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RESEARCH ON THE DEVELOPMENT OF AGRICULTURE IN THE EUROPEAN UNION. A STRUCTURAL ANALYSIS BY GEOGRAPHICAL GROUPS OF COUNTRIES

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ABSTRACT

Innovation in agriculture is responding to the requirements of increasing the competitiveness of the agricultural sector in national and international markets, in conditions of increasing social and political pressures to combat climate change and ensure food security. The aim of the research is to highlight the development level of agriculture in the European Union, by geographical groups of countries.

The research methodology is based on a comparative analysis of the various absolute and relative indicators of economic efficiency, environmental impact and innovative capacity of European agriculture.

The results showed important disparities between analysed regions for all the indicators evaluated. Thus, Scandinavian countries have been noted by very high levels of indicators: production per standard agricultural production unit; work productivity; the degree of renewable energy resources use; the degree of investment in research and development activities. However, agriculture in these countries exerts a strong pressure on the environment, generating significant amounts of greenhouse gases and high energy consumption. On the opposite side, we find for most of the indicators, the countries of South Eastern Europe. From an economic point of view, these countries get the lowest labour productivity and average output per agricultural production unit, but from the point of view of their environmental impact, the agriculture of these countries exerts less pressure on the environment. Regarding the innovative potential of the agriculture of these countries, we have noted a very low share of the R&D expenditures in the agricultural value added.

Keywords: development, innovation, environment, agriculture, European Union.

INTRODUCTION

The aim of the research is to statistically highlight the performance - innovation relation in the agriculture in the European Union, by geographical groups of countries.

In specialised literature we identified studies that analysed, generally, the performance and competitiveness of agriculture at national, regional or world level.

Thus, the study of Latruffe (2010) consists in revising the literature on the competitiveness, productivity and efficiency of the agricultural sector. The author pointed out the importance of the technical progress given by the implementation of new agricultural technologies to increase the productivity and efficiency of the use of inputs. The empirical study by dos Santos (2013) characterized and segmented farms in the 27 member states of the European Union (EU) by using cluster analysis for farm grouping according to financial, structural and organizational features. Among the indicators it analysed were the total value of the total assets on the farm, the share of the labour force in the total labour force on the farm, the size of the farm subsidies, the agricultural area used on the farm.

Spicka (2013) used the cluster analysis to identify the differences between the agricultural performance of the old EU member states - EU 15 and the agriculture of the new EU member states that joined between 2001-2011. The survey results showed that the agriculture of the new EU member states was characterized by higher labour resources per unit area and lower capital consumption (depreciation), which, according to the author, reflects a low level

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of technical endowment with negative effects on performance.

Dogliotti et al. (2014) highlighted the importance of innovation in agriculture to increase productivity in the sector. They estimated that, within 40 years, agricultural output must grow by at least 70% to meet the supply requirements of the global population. Agriculture is also a creator of jobs and an important source of income for the rural population, especially in the developed countries (Curry, 2016).

Most technological innovations have been created to help farmers increase their productivity and the quality of agricultural produce, and the latest challenges for innovation are to reduce environmental impact (Larsson et al., 2016). Economic actors in the field are recommended to innovate and integrate into national and international innovation networks in order to increase their economic performance and market competitiveness. For example, at the level of the European Union through the 2014-2020 Common Agricultural Policy programs, farmers and other actors in the field (processors, research organizations, educational establishments, etc.) can access grants to invest in innovative technologies and receive compensatory funding for the practice of some technologies friendly to the environment.

Since agriculture is the main economic activity for most people in rural areas, increasing its productivity is particularly important for raising living standards of the rural population.

MATERIAL AND METHODS

The empirical study included the descriptive and comparative analysis of key indicators that characterize economic performance, environmental impact and innovative capacity of agriculture across geographical regions of the European Union.

The 28 European countries were grouped according to the geographic region they belong to, considering the classification proposed by the German Standing Committee on Geographical Designations (German: Der Ständige Ausschuss für Geographische Namen - StAGN) (Table 1).

Table 1. The geographical grouping of the European Union member countries

No.	The geographic region	Component countries
1.	South East Europe (S-E)	Bulgaria - Romania
2.	Scandinavian Europe (N)	Denmark - Sweden - Finland
3.	Baltic Europe (N-E)	Estonia - Latvia - Lithuania
4.	Mediterranean Europe (S)	Greece - Spain - Italy - Cyprus - Malta - Portugal
5.	Central Europe (C)	Czech Republic - Germany - Hungary - Austria - Poland - Slovakia - Croatia - Slovenia
6.	Western Europe (W)	Belgium - Ireland - France - Luxembourg - Netherlands - United Kingdom

Source: Grouping according to Der Ständige Ausschuss für Geographische Namen - StAGN

The grouping of countries was done according to the geographic criterion because geographical location within the European continent determines specific pedo-climatic conditions that influence the structure and particularities of agriculture. The field of agriculture is very tied to the natural resources of climate, soil, relief, which is why we consider this grouping of analysed countries to be relevant. The descriptive analysis of the indicators was carried out between 2006-2016. The indicators were analysed with a two-year frequency, in order to outline their evolution and long-term trend.

The analysis period was chosen based on the statistical data available at Eurostat (http://ec.europa.eu/eurostat/data/database), data needed to calculate the indicators proposed in the study.

The indicators included in the analysis were classified into the following three categories: i) economic performance indicators; ii) environmental impact indicators; iii) indicators of innovative agricultural capacity (Table 2).

