DOI: https://doi.org/10.30525/2256-0742/2025-11-3-353-360

# EUROPEAN PROSPECTS FOR THE DEVELOPMENT OF CROP PRODUCTION TECHNOLOGIES IN UKRAINE

**Ihor Didur[1], Svitlana Lutkovska[2], Hanna Pantsyreva[3]**

**Abstract.** The article presents the results of a study of the current state of the crop production industry in Ukraine under martial law. Particular attention is paid to the analysis of trends in the development of organic production in the context of globalization and regionalization processes. The need to transition to organic farming as an important component of sustainable development of the agricultural sector is substantiated. Agrotechnological directions and a set of practical measures are proposed to solve existing problems, taking into account the experience of the European Union countries, in particular within the Eastern Partnership. In the structure of agricultural production in Ukraine, a significant decrease in yields is noted in the regions affected by hostilities (Donbas, southern Ukraine), while the western regions demonstrate positive dynamics. A description of the main crops that form the country's crop production is provided, in particular grain, leguminous, industrial and vegetable crops, indicating the sown areas in 2024. The aim of the article is a comprehensive study of the current state of the crop production sector in Ukraine, while simultaneously identifying key problems facing national agricultural producers. The main task is to substantiate promising measures to increase the productivity of agricultural production with an orientation towards European standards and their adaptation to the specifics of Ukrainian realities. The conducted research acquires particular relevance in the context of the implementation of the state program, financed from the state budget, on the topic: «Development of agrobiotechnological approaches to the production of crop products to restore soil fertility affected by hostilities». The scientific basis of the study was the use of the dialectical method of cognition, a systematic approach to the analysis of economic processes, and methods for calculating the efficiency of the functioning of the crop production sector. In addition, the basis was the provisions of modern economic theories, the results of domestic and foreign research, as well as regulatory and legal acts on improving the efficiency of agricultural production, supplemented by our own observations and accounting data. The study proposed practical recommendations for the development of organic production in Ukraine. The current trends in the field of organic farming in the context of deepening globalization and regionalization processes were analyzed. The problems associated with the need to transition to organic production of crop products as a factor in the sustainable development of the agricultural sector were outlined. Agro-technological directions and a set of promising measures to overcome the identified challenges were also formulated, taking into account the experience of EU countries, in particular within the Eastern Partnership.

**Keywords:** economic efficiency, crop production, organic production, cultivation technology, environmental justification.

**JEL Classification:** Q10, Q13, Q15, Q18, O13, R11

## 1. Introduction

Agricultural production, and in particular the crop production sector, is one of the main types of production and economic activity that provides raw materials for the food security of the state. However, the potential of crop production in Ukraine is not fully utilized (Bulgakov et. al. 2024; Hetman et. al. 2024; Kaletnik et. al. 2024; Tkachuk et. al. 2024; Koval et. al. 2025; Pronko et. al. 2024). The main reasons are military aggression, which led to difficulties in

[1] Vinnytsia National Agrarian University, Ukraine
E-mail: dim@vsau.vin.ua
ORCID: https://orcid.org/0000-0002-6612-6592
[2] Vinnytsia National Agrarian University, Ukraine
E-mail: svetvsau@gmail.com
ORCID: https://orcid.org/0000-0002-8350-5519
[3] Vinnytsia National Agrarian University, Ukraine *(corresponding author)*
E-mail: apantsyreva@ukr.net
ORCID: https://orcid.org/ 0000-0002-0539-5211

the production of crop products, the riskiness of conducting economic activities, the lack of qualified personnel, uncertainty in land issues, the occupation of territories, significant fluctuations and uncertainty in prices (Didur et. al. 2020; Hnatiuk et. al. 2019; Honcharuk et. al. 2021; Didur et. al. 2024; Tsurkan et. al. 2022).

Therefore, identifying the main problems facing producers of plant products and justifying measures to increase productivity in the plant growing industry necessitates constant scientific study (Kaletnik et. al. 2024).

