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The state of the agricultural sector in Ukraine during wartime: The case of farmers

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Abstract. The military aggression of Russia against Ukraine has a significant negative impact on the agricultural sector of the economy, which is one of the key industries for Ukraine. Among the consequences of this aggression are a decrease in production levels, an increase in costs for security and infrastructure restoration, an increased risk of losing personnel and crops, as well as complications in the export of products. The purpose of this study is to assess the state of the agricultural sector under the conditions of war and to investigate the peculiarities of the activities and adaptation to war of individual agricultural producers, using farmers as an example. To achieve this goal, the dialectical method of cognition of economic processes, the basic principles of modern economic theory, and scientific works of domestic and foreign scientists studying the impact of war on the development of the agricultural sector of the economy were used. A sociological research method, in particular interviews, was used to achieve the research goal. The article examines the role of the agricultural sector in the Ukrainian economy and global food security, analyzes the impact of the war on the agricultural sector, and characterizes the current state of agricultural activity under the conditions of war using farmers as

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an example. According to the obtained data, the impact of war on the agricultural sector is significant and has various economic, social, and environmental consequences. The study shows that some commodity producers, using farmers as an example, have adapted to the war and have been able to maintain their market positions, while others have suffered significant losses and could not function properly. This research can be an important source of information for the development of state policy on support for agricultural commodity producers, specifically farmers, under the conditions of war and post-war recovery. It is necessary to consider the possibility of attracting investments in the agricultural sector, supporting farmers through a credit system, and cooperating between farmers

Keywords: agriculture; farms; war; food security; efficiency; global challenges; European integration

INTRODUCTION

The Russian invasion of Ukraine on February 24, 2022 poses a significant threat to food security and the agricultural sector in Ukraine and around the world. The invasion has caused severe damage to the agricultural sector, disrupted supply chains of Ukrainian agricultural products, led to food shortages and increased prices. The current state of the agricultural sector, the impact of the war on it, and the adaptation of producers to wartime conditions can be vividly seen in the example of Ukrainian agricultural producers, specifically farmers.

The relevance of studying the current state of Ukraine's agricultural sector in wartime lies in its importance for Ukraine, as 17% of the population works in this sector, it generates 53% of foreign exchange earnings and accounts for 20% of GDP (Data from the Ministry of Agrarian Policy and Food of Ukraine, 2023). It is also important for balancing global food security, as Ukraine has the potential to provide food for over 1 billion people.

In a considerable number of studies, scientists have identified the consequences of war on the agricultural sector of Ukraine's economy, particularly on the production and export of agri-food products (Adekoya, 2022; Câmpeanu, 2022). Researchers (Skydan et al., 2022) argue that the state of the agricultural sector in wartime is complex and requires state support for balanced functioning. Military actions and export restrictions have necessitated ensuring the stability of agriculture in Ukraine.

Fiott (2022) confirms that the deliberate destruction of agricultural infrastructure and the blocking of logistical routes for food exports by Russia have become noticeable trends of the war. The analysis of Russia's military aggression against Ukraine indicates significant damage to the agricultural sector, the recovery of which will require years and investments. According to data from the Center for Food and Land Use Research of the KSE Institute and the Ministry of Agrarian Policy and Food of Ukraine (2022), indirect losses in the agricultural sector because of Russia's aggression amount to 34.25 billion US dollars, and direct losses – 6.6 billion dollars.

Mamonova (2023) emphasizes that the agricultural sector is actively adapting to the conditions of military operations, especially in the context of small farms, which have managed to adapt to the new management realities. Scientists highlight the need to analyze farmers' adaptation to war, their activities during

this period, and development prospects, particularly for small farmers who ensure economic, social, and environmental security in rural areas. In the conditions of military operations, it is essential to provide access to resources and funding for the development of small agricultural enterprises. This can include support from the state and international organizations, including through financial loans, training programs, and other support measures. Authors (Nykoluk, 2021; Vasylykivska, 2019) claim that it is necessary to develop a comprehensive strategy to support farmers in Ukraine, which would take into account current challenges and trends in the global agricultural sector, as well as contribute to the recovery and stabilization of the Ukrainian agrarian economy after military events.

Scientist (Béné, 2020) argues that the situation in the agricultural sector of the economy has changed due to global challenges, such as the COVID-19 pandemic and Russian aggression against Ukraine, which have affected international logistics chains. The COVID-19 pandemic slowed down international logistics and demonstrated the advantages of small producers focused on the domestic market and less dependent on external shocks (Gutierrez, 2022). Borodina (2022) emphasizes the need to support farming households, which are the basis for rural development.

At the moment, it is essential to assess the state of development of the agrarian sector of the economy in the conditions of war and to investigate specific aspects of farmers' adaptation to modern global challenges, the key of which is Russian aggression against Ukraine, in order to develop further proposals for the post-war reconstruction of the agrarian sector of the Ukrainian economy and to identify management forms and production structures of agricultural products that should be prioritized in post-war Ukraine, taking into account socio-economic and environmental criteria.

