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Innovative practices of organic farming for improving the efficiency of small farms in Ukraine

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ABSTRACT: Within the research, the peculiarities of introducing innovations in the agricultural sector of Ukraine during martial law were studied, in particular, the development of organic farming as a strategy for preserving soil fertility, increasing the sustainability of agricultural production and ensuring food security. The role of green manure crops in restoring soil fertility and cleaning contaminated land was analysed, and the effectiveness in enriching the soil with organic matter, improving its structure and reducing the level of toxic substances was emphasised. Attention was focused on how important it was to integrate innovative technologies into the agricultural sphere in order to ensure the sustainable development of the agricultural sector of Ukraine. The problem of financing organic farming under conditions of military conflict was considered separately. The importance of state support and international assistance for the introduction of effective methods of organic farming, which did not require large capital investments but demonstrated high ecological and economic potential, was substantiated. The results of the research could be useful for developing recommendations on improving the efficiency of managing agricultural processes under martial law, forming policies to support small farms, and developing programmes for restoring the agricultural sector after the end of hostilities.

Keywords: green manure crops; bioremediation; economic consequences of war; small and medium-sized enterprises; agrotechnologies.

Práticas inovadoras de agricultura orgânica para melhorar a eficiência de pequenas propriedades rurais na Ucrânia

RESUMO: Dentro da pesquisa, foram estudadas as peculiaridades da introdução de inovações no setor agrícola da Ucrânia durante a lei marcial, em particular, o desenvolvimento da agricultura orgânica como estratégia para preservar a fertilidade do solo, aumentar a sustentabilidade da produção agrícola e garantir a segurança alimentar. O papel das culturas de adubação verde na restauração da fertilidade do solo e na limpeza de terras contaminadas foi analisado, e a eficácia no enriquecimento do solo com matéria orgânica, melhorando sua estrutura e reduzindo o nível de substâncias tóxicas, foi enfatizada. A atenção foi focada na importância da integração de tecnologias inovadoras na esfera agrícola para garantir o desenvolvimento sustentável do setor agrícola da Ucrânia. O problema do financiamento da agricultura orgânica em contextos de conflito militar foi considerado separadamente. A importância do apoio estatal e da assistência internacional para a introdução de métodos eficazes de agricultura orgânica, que não exigem grandes investimentos de capital, mas apresentam alto potencial ecológico e econômico, foi demonstrada. Os resultados da pesquisa podem ser úteis para o desenvolvimento de recomendações para a melhoria da eficiência da gestão dos processos agrícolas sob a lei marcial, para a formulação de políticas que apoiem as pequenas propriedades rurais e para o desenvolvimento de programas de recuperação do setor agrícola após o fim das hostilidades.

Palavras-chave: culturas de adubação verde; biorremediação; consequências econômicas da guerra; pequenas e médias empresas; agrotecnologias.

1. INTRODUCTION

Innovative practices of organic farming consisted of a variety of strategies, methods, and approaches aimed at increasing the productivity of agricultural production without the use of pesticides, synthetic fertilisers, genetically modified organisms or other artificial chemical substances. The main goals of these strategies were the preservation of soil fertility, the enhancement of biodiversity, the reduction of harmful impacts on the environment and the production of high-quality, environmentally friendly products that corresponded to modern standards of sustainable development. Agroforestry, the use of green manure crops, biological plant protection, minimal or zero tillage, integrated plant nutrient management, precision farming and the restoration of abandoned lands were among the most important innovative practices of organic farming. In the conditions of war in Ukraine, with significant economic and environmental problems, the use of organic farming methods could be effectively improved. Thus, it was important to carry out an assessment of Ukraine's possibilities regarding the implementation of innovative technologies in this field.

Nikonchuk; Samoilenko (2024) studied the possibility of using bioproducts as an important component of organic farming. The researchers found that the application allowed an increase in yields and product quality without the use of chemical plant protection agents. Small farms, which sought to reduce costs and become competitive in the market of environmentally friendly products, believed that bioproducts improved soil microflora, increased plant immunity and enhanced resistance to pathogens. Dovgal et al. (2024) argued that the introduction of a circular economy in the agricultural sector contributed to the introduction of environmentally friendly technologies and the efficient use of resources. The use of composts and biofertilizers from agricultural production waste reduced dependence on external suppliers and improved the environmental safety of farms. Such an approach guaranteed the sustainability of production and contributed to the creation of closed ecological cycles, which formed the basis of organic farming.

Gamayunova et al. (2024) considered the prospects and directions of diversification of oilseed crops in Ukraine. One of the promising directions for the development of organic farming was the diversification of oilseed cultivation, which allowed small farms to increase productivity. The use of different types of crops in crop rotation not only increased yields and preserved soil fertility but also allowed farmers to reduce economic risks and expand the range of products, which was particularly important in unstable markets. Shahini et al. (2023) investigated the possibility of using organic nitrogen fertilisers to improve yields and soil health. The researchers found that the use of organic nitrogen fertilisers not only improved soil fertility but also had a smaller negative impact on the environment, which made such fertilisers a tool for supporting sustainability in organic farming.