Modern trends in the development of organic production in the context of deepening globalization and regionalization processes are implemented by the need to transition to organic production of crop products in Ukraine to ensure green growth of agricultural production as a whole. The prospects are agro-technological directions and promising measures to address the problematic issues indicated in the study in Ukraine under martial law with a focus on countries dealing with regional economy problems, agricultural economy of the EU Eastern Partnership countries (Mazur et. al. 2021b; Okrushko, 2022; Belkin et. al. 2025).

Analysis of scientific sources devoted to the economic efficiency of biologized technologies for growing agricultural crops indicates a significant contribution to this topic by a number of leading Ukrainian scientists. Among them, it is especially worth noting Vasyl Petrichenko, Volodymyr Lykhochvor, Mykola Bakhmat, Hanna Pantsyreva and other researchers. In their works, they thoroughly investigated the impact of biological preparations on the productivity and quality of crop products, analyzed the economic advantages of using inoculants and foliar feeding, and also focused on the importance of optimizing costs in the production process (Bakhmat et. al. 2023; Mazur et. al. 2021a)

The results of these studies deepen the understanding of the role of biological methods in increasing seed yield and quality, demonstrating that biologization is an effective approach to increasing profitability. Among the key factors that determine the economic feasibility of production, scientists highlight the technology of pre-sowing treatment, the use of modern types of fertilizers and growth stimulants, as well as innovative agronomic solutions (Tkach et. al. 2023; Mazur et. al. 2021c; Vdovenko, et. al. 2024).

According to V. Petrychenko, the main quantitative indicator that determines the economic efficiency of soybean cultivation is yield. Increasing yield directly affects the increase in gross seed yield, reducing the labor intensity of production and reducing the cost (Petrychenko et. al. 2022; Petrychenko et. al. 2024; Petrychenko et. al. 2025).

Ukraine occupies an important place in the world agricultural production of plant products, growing grain, oilseed and fodder crops, such as wheat, soybeans, barley, corn and sunflower. They determine the country's export potential and contribute to its economic development (Honcharuk et. al. 2024). In addition, it is necessary to pay attention to the environmental aspects of production and develop coordinated strategies to ensure the sustainable development of the crop production industry (Tkachuk et. al. 2025).

## 2. Materials and Methods

The aim of the article is to study the state of the crop production industry in Ukraine while simultaneously identifying the problems facing domestic producers. The main task is to substantiate promising measures to increase production productivity based on European standards and their adaptation to Ukrainian realities. Experimental field studies were conducted on the basis of the scientific research farm «Agronomichne» of Vinnytsia National Agrarian University. The significance of the results obtained is enhanced by the fact that they are part of the implementation of the task of the state scientific research topic, financed from the state budget, within the framework of the project: «Development of agrobiotechnological approaches to the production of crop products to restore soil fertility affected by hostilities». The scientific basis of the research is the application of the dialectical method of cognition, a systematic approach to the study of economic processes, calculations of the efficiency of the functioning of the crop production industry, as well as economic theories, the results of economic research by domestic and foreign scientists, legislative and regulatory acts on ensuring the efficiency of crop production based on our own observations and records.

## 3. Results and Discussion

Crop production is the leading sector of agriculture in Ukraine, accounting for about 60% of the total volume of agricultural products. It is a key area of agricultural production, ensuring the cultivation of crops to meet the food needs of the population, providing fodder for livestock, and supplying raw materials for the processing industry (Razanov et. al., 2018; Dubik et. al., 2024).

The leading place in the structure of crop production is occupied by grain farming, which forms the basis of the global food complex. Grain crops – wheat, rice, corn, barley, oats and rye – cover approximately 50% of the total sown area in the world. According to FAO, their crops occupy half of the world's arable land, and in some countries this figure is even higher,

in particular in Japan it reaches 96%. Grain and its processed products occupy second place in the world agricultural turnover in terms of value, second only to meat and meat products. One of the key tasks of modern crop production is a comprehensive increase in the productivity of grain crops through the introduction of scientifically based technologies, adaptation to climate change and efficient use of resource potential.