The purpose of this study is to assess the current state of the agrarian sector of the economy in the conditions of war on the example of farmers, to explore the specific features of organizing agricultural activities in wartime conditions, and the specifics of farmers' adaptation to new challenges.

MATERIALS AND METHODS

This study used data obtained from Ukrainian statistical sources (State statistics of Ukraine, 2021, Agricultural

export portfolio of Ukraine, 2023), including indicators of land cultivation ease, agricultural and animal husbandry production efficiency, as well as information on farms and agricultural holdings. The study compared data from different commodity producers to analyze sown areas of agricultural crops and the number of farm animals for the period spanning from 2000 to 2021. By using these data sources, the study was able to gain insights into the relative performance of different agricultural producers, as well as identify trends and changes in production efficiency over the years studied. This study is based on both data of Ukrainian statistics and primary qualitative interview data collected in Ukraine from October-November 2022.

The interview data were collected in the context of the completion of the harvest and a partial summary of the results of the 2022 agricultural year, in preparation for 2023. The purpose of the interviews was to gather information from farmers who have directly or indirectly suffered from Russian aggression and to determine the features of adaptation of farmers to production activities in the conditions of war. When conducting the research, ethical and methodological guidelines for conducting "remote research" in conflict conditions were used. A total of 15 semi-structured in-depth interviews (approximately one hour each) were conducted with farmers ("Kavetskoho", "Yuran M", "Veselivske", "Agrotorg", "Vladar", "Polish Geese" and others).

Selection of individuals for in-depth interviews involved defining the research question, determining the sample size, identifying the target population, developing a sampling strategy, screening potential participants, and recruiting and scheduling participants. The sample size was based on the research question and available resources. The target population was selected based on the research question, and a sampling strategy was developed based on the characteristics of the target population. Potential participants were screened based on selection criteria, and the recruitment process was transparent. Overall, a systematic approach was used to ensure a representative sample that provided valuable insights into the research question. Authors used these steps in our research to select participants for in-depth interviews. These interviews were supplemented by numerous chats, calls, and e-mails with representatives of agrarian businesses and agrarian economists.

The interview was administered to farm managers who were actively involved in livestock and crop production in the Korosten district of Zhytomyr region, despite the ongoing war.

The selection of respondents for the conversation was carried out by the "snowball" method (each subsequent person informs the researchers with whom among his acquaintances he can talk on the same topic) with elements of the "maximum variation" method (respondents are selected in such a way that each case, if possible, differed as much as possible from the previous one). As such the results of such a study cannot be

considered as representative of the farming population in the region. Instead, the purpose was to understand the general context of the phenomenon and trace the diversity of events and people's views. This method is most suitable for recording the subjective individual experience of socio-historical processes and events that have occurred. The field stage of the work was carried out ten months after the beginning of the Russian aggression, in the conditions of the continued hostilities on the territory of Ukraine. Before each interview, the respondent's consent was obtained verbally.

Authors used an in-depth interview method. The semi-structured in-depth interview method was guided by a small set of questions and a general conversation plan. The sequence of questions and their wording were not fixed and could change for each subsequent respondent in accordance with the course of the conversation and the course of the respondent's thoughts, to which the interviewer adapted.

During the course of the scientific research, which included surveys of farmers, the focus was on the following aspects: activity of agrarians in the first days of the war, conducting the sowing campaign in conditions of military conflict, compliance with technological standards of production, storage of agricultural products, formation of farmers' cooperatives, functioning of dairy farms, analysis of price disparity, the problem of providing labor resources, and changes in the structure of sown areas.

RESULTS AND DISCUSSION

The impact of the war on the agricultural sector and global food security. The agricultural sector of the economy has always played one of the most important roles in Ukraine. Before the full-scale invasion of Russia, for many years, Ukrainian agricultural producers held leading positions in the world among product exporters. Today, the damage caused to the agricultural sector of Ukraine as a result of active hostilities is estimated at billions of dollars, and it will take several years and significant investments to restore the agricultural infrastructure. It will take tens of years to overcome environmental consequences and demining the territory.

The invasion of Russian invaders into the territory of Ukraine caused the destruction of well-established agricultural processes and logistics chains. Many cultivated areas are now mined or unusable due to the consequences of massive bombings, there is no access to part of the land, and the enemy is deliberately destroying warehouses and agricultural machinery. All these factors will fully influence the development of the agricultural complex in the near future.

In connection with the fact that the agricultural sector has been among the front-runners of advanced news for the past five to seven years, at the beginning of hostilities, most experts mistakenly believed that farmers would suffer little from the criminal actions of the invaders. However, very quickly, already in March 2022, it

became clear that this was a false assessment. When exports from Ukraine by sea stopped, it became clear that there are huge volumes of grain that cannot be exported and sold. This problem was eliminated by opening the sea corridor. However, farmers currently have several related problems, such as mined fields, disrupted logistics, high prices for diesel fuel, etc. (According to the Ministry of Agrarian Policy and Food of Ukraine, 2023).