Table 2. Indicators for assessing the development level of agriculture

Category	Indicator	Unit
1. Economic performance indicators	1.1 Production value per standard agricultural production unit	thousands of euro/ APU
	1.2 Annual labour productivity	euro/ AWU
2. Environmental impact indicators	2.1 Energy intensity of agricultural activities	TOE/ 1,000 euro GVA
	2.2 Degree of use of renewable resources on farms	%
	2.3 Emissions of greenhouse gases from agriculture to 1,000 euro agricultural production	tons/ 1,000 euro
3. Indicators of innovative capacity in agriculture	3.1 Share of R&D expenditures in gross value added in agriculture	%
	3.2 Degree of renewal of fixed assets	-
	3.3 Degree of adoption of „no-till" technological innovations	%

Economic performance indicators

A first indicator indicating the economic efficiency in agriculture is the "production value per standard agricultural production unit (APU)" expressed in thousands of euro. The indicator was calculated as the weighted average of the value of the crop yield per hectare and the value of livestock production per unit of high yield (LU). The formula for calculating this indicator was made up by the authors to ensure the comparability of data between countries specializing in crop production and those specialized in animal husbandry, having the following structure:

$$Q_{APU} = \left(\frac{Qv}{UAA} xa + \frac{Qa}{LU} xb\right) x1000,$$

where:

- Q_{APU} is the value of production per standard agricultural unit of production;
- Qv is the value of vegetable production;
- Qa is the value of animal production;
- a is the weight of vegetable production value in the total value of agricultural production;
- b is the share of the value of livestock production in the total value of agricultural production.

The second indicator, "annual labour productivity" (Wm) expresses the value of agricultural output per unit annual work unit (AWU), that is, the value of the output obtained by a full-time farmer, whether or not paid at farm level. According to Eurostat, an annual unit of work is equivalent to 1,800 hours of work per year, worked by one person for 225 days, for 8 hours/ day.

Environmental impact indicators

The importance of innovation also derives from the effects it can have on reducing the consumption of material resources, with an impact on the environmental performance of the economic entity.

An important indicator measuring the efficiency of resource use and the impact of agriculture on the environment is the "energy intensity of agricultural activities". Energy intensity is the ratio between the gross domestic energy consumption for agricultural activities, quantified by the indicator "tons of oil equivalent - TOE" and the gross agricultural value added (GVA). The indicator is measured in tons of oil equivalent per EUR 1,000 GVA. This indicator measures energy consumption for agricultural activities and the overall energy efficiency of the sector.

The "degree of use of renewable resources on farms" is an indicator calculated as a percentage of the used agricultural area (UAA) of farms owning equipment for the production of energy from renewable sources (wind, solar, hydropower, biomass, biogas and other resources); the total agricultural area used at country level. The use of renewable energy in agriculture improves the environmental performance of farms, contributes to the reduction of greenhouse gas emissions and can reduce energy costs at the level of technological processes, and at the same time constitutes an indicator of the adoption of innovations in agriculture (Kubankova et al., 2016).

The indicator "greenhouse gas emissions from agriculture at € 1,000 agricultural output" (tons/ € 1,000) indicates the negative impact of agriculture on the environment as a result of the amount of gas emitted as a result of agricultural technologies used to obtain an agricultural output of value of 1,000 euro. Calculating the amount of gas by reference to the value of the output obtained is important in assessing the extent to which environmental performance correlates with economic performance. The application of chemical fertilizers, the inappropriate management of livestock manure and the excessive farming of agricultural land are the main technological processes generating greenhouse gases in agriculture (Tubiello et al., 2013; Chebbi, 2010). Reducing this indicator may signal the implementation of technological innovations based on fuel efficiency and waste management.

Indicators of innovative capacity in agriculture

The "share of R&D expenditures in gross value added in agriculture" is an indicator that expresses the percentage of public and private spending for R&D in agriculture relative to country - wide gross agricultural value added. According to the literature, this indicator largely expresses the nation's innovative capacity in a given area and its potential for growth and economic development (Manjinder and Lakhwinder, 2016; Erdal and Ferdi, 2015).

The "degree of renewal of fixed assets" shows the degree of novelty of agricultural assets represented by buildings, equipment, machinery, software and other tangible and intangible assets. The indicator was calculated as a percentage ratio between the annual gross fixed capital formation in agriculture and the net asset value of the previous year. This indicator was chosen to highlight the extent to which farmers modernize their production capacities and adapt to the technological changes in the economic environment (Mazouch and Krejčí, 2016). A high value of this indicator may signal a very good adaptation of the technologies to market news, with positive effects on the competitiveness of farms. Conversely, a low value of this index shows a high degree of depreciation of agricultural assets that can negatively influence the economic performance of farmers (Žídková et al., 2011).

The "degree of adoption of no-till technology innovations" directly shows the extent to which farmers use innovative practices for soil water conservation, farm input reduction and fuel efficiency, and indirectly, the degree of endowment with complex and performing agricultural equipment, which are used in the "no-till" system.

This indicator shall be calculated as a percentage between the arable area exploited in the "no-till" system and the total arable area (AA). According to the literature, conservation of natural resources is one of the most important challenges of agricultural research and innovation (Haque et al., 2016). The no-till system involves the elimination of the ploughing and sowing of the crops through a single pass with complex aggregates that ensure the sowing of plants, loosening, fertilizing and levelling the land. The level of application of this technology also shows the technical endowment of the agricultural holding with specialized machinery and equipment with a high degree of innovation.

This indicator is important both for assessing the capacity of farms to practice innovative agricultural technologies and for analysing the impact of agriculture on the environment.

RESULTS AND DISCUSSION

Characterization of the distribution of the chosen variables was made using descriptive statistics at the level of the following characteristics: the number of valid observations, the minimum value of the variable, the maximum value of the variable, the mean value of the variable and the standard deviation (Table 3). The highest production value per standard production unit was 5.74 thousand euro/ APU, which was registered by the Netherlands in 2016.

Table 3. Descriptive statistics of variables

Indicator	Minimum	Maximum	Average	Standard deviation
Value of production per standard agricultural production unit (thousand euros / APU)	0.79	5.74	2.23	1.19
Annual labour productivity (thousands of euro GVA/ AWU)	2.53	71.58	18.46	15.48
Energy intensity of agricultural activities (TOE/ EUR 1,000 GVA)	0.04	0.85	0.24	0.16
Degree of use of renewable resources on farms (% of UAA)	0.01	67.88	10.74	17.02
Emissions of greenhouse gases from agriculture (tons/ 1,000 euro production)	0.62	3.65	1.42	0.59
Share of RD expenditure in agricultural GVA (%)	0.32	18.52	4.69	4.26
The degree of renewal of fixed assets	0.60	26.11	7.23	5.27
The degree of adoption of “no-till” technological innovations (%)	0.02	11.23	2.85	2.47
NUMBER OF VALID CASES	**168**			

Data source: own processing of Eurostat data

The highest standard deviation from the average, of 17.02%, is observed in the case of the use of renewable resources in farms, indicating an environmental efficiency with large disparities between the analysed countries. Also, at the level of the annual labour productivity, there is a standard deviation of 15.48 thousand euros GVA/ AWU, which indicates the existence of significant differences in the applied agricultural technologies of the EU states (Table 3).