In 2022, global grain production exceeded 2.8 billion tons, with corn accounting for about 40% of the total. In 2024, total grain production reached approximately 3.137 billion tons, and the harvested area was 741 million hectares. The average yield was about 4.2 tons/hectare. In 2024, grain exports amounted to approximately 442-456 million tons, which is slightly lower than in previous years. The total value of grain exports is about $117-$121 billion. By exporting countries: USA (89-92 million tons), Ukraine (55-56 million tons), Brazil (4344 million tons), Argentina (36-38 million tons), Russia (33-34 million tons). By grain type, wheat and corn dominate global exports, together accounting for about 87-88% of the volume. In 2024, the average export price of grain was about $262-266 / t, which is 10% less than in 2023 and significantly lower than the maximum of $333 / t in 2022. Ukraine has favorable natural-climatic, agro-ecological and socio-economic conditions for the development and widespread implementation of organic technologies in agriculture. These technologies are based on the use of natural mechanisms for regulating soil fertility and the phytosanitary state of agrocenoses, without the use of synthetic mineral fertilizers, chemical pesticides and growth regulators. They meet the requirements of sustainable agriculture, contribute to the preservation of biodiversity, improvement of product quality and restoration of the ecological balance of agro-ecosystems. Given the growing demand for environmentally friendly products in both domestic and foreign markets, biological technologies are gaining strategic importance in the system of modern agricultural production in Ukraine (Table 1).

Thus, in Ukraine, during 2040-2050, various models of agricultural production will operate and improve in parallel, in particular intensive technologies aimed at achieving maximum yield and economic profitability. These technologies are based on the active use of resource-intensive factors – mineral fertilizers, plant protection products, powerful equipment, etc. At the same time, resource-saving, biologized and zero (no-till) technologies will become increasingly relevant, which involve minimal intervention in the soil ecosystem, active use of biological agents and natural regulators. The prospects of such approaches are due to the need to preserve soil fertility, reduce anthropogenic load on the environment, ensure environmental safety and improve the quality of agricultural products. Given the global challenges associated with climate change, soil degradation, and growing demand for environmentally friendly products, biological and adaptive farming systems can become the basis for the long-term food and environmental security of the state.

According to FAO experts, by 2040 the share of biological and organic technologies in the overall structure of agricultural production in the countries of Central and Eastern Europe may increase to 25-30%, with a tendency to further expansion. In Ukraine, according to the National Strategy for Agricultural Development, a gradual increase in the area under biological/organic production is expected from the current 500 thousand hectares to over 1 million hectares by 2030. The experience of countries such as Germany, France and Canada shows that the combination of high-tech tools (drones, sensors, precision agriculture) with biological approaches allows not only to maintain productivity, but also to reduce the carbon footprint of agricultural production (Mazur et. al., 2018).

As a result, the combination of intensive and biologized technologies will form an adaptive and sustainable model of agricultural production in the coming decades, focused on the quality, safety, and environmental responsibility of crop production. Vinnytsia region demonstrates a comprehensive approach to the development of biological, organic and no-till agriculture – from practical projects in farms to state strategy and research support. This creates a solid platform for sustainable agricultural transition in the region. At Vinnytsia National Agrarian University in the conditions of the research farm «Agronomichne» student farms with the introduction of organic movement: more than 300 hectares under organic farming. Initiatives include the development of methodological recommendations, agro-ecological

Table 1

**Systematization of technological solutions in the field of crop production**

| Region, country | Type of technology | Crop capacity | Environmental impact |
|---|---|---|---|
| Ukraine, EU, Austria, Switzerland, Sweden | Intensive / resource-saving | Very high / high | Harmful /safe |
| Europe, including Ukraine | Organic | Medium | Safe |
| USA, Argentina, Brazil, Canada, China | Zero | High | Safe |
| USA, Ukraine | Striped | High | Safe |

monitoring, certification maps that determine the suitability of soils for organic cultivation.

