UDC 502.131.1:631(4-12)
502.131.1:631(4-191.2)
Biblid 0543-3657, 74 (2023)
Год. LXXIV, бр. 1187, стр. 107–132
Review scientific paper
Received: 9/10/2022
Accepted: 12/1/2023
doi: https://doi.org/10.18485/iipe_mp.2023.74.1187.5

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Eco-efficiency and sustainable agricultural development in Central and Southeast Europe

ABSTRACT

The modern era ushers in significant changes in the conventional method of achieving economic growth, bringing us to eco-efficiency in economic growth. Nowadays, eco-efficiency is becoming a measure of progress in green growth and an increasingly preferred way of using resources. Eco-efficiency has become a practical approach for businesses to contribute to sustainable development. The focus of the paper is on eco-efficiency and sustainable development in the agriculture sector. In this context, sustainability in the agricultural sector depends on the existence of eco-efficient production models. A number of parameters were researched with the aim of determining and comparing the development level as well as the level of realisation of sustainable development goals (SDG) in Central and Southeast Europe (CSEE). We used the method of a comparative analysis of SDG indicator values between different CSEE countries in order to assess

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The paper presents the findings of a study developed as a part of the research project "Serbia and Challenges in International Relations in 2022", financed by the Ministry of Education, Science, and Technological Development of the Republic of Serbia, and conducted by the Institute of International Politics and Economics, Belgrade, and the project "Eco-efficiency and Sustainability of Small-scale Farming: Exploring Slacks for Undesirable Outputs and Public Goods", financed by the Polish National Agency for Academic Exchange, Poland, project no. NO-2021/41/B/HS4/02433.

the effectiveness of countries in advancing the goals of sustainable development. Since this is a relatively unknown indicator in Serbia, we also research to what extent the concept of eco-efficiency is implemented in the Serbian agricultural policy and strategic development documents. The research gave a basic framework for the answers to the question of how to improve Serbian agriculture based on the postulates set within the EU in order to comply with the SDG.

Keywords: eco-efficiency, sustainable development, eco-efficiency indicators, Serbia, EU, CSEE, agriculture, SDG.

Еколошка ефикасност и одрживи развој пољопривреде у централној и југоисточној Европи

САЖЕТАК

Савремено доба доноси промене у конвенционалном начину економског раста доводећи нас до еко-ефикасности привредног раста. Данас еко-ефикасност постаје мерило напретка у зеленом расту и све више префериран начин коришћења ресурса. Еко-ефикасност је за предузећа постао практичан начин на који могу да допринесу одрживом развоју. У фокусу рада је еко-ефикасност и одрживи развој пољопривредног сектора. У овом контексту, одрживост у пољопривредном сектору зависи од постојања еко-ефикасних модела производње. Истраживан је низ параметара у циљу утврђивања и поређења нивоа развоја, као и степена реализације циљева одрживог развоја (СДГ) у Централној и Југоисточној Европи (ЦЈИЕ). Користили смо методу компаративне анализе вредности индикатора СДГ између различитих земаља ЦЈИЕ како бисмо проценили ефикасност земаља у унапређењу циљева одрживог развоја. Пошто је ово релативно непознат показатељ у Србији, истражујемо и у којој мери је концепт еко-ефикасности имплементиран у аграрну политику Србије и стратешке развојне документе. Истраживање је дало основни оквир за одговоре на питање како унапредити српску пољопривреду на основу постулата постављених унутар ЕУ, како би се ускладила са СДГ.

Кључне речи: еко-ефикасност, одрживи развој, индикатори еко-ефикасности, Србија, ЕУ, ЦЈИЕ, пољопривреда, СДГ.

The concept of eco-efficiency

Conventional approaches to economic growth, "grow now, clean up later", have begun to challenge the sustainable development of more and more of the world's economies, putting the future of entire economies and societies in peril. Gradually, it became clear that it was necessary to take decisive steps towards changes in the conventional way of achieving

economic growth. One approach to overcoming the challenge was to promote eco-efficient economic growth and development. At the same time, attention had to be paid to making more inclusive progress in human well-being and overall socio-economic progress.

Eco-efficiency emerged in the 1990s as a measure of "the efficiency with which ecological resources are used to meet human needs".[2] Eco-efficiency is becoming a key element in promoting fundamental changes in the way economies and societies produce and expend resources. That is why eco-efficiency is becoming a measure of progress in green growth. The very concept of eco-efficiency can even be traced back to the 1970s as the concept of "environmental efficiency".[3] In the 1992 United Nations Conference on Environment and Development and later in the literature on sustainable development, the term "eco-efficiency" became more and more prevalent. Eco-efficiency has a role in expressing how efficient economic activity is with regard to nature's goods and services. Eco-efficiency was intended to be a practical approach for businesses to contribute to sustainable development. This concept has been embraced by hundreds of companies, and it is a practical tool for enhancing both economic and environmental benefits.[4] Eco-efficiency and sustainability concepts are increasingly being studied and gaining importance in all areas of human activity.

The eco-efficiency of a process (or a system of processes) can be assessed by factoring in a host of dimensions – safety-related and economic.[5] Farms should be able to produce at a higher ecological efficiency without losses in economic efficiency.[6] According to Czyżewski, eco-efficiency, in the simplest terms, is about achieving more with less – more agricultural outputs in terms of quantity and quality for less input of land, water, nutrients, energy, labor, or capital.[7]

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[2] Per Mickwitz, Matti Melanen, Ulla Rosenström & Jyri Seppälä, „Regional eco-efficiency indicators–a participatory approach", *Journal of Cleaner Production*, vol. 14, no. 18, 2006, 1603-1611.

[3] A. Myrick Freeman III, Robert H. Haveman & Allen V. Kneese, *The economics of environmental policy*, John Wiley, New York, 1973.

[4] UN ESCAP, *Eco-efficiency indicators: measuring resource-use efficiency and the impact of economic activities on the environment*, https://sustainabledevelopment.un.org/content/documents/785eco.pdf, 13/03/2022, 1.

[5] Ali Mohammadi, Govindarajan Venkatesh, Samieh Eskandari & Shahin Rafiee, „Eco-Efficiency Analysis to Improve Environmental Performance of Wheat Production", *Agriculture*, vol. 12, no. 7, 2022, 1031.

[6] Meike Weltin & Silke Hüttel, "Farm eco-efficiency: can sustainable intensification make the difference?" FORLand-Working Paper 10 Agricultural Land Markets - Efficiency and Regulation, Humboldt-Universität Berlin, https://www.econstor.eu/bitstream/10419/213064/1/FORLand-2019-10.pdf, 1-26.

[7] Bazyli Czyżewski, Anna Matuszczak, Aleksander Grzelak, Marta Guth & Adam Majchrzak, "Environmental sustainable value in agriculture revisited: How does Common Agricultural Policy contribute to eco-efficiency?", *Sustainability Science*, vol. 16, no. 1, 2021, 137–152.

