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THE CONTRIBUTION OF AGRI-ENVIRONMENTAL INDICATORS TO ACHIEVING SUSTAINABLE DEVELOPMENT OBJECTIVES

ABSTRACT

Agri-environmental indicators provide insight into the relationship between the environment and agriculture at the level of a country or region. Some agri-environmental indicators are part of the European Union's sustainable development indicators and are used to monitor progress towards the global sustainable development goals SDG 2 (zero hunger), SDG 7 (clean and affordable energy) and SDG 12 (responsible consumption and production) etc. The study aims to benchmark agri-environmental indicators in Romania against other EU countries and to reveal the contribution of these indicators to the achievement of sustainable development goals. The statistical data will be analysed using the comparison method in order to assess both the trends of the indicators and the significant differences between EU countries in relation to agri-environment and sustainable development. The results of the assessment contribute to inform on the progress made by Romania compared to other EU countries both in terms of agri-environment and sustainable development in the European context.

Key words: agri-environmental indicators, agriculture, sustainable development indicators.

JEL Classification: Q15, Q18.

1. INTRODUCTION

Concerns for environmental conservation and sustainable development of the agricultural sector led to actions taken both at the global and European level and at the level of each country that has expressed its adherence to the 2030 Agenda's Sustainable Development Goals. The European Union monitors a set of agri-environmental indicators that are in line with the Sustainable Development Goals (SDGs): SDG2, SDG7 and SDG12. In this context, the study contributes to knowledge by creating a perspective on how agricultural activities affect the environment, as well as how these activities can contribute to reducing hunger, promoting renewable energy and responsible consumption. The main objectives of the study are: to select agri-environmental indicators relevant to sustainable development objectives; to process and analyse statistical data to understand how

the selected indicators have evolved; to classify the indicators into size classes and to draw conclusions on Romania's position regarding agri-environment and sustainable development in the European context. The study also reports on the progress of agri-environmental indicators towards the achievement of sustainable development goals.

2. STATE OF KNOWLEDGE

At global level, sustainable development indicators are included in the 2030 Agenda, adopted by the United Nations (UN), which includes 17 Sustainable Development Goals (SDGs) (NSI, 2023). Also, the eco-economic accounting system for agriculture, forestry and fisheries accounts for economic and environmental indicators in building the evidence needed to understand the links between food security, sustainable development, environmental issues and climate change (FAO, 2020). In Europe, policy initiatives for the full implementation of the UN 2030 Agenda include the European Green Deal ("for a climate neutral Europe"), the Farm to Fork Strategy ("for fair, healthy and environmentally friendly food systems") and action plans to reduce air, water and soil pollution and promote the circular economy and sustainable products (European Commission, 2022) etc.

At national level, Romania has the National Strategy for Sustainable Development 2030 and the 2030 Agenda for Sustainable Development. The agri-environmental indicators studied, which are part of the sustainable development indicators, are included in various documents and initiatives. For example, the "*National Action Plan for the Development of Organic Production in Romania*" proposes an increase to 6% (800 thousand ha) of the Utilised Agricultural Area (UAA), of which 3.53% (488 thousand ha) is a target set by the CAP Strategic Plan 2023-2027 to support organic farming commitments (MARD, 2023). There are also normative acts that support investments in renewable energy sources for self-consumption in the agricultural sector and food industry" (MARD, 2023). The report "*Sustainable Romania – National Indicators for Sustainable Development – Horizon 2030*" presents the evolution of social, economic and environmental phenomena, as well as the progress and distance in reaching the 2030 targets. These initiatives reflect Romania's commitment to sustainable development and environmental protection. (NIS, 2023).

3. MATERIAL AND METHOD

The agri-environmental indicators are monitored by EUROSTAT statistics and are part of the EU Sustainable Development Indicators (SDGs). The selection of indicators for analysis was based on their relevance as explained in the statistical metadata (Eurostat, Metadata).

The comparison method is used for the data analysis to process the information resulting from the quantification of the indicators in average magnitudes, ranked according to the frequency of occurrence of values between the minimum and maximum limits of the data samples. The analysis allows knowledge to be obtained for a given period of time. In order to reveal the contribution of agri-environmental indicators to the achievement of sustainable development goals, the indicators "percentage of agricultural area used in organic farming", "final energy consumption in agriculture" and "energy productivity" were analysed, with the time span including data for different periods, depending on their availability.

4. RESULTS AND DISCUSSIONS

Percentage of total agricultural area used in organic farming is an important agri-environmental indicator used to measure progress towards Sustainable Development Goal 2 (SDG2): Zero Hunger – to eradicate hunger and malnutrition and considered as part of the overall indicator SDG 2.4.1 "Proportion of agricultural area in productive and sustainable agriculture" (Eurostat, Metadata). How does organic farming contribute to the eradication of hunger and malnutrition? Organic farming has a strong link to hunger eradication. Firstly, organic farming promotes sustainable production practices that can ensure consistent and healthy food production. What are sustainable practices? It means that synthetic chemicals (pesticides, chemical fertilisers, etc.) are not used in organic farming, organic fertilisers are used and plant health is ensured through natural methods. Even if there are yield differences compared to conventional farming, yields stabilise in the long term, thanks to improved soil and water quality to produce healthy, nutrient-rich crops. With healthy soil and water, organic farming will produce food that is cleaner and more suitable for human metabolism (NIS, 2023).