Modern crop production is characterized by the active development of high-tech technical support, which is aimed at increasing productivity, energy efficiency and environmental friendliness of production processes while simultaneously increasing economic efficiency. One of the key areas is the creation and implementation of multifunctional tillage and sowing units that ensure the performance of several technological operations in one pass of the equipment. In particular, thanks to such units, pre-sowing soil cultivation, fertilizer application and sowing of cereals, legumes, rapeseed and other crops are simultaneously carried out, which significantly reduces the total number of passes of equipment across the field (Figure 1).

This, in turn, allows: to reduce soil compaction; to preserve its structure and aeration; to improve conditions for the development of soil biota; to promote the accumulation and effective use of moisture, macro- and microelements; to reduce the cost of fuel, labor and material resources (Bondarenko et. al., 2023). This approach forms a new philosophy of using soil – not only as a physical environment for growing crops, but as a living, self-regulating system that requires careful treatment and long-term preservation. Resource-saving farming systems, in particular no-till technologies, which involve the complete abandonment of mechanical tillage, acquire particular importance in this context. In the context of climate change, frequent droughts and increasing soil degradation, there is an urgent need for scientific substantiation of the effectiveness of such technologies.

Key scientific objectives: Studying the ability of no-till technologies to provide extended reproduction of soil fertility; Analysis of their impact on the sustainability of production, quality and safety of products; Development of adaptive farming models that combine elements of biologization, precision farming and environmental protection approaches. Thus, the development of engineering and technological equipment for crop production and its combination with environmentally friendly tillage systems opens up new horizons for scientific research and the formation of an innovative paradigm of sustainable agriculture in Ukraine. Biological technologies are a common element of agricultural practice in the countries of the European Union, in particular in Austria, Switzerland, Sweden, Germany, Denmark and France (Figure 2). These countries demonstrate a high level of integration of environmentally friendly agricultural technologies into the agricultural system, thereby ensuring both food security and environmental protection.

Thus, in Austria, more than 25% of all agricultural land is certified as organic, and in Switzerland there is a national program to support biological production through financial incentives, scientific support and training of farmers. In Ukraine, there are exceptionally favorable conditions for the widespread implementation of biological technologies – and in some aspects even better than in many European countries. First of all, this is the high natural potential of soils, in particular a significant proportion of black soils, which have