Krishnan et al. (2021), within the research, studied how cooperation in food supply chains, in particular through the formation of farmer-producer organisations in India, contributed to innovation and sustainable development. The study identified the shift of focus of innovation from individual firms to supplier systems, which testified to the advantage of developing new technologies in this way. The study emphasised the inefficiency of traditional agricultural methods, such as excessive use of fertilisers and too many intermediaries, which harmed sustainability and livelihoods, especially for small farmers. Ohanisian et al. (2022), within the research, wrote that Ukraine had great potential for increasing the export of organic livestock products by 2030, with projected revenues of USD 916.3 million for meat and USD 1.97 billion for dairy products. This growth could bring significant benefits to Ukrainian farmers and stimulate broader agricultural development. However, the expansion of livestock production created environmental risks, in particular the increase in methane emissions. Therefore, effective measures needed to be applied to mitigate these emissions, including improved manure management, adjustments to livestock diets and the promotion of biogas production from waste.

The main aim of the research was to study the possibilities of developing organic farming in Ukraine. The work included an assessment of the impact of the war on the country's agricultural sector, the identification of the role of organic farming in restoring soil fertility during the crisis, and the analysis of opportunities for small and medium-sized enterprises in implementing new technologies.

2. MATERIAL AND METHODS

As part of the current research, an assessment of the indicators of the development of organic agriculture in Ukraine was carried out. Information obtained from the OrganicInfo (2025) website, which collected data on organic production in Ukraine, was used. The source data included areas of organic production from 2016 to 2023, the number of organic operators, and sales of organic products to the external market from 2016 to 2023. One of the limitations of this work was that the data for 2024 were not available on the OrganicInfo website at the time the research was conducted.

In addition, data obtained from EUROSTAT (2025a,b,c) were used. These data covered the development of agriculture in most European Union countries, including Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Greece, Spain, France, Croatia, Italy, Cyprus, Lithuania, Latvia, Luxembourg, Hungary, Malta, the Netherlands, and Poland. In particular, data on the area of land used for organic agricultural production, the number of organic products produced in the European Union countries, and the number of animals raised in organic conditions were studied. Due to the lengthy process of obtaining and processing information from farmers' reporting, the information was available only as of the reporting date of 2022.

Furthermore, an assessment of performance was carried out, which was based on the author's method of point evaluation, in order to assess the dynamics of the development of the agricultural sector in the European Union countries. Thus, the country with the highest indicator received the highest score, which was equal to the total number of countries analysed, and the country with the lowest indicator received the lowest score. To determine the score, the countries were listed by indicators from the highest level to the lowest. The country with the highest indicator received the highest score, and the country with the lowest indicator received the corresponding score. The maximum number of points was equal to the number of countries taken for the evaluation of the indicator, and the minimum number of points was equal to one. The overall score of the country was calculated as the arithmetic mean of all the evaluations. According to this, a ranking of countries was created.

Comparative analysis was used to compare the main indicators of the development of organic agriculture in Ukraine and the European Union countries. In addition, graphical analysis was used to show trends through graphs and diagrams. This made it possible to show the changes in the subject of the research clearly. Thus, a comprehensive approach to data collection and analysis made it possible to determine important trends in the field of organic agriculture and to obtain an objective picture of the development of the sector.

3. RESULTS

Innovations in Ukraine's agricultural sector during the war included the use of sustainable and organic methods, which contributed to the preservation of soil fertility and ensured food security even during the conflict, making organic farming an important tool for small farmers (BERXOLLI et al., 2023; RIZZO et al., 2024). Farmers sought alternative methods of farming due to the loss of part of the land, soil damage from hostilities, and problems with the supply of pesticides and mineral fertilisers. In this context, organic farming was not only an environmentally safe option but also a strategic tool for ensuring the resilience of agriculture. Innovations in organic farming contributed to scientific research, the introduction of new technologies for controlling soil and water quality, and the implementation of digital solutions for the effective management of agricultural processes (SCHNEBELIN et al., 2021).

For the further development of organic agriculture, it was necessary to restore soil fertility after hostilities. The use of green manure crops, organic fertilisers, and bioremediation technologies allowed the reduction of pollution levels and the restoration of the natural structure of the soil. This was particularly important for small farms that sought to adhere to the principles of sustainable production. The hostilities in Ukraine caused significant environmental problems, in particular, soil contamination with heavy metals, petroleum products, and explosive substances, which were physically damaged by artillery shelling, craters from explosions, and mechanical compaction by heavy equipment. All of this negatively affected the fertility and suitability of the land for environmentally friendly production. For the development of organic agriculture, the primary task was the comprehensive remediation of soils, which included the mechanical clearing of areas from explosive objects, phytotechnologies for the removal of toxic substances, and the application of organic fertilisers to restore the microbiota and natural structure of the soil. The restoration of the humus layer, which suffered due to the destruction of natural ecosystems and the reduction of soil biological activity, was of great importance.

Plants that restored the land and gave it unique properties, such as green manure crops, played an important role in the process of restoring fertility. The sowing of such crops as phacelia, lupin, mustard, oil radish, buckwheat, or phacelia contributed to increasing organic matter and nitrogen in the soil, improving soil structure, reducing erosion, and displacing pathogenic microorganisms. In addition, certain green manure crops had the ability to absorb heavy metals and other toxic substances. This was particularly important for areas contaminated by war. Organic fertilisers such as vermicompost, sapropel, manure, and compost restored the soil microflora, increased humus content, and improved the water-air balance. The use of these fertilisers contributed to the activation of beneficial microorganisms that worked on the decomposition of organic substances and the transformation of toxic substances into less harmful forms. Organic fertilisers also improved the agrophysical properties of the soil, promoting soil loosening and increasing its ability to retain water.

