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PROSPECTS FOR THE DEVELOPMENT OF SEED PRODUCTION IN UKRAINE TAKING INTO ACCOUNT ECONOMIC AND ENVIRONMENTAL EFFICIENCY

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Abstract. The scientific study examines the prospects for the development of seed products of the agro-industrial complex of Ukraine to study economic and environmental efficiency under martial law. Research has shown that technological advancements in the agricultural sector are key to economic development and enhancing the quality of seed products, ensuring the state's food security. The establishment of an effective system of seed production is pivotal in creating favourable conditions for increasing seed production and utilising domestic assortments with high yield potential and quality indicators. This will contribute to their widespread use, ensuring competitive advantages and the development of agricultural production. The purpose of the article is to identify trends and determine the prospects for the development of seed production in Ukraine in order to guarantee the country's food security. The research issues concern a number of environmental problems, first and foremost among them being the guaranteeing of the country's food security, the improvement of the social and economic situation of rural areas, and the strengthening of the health of the population. The development of organic production is integral to the development of the sector as a whole. It should be noted that the production of organic agricultural products is impossible without the main basis – seeds grown under organic production conditions, i.e., organic seeds. The study utilised the dialectical method of scientific knowledge, encompassing analysis and synthesis, systemic generalisation (to establish development trends and formulate conclusions), and comparative analysis (to identify key problems in the industry). Following a detailed analysis of the study's findings, the primary trends in the development of seed production in Ukraine have been identified. Key challenges have been highlighted, and proposals have been made to encourage the advancement of breeding activities. Recommendations were also formulated for the further development of the seed industry, which can be used in the development of national seed support programs. The process of organic seed production was emphasised, drawing on existing innovative agricultural technologies that exclude the use of any chemical means. This guarantees the environmental safety of the obtained seed material. The use of high-quality seed material is paramount to achieving high yields.

Keywords: food security, seed production, economic efficiency, environmental efficiency, military aggression.

JEL Classification: Q42, Q28, Q16

1. Introduction

A violation of stability in the field of food security has critical consequences for the livelihoods and working capacity of the population, as well as negatively affecting the development of agriculture, namely the production of seed products. In order to prevent economic decline, it is vital to analyse the areas and programmes that are aimed at regulating food security in Ukraine. These should become priorities in the system of public administration (Petrychenko et al., 2024 b).

The issue of food security is a global concern, and as such, it is a subject that is actively discussed among the scientific community and international organisations dealing with food security and agriculture. The situation in Ukraine, in particular the impact of the war on the formation of food security, has attracted special attention from researchers. Petrychenko V. and Lykhochvor V. analysed changes in the state of food security after the start of the full-scale invasion and outlined key measures of state regulation of the national food market

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(Petrychenko et al., 2024 a). Tkachuk O., Didur I. and others summarised the current problems of organic seed production to ensure food security in Ukraine (Tkachuk et al., 2024; Didur et al., 2024; Pohrishchuk et al., 2023). The works of Mazur V. explore the main directions for strengthening the agricultural sector in wartime conditions, with a focus on the improvement of technological methods for growing major agricultural crops (Mazur et al., 2024; Telekalo et al., 2022). Despite significant scientific achievements, there has been insufficient attention paid to determining priority ways to regulate food security in wartime conditions through the production of seed products. The purpose of the article is to identify trends and determine the prospects for the development of seed production in Ukraine in order to guarantee the country's food security. It should be noted that the production of organic agricultural products is impossible without the key element of seeds that are cultivated under organic production conditions – organic seeds.

2. Literature Review

Achieving high yields is contingent on the use of high-quality seed material, which ensures the stability and productivity of agricultural crops (Awasthi et al., 2018; Tokarchuk et al., 2021). High-quality seeds have been shown to increase germination, resistance to diseases, adverse weather conditions and pests, which ultimately has a positive impact on yield and economic efficiency of agricultural production (Kaletnik & Lutkovska, 2020). In many countries worldwide, specific legal acts are in place to regulate the quality requirements for seed material at all stages of production, storage, sale and use. These legislative norms determine the standards for seed certification, restrictions on the content of impurities, moisture level, germination and genetic purity (Pantsyreva et al., 2024; Khrystynchenko et al., 2023).