By increasing the area under organic farming and applying sustainable practices, including traditional production methods, resilient farming systems are created in the face of climate change or crises of any kind (*e.g.* COVID 19, economic crises, geopolitical crises, etc.), leading to sustainable production, food availability and food accessibility, which means reducing the risk of hunger. *The UN's 2030 Agenda*, as well as the European initiatives of the *European Green Deal* through the *Farm to Fork* and *Biodiversity strategies*, have been created to prevent such crises.

In the same context of sustainability, organic farming is a solution for low-income or no-income people who are able to procure food for consumption. The model that still describes the current consumption situation, although this model was made known in 2007, is the "mixed model of food consumption" which includes the "consumption model of the rural population" (those who own land and depend on agricultural production obtained for their own consumption and for the

market) and the "consumption model of the urban population" (restricted by income, but who can benefit from agricultural products indirectly from relatives who practice agriculture)" (Alexandri, 2007).

From an economic point of view, organic farming can be a profitable business but also a way of life. It can be practised by anyone who is passionate and interested in healthy food, has knowledge on this type of farming, respects nature and the rules imposed by certification, etc. and from the point of view of consumers of organic products, they must be certain that the rules of organic production are respected (European Commission, 2022).

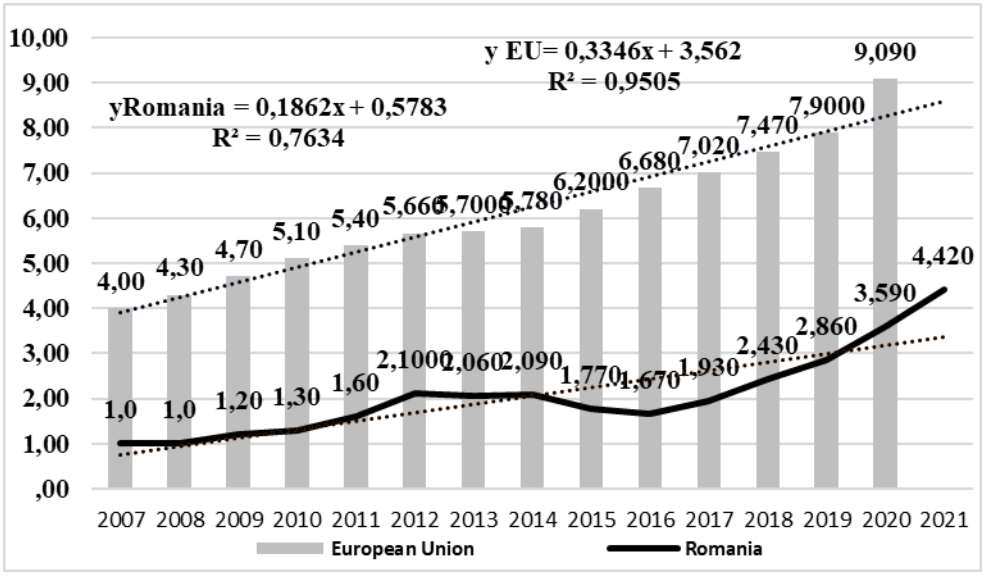
The area under organic farming is not only arable land, but also grassland areas and meadows, etc., which contribute to climate change mitigation (capture CO_2 from the atmosphere and mitigate greenhouse effect, reduce energy consumption in agriculture, etc.).

From a statistical point of view, the indicator "percentage of agricultural area used in organic farming" is presented graphically, in evolution (Figure 1), by ranking the average values for each country of the European Union (Figure 2), as well as the cumulated individual frequencies for the number of occurrences of a value in the dataset, using the histogram as analysis tool (Histogram 1) (Microsoft Excel).

Figure 1 shows the evolution of the organic farming area in Romania compared to the EU average. It can be seen that the slope of the regression line is increasing, with the area increasing on average by 0.3346%/year in the EU, while in Romania it increased by 0.1862%/year. In the analysed period there are 3 periods: a period of increase, for the interval 2007–2011, from 1% to 1.6%, a period of decrease, 2012–2016, from 2.10% to 1.67%, after which the line follows an increasing trend from 2017, from 1.93% to 4.42%.

