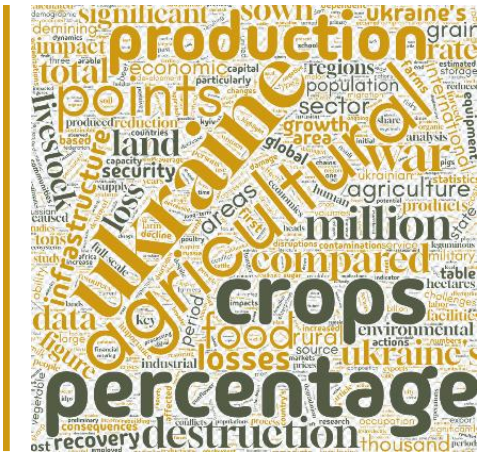
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AGRICULTURE IN UKRAINE: REGIONAL AND GLOBAL IMPACTS OF THE WAR



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Abstract: The article examines the consequences of the war for Ukraine's agricultural sector, focusing on economic, demographic, and environmental aspects. The methodology integrates both quantitative and qualitative analysis across three distinct periods: pre-conflict (2006–2013), partial occupation (2014–2021), and the full-scale invasion (2022). The study reveals significant reductions in sown areas, loss of human capital, infrastructure destruction, and declining production volumes. Particular attention is given to food security challenges and the prospects for Ukraine's agricultural recovery. The results underscore the need for international support, including funding, infrastructure rebuilding, and the adoption of innovative technologies.

Keywords: agricultural sector, war, Ukraine, sown areas, food security, human capital

Анотація: Стаття аналізує наслідки війни для аграрного сектору України, враховуючи економічні, демографічні та екологічні аспекти. Методологія дослідження включає як кількісний, так і якісний аналіз, зосереджений на трьох основних періодах: до початку конфлікту (2006–2013), період часткової окупації (2014–2021) та період повномасштабного вторгнення (2022). Дослідження показує значне скорочення посівних площ, втрату людського

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капіталу, руйнування інфраструктури та скорочення обсягів виробництва. Особливу увагу приділено проблемам продовольчої безпеки та перспективам відновлення сільського господарства України. Результати підкреслюють необхідність міжнародної підтримки, включаючи фінансування, відновлення інфраструктури та впровадження інноваційних технологій.

Ключові слова: аграрний сектор, війна, Україна, посівні площі, продовольча безпека, людський капітал

Highlights

- Analysis of war's economic, demographic, and environmental impact on Ukraine’s agriculture.
- Quantitative and qualitative analysis covering three critical periods.
- Focus on sown area reduction, human capital loss, and infrastructure destruction.
- Food security challenges and recovery strategies for Ukraine's agricultural sector.

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1. Introduction

The war in Ukraine has caused unprecedented disruptions in the country’s agricultural sector, creating serious challenges for both Ukraine’s food security and global food markets. Known as one of the major exporters of grains, oilseeds, and other agricultural commodities, Ukraine has suffered significant losses due to damaged farmland, destroyed infrastructure, and reduced labor resources. These disruptions threaten Ukraine’s food security and contribute to instability in global food markets, intensifying food shortages and inflation in regions highly dependent on Ukrainian exports (Dziurakh et al., 2022; Skydan et al., 2023).

This topic is especially relevant considering the widespread dependence of various regions, particularly the Middle East and Africa, on Ukrainian agricultural exports. The war has disrupted supply chains and exerted inflationary pressures on food markets, further worsening food security in these regions (Bocz & Błażejczyk-Majka, 2022; Prodanova et al., 2022). Initial studies highlight that military actions have also led to environmental degradation and soil contamination, creating long-term risks to the productivity of Ukrainian agriculture (Dannenberg et al., 2024).

The relevance of this topic lies in the urgent need to understand the initial and multifaceted impacts of the war on Ukraine’s agriculture and rural communities. This study provides a preliminary assessment of the immediate consequences of the conflict, examining economic, demographic, and environmental losses. The objective of this study is to offer an initial evaluation of the immediate economic, environmental, and logistical impacts of the war on Ukraine's agricultural sector. By focusing on these early effects, the paper seeks to identify key challenges and support the development of strategies for strengthening the resilience of Ukraine's agriculture. Such an analysis serves as a foundation for further research and strategy development aimed at supporting the resilience and recovery of Ukraine’s agricultural sector (Jiang & Chen, 2024).