Green growth has emerged as the dominant European Union (EU) response to climate change and deteriorating environmental conditions. A European Green Deal was composed to transform the EU into a modern, resource-efficient, and competitive economy. The European Green Deal promotes a farm-to-fork strategy, making the EU's food supply chain from producers to consumers more sustainable. Achieving a healthy, fair, and environmentally friendly food system should lead to healthy people, healthy societies, and a healthy planet. This should set up a sustainable food system and a strategy for sustainable and inclusive EU growth.

The use of the term "eco-efficiency" has become increasingly associated with sustainable agriculture.[8] Measuring resource efficiency and the impact of economic activities on the environment proved to be a demanding challenge in the agricultural sector, among others.

Eco-efficiency indicators

The necessity of existence and work in agriculture, which is the main food producer, cannot be questioned. However, it has become increasingly necessary to limit environmental pollution resulting from agricultural activities. Eco-efficiency is defined as a ratio between economic performance and environmental impact.[9] Eco-efficiency is a measure of an enterprise, an industry, or a region's performance in sustainable development, which simultaneously involves economic, resource, environmental, and social aspects.[10]

In the EU, the agreement on the reform of the common agricultural policy (CAP) was adopted on December 2, 2021, and is due to begin in 2023. This new common agricultural policy (2023-27) is more performance-based and offers ways for a sustainable future for EU farmers. Special attention is focused on targeted support for smaller farms. Also, the European Green

[8] Osman İnanç Güney, „Eco-Efficiency in Farm Management for Sustainable Agriculture: a Two-Stage Data Envelopment Analysis in Wheat Production", *Polish Journal of Environmental Studies*, vol. 30, no. 6, 2021, 5549-5557, Marlena Gołaś, Piotr Sulewski, Adam Wąs, Anna Kłoczko-Gajewska & Kinga Pogodzińska, „On the way to sustainable agriculture—eco-efficiency of polish commercial farms", *Agriculture*, vol. 10, no. 10, 2020, 438, Xiangzheng Deng & John Gibson, „Improving eco-efficiency for the sustainable agricultural production: A case study in Shandong, China", *Technological Forecasting and Social Change*, vol. 144, no. 1, 2019, 394-400, Guofeng Wang, Rui Shi, Lingchen Mi, and Jinmiao Hu, „Agricultural Eco-Efficiency: Challenges and Progress", *Sustainability*, vol. 14, no. 3, 2022, 1051.

[9] Galal M. Abdella, Murat Kucukvar, Adeeb A. Kutty, Abdelsalam G. Abdelsalam, Burak Sen, Muhammet Enis Bulak & Nuri Cihat Onat, „A novel approach for developing composite eco-efficiency indicators: The case for US food consumption", *Journal of Cleaner Production*, vol. 299, art. 126931, 2021.

[10] Jianhuan Huang, Jiejin Xia, Yantuan Yu & Ning Zhang, „Composite eco-efficiency indicators for China based on data envelopment analysis", *Ecological indicators*, vol. 85, 2018, 674-697.

Agreement's focus is on agriculture and rural areas. The new CAP should be a key tool in the realisation of the farm-to-fork and biodiversity strategies.[11] A greener CAP that supports agriculture to contribute to the objectives of the European Green Agreement puts the concept of agricultural eco-efficiency at the forefront.

Apart from the primary production of food for human consumption, agriculture also fulfils other functions, such as providing livelihoods for farmers and preserving an attractive and biodiverse landscape. These agricultural functions are regarded as a new concept of eco-efficiency assessment applied to 47 Austrian farms. According to the study of Grassauer et al., the joint application of life cycle assessment (LCA) and data envelopment analysis (DEA) showed that the eco-efficiency of farms depends on the fulfilment of different functions of agriculture and that individual strategies for improvement could be identified.[12]

The Richterová et al. paper explores Visegrad 4 (the Czech Republic, Slovakia, Hungary, and Poland) regional eco-efficiency of the agricultural sector, which is expressed by the Malmquist productivity index and is estimated using the output-oriented DEA model under the assumption of constant return to scale (CRS). The Malmquist index is decomposed into technical eco-efficiency change (EC) and technological change (TC). The findings show that Central Bohemia, Northwest, Dél-Alföld, Észak-Magyarország, Észak-Alföld, Malopolskie, Wielkopolskie, the Bratislava region, and Western Slovakia have an eco-effective agricultural sector, while the remaining Visegrad 4 regions have an eco-ineffective agricultural sector. The findings also suggest that the main contributor to eco-efficiency improvement is technological progress, indicating that producers implement innovations that lead to more eco-efficient agricultural production.[13]

On the other hand, the Bianchi et al. paper researched regional eco-efficiency patterns in Europe, paying particular attention to territorial heterogeneity, and concluded that most eastern regions made significant progress in reducing the technological divide. But their resource management has become the main driver of inefficiency. Also, southern intermediate and

[11] European Commission, *The new common agricultural policy: 2023-27*, https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27_en, 22/06/2022.

[12] Florian Grassauer, Markus Herndl, Thomas Nemecek, Thomas Guggenberger, Christian Fritz, Andreas Steinwidder & Werner Zollitsch, „Eco-efficiency of farms considering multiple functions of agriculture: Concept and results from Austrian farms", *Journal of Cleaner Production*, 297, art. 126662, 2021.

[13] Eva Richterová, Martin Richter & Zlata Sojková, „Regional eco-efficiency of the agricultural sector in V4 regions, its dynamics in time and decomposition on the technological and pure technical eco-efficiency change", *Equilibrium. Quarterly Journal of Economics and Economic Policy*, vol. 16, no. 3, 2021, 553-576.

rural regions suffered losses of human capital, which seem to be the basis of their widening technological gap. "These results suggest that future efforts to improve eco-efficiency should be aimed at encouraging an efficient use of productive factors within each region, going beyond generic urban/rural approaches and therefore implementing place-based policies building on a good understanding of the complex linkages between the physical, social, and economic environments within individual regions".[14]

As we can see, eco-efficiency includes the economic as well as the ecological dimensions of sustainable agriculture. Eco-efficiency indicators and measuring the ecological efficiency of agricultural production on farms provide a very useful index for policymakers to achieve better performance in terms of agricultural sustainability. For instance, excessive and unplanned use of inputs leads to eco-inefficiencies. But building eco-efficiency indicators that are compliant with sustainable agriculture requirements is not a simple task to perform.

Sustainable agriculture requirements

The "green revolution" has positive effects in meeting the growing global demand for food, but it also leads to increased pressure on agriculture. Since the solution cannot be to reduce food production, the only alternative should be to support environmentally friendly and sustainable production methods that reduce the negative effects of agriculture. The model of sustainable production in agriculture can be implemented by preserving the ecological balance. One segment of securing food security is also the advancement of food distribution channels in order to decrease or eliminate food waste. In this context, sustainability in the agricultural sector depends on the existence of eco-efficient production models.[15]

In its green agenda, the European Union also has in mind the small farms that are present in the countries of Central and Eastern Europe, as well as in accession countries such as Serbia. However, there is resistance to the adoption of new practices for sustainable agricultural production. Therefore, it is necessary to find a model to stimulate farmers to switch to production models that will not greatly endanger the environment.