An explanation of this increase-decrease-increase transition can be summarised as follows: for the first period, *i.e.* for the 2007–2011 period, the increase in organic farming area is due to the demand for organic products and better prices; the decrease in area, corresponding to the 2012–2016 period, is due to the exit of organic operators from the system, caused by the lack of financial support, which was not granted in the period 2007–2013 through the NRDP, but also by lower yields compared to conventional competitors, etc., and for the last timeframe, corresponding to the period 2017–2021, the trend of increasing area in organic farming is due to the granting of subsidies but also to the attention paid to health and environmental issues, etc. During the 2014–2020 NRDP programming period, financial support for conversion to organic farming ranged from 39 EUR/ha/year (permanent grassland) to 620 EUR/ha/year (orchards) and the amount of compensation payments for maintaining organic farming practices ranged from 73 EUR/ha/year (permanent grassland) to 479 EUR/ha/year (vineyards). (APIA, 2014–2020).

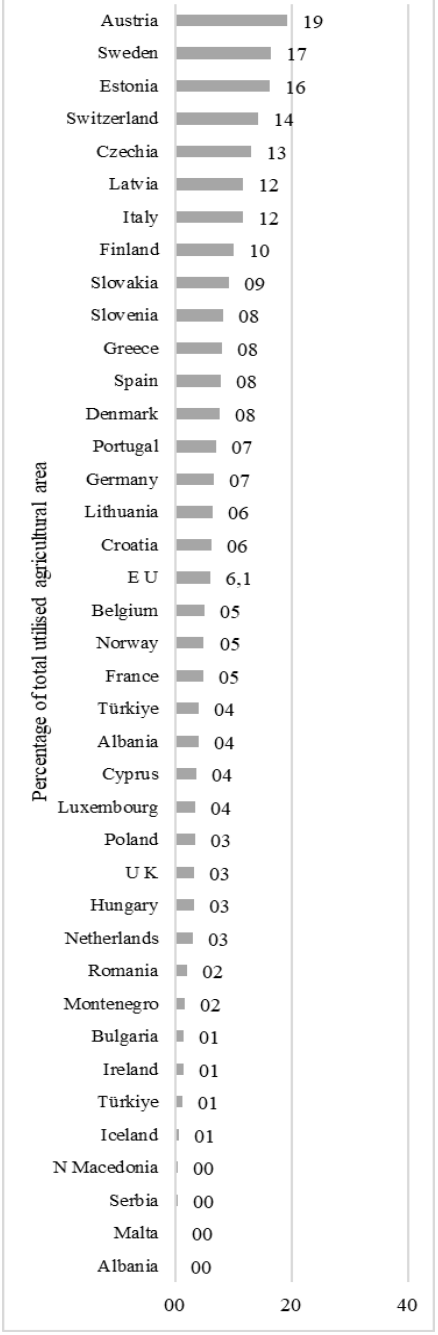
Other factors that have contributed to the poor expansion and development of this segment of agriculture would be due to "lack of local markets, higher prices for these products and low domestic incomes, lack of consumer information and education on the quality and advantages of organic products" (Rusali, 2007).

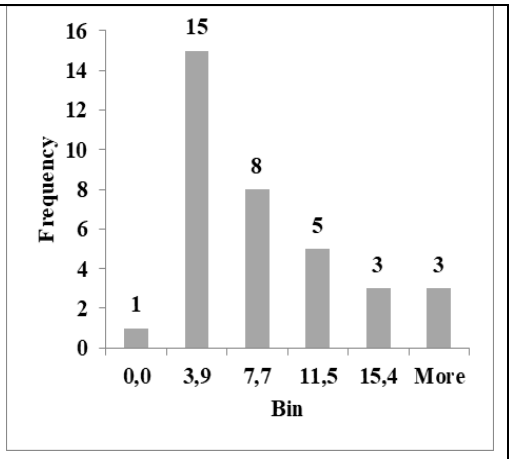


Source: Eurostat, [sdg_02_40__custom_9422323].
Figure 1. Area under organic farming (%).

Distribution of countries according to areas under organic farming: the graph shows the distribution of countries according to the areas under organic farming and their grouping according to the frequency with which values occur between the minimum (0%) and maximum (19.2%) limits of the data sample.

EU countries with areas under organic farming are grouped into five classes and the values are presented in descending order. Romania is in the group of countries with areas in organic farming in the data range between 0% and 3.9%, with an average area of 2.1% for the period 2007–2021 (Histogram 1).





Histogram 1. Grouping of countries by area under organic farming, average 2007–2021 (%)

Frequency of occurrence in the range from minimum 0% to maximum 19.2%.

Range 15.4% to 19.2% – 3 countries: Austria, Sweden, Estonia.

Range 11.5% to 15.4% – 3 countries: Switzerland, Czech Republic, Latvia, Italy.

Range 7.7% to 11.5% – 5 countries: Finland, Slovakia, Slovenia, Greece, Spain.

Range 3.9% to 7.7% – 8 countries: Denmark, Portugal, Germany, Lithuania, Croatia, Belgium, Norway, France.