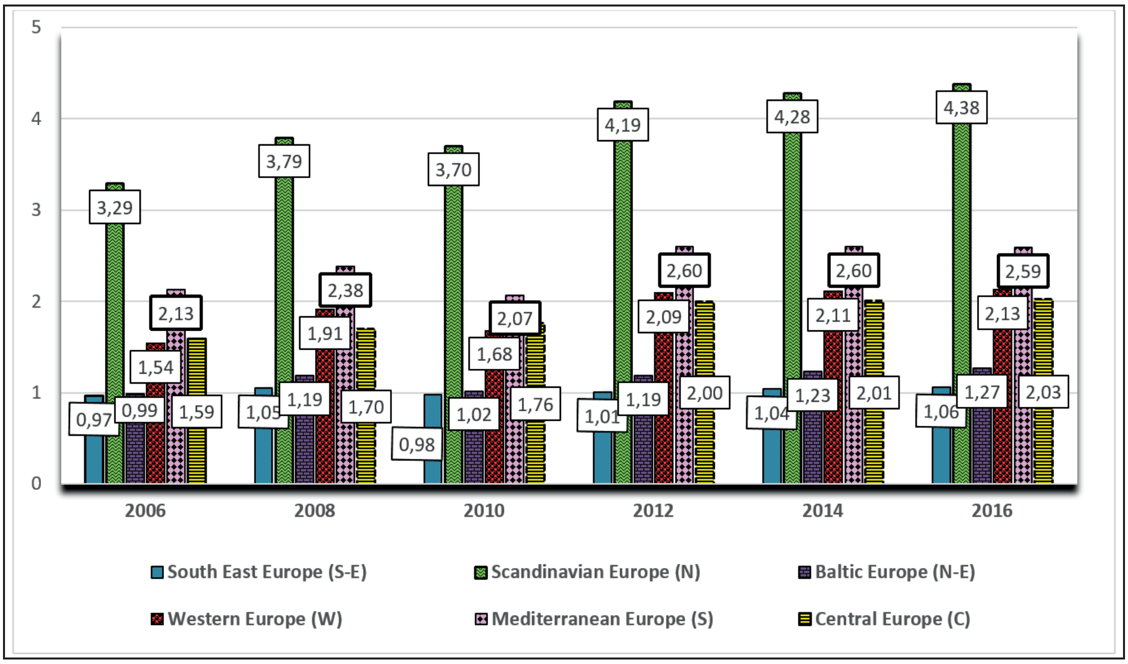

Figure 1. The value of production per standard agricultural production unit – average per group of EU-28 countries (thousand Euro/ APU)
Source: own representation using Eurostat data

According to Figure 1, the geographical group of countries with the highest average value of agricultural output is represented by Scandinavian Europe, with an average value of EUR 4.38 thousand/ APU in 2016. In contrast, there are SEE countries registering the lowest average production value of 0.97 thousand euro/ APU (2006).

In Romania, the maximum amount of agricultural production per APU was 1.06 thousand euro, registered in 2016. The general trend is to increase this indicator from one period to the next, in most of the analysed countries as a result of the implementation of some technologies more productive, efficient organization of the activity and increase of the direct subsidy of the farmers.

Regarding the relationship between the value of the production per standard agricultural production unit and the labour productivity, we can see in Figure 2 that there is a direct relationship, the indicators increasing in the same direction.

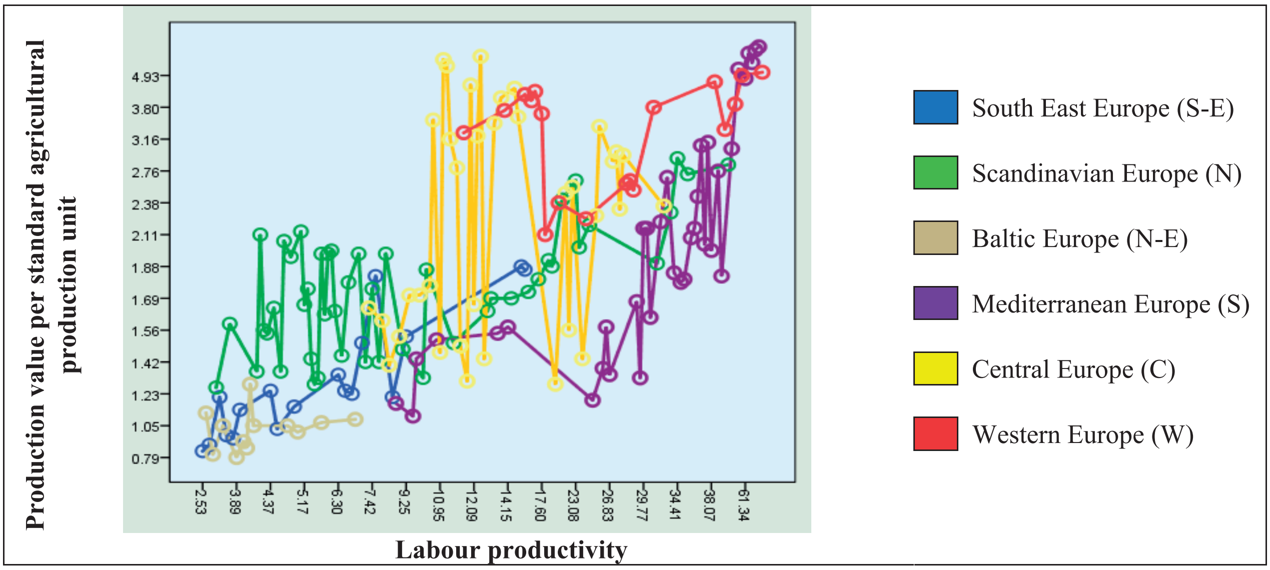

Figure 2. Graphical representation of the labour productivity relation - production value per standard agricultural production unit at EU-28 level (average of 2006-2012 period)
Data source: own processing by Eurostat data

At the EU level, the average labour productivity was 19.80 thousand euro/ AWU in 2016, up 28% compared to the average of 2006 (15.50 thousand euro/ AWU). The highest average values of labour productivity were registered in the countries of Western Europe and Scandinavian Europe, over 20 thousand euro/ AMU during the analysed period (Figure 3).