On the one hand, agriculture plays a key role in providing a wide range of products, primarily human food, animal feed, fibre, and biofuel. In this way, it contributes to the maintenance and economic development of the

[14] Marco Bianchi, Ikerne del Valle & Carlos Tapia, „Measuring eco-efficiency in European regions: Evidence from a territorial perspective", *Journal of Cleaner Production*, vol. 276, art. 123246, 2020.

[15] Marlena Gołaś, Piotr Sulewski, Adam Wąs, Anna Kłoczko-Gajewska & Kinga Pogodzińska, "On the way to sustainable agriculture—eco-efficiency of polish commercial farms", op. cit.

country. On the other hand, agriculture, as well as other sectors of human activity, produce negative effects on the environment in which they take place. Decision-makers need to find ways to encourage farmers to switch to sustainable agricultural production — a climate-neutral production. It is also important to identify bottlenecks and issues in transitioning to and maintaining sustainable agricultural production.

This is where eco-efficiency indicators come into play, which can help analyse such problems and make it easier to make decisions about encouraging certain activities as well as discouraging practices that can be detrimental to biodiversity and sustainable development. It is also necessary to point out the fact that it is more and more complex when looking at smaller agricultural farms because there is the human factor, the behavioural factor, which is decisive and which is the most difficult to quantify.

Rybaczewska-Błażejowska & Gierulski's paper evaluated the EU-28 eco-efficiency performance of agriculture at the sector level using the joint application of life cycle assessment (LCA) and DEA techniques, and the analyses concluded that the agricultural sectors of 10 member states (Belgium, Bulgaria, Estonia, Finland, Greece, Italy, Malta, the Netherlands, Romania, and Sweden) are relatively eco-efficient, while the remaining 18 member states have eco-inefficient agricultural sectors. The main reasons for eco-inefficiency are that the agricultural sector consumes too many natural resources, primarily energy, uses too much fertilizer, and produces considerable amounts of airborne emissions in relation to the level of GDP per hectare.[16]

In Güney research through a field survey of 111 wheat farms in the lower Seyhan plain of Adana City, the Çukurova Region (Turkey), the results of the DEA model demonstrated that the sampled wheat farmers are operating at a technical efficiency level of 88.3% under VRS conditions. This was inefficient and represented an environmental cost because if their inputs were reduced by 11.7%, the producers would still reach the same level of production. Mechanization had the highest rate of inefficient use among the inputs used in production (at an excess of 35%). There is also a high degree of inefficiency in the use of the labour force, which arises due to the low level of education and the fact that agricultural workers do not see agriculture as a profession. The negative relationship between experience and effectiveness level is also interesting, indicating that young and new wheat farmers have started to produce more effectively.[17]

The Huang et al. paper explores the dynamics of agricultural carbon emissions (ACE) and agricultural eco-efficiency (AEE) in China and the driving

[16] Magdalena Rybaczewska-Błażejowska & Wacław Gierulski, „Eco-efficiency evaluation of agricultural production in the EU-28", *Sustainability*, vol. 10, no. 12, 2018, 4544.

[17] Osman İnanç Güney, "Eco-Efficiency in Farm Management for Sustainable Agriculture: a Two-Stage Data Envelopment Analysis in Wheat Production", op. cit., 5555.

factors of AEE growth by DEA–Malmquist–Luenberger and panel data analyses. The research showed that the improvement of human capital and agricultural infrastructure contributed positively to the growth of AEE. In contrast, public investments in agricultural research and development and the agricultural industrial structure have undermined it. So the conclusion is that what is needed for ACE reduction and AEE growth, at the same time, are green-oriented policies targeted at regional heterogeneity and agricultural public investments.[18]

The Coluccia et al. paper evaluates the eco-efficiency of the Italian agricultural sector as an index useful for emphasising the differences among some national geographical areas, with DEA methodology focusing on the integration between agricultural productivity and resource conservation. The authors concluded that "CAP subsidies should be granted in exchange for specific environmental externalities provided by farmers as a result of more ecologically friendly management with a land use planning avoiding the depleting of Ecosystem Services rich areas, allowing for the achievement of a balance between economic growth and ecosystem protection".[19]

In the research of Gołaś et al. the results show that more eco-efficient farms have a larger utilised agricultural area (UAA), a higher production value, a higher intensity of chemical inputs per 1 ha, and lower amounts of inputs used per production unit. Also, more eco-efficient farms achieved higher farm incomes in many terms: total, per 1 ha of UAA, and per 1 EUR of production value.[20]

In the Gómez-Calvet et al. research, which evaluates the evolution of environmental performance in the context of the EU over the period 1993–2010, the eco-efficiency indicator has improved over the last two decades, but in the case of the traditional indicators (CO2e, SO2, and NOx), the opportunities for decreasing are still outstanding, especially in the case of SO2.[21]

Building eco-efficiency indicators compliant with sustainable agriculture requirements enables policy makers to obtain important indicators for

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[18] Jianhuan Huang, Jiejin Xia, Yantuan Yu & Ning Zhang, "Composite eco-efficiency indicators for China based on data envelopment analysis", op. cit.

[19] Benedetta Coluccia, Donatella Valente, Giulio Fusco, Federica De Leo & Donatella Porrini, „Assessing agricultural eco-efficiency in Italian Regions", *Ecological Indicators*, 116, art. 106483, 2020.

[18] Jianhuan Huang, Jiejin Xia, Yantuan Yu & Ning Zhang, "Composite eco-efficiency indicators for China based on data envelopment analysis", op. cit.

[19] Benedetta Coluccia, Donatella Valente, Giulio Fusco, Federica De Leo & Donatella Porrini, „Assessing agricultural eco-efficiency in Italian Regions", *Ecological Indicators*, 116, art. 106483, 2020.

[20] Marlena Gołaś, Piotr Sulewski, Adam Wąs, Anna Kłoczko-Gajewska & Kinga Pogodzińska, "On the way to sustainable agriculture—eco-efficiency of polish commercial farms", op. cit.

[21] Roberto Gómez-Calvet, David Conesa, Ana Rosa Gómez-Calvet & Emili Tortosa-Ausina, „On the dynamics of eco-efficiency performance in the European Union", *Computers & Operations Research,* vol. 66, no. 1, 2016, 336-350.

developing policies aimed at sustainable management and efficient use of natural resources in agriculture. Achieving sustainable agriculture can also be a long-term guarantee of food security and social well-being. Thus, it would be best to conduct research into eco-efficiency measurement, which is compliant with the concept of sustainable agriculture by means of the slack-based measure approach (SBM), including undesirable and desirable outputs that reflect social, economic, and environmental dimensions of sustainability. When analysing, it should be kept in mind that the significant problems in Serbia are, among others, the lack of data availability and the absence of modern infrastructure in the countryside.

Agriculture and sustainable development of Central and Southeast Europe

The improvement of Serbian agriculture will be based on the postulates set within the EU: the European Green Agreement (EGA) and the instrument for its implementation, the Green Agenda for the Western Balkans (GAWB).[22] The goal is to form sustainable agriculture through a circular economy, which will be based on competitive and productive agriculture and the efficient use of resources in a way that minimises pollution of climate, water, and land with the application of biodiversity.