The complexity of these processes lies in the impossibility of planning because there is no understanding of how many areas will be sown and in what amounts. But already today, having some data on the amount of grain sown, authors can say that it is extremely insignificant compared to last year's indicators. In addition, the situation with the weather conditions is disappointing. All this collectively allows us to draw conclusions that the situation that has developed in the agricultural sector is quite difficult both for the internal social and economic security of Ukraine and for the global food market. The grain agreement signed in July in Istanbul by representatives of Ukraine, Russia, Turkey, and the UN has become a lifeline for Ukrainian farmers. However, not all problems of the agricultural sector could be solved by exporting the grain blocked by the occupiers.

The Russian invasion of Ukraine shocked the world, causing terrible suffering and destruction, and the dire consequences are already being felt beyond the conflict zone. The war disrupted global food security, causing food prices for consumers and fertilizer prices for producers to skyrocket. It is already clear that this crisis requires immediate global action to provide relief in the short term, as well as policy changes to diversify global food markets in the long term to increase resilience and avoid future crises.

According to FAO (2023) estimates, if the export of wheat, fertilizers, and other goods from Ukraine and Russia is stopped for a long time, the number of malnourished people worldwide may increase from 8 to 13 million in 2023. Food insecurity is most pronounced in the Asia-Pacific region, followed by sub-Saharan Africa and the Middle East. Commodity food prices have been

rising steadily even before Russia's invasion of Ukraine, according to the FAO's food price index, which reached a record high back in early February. Grain and vegetable oil prices reach levels exceeding the global food price crisis of 2008-2009.

Russia's invasion of Ukraine has slowed, and in some cases stopped, the production and trade of Russian and Ukrainian grain and vegetable oils, which account for a significant share of the global market – for example, about 30% of global wheat and barley exports. Fertilizer exports from Russia and Belarus, which together account for the main share of world production, have also been suspended.

Examining the price dynamics of key agricultural crops, specifically corn, soy, and wheat, from 2019 through mid-2020, a stabilization of prices for these commodities is observed. Minimal price variability was observed, indicating the absence of significant influencing factors on the price or the effectiveness of the market regulatory mechanism. The transformation of price dynamics began in late 2020. Notable price fluctuations, especially their growth, could be triggered by several factors. Primarily, these could have been factors related to the COVID-19 pandemic, which affected global agriculture and logistics. Another significant factor could have been unfavorable weather conditions, which negatively affect crop yields. The price peak was reached in mid-2021, which could indicate an increase in demand for these products on a global level or problems with supplies (Fig. 1). In 2022, prices for the main agricultural crops continued to be at a prominent level.

Prices for most grain and oil crops have risen sharply since the beginning of the war. This is because Russia and Ukraine together supply about 12% of the world's export of agricultural products in caloric terms and more than 30% of the world's export of wheat (Gafarov, 2022). The two countries hold significant shares in the wheat-dependent economies of the Middle East and North Africa, where wheat prices have risen by more than 30% from pre-war levels. Fertilizer and energy markets also saw price increases and supply disruptions.

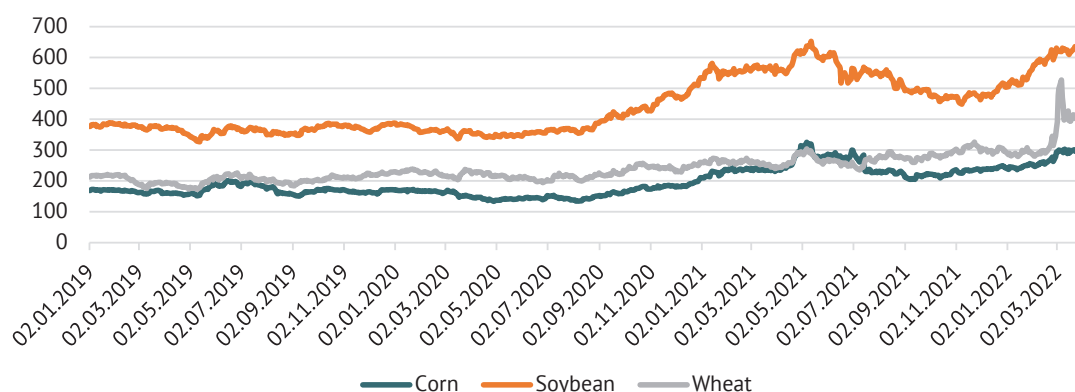


Figure 1. Food prices in US dollars. per metric ton, 2022

Source: IFPRI

The National Bank forecasts a decrease in the production of cereals and legumes in 2023 by 15.2% to 45.6 million tons compared to 53.8 million tons in 2022. Prices in global markets will show a decline. According to the regulator's data, grain production in 2022 decreased by 40%, although these figures are mainly due to a significant reduction in harvested areas due to the occupation and mining of some territories, as well as in the context of record harvests in the previous year.