One of the promising areas of ecological soil restoration was bioremediation technologies, which included soil-cleaning methods using the metabolic potential of living organisms or enzymes. The use of bacteria, fungi, and plants capable of decomposing and absorbing pollutants could significantly accelerate the natural process of soil purification. For example, microbiological preparations based on phosphate-mobilising microorganisms and nitrogen-fixing bacteria improved fertility and neutralised toxins. A subtype of bioremediation was phytoremediation, which was essentially the use of plants such as sunflowers, hemp, and mustard, which actively absorbed heavy metals, cleaning the soil without significant interference in natural processes. In turn, the use of a flexible working organ in soil cultivation made it possible to achieve uniform tillage depth and improve soil quality, reducing the need for agrochemical measures for weed control, which was important for small farms focusing on sustainable development. This method preserved soil structure, reduced mechanical load on it, and maintained an optimal level of moisture, which was particularly important in the context of climate change. The use of such technologies also increased the effectiveness of crop rotation due to better seed germination and the uniform development of root systems, reducing the need for additional growth stimulation measures. The introduction of flexible working organs in small farms was one of the elements of adaptation to modern environmental challenges and contributed to the transition to regenerative agriculture, which ensured long-term preservation of soil fertility and the stability of agricultural production.

Small and medium-sized enterprises (SMEs) also faced these organic farming practices. Nevertheless, the effectiveness of the use in Ukraine depended on a number of factors, including financial capacity, the ability to gain experience, and the availability of necessary resources (UHUNAMURE et al., 2021; KARESKA, 2025). Unlike large agricultural holdings, SMEs often have limited capital to invest in expensive recovery and sustainability technologies. Nevertheless, some of these methods, such as the use of organic fertilisers and green manure crops, did not require significant capital investment and could be gradually introduced with small investments. In addition, the growing market demand for organic products created opportunities for such enterprises to obtain funding through grants, government support programmes, and partnerships with research institutions developing innovative agricultural products. Bioremediation technologies, in particular microbiological preparations and phytoremediation, were an effective and relatively cost-efficient approach for SMEs to restore contaminated soils (MUNGUIA et al., 2021; KARUNATHILAKE et al., 2023). These methods use natural biological processes, reducing the need for expensive chemical treatments. Since plants such as sunflower, hemp, and mustard could later be processed for agricultural or industrial use, the application for soil purification corresponded to the principles of a circular economy. However, for the successful implementation of such methods, SMEs needed appropriate knowledge and technical support, which could be facilitated through cooperation with advisory services and research organisations.

The situation for small and medium-sized enterprises in Ukraine became even more complicated due to a number of factors, all of which were related to Russia's full-scale invasion and its consequences. The introduction of innovative methods of organic farming was both necessary and challenging for SMEs in Ukraine, particularly in the light of war, land degradation, and economic instability (FLEMING et al., 2021). The above-mentioned methods were effective, but finding money for the implementation was even more difficult than for SMEs in other countries. As a result of the war, supply chains, access to credit, and investment in agriculture were severely affected, making the adoption of expensive technological solutions difficult.

However, finding opportunities for the use of green manure crops and the application of compost-based fertilisers required minimal capital investment, so these practices could also be integrated. Nevertheless, the deeper implementation of new technologies required assistance either from the Ukrainian state or from international organisations. In order to study the state of organic agriculture in Ukraine, it was necessary to examine certain statistical indicators. Figure 1 shows the areas of organic land and land in transition.

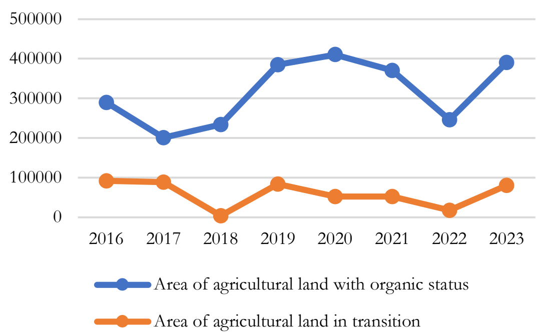

Figure 1. Area of agricultural land with organic status and in transition in Ukraine in the period from 2016 to 2023, in ha.
Source: compiled by the authors based on OrganicInfo (2025).
Figura 1. Área de terras agrícolas com estatuto orgânico e em transição na Ucrânia, no período de 2016 a 2023, em ha.
Fonte: compilado pelos autores com base em OrganicInfo (2025).

As shown in Figure 1, the amount of agricultural land with organic status increased compared with 2016 and reached its peak in 2020. As for the transition period, the volume decreased compared with 2016 but remained large until 2023. Nevertheless, the comparison had to be made in the context of the share compared with the total area of rural land. Figure 2 shows these data.

