for the regions where the following are achieved:

- lead to the exploitation of agro-productive potential at a higher level;
- ensuring safe and high-yield agricultural production;
- reducing the negative effects of limiting environmental factors (prolonged droughts; combating soil erosion);

-improving the microclimate by avoiding soil degradation and supporting growing vegetation in the area.

The purpose of this work is to present the importance of a well-functioning agricultural system resulting from the creation of crop-friendly conditions, particularly wheat, on the volume of agricultural production and the economy of Romania as a whole, by quantifying the impact of the evolution of agricultural wheat production on the development of gross domestic product per capita.

MATERIALS AND METHODS

In order to identify the influence that the gross value generated by wheat production, the average yield of wheat per hectare and the value of the actual irrigated agricultural area have on the evolution of the gross domestic product per capita has been chosen to use the linear regression model.

Since several independent variables are used in the analysis, the linear regression model [2] will be that of multiple linear regression.

The multiple linear regression equation has the formula:

$$y = \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_n x_n + \varepsilon \dots\dots\dots(1)$$

where:

y = dependant variable;

x = vector of independent variables;

α = vector of coefficients/parameters the model;

ε = variable interpreted as error

The analysis shall include, in order to certify the correctness of the model under consideration, the following assumptions:

P1. The increase in the productivity of wheat crop, expressed as the gross value by which it contributes to GDP, will implicitly also lead to an increase in the value of the gross domestic product per capita macroeconomic indicator.

P2. The increase in average wheat yield per hectare leads to an increase in the value of the gross domestic product per capita;

P3. The extent of irrigated agricultural crops, including wheat, is leading to a significant

increase in the gross domestic product per capita, as a result of the increase in agricultural performance that could be achieved.

RESULTS AND DISCUSSIONS

The econometric model analysed is focusing on the value of gross domestic product per capita. From the analysis of the values recorded by this indicator it can be seen that for the period 2010-2018 it had an upward rather than perfectly linear trend, and there were also year-to-year shifts when small decreases were recorded, but overall the trend is an upward trend.

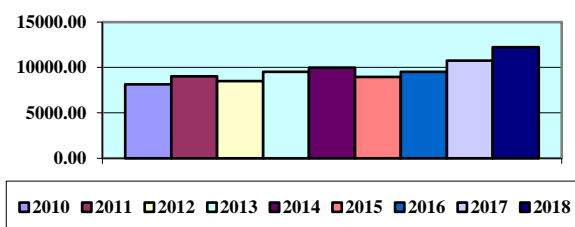


Fig. 3. Values recorded by gross domestic product per capita in the period 2010-2018 (USD)
 Source: Own representation based on data provided by the European Commission (EC), 2021[5].

As shown in the graph (Fig. 3), 2010 was the year when the value of this indicator was the minimum of the period analysed, being the year when the recovery period after the economic crisis of 2008 began to evolve, by taking measures to ensure the reduction of budgetary expenditure and the increase of government revenue. At the mid-term of the analysis period, the indicator was around \$10 thousand per capita GDP. The last year of the period analyzed, 2018, was the year when the GDP per capita exceeded the 12 thousand dollars per capita terminal. Compared to the reference year of the period analysed, i.e. 2010, the percentage increase reported is around 50%, which means a significant increase in relation to the environment and the economic situation marked by the influences of the various factors in Romania.

The value of the gross production generated by the wheat crop showed oscillating developments during the period under review, with significant influence on it having several

factors including: Climate conditions, the economic environment as a whole, the country's external trade policy, the attraction and use of sources of non-reimbursable financing from international bodies, etc.

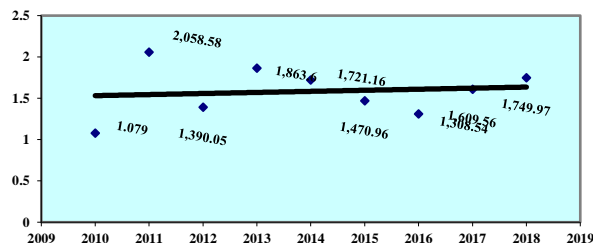


Fig. 4. Development of the gross value of wheat production in the period 2010-2018 (million dollars)
 Source: Own representation based on data provided by the Food and Agriculture Organization of the United Nations (FAO), 2021[6].

Analysing the trend in the gross value of wheat production (Fig. it can be noted that the value of this value was based on around USD 1,079 billion in 2010, almost doubled the following year (2011), rising by 90.71%. To be noted are subsequent fluctuations, significant in value, which are to a large extent the result of agricultural policies, the economic orientation toward the development of the agricultural sector and the capacity of the state as a whole to attract and direct European (non-refundable) structural funds to the agricultural sector and to provide the subsidies for agriculture from its own budget. The trend in the average wheat yield per hectare showed a significant increase in value over the period under review, with the trend being almost entirely upwards compared to the extended period under review, with the exception of the rising rule being the year 2012, when the average wheat yield per hectare decreased compared to the previous year - 2010.