The aspect of eco-efficiency is almost unknown within the Serbian economy when we talk about small farms. In general, this type of view of agriculture was insufficiently implemented in the Serbian agricultural policy and strategic development documents until the GAWB was signed. With the GAWB, the course has changed in a direction that ensures the transformation of the agricultural sector by minimising its negative impact on the environment and climate and protecting affordable and healthy food for the citizens of the Western Balkans and export markets. In fact, the GAWB is an instrument that is realising the EGA in the Balkans. The European Green Agreement is a novelty in the fight against climate change and EU growth strategies, which aims to achieve climate neutrality until 2050. The countries of the Western Balkans have committed themselves to implementing the GAWB through concrete actions and measures that would lead to "low carbon" development and economic growth. In accordance with the principles of sustainable development, the GAWB covers five areas: climate, energy, and mobility; a circular economy; pollution prevention; sustainable agriculture and food production; and biodiversity.

[22] "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal", European Commission, December 11 2019, "Guidelines for the Implementation of the Green Agenda for the Western Balkans", European Commission, December 11 2019.

Numerous goals of the EGA define the directions in which future agriculture can go. Goal 26 is the new "farm-to-fork" strategy. Goal 27 is even more important for Serbia: measures, including legislative ones, to significantly reduce the use and risk of chemical pesticides, fertilizers, and antibiotics. The development of rural infrastructure and market value chains based on the principles of sustainability, environmental friendliness, and low emissions affects the preservation of the environment. Establishing product quality schemes contributes to the improvement of food (especially organic) production. The land consolidation process contributes to the integrated management of natural resources and the connection of ecosystems in accordance with the requirements of the environment. Overall, improving the competitiveness of agriculture contributes to greening, improving rural agro-biodiversity, and mitigating climate change. The development of rural infrastructure is important for balanced regional development as well as for the negotiation of Chapter 22 and the chapters dealing with agriculture in accordance with the Rural Development Strategy.[23]

The greatest progress in terms of agriculture within the systemic national development policy can be seen through the goals of sustainable development (SDG), which are directly related to agriculture, rural life, food production, rural development, environmental protection, etc. Basically, agriculture is mainly related to SDG2, but in addition to this goal, it is also visible through SDG1, SDG4, SDG5, SDG6, SDG7, SDG8, SDG12, SDG13, and SDG15.

Data and methodology

Common indicators for Central and Southeastern Europe (CSEE) countries (Poland, Croatia, Romania, Bulgaria, Moldavia, Serbia, Montenegro, North Macedonia, Albania, and Bosnia and Herzegovina) will be examined in this section of the paper. The analysis will include only those indicators that are available for these SDGs and for selected countries, which are in the United Nations and World Bank databases.

For the analysis of the CSEE countries' SDG indicators, a comparative analysis was used. It is a simple methodological tool that allows the analysis of relationships between two or more sets of data. In particular, a comparative comparison of SDG indicator values between different countries is used. This analysis will enable the comparison of a large amount of data on sustainable development in order to assess the effectiveness of countries in advancing the goals of sustainable development. The analysis will provide a clear picture of each country's individual results. At the same time, the results will be comparable and will enable a deeper analysis of the scope of

[23] "Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014–2024. godine", *Službeni glasnik RS*, 85/14, Beograd, 12. avgust 2014, 1-103.

sustainable development goals, their benefits, and their application through strategic national documents on sustainable development.

Results and discussion

Traditionally, the lowest level of income in Serbia is realised in the agricultural sector. The standard of living of farmers on small farms is declining from year to year. In recent years, arable land has brought less income but a good yield to agricultural farms (small farms). For the purposes of analysing small farms in Serbia, we start with the basic indicator from the first goal (no poverty), which refers to the population's risk of poverty (the poverty ratio at $ 1.90 per day,%). The fact is (Table 1) that the value of raids is decreasing, and there is no fear of poverty in Serbia. In addition, the population living in rural areas manages to feed themselves. Compared to other Central and Eastern European (CEE) countries, there is almost no risk of poverty in Poland; the situation in Romania is the most dramatic because it is measured by income in 2021, when Romania fell into the group of upper-middle-income economies while Moldova was ranked the same year. Poverty in the latter is significantly lower compared to 2010. The biggest disadvantage of agriculture is that the majority of the population engaged in it is poor, but the biggest advantage is that it is twice as effective at reducing poverty.

Table 1. Poverty headcount ratio at $1.90/day in CIE, % (sdg1_wpc)

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
SRB	0.2	2.29	4.39	0.21	5.61	0.16	4.98	3.87	0.06	0.05	0.05	0.04	0.04
POL	0.04	0.06	0.04	0.06	0.05	0.04	0.03	0.02	0.05	0.02	0.02	0.02	0.02
ROM	0.2	0.18	0.18	0.21	4.87	3.83	0.19	2.28	1.7	1.6	1.7	1.54	1.43
MDA	0.43	0.34	0.16	0.12	0.02	0.08	0.15	0.04	0.06	0.05	0.06	0.06	0.05
ALB	0.44	0.49	0.54	0.53	0.53	0.14	0.17	0.33	0.22	0.14	0.18	0.09	0.05
BIH	0.08	0.1	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.06	0.07	0.06	0.06
MNE	0.15	0.24	0.44	0.34	0.02	1.61	2.39	2.26	2.12	2.02	2.17	1.97	1.82
MKD	9.58	8.11	6.3	4.48	3.78	3.92	3.3	3.13	2.32	2.15	2.39	2.2	2.03
BGR	1.38	1.66	1.53	1.61	1.23	2.06	1.51	1.18	0.89	0.83	0.83	0.79	0.75
HRV	0.02	0.65	0.63	0.73	0.76	0.57	0.6	0.6	0.43	0.42	0.43	0.41	0.39

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

The Balkan average is unfavourable due to the highest risk of poverty in Montenegro and Macedonia, unlike Albania and Bosnia and Herzegovina, which have moved closer to Serbia in recent years. Of the EU member states, Bulgaria and Croatia have an unfavourable risk, but less than Romania. At the same time, the latter countries are in the group of higher-income countries (Upper-Middle-Income Countries and High-Income Countries).

Agriculture contributes up to 10% of the annual gross domestic product in the Balkan countries (except Albania, with 20%). According to the FAO's analyses, the countries of the Western Balkans gave their farmers an average of 53 euros per hectare. Albanian farmers received the smallest amount — only 3 euros of direct aid per hectare from the state, while 42 euros went to institutions and entities that monitor the agricultural sector.[24]

SDG goal 2 (Zero Hunger) is closely related to agricultural products. The goal is to provide food for all by 2030. In this part of the analysis, three indicators have been singled out (Human Trophic Level, Cereal Yield, and Sustainable Nitrogen Management Index). The energy intensity of the composition of food consumed in the CEE countries is approximately the same (a higher trophic level represents a higher level of consumption of energy-intensive products). The fight against hunger is not only related to food production but also to a way to increase income and strengthen the market.