At the same time, thanks to the partial reorientation of spring crops in favor of rapeseed and soybeans (which replaced part of the corn), their production even exceeded last year's indicators. The production results of oilseeds turned out to be better than expected. Prices for wheat in global markets in 2023 will decrease by 13.9% to \$310.3 per ton, for corn – by 18.4% to \$259.9 per ton. Notably, as a result of military operations or due to the temporary occupation of territories, farmers do not have access to 25% of the sown area. Global food prices have been declining for the tenth consecutive month. The FAO Food Price Index in January 2023 stood at 131.2 points, which is 0.8% less than in December and 17.9% lower than its peak reached in March 2022 (Data from National Bank forecasts, 2023).

The war in Ukraine affects not only food security, but also has economic consequences for all countries. Today, it is a question of environmental security and a common future. Russia's war in Ukraine is the first international conflict in the last 20 years with such significant and irreparable damage to the environment. Authors can already account for more than 250 cases of ecocide. These are also detonations of fuel and lubricant warehouses, and oil product storages with corresponding consequences for the environment. (Data from the Ministry of Environmental Protection and Natural Resources of Ukraine).

Military actions destroy the forests of Ukraine, which will also affect the world's food security as forests perform protective functions. Their destruction and damage will affect the climate of these regions and may lead to significant erosion processes. In the south of Ukraine, the consequences may result in wind erosion and desertification. This, of course, will affect agriculture and agricultural producers.

Researchers are convinced that the longer the war lasts, the greater and more persistent its negative consequences will be for global food security. At the same time, there is currently little research that, using the example of a specific type of commodity producer, such as farmers, explores the current state of the war and the adaptation of agrarians to modern challenges.

Today, many farmers find it difficult to purchase fuel, which has become more expensive since the beginning of the war. If we talk about spring field work, then the situation is critical. Today, issues of logistics and technology development are acute, because we are entering a completely new level of competition with

our partners. It makes sense in this period to rethink the agrarian and economic policy of the state with the aim of maximum adaptation of domestic commodity producers to modern global challenges, the key of which is Russian aggression.

Farmers' interviews. Conducting interviews with farmers from the Korosten district of Zhytomyr region allowed for a more detailed understanding of the current state of agriculture, evaluating farmers' adaptation strategies to the current realities of the industry, identifying key challenges, and determining potential paths for development in the context of post-conflict recovery of the Ukrainian agrarian economy. The obtained results were systematized in several directions: the beginning of military operations, the sowing campaign, production strategies, storage of products, cooperation, problems of dairy farms, price disparity, etc.

Farmers who were interviewed recall the uncertainty and insecurity in the first days of the war when it was unclear whether to prepare for sowing and whether the threat of occupation of their lands was real. On the third week after the start of military operations, most farmers who were on the territory controlled by Ukraine resumed work and started sowing but faced several difficulties with logistics and the possibility of timely organization of the sowing campaign. As a result, only 70% of the planned volume of work was completed, technological operations were not fully performed, and the cost of resources increased 2-3 times.

Farmers took various measures to ensure production under conditions of resource shortages, such as sowing without prior processing, using alternative sources of seed material, and cooperation. Some equipment (tractors) was handed over by farmers to the Armed Forces for the construction of military facilities, resulting in a shortage of agricultural machinery.

Significant difficulties arose in connection with the storage of agricultural products. The products are stored in warehouses that were previously used by collective farms. In doing so, the method of storage on the floor without the use of dryers was applied. Even though grain is best stored in elevators, this opportunity was absent. This problem was widespread among farmers in the region. Buyers refused to visit the Korosten district due to its proximity to Belarus, which led to lower prices for products compared to the all-Ukrainian indicators.

Small dairy farms faced a lack of a sales market for their products during the first two months of the war, leading to a loss of income and exhaustion of financial resources. Farmers had to process milk into cheese, but sales of this product also proved difficult. The availability of funds for the spring sowing and harvesting period was limited. The main challenges were and remain the preservation of animal populations and providing them with feed. The restoration of land for agricultural needs is also complicated due to the mining of territories.

Farmers are concerned about the significant decrease in prices for agricultural products (by 30-40%), while the costs of fertilizers, fuel, and plant protection products, which are mainly imported, have increased. As a result, an imbalance has arisen between the value of products and the cost of their production. The increase in product prices does not solve the problem, as the purchasing power of the population still is low. Small farms, dependent on the earned funds, are particularly sensitive to this issue, unlike large agricultural holdings, which have certain internal reserves.

Farmers noted that during the year of war, the structure of agricultural crops underwent minor changes in favor of technical crops that are subject to processing in the domestic market, such as soybeans and sunflowers. This year there will be a decrease in the area sown with wheat but an increase in peas and buckwheat. Production of cereals and legumes may be reduced, as well as the likely decrease in the production of wheat, barley, and corn. The main reason is the complication of exports. Currently, exports have been partially restored, but numerous problems exist, including more expensive logistics.