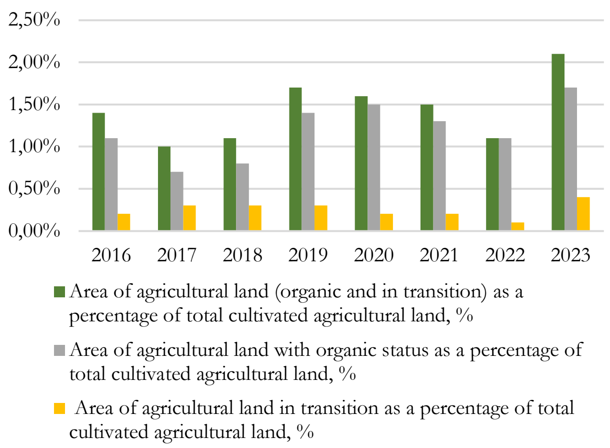

Figure 2. Share of agricultural land with organic status and in transition in Ukraine in the period from 2016 to 2023 relative to the total volume of land under agriculture in Ukraine, %.
Source: compiled by the authors based on OrganicInfo (2025).
Figura 2. Percentagem de terras agrícolas com estatuto biológico e em transição na Ucrânia, no período de 2016 a 2023, em relação ao total de terras agrícolas na Ucrânia, %.
Fonte: compilado pelos autores com base em OrganicInfo (2025).

As shown in Figure 2, during this period, the share of agricultural land with transitional and organic status increased by 23 per cent. There were many reasons for this. Thus, the amount of land directly used for agriculture decreased. This was primarily due to Russia's full invasion of Ukraine, the occupation, and the contamination of these lands. At the same time, as shown in Figure 1, the total value increased throughout the entire evaluation period. Figure 3 shows the number of organic operators in Ukraine.

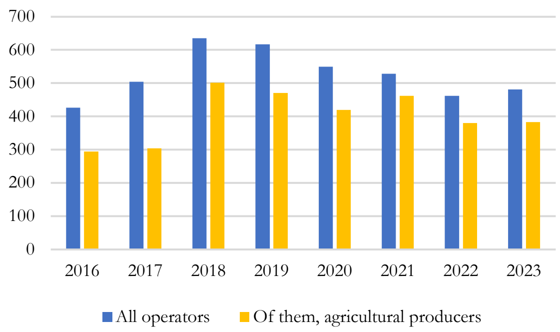

Figure 3. Number of organic operators in Ukraine and, in particular, agricultural operators.
Source: compiled by the authors based on OrganicInfo (2025).
Figura 3. Número de operadores orgânicos na Ucrânia, em particular de operadores agrícolas.
Fonte: compilado pelos autores com base em OrganicInfo (2025).

From 2016 to 2023, the number of organic operators in Ukraine increased by 13% (from 426 to 481), but the number of agricultural operators increased by 30% (from 294 to 383). In 2018, there was a peak value, followed by a declining trend until 2022. Although the increase over such a period of time was not significant, its existence already indicated a positive trend. Figure 4 shows the last indicator characterising organic agriculture: sales of organic products to the foreign market.

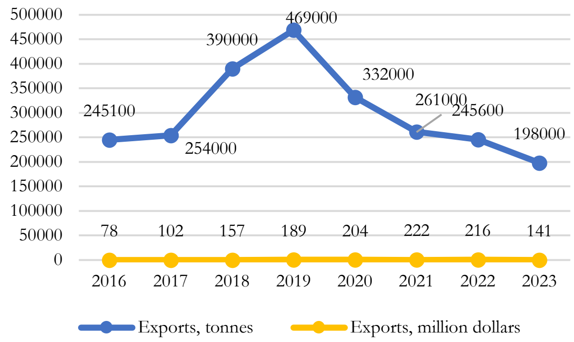

Figure 4. Volume of organic product exports in Ukraine in the period from 2016 to 2023, tonnes and million USD.
Source: compiled by the authors based on OrganicInfo (2025).
Figura 4. Volume das exportações de produtos orgânicos da Ucrânia no período de 2016 a 2023, em toneladas e em milhões de dólares americanos.
Fonte: compilado pelos autores com base em OrganicInfo (2025).

In conformity with Figure 4, exports of organic products in Ukraine demonstrated different trends depending on the measurement considered: tonnes or million USD. The volume in tonnes decreased, but the total value increased by 80.7%. Thus, the overall situation regarding the development of organic agriculture in Ukraine generally improved over time, as seen in the increase in the number of organic operators and the share of land involved in organic farming. Although export volumes declined, it should be considered that this was due to Russia's prolonged invasion in recent years, which resulted in limited access to exporting goods abroad. Hence, the situation might change after the end of the war. Therefore, it was also important to study how the situation changed in European countries and in Cyprus. Table 1 presents the areas of land planted with organic crops. From Table 1, it can be seen that different countries had different areas under organic agriculture, with France leading in absolute figures. However, it is more important to assess not absolute but relative indicators, which can be observed in Table 2.

Table 1. Areas of land used for organic farming in the period from 2014 to 2022, km².
Tabela 1. Áreas de terra utilizadas para agricultura biológica no período de 2014 a 2022, km².