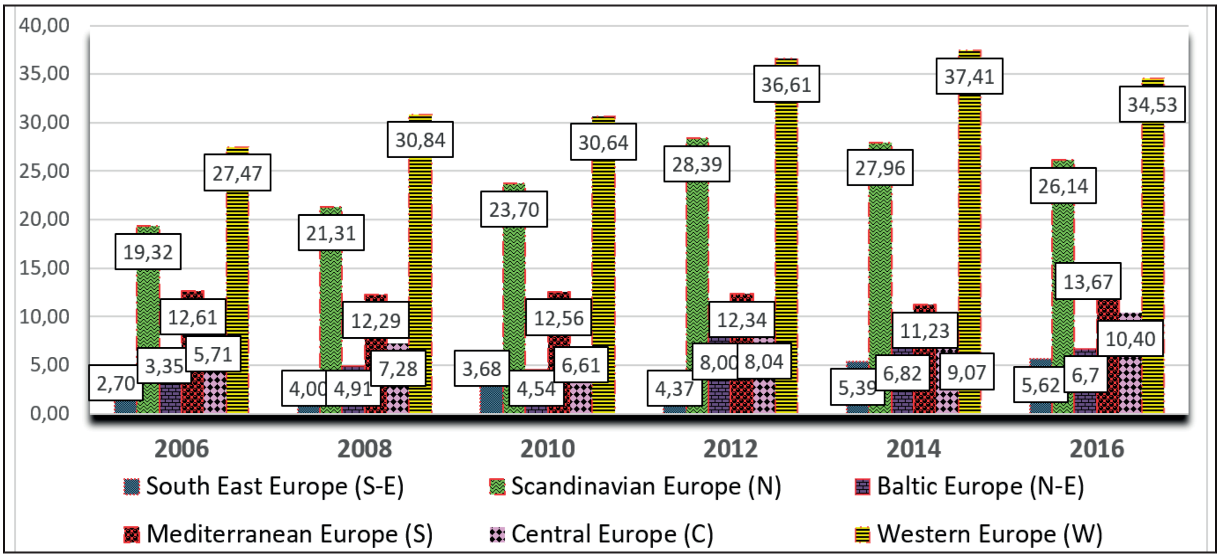

Figure 3. Annual productivity of labour - average per group of EU-28 countries (thousand euro/ AWU)
Data source: own processing by Eurostat data

In the S-E countries (Romania and Bulgaria), the lowest performance in terms of the use of the labour factor is registered, with values lower than 7 thousand euro/ AWU.

Excessive land degradation after the communist period, poor development of the forms of association and cooperation of rural economic actors and poor infrastructure underlie these poor results in terms of productivity and performance. In the 2007-2013 multiannual programme, through the European Agricultural Fund for Rural Development (EAFRD), farmers and other rural economic actors in the European Union benefited from €96 billion in investment funds, of which about 18% were allocated to Romania and Bulgaria. Also, with the current Common Agricultural Policy 2014-2020, European farmers benefit from over 80 billion euro of non-reimbursable funds to finance investment projects. These finances have helped farmers improve their technical endowment and increase their productivity in 2006-2016.

We notice a significant overall increase in labour productivity between 2006 and 2016 in all regions. The increase in labour productivity is in direct relation to the level of technologies and to the general level of economic development of the country. A high degree of modernization and novelty of technologies used in agriculture may reflect rising yields, rising labour productivity, high energy efficiency, and so on (Bakucs et al., 2013).

The impact of agriculture on the environment was first analysed by the energy intensity of agricultural activities.

Figure 4 shows that the highest energy consumption in agriculture, in terms of gross value added, was registered in the Scandinavian and Baltic Europe countries. Thus, in 2016, in order to create a gross agricultural value added of 1,000 euro, farmers in the Baltic countries consumed on average an amount of energy equal to 0.38 tons of oil equivalent, as opposed to farmers in South East Europe which consumed only 0.09 tons of oil equivalent.

High energy intensity in the Nordic countries can be explained by the impact of the cold climate that calls for high energy consumption for heating and for drying the harvested products, but also by a high degree of mechanization and automation of agricultural technological processes, reflected by an increased level of labour productivity (in the Scandinavian countries) (Figure 4).