Given the limited scope of current literature on the cumulative impact of war on Ukraine’s agriculture, this article does not aim to present a comprehensive theoretical analysis but rather highlights key areas affected by the war. The emphasis on preliminary findings and immediate consequences aligns with the emerging need to monitor and document ongoing disruptions in Ukrainian agriculture, providing a basis for strategic interventions for post-war recovery.

Addressing these issues is vital, as the stabilization and recovery of Ukraine’s agricultural sector will be essential for national economic development, rural employment, and ecological balance. By documenting these early impacts, this paper aims to identify the main challenges complicating sectoral recovery, contributing valuable insights for Ukrainian policymakers, farmers, and international organizations supporting Ukraine.

The long-term resilience of Ukraine's agricultural sector will require substantial investment and international collaboration, focusing on infrastructure rebuilding, production capacity restoration, and sustainable development (Garafonova et al., 2023). This study provides valuable preliminary data that can assist policymakers, international organizations, and stakeholders in supporting Ukraine's agricultural sector during and after the current crisis.

2. Theoretical background

Currently, researchers are paying significant attention to various aspects of the war's impact on Ukraine's agriculture. Existing studies cover the consequences of Russia's full-scale invasion in 2022, focusing on the destruction of infrastructure, crop losses, disruptions to supply chains, and economic damage to specific sectors of the agri-food industry. Additionally, there is attention to social and demographic changes in rural areas or particular events, such as the explosion at the Kakhovka Hydroelectric Power Plant, which severely impacted access to water resources, and thus the ability to irrigate and grow crops (Mamonova et al., 2023).

The war has caused substantial economic losses in Ukraine's agri-food sector. Various studies highlight specific losses, such as the destruction of grain storage facilities, damage to crops, and the loss of agricultural machinery (Garafonova et al., 2023). Some studies point to the significant reduction in Ukraine's export capacity, which has driven up food prices on international markets (Rahimi et al., 2023). This negatively affects not only Ukraine's economy but also global food security.

One of the key aspects discussed in the literature is the issue of food security at both local and international levels. The war has severely impacted Ukraine's ability to provide food for itself and other countries. Infrastructure destruction and reduced production volumes have led to a shortage of essential food products within the country (Rahimi et al., 2023). Many nations, particularly those dependent on Ukrainian grain exports, such as Egypt, Lebanon, and Tunisia, have felt the negative effects of reduced food supplies, which has led to rising food prices and poses a threat to food security (Al-Saidi, 2023). This emphasizes the importance of ensuring the resilience of food supply chains both in Ukraine and globally (Hu et al., 2024).

The war has also triggered a demographic crisis in Ukraine's rural areas. The threat to life has forced many people to flee their homes, leading to a significant reduction in the agricultural labor force (Kolodiichuk et al., 2024). Some studies examine the impact of the war on the demographic composition of rural populations, particularly the migration of youth, which complicates agricultural recovery and threatens the demographic aging of rural communities (Matsybora, 2023).

The war has significantly restricted access to financing, creating additional challenges for farmers trying to restore their operations (Cheremisina & Tomashuk, 2023). However, some research show that investments in innovative technologies and the modernization of the agricultural sector could support sustainable development even amid economic instability (Matsybora, 2023). It is also important to ensure the support of international financial organizations, which could aid in the recovery and development of agriculture in Ukraine (Garafonova et al., 2023).