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	667	688	785	835	890	931	991	1,024	1,034
Bulgaria	479	1,186	1,606	1,366	1,288	1,178	1,163	863	1,104
Czech Republic	4,727	4,780	4,886	4,963	5,199	5,352	5,404	5,488	5,637
Denmark	1,658	1,668	2,050	2,263	2,567	2,912	3,000	3,031	3,001
Germany	10,338	10,603	11,359	11,383	12,213	12,908	15,910	16,013	16,310
Estonia	1,556	1,558	1,809	1,964	2,066	2,207	2,208	2,266	2,310
Ireland	519	730	767	743	743	740	747	869	957
Greece	3,628	4,071	3,426	4,101	4,926	5,288	53.46	6,360	9,249
Spain	17,105	19,686	20,188	20,822	22,465	23,549	24,379	26,354	26,753
France	11,188	13,229	15,374	17,444	20,341	22,408	25,175	27,757	28,215
Croatia	501	759	936	966	1,032	1,081	1,086	1,219	1,294
Italy	13,879	14,926	17,963	19,086	19,579	19,932	20,946	21,862	23,495
Cyprus	39	47	56	56	60	62	59	78	77
Latvia	2,034	2,316	2,591	2,689	2,804	2,898	2,912	3,022	3,128
Lithuania	1,644	2,136	2,217	2,341	2,397	2,421	2,355	2,618	2,713
Luxembourg	45	42	45	54	58	58	61	69	83
Hungary	1,248	1,297	1,863	1,997	2,094	3,032	3,014	2,936	3,205
Malta	0.34	0.30	0.24	0.41	0.47	0.55	0.67	0.66	0.66
Netherlands	492	493	544	592	638	681	716	764	801
Poland	6,579	5,807	5,366	4,950	4,847	5,076	5,093	5,494	5,546
Portugal	2,123	2,414	2,451	2,538	2,131	2,932	3,195	7,688	7,600
Romania	2,893	2,459	2,263	2,585	3,263	3,952	4,689	5,787	6,445
Slovenia	412	422	436	462	478	496	498	518	532
Slovakia	1,803	1,819	1,870	1891	1,890	1,976	2,229	2,497	2,532
Finland	2,106	2,252	2,382	2,593	2,974	3,065	3,162	3,277	3,395
Sweden	5,018	5,190	5,527	5,768	6,088	6,140	6,105	6,067	5,972
Norway	498	476	476	470	464	453	452	449	460
Switzerland	1,333	1,350	1,399	1,496	1,601	1,690	1,763	1,804	1,852
North Macedonia	100	22	32	32	44	37	37	39	46
Turkey	5,158	5,185	5,332	5,679	6,463	5,517	3,826	3,519	3,106

Source: compiled by the authors based on Eurostat (2025b).
Fonte: compilada pelos autores com base em dados do Eurostat (2025b).

Table 2. Some descriptive information regarding the areas of land used for organic agriculture in EU countries, between 2014 and 2022.
Tabela 2. Algumas informações descritivas sobre as áreas de terra utilizadas para a agricultura biológica nos países da UE, entre 2014 e 2022.

Country	Change in land area (%)	Change (ha)	Share in land fund (ha)	Country	Change in land area (%)	Change (ha)	Share in land fund (ha)
Belgium	55	367	3.4	Luxembourg	84	38	3.2
Bulgaria	130	625	1.0	Hungary	157	1,957	3.4
Czech Republic	19	910	7.1	Malta	94	0.3	0.0
Denmark	81	1,343	7.0	Netherlands	63	309	1.9
Germany	58	5,972	4.6	Poland	-16	-1.033	1.8
Estonia	49	755	5.1	Portugal	258	5,476	8.3
Ireland	84	438	1.4	Romania	123	3,553	2.7
Greece	155	5,620	7.0	Slovenia	29	120	2.6
Spain	56	9,649	5.3	Slovakia	40	728	5.2
France	152	17,026	5.1	Finland	61	1,288	1.0
Croatia	158	793	2.3	Sweden	19	954	1.3
Italy	69	9,616	7.8	Norway	-8	-38	0.1
Cyprus	99	39	0.8	Switzerland	39	519	4.5
Latvia	54	1,094	4.8	North	-54	-54	0.2
Lithuania	65	1,069	4.2	Turkey	-40	-2.052	0.4

Source: compiled by the authors based on Eurostat (2025b).
Fonte: compilada pelos autores com base em dados do Eurostat (2025b).

The Czech Republic, Denmark, and Greece had the largest areas of land under organic agriculture, as shown in Table 2. Portugal, Croatia, Greece, and Hungary had the highest growth rates of land used in organic agriculture. This indicated that these countries developed organic agriculture at the fastest pace. Nevertheless, this could also be assessed through other indicators, such as the yields of organic production in these countries, shown in Table 3.

Thus, Sweden, Romania, Spain, and Poland currently produce the largest volumes of production. Nevertheless, relative indicators that changed over time also needed to be considered. This was shown in Table 4.

Table 3. Indicators of volumes of organic production grown in EU countries in the period from 2014 to 2022, thousand tonnes.
Tabela 3. Indicadores dos volumes de produção biológica cultivada nos países da UE no período de 2014 a 2022, em milhares de toneladas.

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	-	-	32.0	43.5	46.2	46.4	54.5	65.4	73.1
Bulgaria	7.7	5.6	5.9	16.2	36.9	48.2	41.4	30.5	27.2
Czech Republic	63.9	65.8	64.9	70.2	77.0	88.2	98.6	112.3	117.4
Estonia	37.3	47.9	45.9	60.1	55.0	101.3	98.8	71.0	101.4
Ireland	-	5.1	4.4	4.0	4.4	5.9	6.7	9.5	9.8
Greece	101.1	97.6	113.7	113.8	98.4	145.8	152.1	166.3	158.6
Spain	177.7	179.6	163.8	206.3	303.1	332.5	382.2	336.5	336.3
Croatia	15.4	31.1	47.5	45.3	52.9	64.1	56.9	63.4	53.3
Cyprus	0.2	0.6	0.2	0.7	0.5	0.6	0.6	0.6	0.6
Latvia	51.4	57.0	58.1	68.1	-	105.8	113.6	90.7	118.6
Lithuania	101.4	123.3	122.0	172.9	154.5	249.6	292.4	186.4	198.9
Luxembourg	2.3	2.8	1.9	3.1	3.3	3.2	3.4	3.0	4.5
Hungary	66.7	57.6	64.3	69.6	86.8	101.5	100.0	99.5	95.2
Netherlands	-	20.2	16.2	12.7	16.3	16.9	19.6	19.9	26.9
Poland	131.9	135.2	151.3	176.0	195.9	271.9	315.3	296.4	336.3
Romania	290.1	254.9	192.4	198.0	240.5	313.0	229.8	403.9	387.8
Slovenia	3.9	3.4	4.7	4.8	5.5	5.5	5.6	-	6.0
Slovakia	40.5	41.8	48.6	45.0	57.0	54.3	66.8	60.7	66.2
Finland	78.2	82.9	74.6	90.8	76.2	129.0	159.1	116.2	179.3
Sweden	253.0	271.2	280.0	323.2	198.5	403.3	421.2	310.1	410.5
Turkey	274.6	328.6	363.5	297.4	337.2	287.4	263.1	280.1	259.0