Farmers face problems in providing workers. For family farms, the situation is ambiguous, as most of them do not have legal status, independently cultivate their land, and as a result, have no legal basis for reserving their workers. Moreover, a considerable number of farm managers are now serving in the Armed Forces. Therefore, the question of the future of agriculture becomes extremely relevant, as for most farms it depends on one person.

Farmers pointed out that in the situation of war, survival is only possible due to state support, but state resources are limited. Cooperatives have proven to be the answer to the needs of small farmers. The 2022 planting

season highlighted the complexity of independent management in difficult conditions, characterized by constant threats and uncertainty. To ensure a successful harvest, farmers need to implement new technologies, adhere to crop rotation, and increase the amount of fertilizers. This is only possible with the availability of appropriate resources. The war has intensified the need for farmers to unite and consolidate their resources.

Respondents noted that one of the key advantages of small farmers is their flexibility and rapid adaptation to challenges. While large agricultural enterprises (agroholdings) were forced to partially suspend operations in the area, small farmers continued their activities. Most stayed and tried to work, adapting to the difficult conditions. However, there are numerous problems, especially for farmers working in frontline areas. In some cases, the harvest was left in the field, and there are also areas with landmine warnings. As a result, the harvest was not collected in such places. Moreover, there is a threat from the Belarusian border, as a result of which a significant part of the land is mined or cannot be used due to potential dangers of attacks from Belarus.

Despite limited financial potential, farmers have demonstrated high activity since the beginning of the military conflict, providing significant assistance to military personnel and internally displaced persons. They provide support in the form of food products, including vegetables, purchasing vehicles, and actively cooperating with volunteers and charitable organizations. Small farms are still the axis of economic and social activity in rural areas, surviving through their own efforts and supporting the livelihood of the village. However, their resource potential has its limits. Most resources are already close to exhaustion.

Systematized results of interviews with farmers are presented in Table 1.

Table 1. Results of farmers' interviews

<i>Activity during the first days of the war (all 15 farmer respondents remained in their area)</i>
<ul style="list-style-type: none"> • no one could predict how the events would unfold. • the farmers didn't know if the Russian troops would march here. • the farmers decided not to remain under occupation. • the move was difficult as they had to leave behind everything that had been earned over decades. • everything was unfolding very quickly, and there was occasional panic.
<i>Sowing campaign under wartime conditions (only 6 out of 15 respondents were able to fully carry out the sowing campaign)</i>
<ul style="list-style-type: none"> • three weeks after the war, the farmers began preparing for the planting season; • 60-70% of the planned volumes of work for the planting campaign have been completed; • prices for fuel, fertilizers, chemicals, and seeds have doubled or even tripled; • the biggest problem for farmers was logistics; • there remains a significant amount of land that is either already mined or potentially unusable due to the possible threat of invasion from Belarus.
<i>Compliance with production technology (12 surveyed respondents noted that they saved on production technologies)</i>
<ul style="list-style-type: none"> • farmers economized and minimized all technological operations;

Table 1, Continued

<i>Compliance with production technology (12 surveyed respondents noted that they saved on production technologies)</i>
<ul style="list-style-type: none"> • some of the farming equipment was handed over to the armed forces for the construction of checkpoints and defensive platforms on the roads; • farmers did not fully adhere to technological operations, they applied less fertilizer and were behind the planting campaign schedule; • the biggest problem for farmers is working capital, they have spent all their savings.
<i>Storage of agricultural products (7 respondents had problems with storing products)</i>
<ul style="list-style-type: none"> • farmers are having significant problems with product storage; • farmers store products in warehouses where a collective farm used to be; • farmers use floor storage without installed dryers, products spoil, but there is no other option; • it is understood that grain is better stored in elevators, but such possibilities are not available now; • buyers do not want to travel to the korosten district for grain due to its proximity to the belarusian border.
<i>Creating a farmer's cooperative (4 respondents mentioned uniting for the sowing campaign)</i>
<ul style="list-style-type: none"> • it's hard to survive in wartime conditions alone, especially to continue working on the farm; • the war has further exacerbated the need for farmers to unite; • for a good harvest, a modern farmer needs to: implement new technologies; adhere to crop rotation; increase the amount of fertilizers. All of this can only be realized with the availability of the appropriate resources; • certain field work was carried out by farmers using a single tractor, taking turns with neighboring farmers.
<i>Dairy farm activities (4 farmers who produced milk lost the ability to sell their products for two months)</i>
<ul style="list-style-type: none"> • farmers had nowhere to sell their produce. Dairy factories stopped, logistics stopped; • farmers tried to process products, to make cheese. But there were difficulties with logistics; • farmers were giving out milk, cream, and cheese to local people; • the main question for farmers in times of war – how to save the animals; • the problem of farmers – the issue of providing feed for the animals.
<i>Price disparity (all 15 surveyed farmers confirmed the problem of price disparity)</i>
<ul style="list-style-type: none"> • the key problem for farmers, as for everyone else, is that the price of agricultural products has effectively decreased by 30-40%; • prices for plant protection means, mineral fertilizers, seeds, and fuel have increased; • there was a period when farmers physically could not purchase fuel at any price; • currently, farmers also need to increase the cost of the goods they sell, but who will buy them when people still have no money.
<i>The problem with labor resources (6 surveyed farmers had problems with workers in wartime conditions)</i>
<ul style="list-style-type: none"> • large agricultural enterprises managed to "reserve" machine operators; • farmers are having problems with workers; • sometimes for a farmer, the loss of a single worker means the cessation of the farm's operation; • a significant number of farm managers are currently defending the country as part of the Armed Forces, the activity of the farms is suspended; • many machine operators from the farms have voluntarily joined the Armed Forces.
<i>Change in the structure of sown areas (9 of the surveyed farmers changed the structure of sown areas)</i>
<ul style="list-style-type: none"> • due to the proximity of the border and the mining of a significant territory, the sowing area has decreased; • the volumes of technical crops cultivation, which are processed on the domestic market, have increased. These are soy and sunflower; • farmers sowed less wheat and more peas and buckwheat; • the production of wheat, barley, and corn will decrease.