As seen in Fig. 5., average wheat yields per hectare increased in the second year of the review period (2011) and then decreased by around 27.52% in 2012. Since 2013, the average wheat yield per hectare has been on an upward trend, with a maximum of 4.89 tons of wheat per hectare in 2017, and is also favoured by favourable weather conditions in that year.

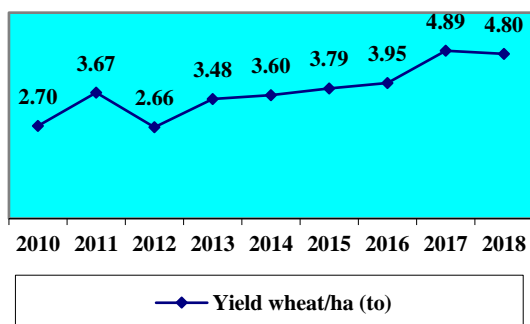


Fig. 5. Development of average wheat yield per hectare in the period 2010-2018

Source: Own representation based on data provided by the Food and Agriculture Organization of the United Nations (FAO), 2021[6].

As for the agricultural area actually irrigated for the period under review, an upward trend can be observed, which confirms and supports Romania's desire to create and support the development of a well-functioning farming based on good technology and techniques.

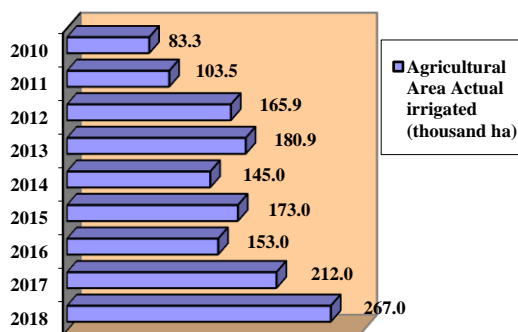


Fig. 6. Development of the agricultural area actually irrigated in the period 2010-2018

Source: Own representation based on data provided by the Food and Agriculture Organization of the United Nations, (FAO) 2021[6]

Starting from a value of only 83.3 thousand hectares irrigated agricultural land, with the help of government policies, programs to support the development of agriculture and as a result of the increase in the absorption of non-reimbursable European Structural Funds through various financing programs (PNDR, PDL).

In order to highlight the relationship between the evolution of the variables whose evolution has been described above, the Plott correlogram is first performed. This diagram shall be plotted on the scatter graph of the intersection points and check that correlation exists between the variables.

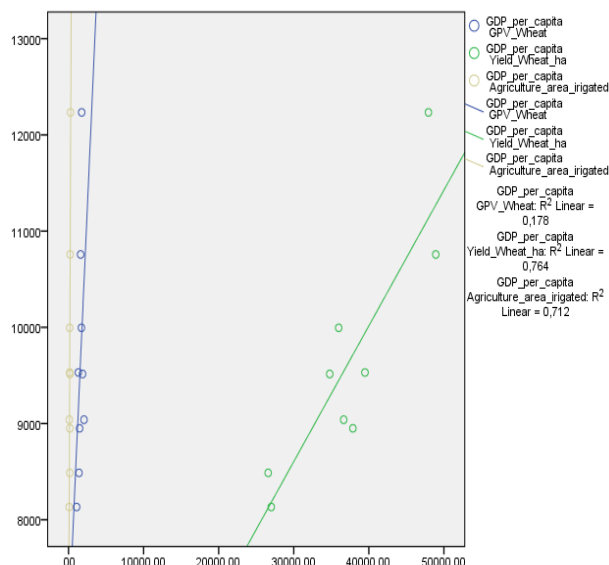


Fig. 7. Plott Chart

Source: Own representation using SPSS statistical program, based on data provided by Food and Agriculture Organization of the United Nations, the World Bank and European Commission (FAO, WB, EC), 2021[5][6][13].

According to the Plottchart, there is correlation between the evolution of the dependant variable and the evolution of the independent variables, so there is also an economic model. By analysing the correlation lines drawn on the graph by the correlation points, it can be concluded that a multiple linear regression relationship exists between the analysed variables.

This relationship is characterized by a regression equation of form:

$$GDP / capita = \kappa + \alpha \cdot GPV_{wheat} + \beta \cdot Yield_{wheat/ha} + \chi \cdot Agriculture_{Arealrig} + \varepsilon \dots\dots\dots(2)$$

where:

- k - the free term of the econometric model;
- GPV_{wheat} - gross added value brought by wheat production to GDP formation;
- $Yield_{wheat/ha}$ - average wheat yield per hectare;
- $Agriculture_{Arealrig}$ - area actually irrigated;
- ε - variable interpreted as error.