Range 0% to 3.9% – 15 countries: Cyprus, Luxembourg, Poland, UK, Hungary, Netherlands, **Romania,** Montenegro, Bulgaria, Ireland, Turkey, Iceland, Northern Macedonia, Serbia, Malta.

Source: Eurostat, [sdg_02_40__custom_9422323].
Figure 2. Area under organic farming, 2007-2021, (%).

Final energy consumption in agriculture – covers only the energy consumed by end-users, without the energy consumption of the energy sector itself and the losses that occur during energy transformation and distribution. The indicator is used to monitor progress towards SDG 7 on clean and affordable energy, which is embedded in the European Green Deal. The target for improving *energy* efficiency *should be at least 32.5% by 2030*. In terms of *improving energy efficiency* and *increasing the share of renewable energy*, investments are needed in research, infrastructure and the development of clean energy technologies. The target set is driven by energy efficiency by reducing EU final energy consumption by 11.7% by the year 2030, and Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources.

From a methodological point of view, *final energy consumption* in agriculture includes all types of energy from solid fossil fuels, peat and peat products, oil and oil products, natural gas, renewables and biofuels, renewable municipal waste, ambient heat (heat pumps), heat, electricity (Eurostat, a).

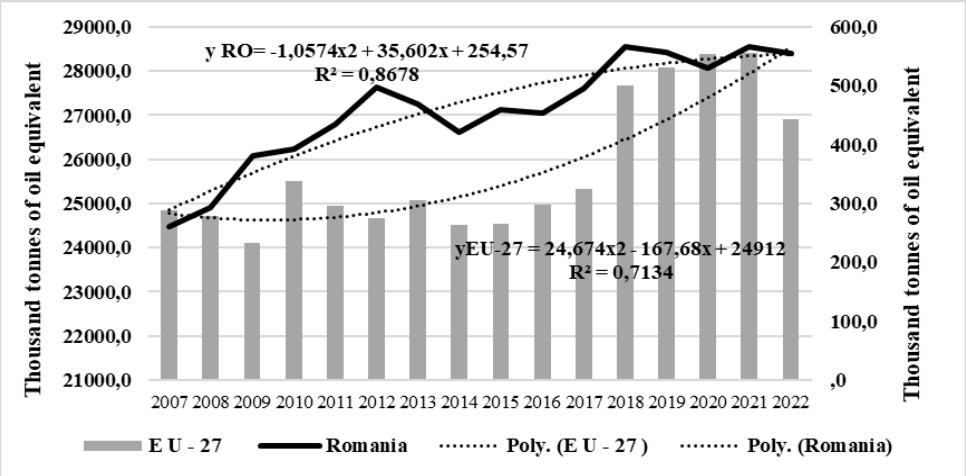
For 2017 (available data), final energy consumption in agriculture and forestry has the following structure: (total energy ktoe) = *solid fossil fuels (4.2%)* + manufactured gas (0) + *peat and peat products (0.3%)* + oil shale and tar sands (0) + *oil and oil products (53%) + natural gas (14.1%) + renewables and biofuels (9.8%)* + non-renewable waste (0) + nuclear heat (0) + *heat (1%) + electricity (17.6%)*. Renewables and biofuels have a share of 9.8% and this share needs to increase to replace oil and gas fuels which have a share of more than 50%.

1 kg diesel = 0.92...0.79 kg oil = 2.94...3.2 kg CO_2

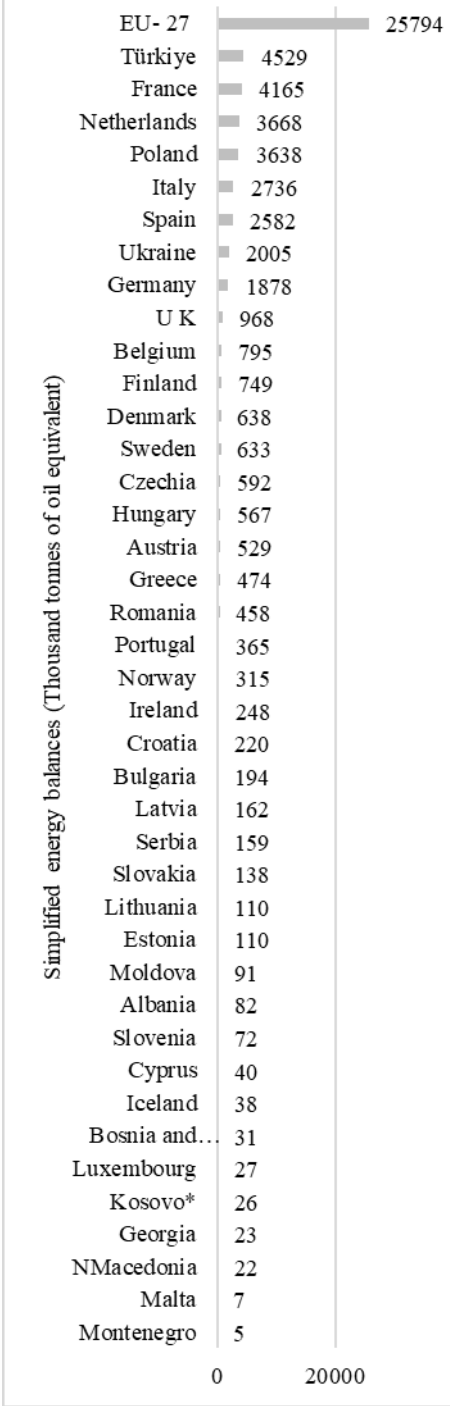
"Substituting, or saving, 1 kg diesel consumes about 0.92...0.79 kg less oil, which means 2.94...3.2 kg CO_2 less. Every saving of diesel means a contribution to global environmental protection" (Mitroi, 2005).