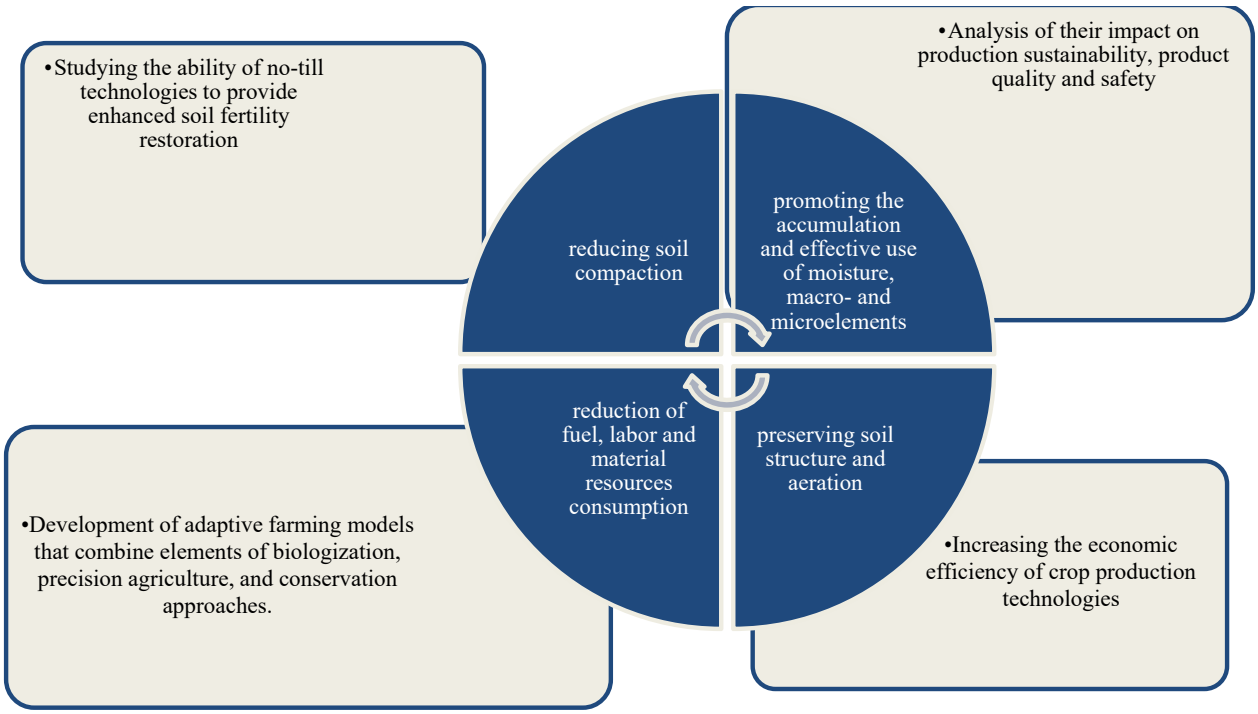


**Figure 1. European prospects for high-tech technical support in Ukraine**

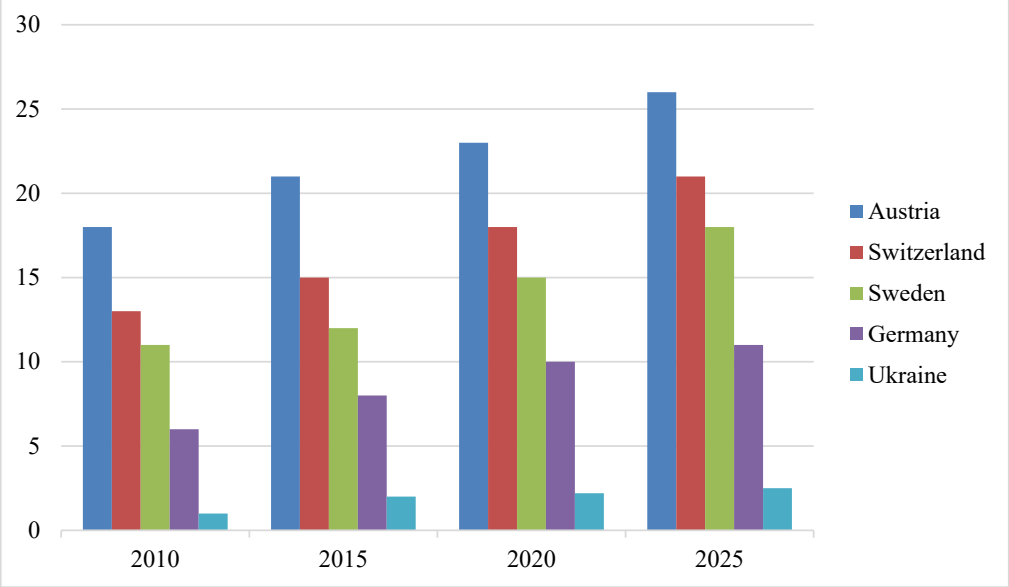


**Figure 2. Dynamics of the introduction of biological technologies for the production of crop products in agriculture in European countries and Ukraine**

a large buffer capacity, high biological activity and the ability to self-regulate (Kupchuk et. al., 2024). This makes it possible to partially or fully meet the needs of plants in macro- and microelements without excessive use of synthetic fertilizers. The essence of biological technologies is not to simplify agricultural production processes, but, on the contrary, to complicate them through a deep understanding and modeling of the natural mechanisms of functioning of agrophytocenoses. Therefore, biological technologies are not only an ecological alternative to chemical approaches, but also the basis for the formation of a new type of agricultural production – scientifically based, resource-saving and environmentally responsible.