Government and international organisations, such as the Organisation for Economic Co-operation and Development (OECD), the International Seed Testing Association (ISTA) and the Food and Agriculture Organization of the United Nations (FAO), are responsible for developing and implementing uniform standards for seed quality control. This ensures that seeds meet international requirements and facilitates their export. Government agencies, laboratories and independent certification bodies are responsible for monitoring compliance with the relevant standards. This involves verifying seed quality through a variety of means, including laboratory analysis, field testing and monitoring compliance with technological standards during cultivation. Ukraine also has a seed certification system that meets international standards. The process encompasses a range of control measures, from field testing to laboratory testing. Breeding and seed farms that grow seeds with specified characteristics and high yields play an important role. The provision of quality seeds is a strategically important task for the agriculture sector. This is because it affects the country's food security, the competitiveness of the agricultural sector and the development of environmentally sustainable crop-growing technologies. Consequently, the issue of quality control and improvement of the legislative framework in the field of seeds is a priority area of agrarian policy in many countries (Lohosha et al., 2023; Kupchuk et al., 2022; Pidvalna et al., 2022; Kaletnik et al., 2024).

Ukraine has significant potential for the development of organic agricultural seed production, both for the domestic market and for export. The company has achieved positive results by expanding its own organic production. According to official statistics from the IFOAM Federation of the Organic Movement of Ukraine, as of January 1, 2020, only about 1% of agricultural land was used for growing organic products. However, by January 1, 2024, this area had increased significantly, reaching 60%, which corresponds to global trends in the development of organic agriculture (Tomashuk et al., 2024).

Following Ukraine's accession to international organisations that regulate the seed sector, significant changes are taking place in the domestic production of seed products. The country has recently become a member of several international organisations, including the World Trade Organisation (WTO), the International Seed Testing Association (ISTA), and the Organisation for Economic Co-operation and Development (OECD), among others. This integration contributes to the improvement of the regulatory framework of the industry, stimulates its deep reform, and also requires the strengthening of logistical and scientific support in accordance with international standards for seed production.

3. Materials and Methods

In the course of conducting scientific research, the following methodology was employed in order to achieve the set objective: the dialectical method of scientific knowledge, analysis and synthesis, systemic generalisation (to establish development trends and formulate conclusions), as well as comparative analysis (to identify key problems in the industry). The study drew on a range of reliable sources, including FAOSTAT (Food and Agriculture Organisation of the United Nations statistical data for 2020–2024), as well as periodic and reference publications. It also incorporated the results of the own scientific and experimental research and calculations, ensuring a comprehensive and robust analysis.

The issues of the scientific article are reinforced by the main objectives of the applied research on the topic: "Development of scientific and technological support for increasing soil fertility and rational use of the potential of bioresources" (0124U000444).

4. Results and Discussion

Sown areas under crops such as sunflower and soybean in European countries and the world in general have a tendency to grow (Figure 1).

However, it should be noted that growing crops such as corn for grain has a tendency to reduce the area sown for the production of seed products (Figure 2). Most Ukrainian and European farmers are reducing the area sown under corn for grain, instead focusing on growing oilseed crops.

An analysis of statistical data from 2020 to 2024 reveals that the figures were minimal in 2020 and maximal in 2024. The areas in question are those sown with oilseed crops. An inverse relationship is recorded for corn crops. During the period under review, the global area sown under sunflower increased by 28%, and in Europe by 49%. While the area under cultivation of soybeans has seen a 15% increase worldwide and a significant 42% increase in Europe. It is also worth noting that there has been an increase in the area of land designated for sunflower and soybean cultivation in Ukraine. It is evident that significant growth has been achieved over the past year. It is evident that there has been an increase of 0.432 million hectares in sunflower crops, and 0.086 million hectares in soybean crops.

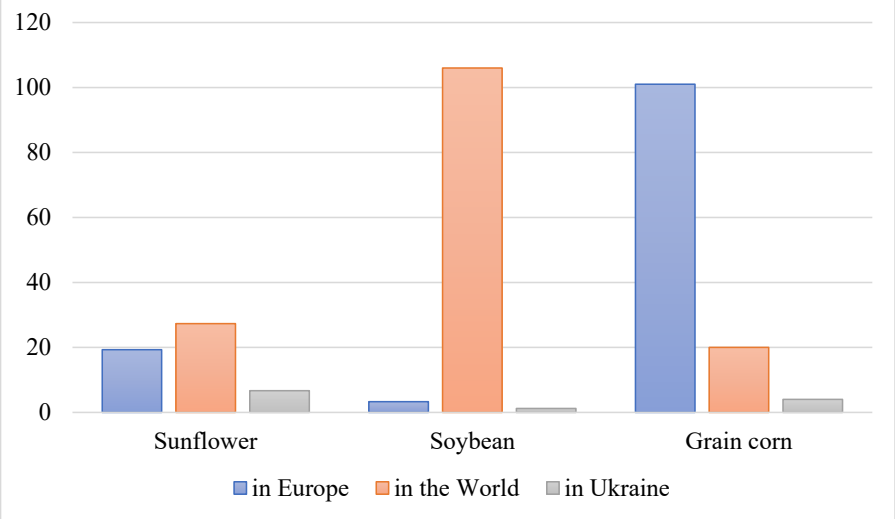

Figure 1. Dynamics of sunflower, soybean and corn acreage in Europe and globally, million ha