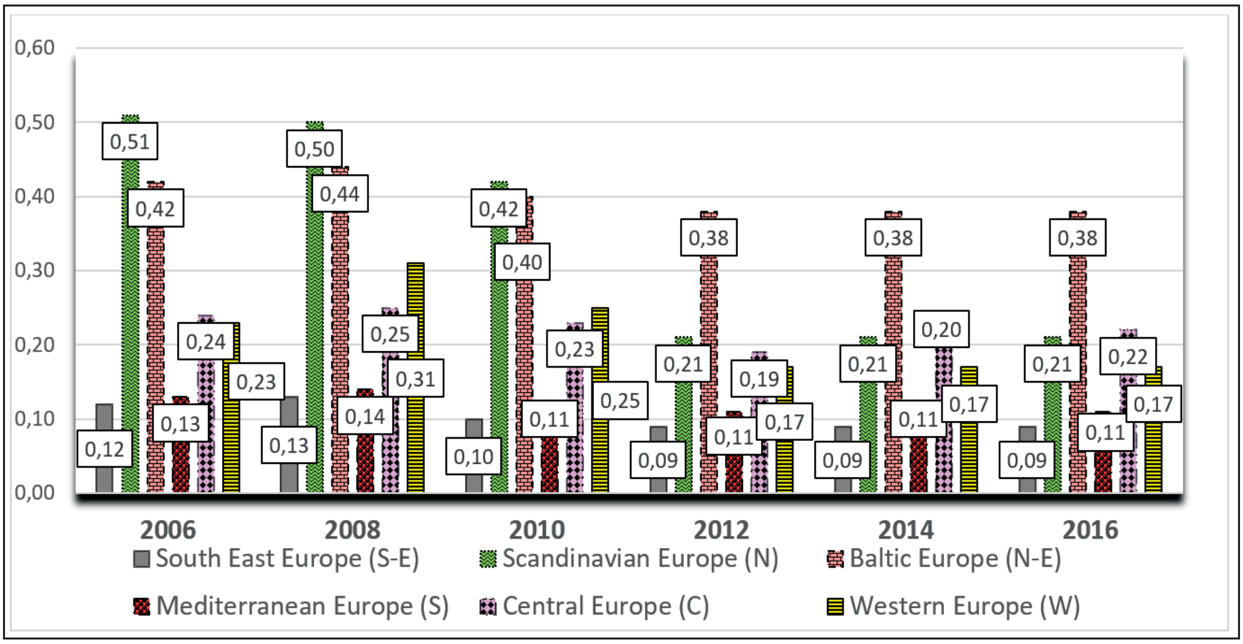

Figure 4. Energy intensity of agricultural activities - average per group of EU-28 countries (TOE/ EUR 1,000 GVA)
Data source: own processing by Eurostat data

The lowest energy intensity levels in agriculture in South Eastern Europe and in Mediterranean Europe are about 0.10 tons of oil equivalent per 1,000 euro GVA. These values may be the effect of a milder climate, the implementation of eco-efficient technologies or a lower level of mechanization and automation of agricultural processes. The overall trend is to decrease energy intensity between 2006 and 2016, with a positive impact on the environment and a decrease in energy costs at farm level.

A second indicator for assessing the impact of agriculture on the environment is the degree of use of renewable resources on farms. The holdings in the Scandinavian countries represented by Sweden, Finland and Denmark have the highest average endowment of renewable energy equipment. Thus, more than 50% of the agricultural area used was owned in 2016 by farms with at least one renewable energy production equipment (biomass, wind energy, photovoltaic energy, geothermal energy, etc.) (Figure 5). Although the agricultural sector of these countries enjoys high energy autonomy, given the intensive use of renewable energy sources, the energy costs needed to transform assets into agricultural production are the highest at European level. A high level of use of renewable energy shows an affirmative response of farmers to the demand for sustainable development of agriculture, especially from the European Union through the Common Agricultural Policy. It also reflects the diffusion of energy industry innovations at the level of economic entities operating in an area with particularly social barriers to innovation.

One of the barriers would be the reluctance of farmers, inclined to conservatism, to engage in innovation activities or to accept the implementation of innovative production technologies. We notice a general trend towards increasing the use of renewable resources in all analysed regions in between 2006-2016, which contributes to reducing the impact of agriculture on the environment by reducing the carbon footprint of agriculture.

Very low values of this indicator are registered in the countries of South Eastern Europe, represented by Romania and Bulgaria, of less than 1% of the agricultural area used (Figure 5). The carbon footprint of agricultural activities is determined by the emissions of gases with effect of greenhouse gases mainly from the use of chemical fertilizers, from the execution of a large number of agricultural works and animal husbandry activities.

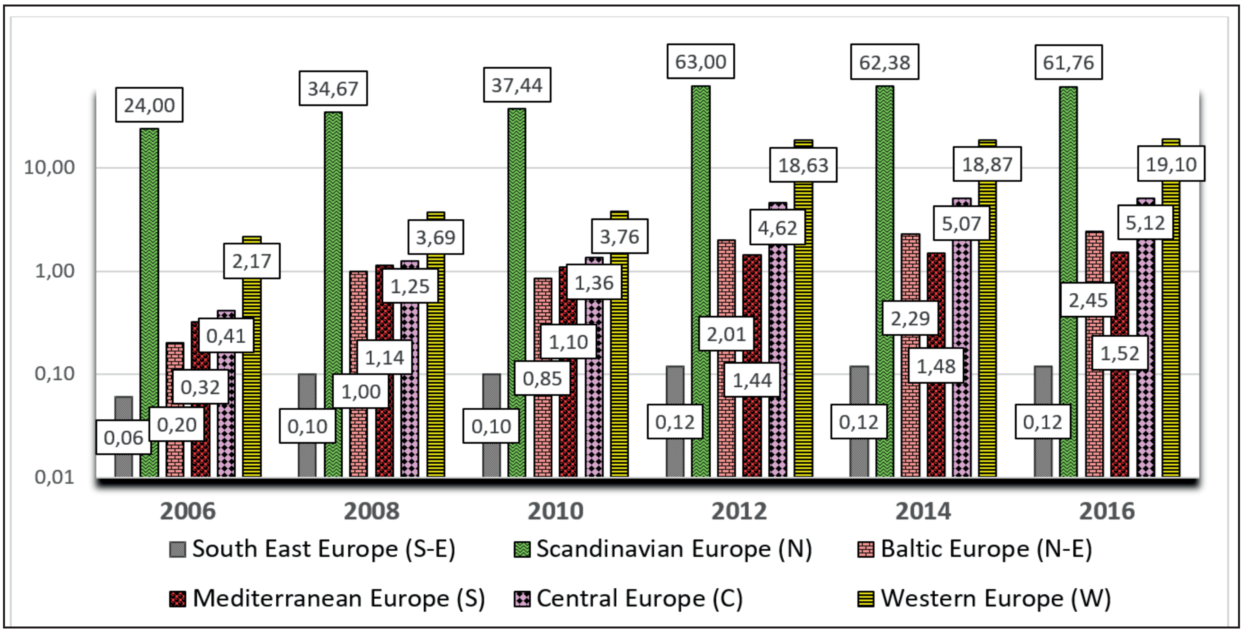

Figure 5. Degree of use of renewable resources in farms - average per group of EU-28 countries (% in total UAA)
Data source: own processing by Eurostat data

Greenhouse gas emissions indicate the impact of agriculture on the quality of environmental factors, and a low amount of emissions reflects a reduced impact of agricultural activities on the environment.