Source: compiled by the authors based on Eurostat (2025a).
Fonte: compilado pelos autores com base em dados do Eurostat (2025a).

Table 4. Analytics of data on organic production in EU countries.
Tabela 4. Análise dos dados sobre a produção biológica nos países da UE.

Country	Change* (%)	Change* (tone)	Change in absolute indicators (points)	Change %, points	Total points	Country ranking
Belgium	128	41,059	11	17	14	7
Bulgaria	358	21,286	9	21	15	5
Greece	40	44,933	12	5	8.5	15
Estonia	121	55,540	14	14	14	6
Ireland	124	54.37	5	16	10.5	14
Spain	105	172,416	19	13	16	4
Cyprus	242	442	2	20	11	13
Latvia	104	60,561	15	12	13.5	8
Lithuania	63	76,933	16	8	12	10
Luxembourg	133	2,592	4	18	11	12
Netherlands	66	10,719	7	9	8	17
Poland	122	184,961	20	15	17.5	2
Romania	102	195,333	21	11	16	3
Slovakia	36	17,644	8	4	6	18
Slovenia	28	1,316	3	3	3	20
Turkey	-29	-104,546	1	1	1	21
Hungary	48	30,941	10	7	8.5	16
Finland	140	104,690	17	19	18	1
Croatia	12	5,754	6	2	4	19
Czech Republic	81	52,528	13	10	11.5	11
Sweden	47	130,500	18	6	12	9

Note: * – indicators of "change" were calculated by comparing 2022 and 2014 data.
Source: compiled by the authors based on Eurostat (2025a).
Nota: * – os indicadores de "mudança" foram calculados comparando os dados de 2022 e de 2014.
Fonte: compilado pelos autores com base em dados do Eurostat (2025a).

Table 4 showed that the countries that demonstrated the highest growth from 2014 to 2022 also demonstrated the highest production levels in 2022. Finland, Poland, and Romania had the best results based on the scoring system. Table 5 contained indicators relating to the number of organically reared animals. France, Germany, and Italy had the largest number of animals, as shown in Table 5. Nevertheless, as with other indicators of organic agriculture, relative indicators should be considered, presented in Table 6.

France, Greece, and Italy were the leading countries in organic animal production, as shown in Table 6. Cyprus, Bulgaria, and Greece had the highest relative growth rates in the number of animals. According to the results of the analysis conducted in the context of organic production in EU countries, different countries demonstrated positive results in different areas. Other countries, such as Poland and Romania, developed rapidly in this area, although countries such as France and Germany were the leaders in absolute terms.

Table 5. Number of animals in EU countries in the period from 2014 to 2022.
Tabela 5. Número de animais nos países da UE no período de 2014 a 2022.

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	76,620	80,405	88,787	108,016	106,049	107,690	111,951	110,415	110,306
Bulgaria	1,344	4,209	9,718	10,400	9,314	9,402	10,343	10,408	8,555
Czech Republic	224,873	237,635	246,684	255,978	262,061	262,910	268,831	278,346	279,939
Denmark	182,131	157,527	164,397	199,870	220,754	224,348	227,336	231,472	228,268
Germany	643,600	654,386	700,356	788,561	771,320	870,372	861,272	896,760	965,909
Estonia	32,149	34,312	36,774	40,049	41,499	42,290	45,713	44,694	44,275
Ireland	38,923	46,946	52,742	56,873	61,819	64,093	58,659	59,291	59,436
Greece	70,346	68,454	75,132	81,425	138,015	142,609	163,066	193,596	266,262
Spain	168,214	190,224	199,737	207,121	212,066	215,802	219,769	264,259	275,786
France	541,129	541,312	573,623	649,856	751,382	830,921	860,308	925,800	1,269,301
Croatia	7,308	7,002	14,442	17,226	19,613	21,551	22,302	31,076	34,518
Italy	222,924	266,576	331,431	336,278	375,414	389,665	397,187	409,332	452,320
Cyprus	0	101	350	506	469	731	601	837	794
Latvia	76,048	80,400	92,546	95,585	96,423	99,041	101,968	102,422	87,822
Lithuania	35,279	34,929	37,814	57,270	57,884	58,356	58,737	59,151	57,891
Luxembourg	3,459	3,576	3,873	4,177	4,956	4,814	5,111	4,945	5,734
Hungary	18,871	18,919	20,815	17,741	18,964	27,007	26,087	27,810	23,216
Netherlands	53,603	56,264	60,150	65,189	71,715	71,817	76,069	79,300	80,250
Austria	376,647	266,236	404,648	422,008	421,324	420,693	417,658	420,118	428,676
Poland	38,744	31,896	29,107	27,901	26,953	30,186	31,102	31,195	29,283
Portugal	74,343	97,320	80,152	86,881	93,191	95,306	92,673	95,650	100,084
Romania	33,782	29,313	20,093	19,339	16,872	19,358	19,870	23,339	26,415
Slovenia	27,359	30,592	33,397	35,095	35,751	37,126	37,904	38,836	39,583
Slovakia	44,772	58,945	65,724	55,906	63,340	61,432	61,977	59,636	60,664
Finland	52,395	59,700	61,942	68,197	72,082	76,173	81,360	84,740	87,113
Sweden	281,320	285,774	296,260	307,120	332,294	333,245	331735	329851	325,162
Norway	27,385	28,516	29,329	29,931	30,307	28,361	28,639	28,332	35,234
Switzerland	167,024	170,420	175,520	187,745	200,450	205,389	211,041	213,595	219,304
North	2,133	4,401	3,368	4,698	6,390	7,170	8,723	9,752	7,821
Turkey	9,746	8,234	7,234	6,632	5,113	4,751	7,888	8,109	7,220