Table 2. Human Trophic Level in CIE and SIE by countries (best 2/worst 3) (sdg2_trophic)

Country	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017
SRB	2.408	2.393	2.321	2.315	2.344	2.318	2.351	2.34	2.332	2.348
POL	2.344	2.339	2.357	2.351	2.353	2.364	2.344	2.359	2.346	2.352
ROM	2.314	2.34	2.332	2.33	2.33	2.322	2.335	2.336	2.341	2.331
MDA	2.291	2.338	2.357	2.349	2.359	2.361	2.333	2.337	2.334	2.357
ALB	2.357	2.399	2.364	2.361	2.36	2.362	2.371	2.37	2.377	2.383
BIH	2.271	2.25	2.26	2.258	2.267	2.247	2.264	2.263	2.257	2.258
MNE	2.412	2.393	2.361	2.362	2.36	2.382	2.386	2.398	2.507	2.464
MKD	2.288	2.305	2.292	2.264	2.273	2.274	2.276	2.275	2.257	2.244
BGR	2.354	2.342	2.341	2.339	2.34	2.35	2.353	2.348	2.372	2.363
HRV	2.385	2.385	2.393	2.379	2.39	2.396	2.429	2.415	2.437	2.433

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

Cereal yields, measured in tonnes per hectare of harvested land, differ approximately in these economies during the observed period and range from the lowest in Poland to the highest in Serbia. In the Balkans, Croatia and Romania dominate this indicator, followed by Bulgaria and Bosnia and Herzegovina. These are traditionally the countries with an even higher share of agriculture in their GDP compared to the EU average.

[24] Alice Taylor, https://www.euractiv.com/section/agriculture-food/news/albanian-farmers-receive-lowest-government-subsidies-in-region, *Albanian farmers receive lowest government subsidies in region*, 20/12/2022.

Table 3. Cereal yield in CIE and SIE by countries (sdg2_trophic)

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SRB	4.455	3.233	4.571	4.601	4.959	4.751	3.702	5.158	5.966	4.787	6.168	3.968	6.133
POL	2.598	3.249	3.217	3.475	3.584	3.43	3.705	3.804	4.268	3.728	4.034	4.2	3.431
ROM	3.102	1.645	3.247	2.825	3.33	3.993	2.364	3.863	4.069	3.544	3.971	5.228	6.006
MDA	2.55	2.111	3.222	2.373	2.734	2.866	2.344	2.852	3.162	2.371	3.197	3.652	3.683
ALB	3.603	3.728	4.081	4.315	4.762	4.751	4.884	4.95	4.893	4.874	4.716	4.813	4.84
BIH	4.291	3.223	4.427	4.503	3.853	3.725	3.001	4.027	3.977	3.812	5.192	3.732	5.488
MNE	2.971	1.992	3.24	3.348	3.321	3.306	2.639	3.771	3.451	3.147	3.262	3.288	3.312
MKD	3.244	2.625	3.537	3.386	3.33	3.502	2.839	3.381	3.9	3.051	3.859	2.808	3.715
BGR	3.572	2.524	4.094	3.413	4.031	4.251	3.672	4.561	4.861	4.67	4.818	5.48	5.464
HRV	5.42	4.558	6.639	6.11	5.456	5.22	4.574	5.445	6.028	5.695	6.666	5.705	6.975

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

Serbia and Romania dominate the Sustainable Nitrogen Management Index (SNMI). In other words, they exhibit the highest level of plant production efficiency — the combined efficiency of nitrogen use and efficiency of land use. Poland and Moldova rank worse even than other Balkan countries, such as Croatia and Bulgaria, but are not less efficient than Montenegro, Bosnia and Herzegovina, or Albania. It should be noted that the good results related to SNMI are sometimes caused by the low rate of fertilizer application at the farm level, especially at the family farm level in some countries.

Table 4. Sustainable Nitrogen Management Index in CIE and SIE by countries (best 0/ worst 1.41) (sdg2_crlyld)

Country	2001	2005	2010	2011	2012	2013	2014	2015
SRB	0.536	0.571	0.531	0.531	0.531	0.5	0.502	0.482
POL	0.653	0.632	0.615	0.613	0.611	0.605	0.6	0.608
ROM	0.613	0.602	0.511	0.51	0.503	0.489	0.481	0.452
MDA	0.635	0.611	0.588	0.592	0.59	0.583	0.605	0.602
ALB	0.941	0.933	0.873	0.864	0.854	0.842	0.836	0.829
BIH	0.726	0.794	0.901	0.916	0.938	0.946	0.986	1.003
MNE	1.002	0.899	0.999	0.999	0.998	1.006	1.027	1.061
MKD	0.785	0.756	0.746	0.749	0.751	0.738	0.743	0.748
BGR	0.704	0.666	0.56	0.55	0.549	0.539	0.543	0.52
HRV	0.644	0.637	0.557	0.553	0.537	0.508	0.477	0.486

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

The importance of education, from the aspect of SDG 4: Quality Education, is gaining more and more importance from the aspect of agriculture, especially when it comes to new technological solutions, the application of new techniques and procedures in land cultivation, and the cultivation of agricultural products. The educated structure of the rural population in the Balkan villages is at the level of primary education (except for Moldova and Montenegro, for which there are no data). This is a limiting factor in the competitiveness of agriculture and rural development in Serbia. However, different forms of advice for farmers will give them access to the skills, tools, inputs, and knowledge they need for sustainable agriculture. It should be noted here that there is a limitation in the function of knowledge transfer (advisory services, input distributors, scientific-research institutions, etc.), which is not organised in a unique way in the individual observed countries.

The high participation of women in agricultural work far exceeds the desired participation of women in the labour force in the market (SDG 5: Gender Equality). Women are more engaged in certain agricultural jobs than men, so they exceed the current rates of participation of women aged 15+ in the economically active (Ratio of female-to-male labour force participation rate, %) in the CEE countries of over 70%. Moldova and Bulgaria are over 80%, and in Bosnia and Herzegovina and Macedonia, about 60%. However, the participation of women farmers, i.e., the number of household owners, is almost negligible (except in one-member households), so it is impossible to measure their realised production volume, efficiency, and way of using resources in the observed period through the existing sample.

Access to water (SDG 6: Water Use) is increasingly important, especially as global water demand is expected to grow and agricultural water demand will be higher to feed the world even before the needs of households and industries are met. During the observed period in the CEE countries, access to water is at a high level, with the inhabitants of rural areas being additionally supplied with natural (springs) or their own (wells) water capacities.

In terms of energy use (SDG 7: Energy Use), the CEE region has a high level of electricity availability (population with access to electricity, %). The only issue in rural areas is voltage sustainability, but electricity is available to everyone (about 100% in all economies during the observed period, sdg7_elecac). At the same time, we are talking about energy obtained from fossil fuels, which is less environmentally acceptable, and about the lower energy needs of rural households. However, at the level of total agricultural activity, insufficient availability can be a limiting factor for further agricultural intensification. The share of renewable energy in the total primary energy supply is equally represented in Serbia and Romania, as it has been in recent years in Moldova. At the same time, the share is very low in Poland. Of the other Balkan countries, the share of renewable energy in primary energy is the most common in the countries facing the Adriatic

and Ionian Seas (wind, water, and sun), and it is dominated by Albania and Montenegro, to a lesser extent Croatia, followed by Macedonia and Bosnia and Herzegovina. Bulgaria is in last place. This is an ideal opportunity to see the future benefits of producing electricity from renewable sources. In agriculture, they are expected to respond to the growing demand for energy by using crops as biofuels (cereals, vegetable oils, sugar cane, and legumes).