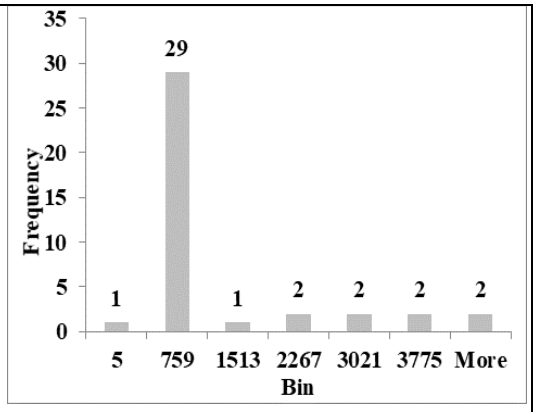
Energy consumption in agriculture, together with energy consumption in other economic sectors, contributes to the energy balance, which provides information on *energy supply and demand, the efficient functioning of energy markets and other relevant policies, as well as for formulating energy policies* (Eurostat, a).

Figure 3 shows final energy consumption in Romania compared to the EU-27 average. Energy consumption in the European Union shows variations, the constant increase is recorded in the time span 2018–2021. The slope of the regression line shows a reduction in final energy consumption, on average, by 167.68 thousand tonnes of oil equivalent/year (ktoe /year). Romania's final energy consumption shows an increase of 35.602 ktoe /year on average.



Source: Eurostat, [nrg_bal_s__custom_9144258].
Figure 3. Simplified energy balance,
Final energy consumption – other sectors – agriculture and forestry.





Histogram 2. Final energy consumption from agriculture, average 2011–2022, thousand tonnes oil equivalent (ktoe).

Range 3775 ktoe **to 4529** ktoe **– 2 countries**: Turkey, France.

Range 3021 ktoe **to 3775** ktoe**:** Netherlands, Poland.

Range 2267 ktoe **to 3021** ktoe**:** Italy, Spain.

Range 1513 ktoe **to 2267** ktoe **– 2 countries:** Ukraine, Germany.

Range 759 ktoe **to 1513** ktoe**: 1 country –** UK.

Range 5 ktoe **to 759** ktoe**: 29 countries –** Belgium, Finland, Denmark, Sweden, Czech Republic, Hungary, Austria, Greece, **Romania,** Portugal, Norway, Iran, Croatia, Bulgaria, Latvia, Serbia, Slovakia, Lithuania, Estonia, Moldova, Albania, Slovenia, Cyprus, Iceland, Bosnia and Herzegovina, Luxembourg, Kosovo, Georgia, North Macedonia, Malta.

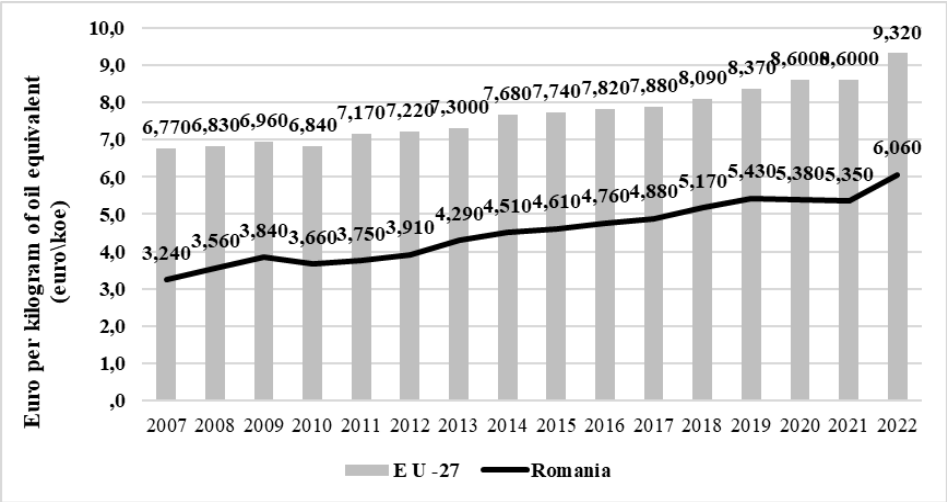
Range 0 ktoe **to 5** ktoe **1 country –** Montenegro

Source: Eurostat, [nrg_bal_s__custom_9144258].