Source: conducted interviews with local farmers

Despite the enormous difficulties and danger to life, the farmers have managed to cultivate their land and then harvest. Admittedly, the harvest was different from last year. They work themselves and give work to many people in the village. Farmers had many problems. Most of them did not have fuel (small owners did not have a license to store fuel in reserve, and what they had was

donated to the needs of the Ukrainian army), so they used cart transport and manual labor. Small farmers began to cooperate, they shared seeds and equipment and replaced chemical fertilizers with organic ones. Given that they have small areas of agricultural land, they were able to adapt to the market, namely the domestic market, producing, for example, buckwheat instead of corn.

Farmers began to unite. On the initiative of agricultural producers in Ukraine, the public union “Agro-producers of Occupied Territories” was created, one of the main tasks of which is to speed up work on demining agricultural lands. Today, 130,000 km² are mined or damaged and the part of the production areas in the agricultural sector are lost. Currently, it is needed to find funding for demining the territories that were under occupation.

Ten months of war showed that smaller holders could better adapt and survive in extreme conditions by relying on short food chains, alternative resources of production, mutual aid, and reciprocity. If there was still proper support from the state, they would be able to be quite competitive. War and uncertainty drove people back to the land. It is a resource that can feed. The advantages and problems of farmers’ activities in wartime conditions highlighted in the research are presented in Table 2.

Table 2. Benefits and issues with farmers during wartime

Benefits	Issues
<ul style="list-style-type: none"> • flexibility and quick adaptation to challenges; • if large farms and agricultural holdings partially stopped working in the district, small farmers did not; • farmers work on their land and this is their only income; • now the advantage of the farmer is to be physically present on his land; • farmers also focus on the domestic market. They ensure the food security of a specific area and support the Armed Forces 	<ul style="list-style-type: none"> • mining of large areas, including agricultural land; • proximity to the border with Belarus, constant danger of attack; • problems with logistics and sale of agricultural products; • significant problems with working capital; • lack of workers, especially machine operators; • lack of opportunity to harvest (a significant portion of the corn crop remained in the fields)

Source: conducted interviews with local farmers

Preparations for the 2023 planting year continue in conditions of low financial capital for farmers. Prices in the middle of the country for agricultural products are below the market, while other services have become more expensive, in particular, supply chains sometimes take up to 80% of the value of exported products. Agribusiness also operates against the background of problems with energy carriers.

The war forced farmers to adapt to modern realities, change the structure of cultivated areas, and reorient to new logistics routes and new product sales markets. Before the war, most of the harvest was wheat, sunflower, and corn, as a significant part of it was intended for export. The blockade of ports showed the disadvantages of exporting a large volume of these goods, therefore the demand for niche high-margin crops (peas, berries, mustard, etc.) is growing, the transportation of which is more variable. There are reasons to believe that such trends will continue to develop in the coming years. In rural areas, the trend towards food self-sufficiency can be expanded by keeping birds and animals.

According to preliminary estimates by scientists, the potential damage caused only to the agricultural infrastructure in Ukraine is about 6 billion US dollars, but if we take into account the damage and loss of potential benefits associated with the disruption of work, disruption of supply chains, reduction of export opportunities, etc., then the losses reach about 22-23 billion US dollars according to various estimates (KSE Agrocenter, 2022). Although the exact value cannot be established due to the complexity of calculations and the continuation of hostilities.

Currently, it is necessary to review the state policy in the direction of greater support for farms, which

have proven to be more adapted to modern global challenges and ensure the economic, social, and environmental sustainability of the rural areas where they carry out economic activities. Small and medium-sized farms have more opportunities to implement greener practices and support local communities and economies. In modern economic conditions, farmers face many risks and challenges. In the course of the conducted research, it was found that farmers face difficulties in privatizing land that is temporarily used, there are difficulties in developing rural infrastructure, insufficient state support for livestock development, they need an advisory system and scientific-innovative support. In wartime conditions, key issues became the necessity of surveying and demining fields and preferential lending for production activities. Based on an interview with farmers of the Zhytomyr region, directions for supporting farms in the conditions of the post-war reconstruction of the agrarian sector of the Ukrainian economy are outlined (Fig. 2).