Source: compiled by the authors based on Eurostat (2025c).
Fonte: compilado pelos autores com base em dados do Eurostat (2025c).

4. DISCUSSION

Thus, due to the war in Ukraine, the agricultural sector began to seek alternative ways of developing the economy. Organic farming is one such alternative. In this study, numerous potential farming methods were considered, which could be used to improve both the condition of the sector and the state of the country's environment. In particular, the nation should focus on promoting such technologies through small and medium-sized enterprises. Nevertheless, Ukraine currently faces significant problems, both financially and otherwise. Under such conditions, the state should support small and medium-sized enterprises by providing them with additional incentives. Attracting funding from abroad from donors and international organisations is a possible option for support. However, the use of state funds in this direction is also appropriate and effective.

Within this study, it was demonstrated that agriculture, particularly organic farming, was actively developed in Ukraine despite the war and the difficulties it brought. Gamage et al. (2023), in turn, examined organic farming and its role in achieving a better level of agricultural sustainability in the country. The scholars wrote that organic farming faced many challenges, primarily related to costs, labour, pest control, and product spoilage. While organic farmers spent less on synthetics, the labour and feed costs were significantly higher. Organic products required quicker access to the market due to the shorter shelf life and sensitivity to temperature during transportation, and such farmers also had far fewer options for pest control. Furthermore, organic farming requires extensive knowledge for managing soil fertility, weeds, and biodiversity without the use of synthetic materials. However, there were significant global problems associated with the use of traditional farming methods. Therefore, existing farming practices needed to be improved through timely and collective crop cultivation, crop rotation, and the improvement of soil fertility through the application of organic matter. In addition, it was important to develop such methods of addressing problems that were previously tackled with chemicals, to resolve the problems using organic methods. Thus, the conclusions obtained within this study confirmed Ukraine's need to develop organic agriculture.

Table 6. Some data regarding the number of animals in different countries from 2014 to 2022.
Tabela 6. Alguns dados sobre o número de animais em diferentes países entre 2014 e 2022.

Country	Change* (%)	Change* (tone)	Change in absolute indicators (points)	Change %, points	Total points	Country ranking
Austria	114	52,029	23	4	13.5	22
Belgium	144	33,686	19	15	17	13
Bulgaria	637	7,211	8	29	18.5	8
Greece	379	195,916	27	27	27	2
Denmark	125	46,137	22	9	15.5	17
Estonia	138	12,126	11	14	12.5	24
Ireland	153	20,513	14	19	16.5	15
Spain	164	107,572	26	20	23	6
Italy	203	229,396	28	24	26	3
Cyprus	786	693	4	30	17	11
Latvia	115	11,774	10	5	7.5	26
Lithuania	164	22,612	15	21	18	9
Luxembourg	166	2,275	5	22	13.5	20
Netherlands	150	26,647	17	17	17	12
Germany	150	322,309	29	18	23.5	4
Norway	129	7,849	9	10	9.5	25
North Macedonia	367	5,688	7	26	16.5	14
Poland	76	-9,461	1	2	1.5	30
Portugal	135	25,741	16	12	14	19
Romania	78	-7,367	2	3	2.5	28
Slovakia	135	15,892	13	13	13	23
Slovenia	145	12,224	12	16	14	18
Turkey	74	-2.526	3	1	2	29
Hungary	123	4,345	6	7	6.5	27
Finland	166	34,718	20	23	21.5	7
France	235	728,172	30	25	27.5	1
Croatia	472	27,210	18	28	23	5
Czech Republic	124	55,066	25	8	16.5	16
Switzerland	131	52,280	24	11	17.5	10
Sweden	116	43,842	21	6	13.5	21

Source: compiled by the authors based on Eurostat (2025c).