Source: FAOSTAT, 2020

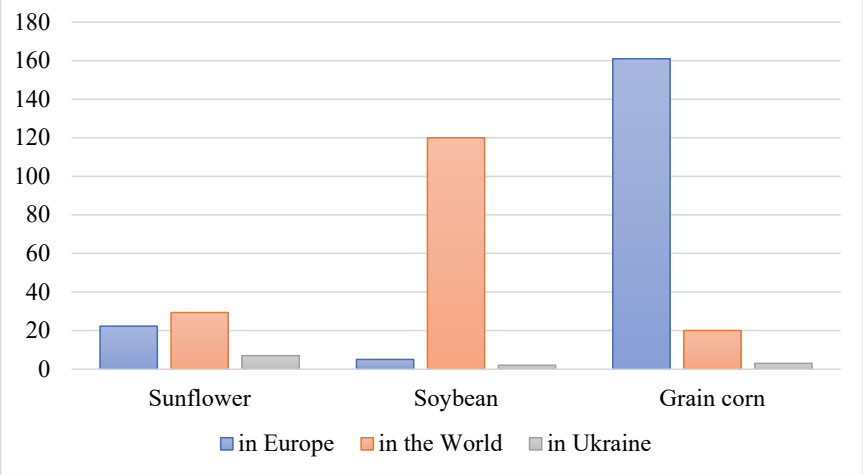

Figure 2. Dynamics of sunflower, soybean and corn acreage in Europe and globally, million ha

Source: FAOSTAT, 2024

A slightly more complex situation is evident in corn crops for grain. Consequently, due to the absence of sales markets, corn exports have declined, leading to a contraction in the sown areas. Romania, along with China (4.4 million tons) and Spain (2.8 million tons), was among the top three largest importers of Ukrainian corn in 2022. A low level of seed production is observed in the Luhansk, Donetsk, Zaporizhzhia, Kyiv, Odesa and Lviv oblasts, which creates significant risks for the country's food security. Limited seed production in these regions can lead to dependence on imports, an increase in the cost of agricultural products and a shortage of high-quality seed material for the agricultural sector (Figure 3).

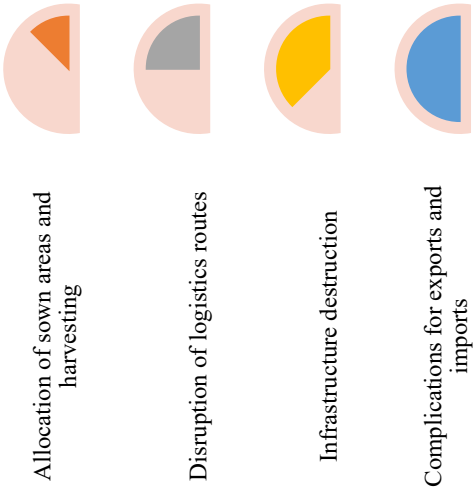

Figure 3. Impact of military operations in Ukraine on seed production

Conversely, the Vinnytsia, Volyn, Ternopil, Cherkasy, Chernivtsi, Dnipropetrovsk and Ivano-Frankivsk oblasts have demonstrated a relatively high level of food self-sufficiency. The oblasts' substantial resource potential enables them to meet domestic needs and offset deficits in war-affected regions. In view of the military actions that impacted production and logistics chains in the agricultural sector, specifically the production of seed products, it is imperative to undertake a timely study of the oblasts' self-sufficiency in seed products. A comprehensive approach to their solution, in particular the development of breeding centres, support for farms and the implementation of effective state support programs, will contribute to improving the country's food security and ensuring the stable development of the agricultural sector.

Thanks to the development of zonal models of varietal cultivation technologies adapted to climate change, modern technological methods of growing sunflowers and soybeans are constantly being improved. This applies not only to these crops, but to many other agricultural activities too, enabling significant increases in yield and gross crop production. World production volumes of seed products are increasing (see Table 1).