Figure 4. Simplified energy balance, Final energy consumption – other sectors – agriculture and forestry.

Energy productivity in agriculture can be expressed in EUR/koe (kilogram oil equivalent) or by standard purchasing power (SPP). EUR/koe is a unit of measurement that estimates the energy cost of a quantity of resources consumed in agriculture, while SPP expresses how much energy can be purchased with a given amount of money in a given place and time. These metrics can be used to assess the energy efficiency of agricultural activities and to compare results between different farms or countries (Eurostat, c, d; NSI).

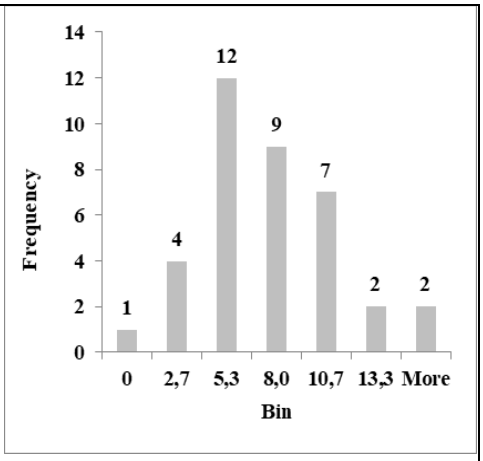
Energy productivity is part of the set of agri-environmental indicators and is used to monitor progress towards SDG 7 on clean and affordable energy and SDG 12 on ensuring sustainable consumption and production patterns (Eurostat, f).



Source: Eurostat, [sdg_07_30__custom_9144455].
Figure 5. Energy productivity (euro/ koe).

The graph shows the evolution of energy productivity expressed in EUR/ koe over time. There are 3 periods: the period 2007–2013, where the cost per kg oil equivalent ranged from 3.24 EUR/ koe to 3.91 EUR/ koe, the period 2013–2017 where the cost ranged from 4.29 EUR/ koe to 4.18 EUR/ koe and the period 2018–2022 with a cost ranging from 5.15 EUR/ koe to 6.06 EUR/ koe.

Compared to the EU countries, Romania is in the 5th group of values (distribution in descending order), in the range of 2.7 EUR/ koe and 5.3 EUR/ koe, with an average energy cost of 4.5 EUR/ koe, considering this position as unfavorable compared to Italy (9.8 EUR/ koe), Germany (8.7 EURs/koe), France (8.2 EUR/ koe), Spain (8.2 EUR/ koe), but less favorable compared to Hungary (4.2 EUR/ koe), Poland (4.2 EUR/ koe), Bulgaria (2.2 EUR/ koe).



Histogram 3. Energy productivity, average 2007–2022.
Euro per kilogram oil equivalent (koe)

Range 13.3 EUR / koe **to 16.0** EUR / koe **– 2 countries**: Ireland, Denmark.

Range 10.7 EUR / koe **to 13.3** EUR / koe **– 2 countries**: Norway, Luxembourg.

Range 8.0 EUR / koe **to 10.7** EUR / koe **– 7 countries**: UK, Italy, Austria, Germany, France, Spain, Sweden.

Range 5.3 EUR / koe **to 8.0** EUR / koe **– 9 countries**: Netherlands, Portugal, Greece, Cyprus, Belgium, Turkey, Finland, Slovenia, Croatia.

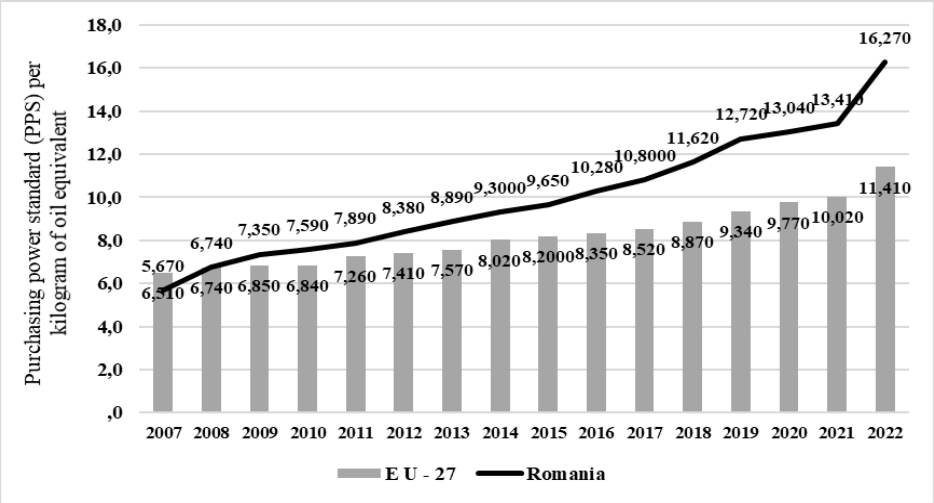
Range from 2.7 EUR / koe **to 5.3** EUR / KGOE **– 12 countries**: **Romania**, Latvia, Slovakia, Lithuania, Hungary, Albania, Poland, Czech Republic, Malta, Estonia, Montenegro, Northern Macedonia.