We note the lowest greenhouse gas emissions from agriculture in the agriculture of the Mediterranean countries, below one tonne of gas at a production of 1,000 euros. Italy, Spain and Greece have the lowest degree of chemical fertilizer use, which directly influences the low level of greenhouse gas emissions (Figure 6).

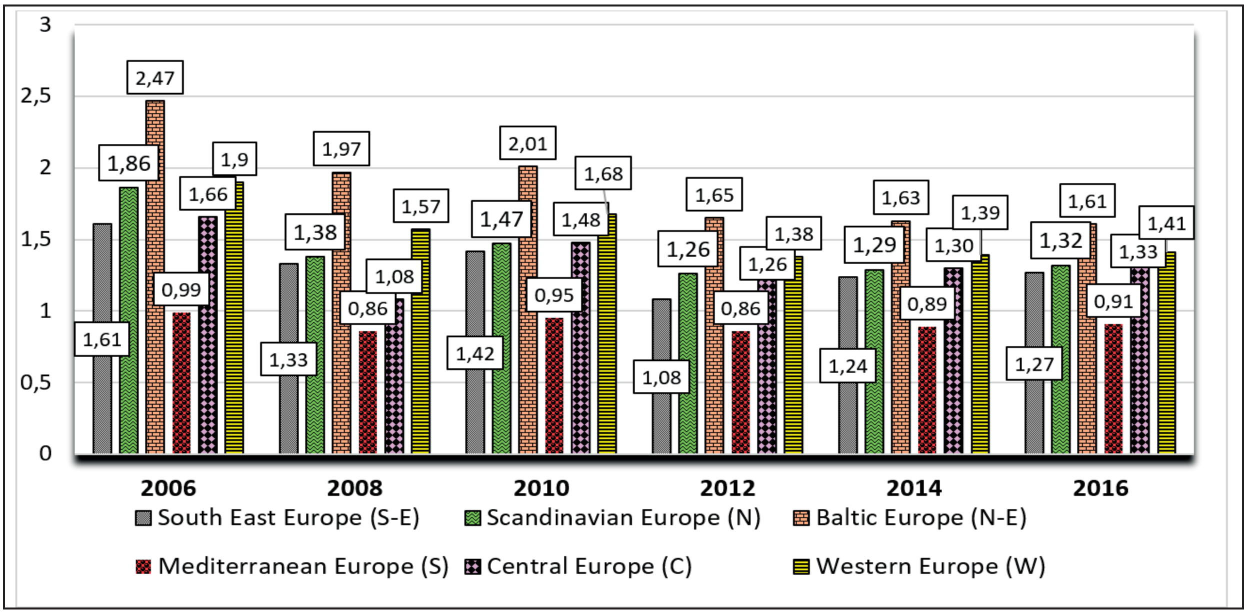

Figure 6. Agricultural greenhouse gas emissions per 1,000 euro agricultural production - average per group of EU-28 countries (tons/ EUR 1,000)
Data source: own processing by Eurostat data

Higher quantities of greenhouse gases have been registered at the level of agriculture in the Baltic and Western European countries, which are highly consuming for fertilizers and plant protection chemicals. During the analysed period there was a significant reduction of gas emissions in all regions, which may signal the implementation of technological innovations based on efficient consumption and good management of agricultural waste, animal manure and potential sources of pollution.

The need to reduce pollution and global warming was the basis for the conclusion of the Paris Climate Change Agreement in December 2015, among 55 countries around the world, to which 175 other countries joined in April 2016. This agreement seeks to implement, at the level of each signatory country, specific actions to limit global warming to less than 2ºC from 2020 (Rogelj et al., 2016).

The signatory states of this agreement, including all the countries of the European Union, have the responsibility and obligation to actively participate in achieving the overall objective of reducing global warming. The downward trend in agricultural greenhouse gas emissions observed in the countries surveyed indicates their potential to meet their commitments under the Paris Accord from 2020.

The reduction of polluting emissions from agriculture is the responsibility of the farmers who have to adapt their technologies to the current pressures on environmental protection and to give greater importance to the compliance with the obligations imposed by the environmental legislation. Attracting innovation in agricultural production processes is an essential requirement for correlating the economic objectives of the farmers, with the environmental protection objectives imposed by the society.

In order to assess the level and potential of EU agricultural development, we have further investigated a number of indicators of agricultural innovation capacity. One of the most important and used indicators for assessing the innovation capacity of a nation or industry is the share of R&D expenditures in Gross Domestic Product (GDP).

Taking into account the analysed economic field, the share of R&D expenditures in gross value added from agriculture was calculated. Scandinavian European countries attach great importance to agricultural research, spending more than 10% of gross agricultural value added for R&D activities (Figure 7).

Natural pedoclimatic conditions unfavourable to agriculture in these countries are driving the public and private research landscape to look for innovative solutions to compensate for natural handicaps and achieve high returns through massive industrialization of agriculture (intermediate consumption accounts for more than 70% of total production value).