Support for farms should be carried out at the expense of accelerating the privatization of land that is in temporary use, state support for the development of animal husbandry, reducing taxation, loaning the fund to farmers for the purchase of equipment, assistance in surveying and demining fields, scientific and innovative support for their activities and the introduction of innovations.

To minimize the negative consequences of Russia’s military invasion of Ukraine and to restore the agricultural sector of the Ukrainian economy after the war, it is necessary to introduce innovations and modernize agricultural production. In the long term, provided the war ends and Ukraine wins, the agricultural sector will need investments for recovery. If they include a

modernization component, Ukraine will have a chance to reach a higher level of productivity and use new

technologies in the production, storage, processing, and logistics of agricultural products with added value.

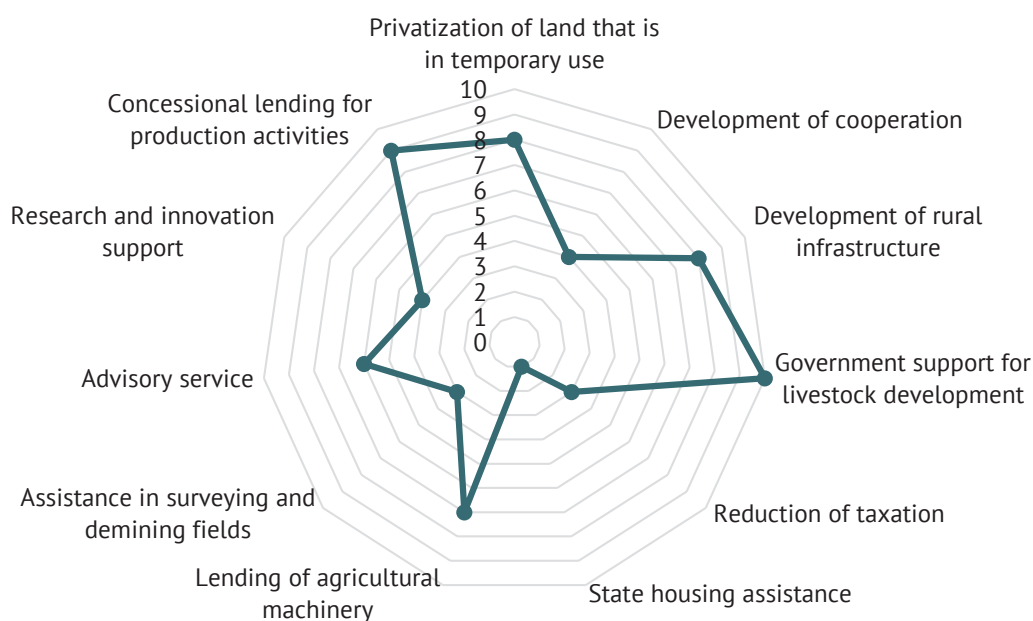


Figure 2. Areas of support for farms in the conditions of the post-war reconstruction of the agrarian sector of the Ukrainian economy

Source: conducted interviews with local farmers

There are currently debates among scientists regarding the further consequences of the war on the agricultural sector and the country's economy as a whole. M. Banse (2022) in his scientific works notes that the war will cause economic damage worldwide, leading to an asymmetric shock, the consequences of which must be dealt with over 15 years. G. Celi *et al.* (2022) consider the asymmetric impact of war: resilience, vulnerability, and implications for EU policy. Scientists equate Russia's military invasion of Ukraine with the financial crisis of 2009 and the COVID-19 pandemic, as there is an increase in uncertainty, which negatively affects consumption and investment, and has a depressive effect on GDP and employment.

The agrarian sector in Ukraine is characterized by considerable complexity and multi-aspectuality, within which the efficient use of land resources and their potential plays a significant role. Research by L. Kurbatska *et al.* (2023) emphasizes many factors influencing this process, with which authors fully agree. However, a critical challenge that confronted Ukraine's agrarian sector in 2022-2023 was the invasion by Russia, which caused targeted damage to this sector of the economy. The impact of this situation on the global context is also important to consider. According to A. Nimani and D. Spahija (2023) the invasion provoked an intense rise in prices on the global market, affecting the prices of food products, which surged rapidly. In their research,

Y. Wang *et al.* (2023) also draw attention to significant fluctuations in agrarian markets following the onset of Russia's invasion in Ukraine.

The topic of restoring Ukraine's economic potential in the post-war period and the role of different goods manufacturers in this process is in the focus of research by T. Borko *et al.* (2022). In this work, authors also focus on this aspect and emphasize the importance of further support specifically for farms.