Range from 0 EUR / koe **to 2.7** EUR / koe **– 4 countries**: Bulgaria, Bosnia and Herzegovina, Serbia, Kosovo, Iceland.

Source: Eurostat, [sdg_07_30__custom_9144455].

Figure 6. Energy productivity (EUR/koe).

In order to eliminate the existing differences in prices for the production of goods, the optimal solution, which also allows for a more relevant appreciation of the differences between EU countries, was to replace the euro by the purchasing power standard (PPS/ koe). (Eurostat, f).



Source: Eurostat, [sdg_07_30__custom_9144455].
Figure 7. Energy productivity PPS/ koe.

In terms of energy productivity relative to the standard purchasing power (SPP) of energy that can be purchased *with a given amount of money in a given place and time,* Romania is in the 3rd group, with energy productivity averaging 10 PPS/ koe, after Italy (10.3 PPS/ koe). Ireland has the highest energy productivity (15.5 PPS/ koe) and Iceland the lowest (2 PPS/ koe). There are major differences between EU countries in the amount of energy purchased. Thus, 25 countries are below the European average (8.2 PPS/ koe), including all Central and Eastern European countries except Albania, Romania, Austria, Germany and Croatia.

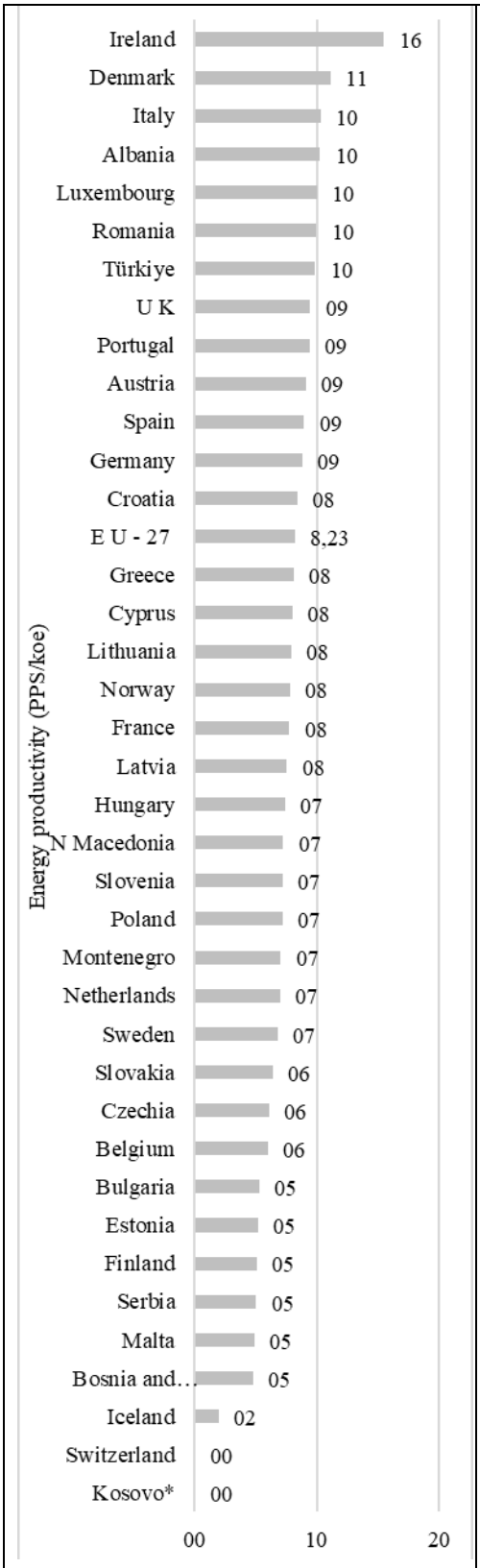
Romania is in the range of 7.8 PPS/ koe to 10.3 PPS/ koe, after Italy, Albania, Luxembourg, and ahead of Turkey, UK, Portugal, Austria, Spain, Germany, Croatia, Greece, Cyprus, Lithuania, Norway, France.

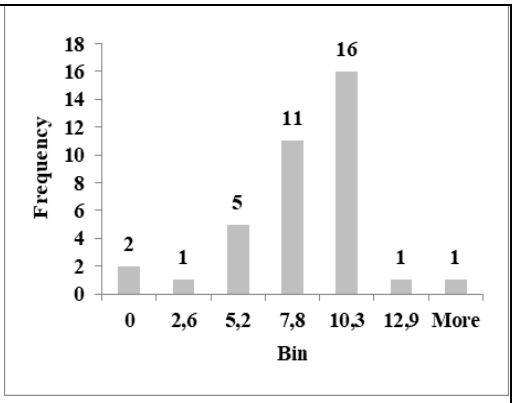
Energy productivity in Romania, expressed in standard purchasing power (SGP), is above the EU average by 1.5 percentage points.