The eighth goal of economic growth and employment (SDG 8: Economic growth and employment) implies a new approach to the agricultural sector. First, agriculture is a driver of economic growth in rural areas, while entrepreneurship in rural and agricultural production can generate employment and growth. Table 5 shows the value added as net production of the sector (production less intermediate inputs) and includes forestry, hunting, fishing, and crop and livestock production. The Balkan countries are gradually reducing the share of this sector in GDP, but in some economies, this share is still high (Albania, Moldova, and North Macedonia).

Table 5. Agriculture, forestry, and fishing in CIE, value added (% of GDP)

Country	2000	2005	2010	2015	2016	2017	2018	2019	2020
SRB	17.1	6.7	6.6	6.7	6.8	6.0	6.3	6.0	6.3
POL	3.1	2.9	2.9	2.4	2.5	2.9	2.3	2.3	2.5
ROM	10.9	8.5	5.0	4.2	4.1	4.3	4.3	4.1	3.8
MDA	25.4	16.4	11.2	11.5	11.4	11.5	10.3	10.2	9.6
ALB	24.5	18.8	18.0	19.8	19.8	19.0	18.4	18.4	19.1
BIH	9.0	8.3	6.8	6.2	6.4	5.6	5.9	5.6	6.1
MNE	11.3	8.8	7.7	8.1	7.5	6.9	6.7	6.4	7.6
MKD	10.1	9.7	10.1	9.7	9.2	7.9	8.5	8.1	9.1
BGR	11.0	7.3	4.0	4.1	4.1	4.0	3.4	3.2	3.5
HRV	5.0	3.9	3.7	3.0	3.1	2.9	3.0	2.9	3.2

Source: The World Bank, *World Bank Open Data*, https://data.worldbank.org/.

One of the key values of sustainable development refers to sustainable production and consumption (SDG 12: Responsible consumption and production). Problems in overproduction, and thus a growing and unsatisfactory supply, are causing more and more waste. Table 6 shows the amounts of food individuals and households throw away each year. The Balkan countries are showing little success in balancing food production and consumption. Traditional food production and use indicate poor investment management in agriculture.

Table 6. Household food waste estimates
(from measured data points or extrapolation) for each country, 2021.

Country	Household food waste estimate (kg/capita/year)	Household food waste estimate (tonnes/year)
SRB	83	726 196
POL	56	2 119 455
ROM	70	1 353 077
MDA	76	307 419
ALB	83	238 492
BIH	83	273 269
MNE	83	51 988
MKD	83	172 480
BGR	68	478 667
HRV	84	348 091

Source: „Food Waste Index Report 2021", UNEP, 04 March 2021.

The nature of many production processes, and even food, can have detrimental effects on the environment. Various nitrogen compounds (reactive nitrogen, ammonia, and nitrogen oxides) are emitted during the production process and most often accumulate in the ground instead of being properly disposed of, which is harmful to human health and the environment. An additional problem for agriculture is the increasing use of nitrogen-based fertilizers for food production, which further increases the emission of greenhouse gases. At the same time, the control of international trade is important from the aspect of sustainable development because reactive nitrogen emissions are embodied in imported goods and services. Table 7 shows nitrogen emissions due to the production process and contained in imports.

Table 7. Nitrogen emissions in CIE, kg/capita
(sdg12_nprod; sdg12_nimport)

	Production-based						Embodied in imports					
Country	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015
SRB	10.921	11.055	12.324	14.516	13.183	14.32	3.555	4.812	5.84	5.985	6.276	6.629
POL	15.105	14.937	15.731	14.836	15.296	16.181	2.979	3.221	3.192	3.275	3.478	3.779
ROM	14.392	16.611	15.352	16.603	18.034	20.195	2.458	2.658	2.613	2.781	2.931	2.936
MDA	4.923	5.486	5.385	8.2	8.106	8.357	0.04	0.037	0.104	0.131	0.13	0.14
ALB	10.494	10.829	12.344	11.289	13.348	14.432	1.377	1.442	1.581	1.685	1.792	1.863
BIH	7.005	7.205	7.391	8.412	8.58	9.293	1.216	1.361	1.475	1.515	1.586	1.63
MNE	4.874	4.513	4.782	4.858	5.134	5.457	12.802	13.332	17.218	17.015	17.883	19.543
MKD	8.129	8.185	7.795	7.538	8.189	8.142	2.334	2.592	2.87	2.989	3.201	3.236
BGR	14.057	14.47	16.215	19.386	24.693	23.026	2.22	2.424	2.492	2.572	2.735	2.838
HRV	12.546	13.438	15.035	14.975	13.847	14.387	3.918	4.036	4.055	4.263	4.55	4.822

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

CO2 emissions from energy consumption are becoming an increasing problem for the environment. It is estimated that by 2030, the potential of agriculture for carbon mitigation will reach as much as 7.5% of total global emissions (conditioned by the price of carbon and productivity measures in agriculture). The data in Table 8 show CO2 emissions due to energy consumption in economies.

Table 8. Energy-related CO emissions u CIE, tCO/capita (sdg13_co2pc)

Country	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SRB	4.738	5.616	5.082	5.462	4.891	4.995	4.179	4.928	5.086	5.156	5.028	5.624	4.937
POL	8.24	8.428	8.737	8.732	8.546	8.455	8.146	8.24	8.538	8.897	8.887	8.433	7.916
ROM	4.172	4.681	3.807	4.231	4.147	3.713	3.773	3.832	3.746	3.928	3.979	3.865	3.715
MDA	0.85	1.187	1.182	1.212	1.169	1.202	1.168	1.175	1.206	1.286	1.341	1.275	1.276
ALB	0.96	1.36	1.509	1.718	1.602	1.697	1.941	1.555	1.556	1.838	1.642	1.688	1.576
BIH	3.653	4.262	5.707	6.49	6.14	6.154	5.546	5.383	6.418	6.51	6.641	7.527	6.528
MNE	2.479	2.84	3.88	3.85	3.536	3.434	3.362	3.571	3.213	3.351	3.823	4.212	3.678
MKD	5.895	5.426	4.105	4.437	4.211	3.743	3.59	3.378	3.358	3.604	3.372	3.828	3.43
BGR	5.685	6.59	6.446	7.207	6.591	5.855	6.241	6.705	6.362	6.699	6.188	6.032	5.389
HRV	4.44	5.332	4.856	4.788	4.443	4.311	4.155	4.209	4.297	4.475	4.258	4.304	4.137

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller, and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

Ecosystem management implies improving the efficiency of agricultural land and improving crops in order to satisfy growing world demand while minimising the loss of natural habitats and forests for further cultivation. Although we are witnessing forest devastation everywhere, data for the Balkan economies are unavailable. Biodiversity is largely dealt with by EU countries, unlike the Balkan countries, which still nurture a traditional approach to growing crops (Serbia has not yet passed a law on biodiversity). Table 9 shows the average percentage of land and freshwater biodiversity areas.