Table 1
Dynamics of seed production, million tons

World production	Europe	Ukraine
Sunflower		
60,167	45,022	17,021
Soybean		
336,590	12,234	5,202
Corn for grain		
965,123	59,653	26,543

Source: FAOSTAT, 2024

Sunflower seed production in Ukraine has shown steady growth over the past two decades, driven by favourable climatic conditions and the economic benefits it brings to farmers. This growth has had a positive impact on Ukraine's economy, establishing it as the world's leading exporter of sunflower oil. Concurrently, the production of sunflower seeds in Europe is noteworthy, particularly within the European Union (EU). In the 2023/24 marketing year (MY), global sunflower production reached a record 57.2 million. Ukraine supplied 17.5 million tonnes, accounting for 31% of the global volume. Within the European Union, the production of sunflowers also demonstrated a favourable trend. In the 2023/24 MY, the EU sunflower harvest area was 28.75 million hectares, representing a 7% increase on the previous season and the largest increase observed in the past 5 years.

Soybean production is strategically important for many countries around the world as this crop provides a significant proportion of vegetable protein and oil requirements. According to data from the 2024/25 marketing year, global soybean production reached almost 336.59 million tonnes. The main producers were Brazil, the US and Argentina, which together harvested a record 271.67 million tonnes of soybean products. Meanwhile, Ukraine's soybean production is also showing positive dynamics. From 2000 to 2024, the area sown with soybeans increased exponentially, by 25 times in fact. This development resulted in Ukraine achieving the top ranking in Europe in terms of production of this particular crop. As of 2024, the level of soybean yield in Ukraine increased to 2.35 t/ha, indicating significant potential for further development of the industry. Consequently, a notable trend has emerged among the nations of the European Union, characterised by a substantial increase in soybean production. According to forecasts for 2025, soybean seed production is expected to increase by 12%, driven by relatively high prices for this crop, growing demand

for vegetable proteins, and incentives from EU domestic policies. It is evident that the dynamics of global soybean production, as well as within the specific contexts of Ukraine and Europe, are indicative of an upward trend. This phenomenon corresponds to the global demand for products that contain significant quantities of vegetable protein and oil. Soybean production is of strategic importance to many countries worldwide, as this crop provides a substantial proportion of vegetable protein and oil requirements.

The United States Department of Agriculture (USDA) has stated that, in the 2024/2025 marketing year, global corn production may experience a marginal decline to 1.2125 billion tons. This projection is primarily attributed to the anticipated reduction in harvest yields in Argentina and Brazil. However, these data indicate minor fluctuations in global corn production, with a tendency towards a stable high level of production. Corn grain production in Europe is subject to variation depending on weather conditions and other factors, particularly technological methods of cultivation in view of climate change. According to data for 2024, it is predicted that the European Union (EU) will produce approximately 59 million tons of corn seed products, which is marginally less than the 61.45 million tons produced in 2024.

In the context of Ukraine, the data suggest that, despite the challenges faced, the country continues to be a leading producer of corn on a global scale. However, in order to maintain and improve these indicators, it is necessary to take into account both domestic agricultural practices and external market conditions.

Conclusions

The sustainable development of the agricultural sector is predicated on the cultivation of seeds for the principal market-forming agricultural crops. The development of innovative systems that consider the economic and environmental efficiency of cultivation is of significant importance. Such systems would facilitate an increase in the yield of seed products. In light of the findings of the study, the following conclusions can be drawn.

One of the most important factors in achieving high yields is using high-quality seed material, as this ensures the stability and productivity of agricultural crops. Analysis of statistical data from 2020 to 2024 shows that yields were minimal in 2020 and maximal in 2024. This was observed in areas sown with oilseeds. For corn crops, however, an inverse relationship is evident. During the analysed period, the areas under sunflower cultivation worldwide increased by 28%, and in Europe by 49%. Meanwhile, the sown areas under soybeans increased by 15% worldwide and by 42% in Europe. The trend of increasing the areas of land sown with sunflowers and soybeans is also evident in Ukraine. Significant growth has occurred over the past year. Thus, an increase of 0.432 million hectares is recorded for sunflower crops and 0.086 million hectares for soybean crops. In light of the military actions that have impacted the production and logistics chains in the agricultural sector, particularly the production of seed products, it is crucial to promptly address the issue of regional self-sufficiency in seed products. Thanks to the development of zonal models of varietal cultivation technologies adapted to climate change, modern technological methods for growing sunflowers and soybeans are constantly being improved. This applies not only to these crops, but to many other agricultural activities too, enabling a significant increase in the yield and gross harvest of market-forming crops.

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