According to the data provided by the statistical program, on the basis of the input values, the model studied is economically valid and is characterized by an R-correlation coefficient value of 0.930. R^2 with a value of

0.866 also shows that the model studied is correct.

By its value of 0.785, adjusted R shows that the variables considered within the econometric model have linear correlation and regression. Safety significance test F change, with a value of 0.013, certifies the validity of the model and a value below the threshold of 0.50 is recorded.

Table 1. Residual statistics of the model under consideration

| Residuals Statistics ^a | | | | | |
|-----------------------------------|----------|----------|---------|----------------|---|
| | Minimum | Maximum | Mean | Std. Deviation | N |
| Predicted Value | 7730,32 | 11624,54 | 9626,77 | 1166,212 | 9 |
| Residual | -762,916 | 615,843 | ,000 | 459,400 | 9 |
| Std. Predicted Value | -1,626 | 1,713 | ,000 | 1,000 | 9 |
| Std. Residual | -1,313 | 1,060 | ,000 | ,791 | 9 |

a. Dependent Variable: GDP_per_capita

Source: Own representation using SPSS statistical program, based on data provided by Food and Agriculture Organization of the United Nations, the World Bank and European Commission, (FAO, WB, EC), 2021[5][6][13].

Table 2. The ANOVA test

| | ANOVA ^a | | |
|----------------|--------------------|-------------|-------------|
| | Model | | |
| | Regression | Residual | Total |
| Sum of Squares | 10880404,31 | 1688389,020 | 12568793,33 |
| df | 3 | 5 | 8 |
| Mean Square | 3626801,435 | 337677,804 | |
| F | 10,740 | | |
| Sig. | ,013 ^b | | |

a. Dependent Variable: GDP_per_capita

b. Predictors: (Constant), Agriculture_area_irigated, GPV_Wheat, Yield_Wheat_ha

Source: Own representation using SPSS statistical program, based on data provided by Food and Agriculture Organization of the United Nations, the World Bank and European Commission, 2021[5][6][13].

The descriptive statistics of the analysed model shall show the mean values and standard deviations recorded by the variables considered within it. Thus:

- for gross domestic product per capita, the average recorded value is USD 9,623.77 with a standard deviation of USD 1,253.43;
- for the gross value of wheat production, the average recorded value is about 1,583.49

million dollars, with a standard deviation of 302.43 million dollars;

-for average wheat yield per hectare, the average value is approximately 3.72 to/ha or 3,7246.11 hg/ha, with a standard deviation of 0.77 to/ha or 7,776.65 hg/ha;

-for the area of agricultural land actually irrigated, the average value is about 164.84 thousand hectares, with a standard deviation of 54.70 thousand hectares.

Table 3. Descriptive statistics of the analyzed model

| Descriptive Statistics | | | |
|---------------------------|------------|----------------|---|
| | Mean | Std. Deviation | N |
| GDP_per_capita | 9626,77 | 1253,435 | 9 |
| GPV_Wheat | 1583,4910 | 302,42858 | 9 |
| Yield_Wheat_ha | 37246,1111 | 7763,64807 | 9 |
| Agriculture_area_irigated | 164,8444 | 54,69408 | 9 |

Source: Own representation using SPSS statistical program, based on data provided by Food and Agriculture Organization of the United Nations, the World Bank and European Commission, (FAO, WB, EC), 2021[5][6][13].

With the coefficients of the econometric model variables, the multiple linear regression equation can be written. It is in the form of:

$$GDP / capita = 4,198.65 + 0.436 \cdot GPV_{Wheat} + 0.082 \cdot Yield_{wheat/ha} + 10.310 \cdot Agric_{Areairig} + \varepsilon$$

Table 4. Coefficients of the econometric model

| Model | Unstandardized Coefficients | |
|---------------------------|-----------------------------|------------|
| | B | Std. Error |
| 1 (Constant) | 4198,65 | 1254,76 |
| GPV_Wheat | ,436 | ,742 |
| Yield_Wheat_ha | ,082 | ,041 |
| Agriculture_area_irigated | 10,310 | 5,471 |

Source: Own representation using SPSS statistical program, based on data provided by Food and Agriculture Organization of the United Nations, the World Bank and European Commission, (FAO, WB, EC), 2021[5][6][13].

CONCLUSIONS

By analysing the multiple linear regression equation resulting from the analysis, it can be concluded that the developed and analysed econometric model verifies the three

assumptions made when presenting the methods and means used.