Table 9. Sites important to biodiversity (%) (sdg15_cpta; sdg15_cpfa)

	terrestrial					freshwater				
Country	2000	2005	2010	2015	2020	2000	2005	2010	2015	2020
SRB	16.506	20.546	20.72	24.178	26.768	14.382	15.944	16.222	18.792	23.202
POL	51.173	67.956	84.279	87.336	87.338	52.972	75.421	91.013	91.123	91.128
ROM	13.308	17.318	64.977	75.91	75.967	6.778	13.597	57.28	60.798	60.816
MDA	:	:	:	:	:	:	:	:	:	:
ALB	16.405	28.203	41.776	49.399	50.487	38.026	70.422	96.613	96.613	96.613
BIH	10.69	10.69	28.872	28.992	28.992	33.292	33.292	99.958	99.958	99.958
MNE	49.223	49.223	49.223	49.223	49.223	0.855	0.842	0.828	0.816	0.803
MKD	23.783	24.183	24.398	24.398	24.398	93.54	93.54	93.639	93.639	93.639
BGR	12.408	27.695	95.732	95.737	96.608	13.722	32.161	94.988	94.988	98.668
HRV	21.844	22.28	23.996	76.88	76.885	16.247	16.646	16.665	84.932	84.932

Source: Jeffrey Sachs, Guillaume Lafortune, Christian Kroll, Grayson Fuller and Finn Woelm, *Sustainable Development Report 2022, From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond*, Cambridge University Press, Cambridge, 2022.

Eco-efficiency and sustainability of small-scale farming in Serbia

Small farms in Serbia, with fragmented holdings and the existing structure of production, have high production costs and inefficient use of resources, and because of that, they are unable to achieve efficient use of land.[25]

The consequences of the negative impact of agriculture on the sustainable use of resources require the development of modern agricultural practices in line with ecological principles that are sustainable in the long term. Accordingly, we must define the level of development of agriculture in Serbia in comparison to the EU member states. Considering the lower level of agricultural development in Serbia in comparison to the European Union member states, the opportunity for sustainable agricultural development in Serbia is the Instrument for the Pre-Accession Assistance (IPA) funds, respectively the Instrument for pre-accession assistance for rural development (IPARD) component of pre-accession assistance available to EU candidate countries aimed at reducing development disparities.[26] Through the IPARD fund, the EU granted Serbia 175 million euros (IPARD II programme 2014-2020). The IPARD III 2021-2027 programme is being developed and will be even more financially significant; Serbia will have 288 million euros at its disposal, about 65% more compared to the IPARD II.[27]

[25] Rade Popović & Mina Kovljenić, „Efficiency of wheat production in the Republic of Serbia", *Economics of Agriculture*, vol. 64, no. 4, 2017, 1501.

[26] Jelena Birovljev & Žana Kleut, Analysis of the factors of sustainable agriculture in Serbia and the European Union member states", *Ekonomika preduzeća*, vol. 64, no. 7-8, 2016, 469-477.

[27] IPARD, *Šta je IPARD fond?*, https://ipardfond.rs/sta-je-ipard-fond/, 13/12/2022.

According to the documents from the EU for Serbia - *Action document "EU for a sustainable economy, agriculture and rural development",* the actions that are relevant to the Commission's Strategic Plan 2020-2024 on research and innovation are that the harmonisation process of the key Single Market legislative requirements and strengthening enforcement capacities will open the space for more research, development, and innovation, as the key drivers and enablers for implementing green industrial policy and achieving sustainable development.[28] The Action is in line with the EU's latest enlargement package, directly supporting Serbia's preparation in the "Internal Market" cluster of negotiating chapters as well as part of the "Resources, Agriculture and Cohesion" cluster of negotiating chapters.[29] It is also in line with the recommendations from the Commission's 2021 Serbia Report. The Report highlights the progress in the implementation of the pre-accession assistance for rural development (IPARD II) and the first steps for the establishment of the integrated administration and control system (IACS). The Report also recommends that the processing of IPARD applications be accelerated. In addition, it is necessary to ensure timely alignment with the EU acquis on agriculture and rural development.

The Action is linked with the European Green Deal, which directly affects the need to increase competition in the Serbian market and help companies and businessmen prepare for accession. According to the European Green Deal, competition will drive innovation and the development of new technologies that can reduce environmental damage.[30] In addition to all the listed benefits, as we know, competition contributes to lowering prices, so thanks to that, there can be an increase in investment in green technologies. Thanks to the strong competition, the industry receives a strong incentive towards more efficient use of natural resources. With the right incentives from the competition and public policies, European businesses (and, if they

[28] European Commission, *Annual Action Plan in favor of the Republic of Serbia for 2021 Action Document for EU for Sustainable Economy, Agriculture and Rural Development*, https://ec.europa.eu/neighbourhood-enlargement/system/files/2022-01/C_2021_9653_F1_ANNEX_EN_V2_P1_1661249.PDF, 13/12/2022.

[29] "Internal Market" cluster of negotiating chapters comprising the following negotiating chapters:1 - Free movement of goods 2 - Freedom of movement for workers 3 - Right of establishment and freedom to provide services 4 - Free movement of capital 6 - Company law 7 - Intellectual property law 8 - Competition policy 9 - Financial services 28 - Consumer and health protection; "Resources, Agriculture and Cohesion" cluster of negotiating chapters comprising of the following negotiating chapters: 11 - Agriculture and rural development, 12 - Food safety, veterinary and phytosanitary policy, 13 - Fisheries, 22 - Regional policy & coordination of structural instruments, 33 - Financial & budgetary provisions.

[30] European Commission, "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal", op. cit., 18.

follow their example, Serbian businesses) will be well-positioned to become world-leading climate-efficient businesses capable of thriving in tomorrow's green economy. At the same time, the Action is supporting Serbia in protecting the rights of consumers, which is in line with the Green Deal, which is considering new horizontal rights for consumers. The Action envisages building the capacities of Serbian stakeholders for the EU's Circular Economy Action Plan, which wants to establish a strong and coherent product policy framework that will make sustainable products, services, and business models the norm and transform consumption patterns so that no waste is produced in the first place.[31] Apart from that, the Action is in line with a number of European Commission initiatives aiming to ensure that products sold to EU consumers are fit for the Green Deal objectives. More precisely, the Action complements the Farm-to-Fork Strategy (European Commission, 2020) and the EU Biodiversity Strategy,[32] aiming at reducing the environmental and climate footprint of the EU food systems and empowering consumers to make informed, healthy, and sustainable food choices.[33]

So once again, according to Birovljev and Kleut, a chance for Serbian agriculture is the IPA and IPARD components of pre-accession assistance to candidate countries for the EU because they deal with the reduction of development disparities. Therefore, the positive effects of using these funds, such as improving the quality of life and protecting the environment, will depend on the efficiency of their disbursement as well as on the modality of using their respective funds.[34]

The first goal within the Strategy of Agriculture and Rural Development of the Republic of Serbia for the period 2014-2024 is to define the direction of the future development of agriculture and the food industry based on the concept of sustainable development, which affirms the preservation of the environment and the sustainable management of natural resources.[35]

One of the major priorities of the Sustainable Development Strategy of the Republic of Serbia (2008) is the protection and improvement of the environment and the rational use of natural resources. According to the

[31] "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions A new Circular Economy Action Plan For a cleaner and more competitive Europe", European Commission, 11 March 2020.