Scientists V. Brown (2022) and co-authors highlight the significant potential of farms in the context of modern global challenges. This demonstrates the need for intensifying efforts to stimulate the development of farms and maintain their competitiveness at the global level. As evident from our findings, farms not only play a key role in the development of Ukraine's agrarian sector but also have a great potential to withstand modern challenges. Given this, their role and contribution to restoring Ukraine's economic potential in the post-war period cannot be underestimated.

It is important to provide adequate support for farms, as they are capable of making a significant contribution to the restoration and strengthening of the country's agrarian sector, stimulating rural development, improving food security, and affecting price stabilization on the global market. Strengthening farms in Ukraine will contribute to increasing productivity and stabilizing market fluctuations caused by political and military challenges.

CONCLUSIONS

The conducted research allows us to conclude that the war had a significant impact on the agricultural sector of the Ukrainian economy. At the regional scale authors found that the Russian invasion of Ukraine has caused the destruction of well-established agricultural processes and logistics chains, including warehouses and agricultural machinery. Many cultivated areas are now mined or unusable from the bombings and there is no access to part of the land. Disrupted logistics have increased the prices for diesel fuel and other inputs. The harvesting period occurred late, and a much smaller area of grain was sown relative to the previous year.

The agricultural sector in Ukraine faces a challenging environment due to the impact of military actions and export restrictions. In this context, it is essential to achieve a balance between agricultural production, diversification, and the development of both large and small commodity producers to ensure sustainable growth. This balance must consider both foreign and domestic markets, as well as the environmental and social impact of agricultural activities. Achieving this balance will be crucial to ensuring the long-term success of the agricultural sector in Ukraine.

Among the farmers interviewed, authors found that the war has had a clear negative impact on their farm. The interviews conducted with farmers from the Zhytomyr region allowed an assessment of the state of agriculture and adaptation of farmers to the conditions of war. In the first days of the war, all 15 surveyed farmers continued their activities in place. However, only 6 of them were able to fully carry out the sowing campaign in the conditions of war. Most respondents (12)

noted that they economized on production technologies. Storing products became a problem for 7 farmers. Four respondents joined a cooperative to carry out the sowing campaign. Four dairy farmers lost the ability to sell their products for two months. All surveyed farmers faced the problem of price disparity. Six of them pointed out issues with labor resources in wartime conditions. Nine farmers changed the structure of sown areas.

During the research, it was established that diverse agricultural production of farmers contributes to reducing the negative consequences of war, providing for self-consumption and ensuring food security in rural areas. Currently, supporting small farms is especially important for the socio-economic security of rural areas and creating conditions for internally displaced persons. To achieve this goal, the following measures are proposed: increasing state support for the development of animal husbandry, preferential lending for production activities, simplification of land privatization procedures, development of rural infrastructure, consulting services, and scientific and innovative support for farm enterprises. The mentioned changes will promote the modernization of small farming enterprises in the agricultural sector, allowing Ukrainian farmers to cope with the negative consequences of war, contemporary challenges, and continue to support food security more effectively at both the national and global levels.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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Стан аграрного сектору в Україні у воєнний час: приклад фермерів

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Анотація. Військова агресія росії проти України має значний негативний вплив на аграрний сектор економіки, який є однією з ключових галузей для України. Серед наслідків цієї агресії – зниження обсягів виробництва, збільшення витрат на безпеку та відновлення інфраструктури, зростання ризиків втрати персоналу та врожаю, а також ускладнення експорту продукції. Мета цього дослідження – оцінити стан аграрного сектору в умовах війни та дослідити особливості діяльності та адаптації до війни окремих агровиробників на прикладі фермерських господарств. Для досягнення поставленої мети використано діалектичний метод пізнання економічних процесів, основні положення сучасної економічної теорії, наукові праці вітчизняних і зарубіжних вчених, які досліджують вплив війни на розвиток аграрного сектору економіки. Для досягнення мети дослідження використано соціологічний метод дослідження, зокрема інтерв'ю. У статті досліджено роль аграрного сектору в економіці України та глобальній продовольчій безпеці, проаналізовано вплив війни на аграрний сектор, охарактеризовано сучасний стан сільськогосподарської діяльності в умовах війни на прикладі фермерів. Згідно з отриманими даними, вплив війни на аграрний сектор є значним і має різні економічні, соціальні та екологічні наслідки. Дослідження показує, що деякі товаровиробники, на прикладі фермерів, адаптувалися до війни і змогли зберегти свої ринкові позиції, тоді як інші зазнали значних втрат і не змогли функціонувати належним чином. Це дослідження може стати важливим джерелом інформації для розробки державної політики підтримки сільськогосподарських товаровиробників, зокрема фермерів, в умовах війни та післявоєнної відбудови. Необхідно розглянути можливість залучення інвестицій в аграрний сектор, підтримки фермерів через систему кредитування, кооперації між фермерами

Ключові слова: сільське господарство; фермерські господарства; війна; продовольча безпека; ефективність; глобальні виклики; європейська інтеграція