Clark (2020) examined the life cycle of farming systems as an important tool for assessing the impact on the environment, from resource extraction to product disposal. The study showed that both traditional and organic farming produced different greenhouse gas emissions. The study of Venkat (2012) in California revealed that organic farming had lower greenhouse gas emissions per unit of land but higher emissions per unit of product due to lower yields. The studies of Aguilera et al. (2015), conducted in Spain, showed lower emissions from organic crops, except for rice, and significantly reduced emissions from organic perennial crops due to carbon sequestration. These results questioned the assumption that large-scale organic farming would automatically reduce greenhouse gas emissions. However, organic farming provided benefits in biodiversity, pesticide reduction, and soil health improvement. Thus, addressing climate change through agriculture required a nuanced approach, integrating organic and conventional methods, technological innovations, and systemic changes in production and consumption models. Within this study, the role of applying the latest technologies to improve the ecological condition of the country was also emphasised. In a previous work, slightly different methods were considered compared to the current study; however, all of these methods could be effectively used to reduce the negative impact of enterprises' activities on the environment.

Farrell et al. (2022) highlighted the potential of organic farming to enhance farm viability in Ireland, not only by supporting existing organic producers but also by attracting new entrants into agriculture. This was consistent with the European Union strategies, which set ambitious growth targets for the sector. Within the study, the scholars showed that organic farming also contributed to social stability by encouraging farm succession and attracting new farmers, and the examples in the study showed the advantages of collective problem-solving of farm viability, where knowledge sharing and innovation played key roles. Problems such as land access, agricultural land succession planning, and the perception of organic farming were identified. Within this study, the current state of agricultural development in European countries was also examined. Based on the evaluation carried out, it was shown that countries such as

France and Germany were leading. At the same time, Poland and Romania were the fastest developing countries in this direction, since different countries were advanced in different areas. Nevertheless, Ireland was not recognised as a country with leading achievements in this field in the analysis. Nevertheless, the results of both studies showed that the development of organic farming in countries was necessary to achieve better results and to increase agricultural efficiency.

Tscharntke et al. (2021) assessed how organic farming supported biodiversity more than conventional farming, but its benefits were limited and accompanied by significant yield losses. More effective measures to support biodiversity included crop diversification, smaller fields, and semi-natural habitats, which could be applied in both organic and conventional farming to achieve broader improvements in agricultural landscapes. Policy should prioritise the diversification of arable land, such as small fields with high edge density, rather than focusing exclusively on organic farming. Soni et al. (2022) noted that organic farming was an environmentally and economically sustainable method that helped prevent environmental degradation while simultaneously improving the socio-economic conditions of farmers. It provided safe, nutritious food with minimal contaminants, reduced financial risk, and ensured high net profit due to lower costs and market prices. However, conventional farming benefited from greater economies of scale. To encourage organic farming, policy should support premium prices, improve market access, and promote innovative organic methods. Local farming practices, better market conditions, financial support, training, and educational programmes could further expand organic farming, making it more profitable, sustainable, and accessible for small farmers. Thus, the results of both of the above-mentioned studies coincided with the results of the current study, which examined the importance of implementing the principles of organic farming and the positive impact on the development of the industry and the economy as a whole.

Drobitko et al. (2024) investigated the impact of new grain-growing technologies in the Southern Steppe of Ukraine. The results showed that new grain cultivation methods increased productivity, optimised resource use, and improved the ecological sustainability of agro-systems. This was necessary for maintaining food security and the economic development of Ukraine. Overall, the same conclusions were made in the present study, as the implementation of innovative methods for agricultural development and crop cultivation in Ukraine would be effective under current conditions. This was particularly demonstrated by statistical data that evaluated progress in organic agriculture in Ukraine. The biggest challenge was identifying opportunities for financing the implementation of these technologies and their further use.

5. CONCLUSIONS

Thus, during the war, innovations in Ukraine's agricultural sector were important for ensuring food security and preserving soil fertility despite difficult conditions. The shift to sustainable and organic farming methods became a key strategic response to challenges caused by the war, such as land loss, soil contamination, and disruptions in the supply of agricultural resources. For this reason, organic farming became not only an environmentally friendly alternative but also a means of supporting the resilience of small farms facing financial and logistical challenges.

Soil restoration was an important part of post-war recovery. Due to soil contamination with heavy metals, petroleum products, and explosive residues, it was necessary to implement new reclamation methods such as green manure, organic fertilisers, and bioremediation technologies. All of these technologies could improve the financial condition and ecological development of small and medium-sized enterprises. Nevertheless, SMEs could not use these organic farming methods due to a lack of financial and technical resources.

Small and medium-sized enterprises often find it difficult to obtain the necessary capital to invest in advanced sustainable development technologies, unlike large agricultural holdings. However, the gradual implementation of cost-effective solutions, such as compost fertilisers and green manure, was still possible.

This study also examined the metrics of organic farming development in Ukraine, including during the war. From 2016 to 2023, the area of agricultural land (organic and in transition) increased by 23%, the area of agricultural land with organic status grew by 35%, and the area in transition decreased by 13%.

It should be noted that the total area of agricultural land decreased simultaneously with the increase in the area of organic land. As a result, the share of organic land rose. On the other hand, considering European experience, it was found that the Czech Republic had the highest percentage of land allocated to organic farming (7.1%), Denmark (7.7%), and Greece (7.7%). Sweden (410.5 thousand tonnes), Romania (387.8 thousand tonnes), and Spain (336.3 thousand tonnes) led in terms of organic production volumes. Regarding livestock in organic production, France (1,269,301 heads), Germany (965,909 heads), and Italy (452,320 heads) held leading positions. These data reflected the state of the respective sector in Ukraine, the development of which should continue in the future.

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