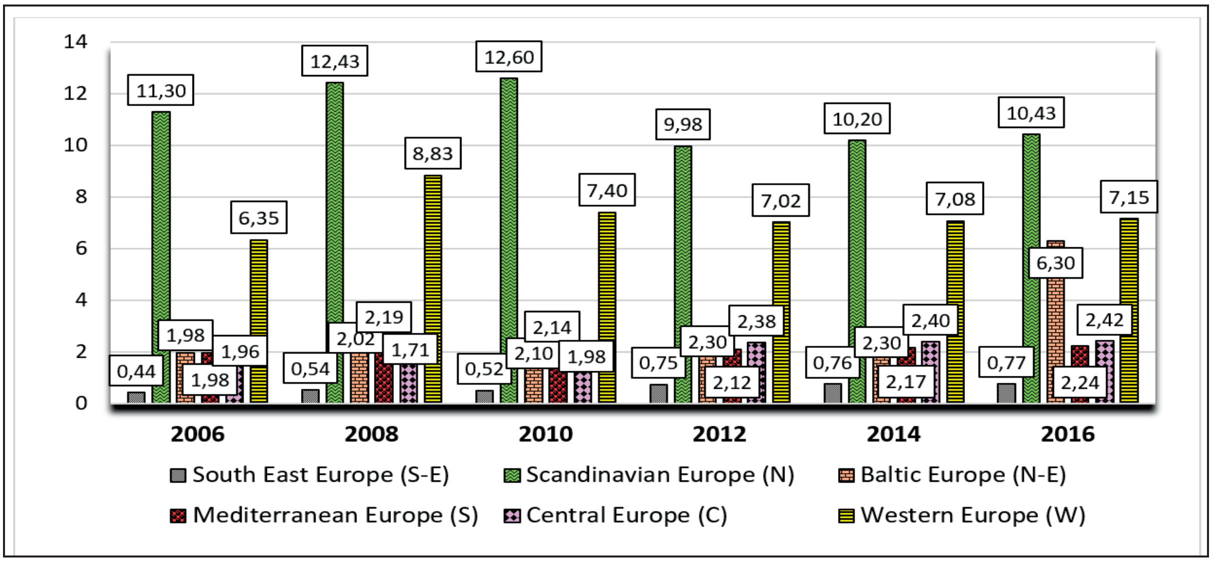

Figure 7. The share of R&D expenditures in the gross value added of agriculture - average per group of EU-28 countries (%)
Data source: own processing by Eurostat data

Analysing this indicator as compared to the economic yield indicator, represented by the value of production per standard agricultural production unit, we note that these countries also registered the highest values of the productions. In the SEE countries, respectively Romania and Bulgaria, the lowest percentages of R&D spending are registered, less than 1% of the agricultural value added (Figure 7), indicating a low intensity of the innovation activity in this economic field.

The overall trend was to increase the share of R&D spending in most of the analysed regions, with the exception of Scandinavian Europe and Western Europe. In Romania, over the last 10 years, there has been a relative increase of this indicator from 0.32% in 2006 to 0.58% in 2016. The increase of this weight can be the effect of the implementation of the research and development projects supported by the European Operational Programs carried out between 2007-2016. During this period, 39 research-development-innovation projects were financed through the Sectoral Operational Program Increase of Economic Competitiveness 2007-2013 (SOP IEC), with a total value of 85 million Euro and 14 innovative projects under the Operational Program Competitiveness 2014-2020 with a total value of approximately 15 million Euro. The main source of funding for research and development activities in most European countries is the national and international public budgets and the research organizations' own sources. The participation of the private business environment in financing research activities has very low levels (below 10%) in less developed countries, such as those in S-E Europe, represented by Romania, Bulgaria and Hungary.

The efficiency of research investment is influenced by the involvement of both public research organizations and private economic actors. Increasing the involvement of the private environment in research activities is stimulated by EU policies by allocating grants to research projects carried out by various partnerships between these categories of economic actors.

As the information travels at high speed and becomes more and more accessible to the population, the main issue of agricultural innovation is not the relative size of the financial effort allocated to research but the capacity to adopt and effectively implement innovations, these are the result of national research or research conducted abroad. In other words, it is important for farmers to have access to information and their ability to accept new production technologies and to invest in efficient equipment and equipment, or to renew their means of production.

In order to assess the capacity to renew the means of production at the level of the agriculture of the analysed countries, the degree of renewal of fixed assets was calculated.

With regard to the renewal of fixed assets in agriculture, Western European farmers are more likely to renew more than 10% of their assets annually by purchasing machinery, equipment and installations, building or upgrading buildings, purchasing IT equipment and various soft- production management and other investments in tangible and intangible assets (Figure 8).

The lowest annual renewal rates of assets are registered in the three Scandinavian countries in Finland, Denmark and Sweden, with values lower than 5% (Figure 8), although these countries have the highest relative importance for research and development in agriculture.

The renewal of fixed assets in agriculture is a process with significant variations in the analysed period and regions and with different growth or declining trends. For example, the lowest annual renewal rates of fixed assets were registered in Cyprus, up to 1.79% in the analysed period, and among the highest annual renewal degrees in Romania, over 15% throughout the analysed period. Thus, Romanian farmers have invested over 14 billion euros, between 2006 and 2016, reflecting a specific investment of 900 euros per hectare.

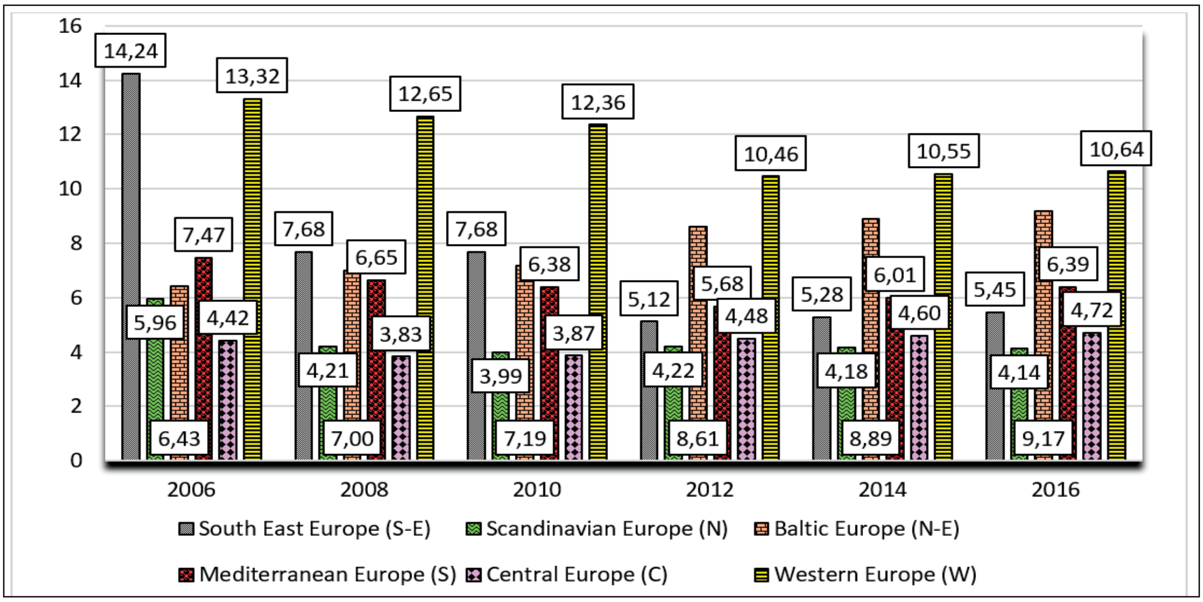

Figure 8. Degree of renewal of fixed assets - average per group of EU-28 countries (%)
Data source: own processing by Eurostat data

These investments were mainly co-financed through the European Agricultural Fund for Rural Development between 2007-2013 and 2014-2020, which allocated over 4 billion euros in non-reimbursable aid received from farmers in 2008-2016.