The lowest energy purchasing power is recorded on average by Iceland, which is 2% below the EU average.

The highest energy productivity is in Ireland and Denmark, at 15.5 PPS/ koe, respectively 11.1 PPS/ koe above the EU average.

The high level of energy productivity can partly be explained by the number of companies working in these countries and contributing to GDP without being part of the resident population. A factor leading to the high level of PPS may be the presence of multinational companies operating in the energy sector. (Guia, 2020; Rosu, 2023).





Histogram 4. Energy productivity at PPS per kg oil equivalent, average 2007–2022.

Range 12.9 PPS/ koe **to 15.5** PPS/ koe **– 1 country**: Ireland.

Range 10.3 PPS/ koe **to 12.9** PPS/ koe **– 1 country**: Denmark.

Range 7.8 PPS/ koe **to 10.3** PPS/ koe **– 16 countries**: Italy, Albania, Luxembourg, **Romania,** Turkey, UK, Portugal, Austria, Spain, Germany, Croatia, Greece, Cyprus, Lithuania, Norway, France.

Range from 5.2 PPS/ koe **to 7.8** PPS/ koe **– 11 countries**: Latvia, Hungary, Northern Macedonia, Slovenia, Poland, Montenegro, Netherlands, Sweden, Slovakia, Czech Republic, Belgium, Bulgaria.

Range 2.6 PPS/ koe **to 5.2** PPS/ koe **– 5 countries**: Estonia, Finland, Serbia, Malta, Bosnia and Herzegovina.

Range 0 PPS/ koe **to 2.6** PPS/ koe **– 2 countries**: Iceland, Switzerland.

Source: Eurostat, [sdg_07_30__custom_9144455].

Figure 8. Energy productivity (PPS/koe).

5. CONCLUSIONS

The area under organic farming represents an average percentage of 2.1% of the utilised agricultural area (UAA) (2007-2021 average), with Romania 3.6 p.p. above the EU average (2.1% compared to 5.7%) and in the range from 0% to 3.9%, after Poland, Hungary and the Netherlands. Austria, Sweden and Estonia are at the upper end of the range (15.4% to 19.2%).

Romania's energy consumption from agriculture is 56 times lower than the EU average consumption (458 thousand tonnes of oil equivalent compared to the EU average consumption of 25794 thousand tonnes of oil equivalent). In this indicator Romania is in the minimum range (from 5 ktoe to 759 ktoe), after Hungary, Austria, Greece, and the countries in the maximum range (from 3775 ktoe to 4529 ktoe) are Turkey and France.

Energy productivity expressed in EUR/kg of oil equivalent (EUR/koe): the energy cost per 1 koe was, on average, 4.5 EUR/ koe compared to 7.7 EUR/ koe, Romania being 3.2 p.p. above the EU average and in the range of 2.7 EUR/ koe to 5.3 EUR/ koe, ahead of Hungary (4.4 EUR/ koe) and Poland (4.2 EUR/ koe). The biggest gap is with Ireland (16 EUR/ koe) and Denmark (14.1 EUR/ koe), which are in the maximum energy cost range (from 13.3 EUR/ koe to 16 EUR/ koe).

Energy productivity expressed in standard purchasing power (PPS) or energy productivity measured as GDP per koe: Romania's energy productivity is 10 PPS/ koe, 1.5 p.p. above the EU average, with the EU having a productivity of 8.23 PPS/ koe.

Over the period 2007-2022, the indicators presented for both Romania and the other countries evolved differently.

In addition to the advantages of organic farming as a source of income, healthy food, protection of the environment, etc., we believe that for the expansion and development of this type of agriculture, financial support measures should be sufficiently incentive to strengthen the conviction of those who choose to practice organic farming that they are "not left behind", due to the rules and restrictions that accompany the practice of this type of agriculture, etc., compared to those who practice conventional agriculture.

Energy plays an important role in farming. In this paper, the final energy consumption used in agricultural production processes is presented. Romania, compared to other EU countries, has a lower consumption compared to France, the Netherlands, Poland, Italy, Spain, Germany, countries with which Romania competes for economic performance in agriculture. The negative impact on the environment and the geopolitical context, etc., which make the transformation processes more difficult due to the lack of resources and the cost of purchasing materials (diesel, chemical fertilizers, pesticides, etc.) for the production processes in agriculture, are causes that contribute to the reduction of energy consumption in agriculture.

The European Union's agri-environment policy aims to promote sustainable agriculture and protect the environment in the context of agricultural activities, through measures and instruments to encourage farmers to adopt environmentally friendly farming practices.

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