The full-scale war in Ukraine has had a significant negative impact on the functioning of the agricultural sector, in particular on the production and export of crop products. Occupied and destroyed territories, mining of agricultural lands, destruction of logistics infrastructure, shortage of resources (fuel and lubricants, fertilizers, equipment) and limited access to markets – all these factors have significantly reduced the level of production activity of farmers. Despite these extraordinary challenges, Ukrainian agricultural producers demonstrate high resilience, adaptability and responsibility, doing everything possible to minimize losses and continue agricultural production.

According to satellite analysis, about 18% of the main crop areas in five eastern regions (Donetsk, Luhansk, Zaporizhia, Kherson and Crimea) remained unsown in 2022-2025. Large-scale mining of farmland affected from 0.47 to 2.5 million hectares of arable land. These areas are blocked for production, even after the redefinition of the front line. In the production structures, a significant decrease in yields was noted in the Donbas and southern regions (–70%–85%), while the western regions (Lviv, Volyn, Vinnytsia) demonstrate growth from +10% to +20% (Table 2).

The main agricultural crops in Ukraine used for the production of crop products are: grain and leguminous crops: wheat, corn, barley, rye, oats, soybeans, peas, the sown area of which in Ukraine in 2024 was 72,114 thousand hectares, the area of sugar beet was 250 thousand hectares, sunflower – 5,220 thousand hectares, the sown area of potatoes in Ukraine in 2024 was 1,210 thousand hectares, vegetable crops occupied 405 thousand hectares. However, an urgent re-profiling of technologies, the use of biological protection products and alternative sources of nutrition, and optimization of agrotechnical operations taking into account available resources are being carried out.

Table 2
**Crop production in Ukraine, 2020–2024**

| Group of cultures | Cultivation volumes, thousand tons | Yield, t/ha | Deviation,+/- 2020-2024, thousand tons |
|---|---|---|---|
| Cereals and legumes | 72114 | 2,2 | 11234 |
| Industrial crops | 10985 | 5,4 | 987 |
| Oil crops | 13456 | 2,4 | 1509 |
| Fruit and vegetable crops | 34543 | 8,3 | 1567 |

The Ukrainian agricultural sector continues to play an important role in ensuring food security not only within the country, but also on a global scale, maintaining the export of grain, oilseed and legume crops, in particular through alternative logistics routes (grain corridors, railway, Danube ports, etc.).

## 4. Conclusions

The study showed the urgent need to transform domestic crop production taking into account European approaches to sustainable agricultural production, in particular through the introduction of organic farming. In the context of globalization challenges and regional instability, technologies focused on preserving soil fertility, rational use of resources, and restoration of production potential in territories affected by hostilities are of particular importance. The decline in yields in regions devastated by hostilities has a significant negative impact on the overall production volumes, food security, and export potential of Ukraine. At the same time, the increase in productivity in the western regions indicates the presence of local economic reserves and the effectiveness of the use of modern agricultural technologies even in times of crisis. The transition to organic farming, despite high start-up costs, will contribute in the long term to increasing the added value of products, expanding access to premium EU markets, and reducing dependence on imported resources. Implementation of state and regional programs to support agricultural producers is a key factor in the economic stabilization of the industry.

Analysis of the spatial structure of yields in Ukraine revealed critical disparities between regions, which requires increased state support for the restoration of agriculture in the eastern and southern regions. At the same time, positive dynamics in the western regions confirm the potential for adaptation to modern agricultural technologies and the requirements of the European market.

As a result, a number of practical recommendations have been formulated for the development of organic production, agro-technological modernization and harmonization of the regulatory framework in accordance with EU standards. The transition to such approaches will not only contribute to increasing the competitiveness of Ukrainian products, but will also create the basis for a "green" restoration of the agricultural sector in the post-war period.

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Received on: 21th of June, 2025
Accepted on: 15th of August, 2025
Published on: 20th of August, 2025