According to the value returned by the SPSS statistical program, the coefficient of the parameter entitled *Gross value added of wheat production* has a positive value, which means that a unit increase in wheat results in an increase of USD 0.436 per capita gross domestic product. By efficient agricultural techniques, the development of programs and measures to support the agricultural plant sector, the implementation of programs aimed at training farmers, coupled with the establishment of a well-established anti-calimity system (anti-drought, hail), can lead to an increase in wheat production, which will then be reflected in the value of national GDP and in the value of GDP per capita. The results obtained with this parameter emphasize its importance and verify the first hypothesis of the analysis.

The coefficient of the parameter entitled *Average wheat yield per hectare* also has a positive value, which means that an increase by one single so unit results in an increase of USD 0.082 in Gross Domestic Product per capita. The second hypothesis of the analysis that the increase in the average wheat yield per hectare will also lead to an increase in the gross domestic product per capita is thus confirmed.

The value of the coefficient of the last and most important parameter, according to the analysis, entitled actual irrigated agricultural area, has a positive value, significantly higher than for the other two parameters, which expresses its particular importance on per capita gross domestic product, with an increase of one unit resulting in an increase of USD 10.31 per capita gross domestic product. This also checks the third hypothesis contained in the analysis.

The non-reimbursable European Structural Funds, the setting up of irrigation systems managed either by the state, through ANIF, or by private companies, is a real support for the process of developing plant farming equipment, by setting up irrigation systems managed either by the state, through ANIF, or by private companies, by means of partnerships between private persons and the

Romanian state. What can be accessed in the various financing programs made available by the European Union to the Member States, in Romania the most important in this field are POR, PNDR, PDL, EAFRD and POPAM.

REFERENCES

- [1]Albu, L. L., Lupu, R., Calin, A. C., Popovici, O. C., 2018, The impact of Romania's accession to the European Union on the Romanian economy. Sector analysis (industry, agriculture, services, etc.)(Impactul aderarii Romaniei la Uniunea Europeana asupra economiei romanesti. Analiza sectoariala (industrie, agricultura, servicii etc.)), European Institute of Romania, Bucharest, 2018, pp. 16.
- [2]Canova, F., 2007, Methods for Applied Macroeconomic Research, Princeton University Press, 2007, pp. 423;
- [3]Chivu, I., 2018, The cult of wheat and bread at the Romanians (Cultul graului si al painii la romani), Sitech Publishing House, 2018, pp. 41–50.
- [4]Constantin, E., Maracineanu, F., Luca, E., Maracine, N., 2009, Global Strategy for water resources management (Strategia globală a gospodăririi resurselor de apă), 2009, Rev. Agriculture, Vol. 69, No 1-2, p. 108.
- [5]European Commission (EC) - Eurostat, 2021, <https://ec.europa.eu/eurostat/web/national-accounts/date/date>, Accessed on 23.02.2021.
- [6]FAO, Food and Agriculture Organization of the United Nations, 2021, www.fao.org/faostat/en/#data, Accessed 23.02.2021.
- [7]Lacrois, Y. I., 2007, Influences of the common agricultural policy on Romanian agriculture (Influente ale politicii agricole comuna asupra agriculturii Romaniei), Pro Universitaria Publishing House, pp. 7-9.
- [8]Oltenacu, N., Burcea, M., Gavrilă, V., 2019, Influence of varieties and some qualitative indicators upon on yield of several wheat varieties in South Eastern part of Romanian plain, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. Vol. 19(3), 423-428.
- [9]Păcurar, I., 2007, Production of cereal seed, grain legumes and technical plants (Producerea semințelor de cereale, leguminoase pentru boabe și plante tehnice), Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu Sisesti" INCDA Fundulea, Phonix Publishing House, Brasov, 2007, pp. 21.
- [10]Popescu, A., Dinu, T.A., Stoian, E., Serban, V., 2020, Variation of the main agricultural crops yield due to drought in Romania and Dobrogea region in the period 2000-2019, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.20(4):397-415.
- [10]Popovici, E.A., Balteanu, D., Kuckicsa, G., 2016, Land use and current development of agriculture (Utilizarea terenurilor si dezvoltarea actuala a

agriculturii), Romanian Academy Publishing, Bucharest, 2016, pp. 329.

[11]Roman, Gh. V., Toader, M., 2011, General Agriculture - Part I (Agricultura generala – Partea I), University Publishing House.

[12]The World Data Bank, 2021, <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?namedesc=true&view=chart>, Accessed on 23.02.2021

[13]Toma, E. et al, 2010, Romanian agriculture in the European integration process (Agricultura Romaniei in procesul de integrare europeana), ARS Academica Publishing House, Bucharest, 2010, pp. 14.

[14]Zahiu, L., Thomas, E., Dachin, A. Alexandri, C., 2010, Agriculture in Romania's economy (Agricultura in economia Romaniei), Ceres Publishing House, pp. 41–45.