A high level of renewal of fixed capital reflects a good capacity of agricultural economic entities to adapt their technologies to the latest market trends and to attract technical progress.

Investments bring added technological and organizational novelty at the level of the economic entity and contribute, on the one hand, to the increase in production capacities and, on the other hand, to the improvement of the production processes and the efficiency of the consumption of production factors, with direct impact on increasing economic efficiency.

In investment decisions, it is important to correlate the size of the investment with the profitability gain due to it. The level of innovation in agriculture is also due to changes in production processes, in terms of concrete ways of carrying out farm work, feeding animals, harvesting production, etc.

As agriculture in the 21st century is a "concession" between the pressure of climate change and the pressure of food security, farmers are forced to look for new solutions to achieve high economic returns and minimize environmental impact.

Thus, farmers began to attach greater importance to the consumption of resources in agriculture and to implement non-conventional technologies, such as those based on minimizing the number of agricultural works or eliminating the ploughing, whose main role is to reduce the losses of agricultural resources. ground water.

In order to assess the ability of European farmers to adopt such technologies, we analysed at EU level the degree of adoption of the technological innovations "no-till" (Figure 9).

The highest weights of application of "no-till" technology in total arable land were registered at the level of agricultural holdings in Scandinavian and Southeastern Europe respectively, with an average of 7.74% and 5.88%, respectively (Figure 9).

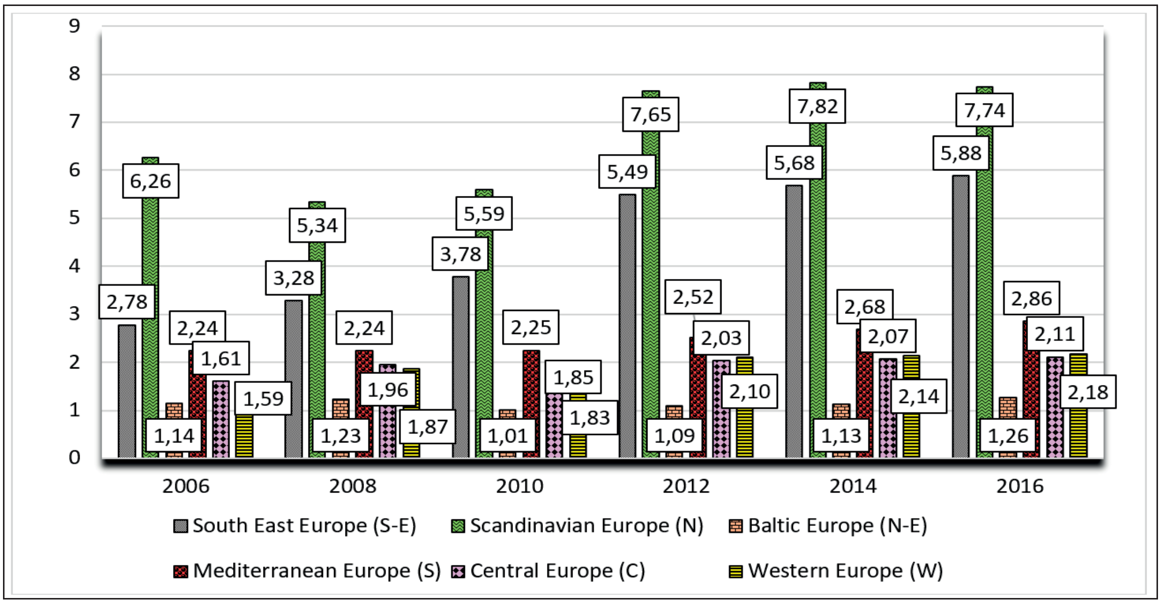

Figure 9. Adoption of technological innovations "no-till"(%) - average per group of EU-28 countries
Data source: own processing by Eurostat data

These results show also the technical endowment of farms with innovative agricultural machinery and equipment specialized in this type of agricultural technology.

The lowest average use of "no-till" technology is registered in agriculture in the Baltic countries (Estonia, Latvia and Lithuania), which exploit about 1% of the arable land under this technology. As a general trend, there is an increase in the relative importance of this innovative type of agricultural technology in all the analysed regions.

CONCLUSIONS

From the analysis of the level of agricultural development and of the innovation potential of the European Union agriculture, large disparities were observed between the analysed regions for all the evaluated indicators. Thus, Scandinavian countries were noted by very high levels of indicators: production per standard agricultural production unit; work productivity; the degree of use of renewable energy resources; the degree of investment in research and development activities. However, agriculture in these countries exerts a strong pressure on the environment, generating significant amounts of greenhouse gases and high energy consumption. On the opposite side, we find for most of the indicators the countries of South Eastern Europe, represented by Bulgaria and Romania.

From an economic point of view, these countries have the lowest labour productivity and average output per farm unit, but from the point of view of the environmental impact, the agriculture of these countries exerts less pressure on the environment, with an energy intensity less than 0.1 TOE/ € 1,000 GVA (57% lower than in Scandinavian countries).

The lower level of pollution in the agriculture of these countries is mainly due to the insufficient financial resources of small farmers, in order to acquire the necessary production factors for the intensification of the applied technologies. Thus, the reduced impact on the environment is not, in itself, an objective for farmers, but an indirect effect of low capitalization of semi-subsistence farms.

Regarding the innovative potential of these countries' agriculture, we noted a very low share of R&D spending in agricultural value added (below 1%).

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