[32] "Biodiversity strategy for 2030", European Commission, 22 December 2020.

[33] European Commission, *Farm to Fork strategy,* https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en, 27/06/2022.

[34] Jelena Birovljev & Žana Kleut, Analysis of the factors of sustainable agriculture in Serbia and the European Union member states", op. cit.

[35] "Strategija poljoprivrede i ruralnog razvoja Republike Srbije za period 2014–2024. godine", op. cit., 2.

National Strategy of Sustainable Development, some of the goals include establishing a system of protection and sustainable use of natural resources, strengthening mutual action between environmental protection and economic growth, protecting and preserving biodiversity, and reducing the high energy intensity of the economy of the Republic of Serbia.[36]

When it comes to agriculture, the general goal of sustainable development is to create economically profitable and ecologically acceptable agricultural production — the backbone of rural development and the basis of the rural population's existence in areas in which there are natural prerequisites to achieve the appropriate level of competitiveness to penetrate the European and other markets.

The sectoral objectives in the field of agriculture are (Sustainable Development Strategy of the Republic of Serbia):

- harmonization of national regulations and actions in the field of agriculture with legislation and practice in the EU (National programme for agriculture for the period 2022-2024 – in preparation[37]);
- encouraging investments in reducing pollution from agriculture, preservation of agrodiversity, and traditional (combined) farm systems in order to preserve the area and species of biodiversity in sensitive agroecological conditions, development of animal welfare protection systems, erosion reduction, and conservation and improvement of the environment as a whole;
- increase of areas under organic and other ecologically acceptable systems of agricultural production;
- raising and developing public awareness among agricultural producers about environmental problems while respecting the principles of protecting biodiversity and animal welfare;
- introduction of the code of good agricultural practice.[38]

Fulfilling these goals through a suitable action programme opens up the field of dynamic economic development based on knowledge. One of the adequate fields of development and application of high technologies in the Republic of Serbia is agriculture, i.e., solving its environmental problems. Forming adequate national food safety laboratories would create an institution that would not only contribute to solving environmental problems in domestic agriculture but would also improve the quality of domestic

[36] "Nacionalna strategija održivog razvoja", *Službeni glasnik RS*, 57/2008, Beograd, 2. jun 2008, 1-117.

[37] Ministarstvo poljoprivrede, šumarstva i vodoprivrede, *Nacionalni program ruralnog razvoja za period 2022-2024. godine*, http://www.minpolj.gov.rs/nacionalni-program-ruralnog-razvoja-za-period-2022-2024-godine/?script=lat, 11/03/2022.

[38] "Nacionalna strategija održivog razvoja", op. cit., 83.

products, thus improving the health of the population, encouraging the export of agricultural products, and improving the quality control of imported food by contributing to the establishment of an environment of equality in competition with domestic products. Also, this institution would contribute to the intensification of agricultural development and the introduction of top technologies in agriculture and the food industry. The creation of positive social effects through the application of the concept of integral rural development will have multiple positive external effects: political, demographical, cultural, and even in terms of security.

Conclusion

Eco-efficiency has recently become an indicator of progress in green growth and an increasingly important conceptual measure for sustainable agricultural production. Eco-efficiency, as the ratio of economic output to environmental input, becomes a dominant factor for decision-makers. At the same time, by using this concept, it is possible to work on overcoming the negative impact of agriculture on the environment.

Unfortunately, the aspect of eco-efficiency is almost unknown in the Serbian economy, especially when it comes to the eco-efficiency of small-scale agriculture. Although regulations, strategies, and some action plans for agriculture, rural development, and sustainable development include some of the priority areas of eco-efficiency in Serbian agriculture, they are still not recognised as an important factor of progress in green growth or an important conceptual measure for sustainable agricultural production.

Therefore, in our analysis, we had to consider the Sustainable Development Goals (SDGs) that are directly related to agriculture SDG2, and indirectly visible through SDG1, SDG4, SDG5, SDG6, SDG7, SDG8, SDG12, SDG13, and SDG15. In this way, we were able to compare the efficiency of the CEE countries in advancing the goals of sustainable development. The results showed that the eco-efficiency of agriculture is low in the selected countries on certain issues. These results also indicated that it is necessary to improve the production process, the application of fertilizers, and the regulatory framework close to the rules represented in the agricultural policy of the EU. What is common for these countries is that the majority of the population engaged in agriculture is poor, that there is no fear of poverty, and that there is little concern on this issue in Romania, Montenegro, North Macedonia, and partly Bulgaria. The energy composition of the food produced and consumed in the selected countries is approximately the same, with a significant difference in the efficient use of land and fertilizers (some candidate countries achieve better results than EU members). The educational structure of the agricultural population is low, especially in the candidate countries. At the same time, the participation of women in agricultural production is higher in these countries, but the number of female

farm owners is lower. The use of water is increasingly prevalent in agricultural production due to the use of its own (well) water capacities. The availability of energy in rural areas is not at a high level. The need for renewable energy potential, which is most lacking in Bulgaria, Serbia, and North Macedonia, is becoming increasingly important. Although there is a trend towards decreasing the share of agricultural production in GDP, it is still high in some economies (Albania, Moldova, and North Macedonia). The problem of excessive production was observed with them, which is the cause of the presence of more waste that is not properly recycled. At the same time, the use of fertilizers and nitrogen has increased, further polluting the environment. Due to the absence of biodiversity and the existence of land devastation in these economies, it is clear that there are inefficient investments in agriculture.

The reform of the existing national legislation in all candidate countries for EU membership should be in accordance with the new generation of European documents on sustainable spatial development, legislation, and practice in the EU and its implementation. Commitment to sustainable agriculture and the eco-efficiency of agriculture should be the backbone of future rural development in Serbia. Incentives for rural and regional development based on well-designed investment programmes, best practices from European countries, and the application of new technology would very quickly have positive economic, social, and other effects.

Some of the recommendations to policymakers could be established through the action of reducing loss and waste in food systems, with a focus on the farming practices, distribution, and habits of the population. Also, a recommendation will be to define a good strategy with a specific action plan for the adoption of new technologies in the sector of agriculture to increase productivity while preserving environmental resources. But because of the complexity of all these issues, some of the recommendations will need action in various sectors, such as environment, education, health, and others. So, the recommendation for the agriculture sector and its policymakers will be to devise new visions and means of cooperation with these other sectors in order to succeed. Research on achieving eco-efficiency in agriculture can be a stimulus for the adoption of more effective incentive agricultural policies as well as agricultural practices and measures that will strive for future sustainable development in accordance with the Green Agenda.

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