The war has also had a substantial environmental impact. For example, land contamination with toxic substances, remnants of ammunition, and heavy metals is a serious problem that requires immediate attention (Dmytruk et al., 2023). The explosion at the Kakhovka Hydroelectric Power Plant caused catastrophic consequences for aquatic ecosystems, worsening irrigation conditions over vast areas (Mamonova et al., 2023). The war in Ukraine has also significantly affected organic farming, which was actively developing before. Many regions, which were leaders in organic farming, have experienced significant infrastructure destruction, reducing their ability to maintain high organic production standards (Irtyshcheva et al., 2023). The decrease in organic production may negatively affect global food security, as Ukraine is a key exporter of organic products. Restoring organic production could become a crucial element of Ukraine's agricultural recovery strategy, ensuring high-quality products and preserving environmental sustainability (Yu, 2023). These developments highlight the need for effective environmental monitoring and ecosystem recovery methods.

The Russia-Ukraine war has had a significant negative impact not only on Ukraine's agriculture but also on the agricultural economies of other countries. Globally, the war has disrupted food supply chains, driven up agricultural prices, and caused shortages of raw materials.

In Germany, the war triggered a sharp increase in fertilizer and energy prices, which led to a decline in farm profitability. As a result, farmers were forced to cut costs, particularly in environmental initiatives, such as participation in the "eco-schemes" program (Ellßel et al., 2022). This has potentially long-term consequences for sustainable agricultural development and environmental protection in Germany.

Similar issues are occurring in African countries, particularly in North Africa and the Middle East, where disruptions in grain supplies from Russia and Ukraine have exacerbated a severe food crisis (Rahimi et al., 2023). Countries in this region, heavily dependent on imported grains such as wheat, are facing significant food shortages, threatening not only food security but also social stability.

In Latin America, particularly in Argentina and Brazil, the war has had an indirect impact on agriculture. Increased demand for grain exports from these countries in response to the supply disruption from Ukraine has led to a significant expansion of cropland. This, in turn, has resulted in biodiversity loss and increased pressure on water resources, especially in arid regions (Dumortier et al., 2024).

Thus, the Russia-Ukraine war has highlighted how vulnerable global food supply chains can be to external crises, and how these crises can have serious consequences not only for the economies but also for the ecosystems of countries far from the conflict zone.

The experience of other regions of the world affected by armed conflicts confirms that wars always lead to the destruction of infrastructure, loss of fertile land, migration of rural populations, and disruptions in food supply. For example, the war in Syria had a catastrophic impact on local agriculture, causing a significant reduction in cultivated areas and yields due to the destruction of irrigation systems and a lack of resources for farmers (Al-Saidi, 2023). Similar consequences were observed in Iraq and Yemen, where conflicts resulted in food shortages and a significant increase in agricultural product prices (Ouko & Odiwuor, 2023). In Africa, particularly in Sub-Saharan Africa, the agricultural sector also suffered from the impact of armed conflicts and climate change, leading to food security instability and an increase in the number of people facing hunger (Rahimi et al., 2023). In Latin America, the war in Ukraine had an indirect impact, as shifts in global trade routes and demand led to increased grain exports from countries such as Brazil and Argentina, which in turn negatively affected local ecosystems (Dumortier et al., 2024).

Analyzing these cases allows for a better understanding of the general patterns of the impact of armed conflicts on agriculture and food security at the global level. It also highlights the need to develop more resilient agricultural management systems that take into account potential risks from conflicts and climate change.

The war in Ukraine has significantly disrupted global agricultural supply chains, emphasizing the vulnerability of food security worldwide. Previous studies indicate that geopolitical conflicts exacerbate food insecurity by disrupting traditional supply routes and altering land use patterns in conflict zones. For instance, the recent geopolitical tensions in Eastern Europe have intensified debates around food security, with implications that resonate across global agricultural and energy markets (Prodanova et al., 2022; Carriquiry et al., 2022). This article thus examines the initial consequences of the war on Ukraine's agricultural sector, contributing to the emerging body of literature that addresses the economic and environmental effects of armed conflicts on agriculture (Dziurakh et al., 2022).

Despite the extensive coverage of agriculture-related disruptions caused by the war, a comprehensive assessment that focuses on Ukraine's agricultural sector, particularly in the context of ongoing challenges, is still limited. Recent analyses have started documenting these impacts, yet the literature emphasizes either broader economic assessments or isolated environmental considerations without a specific focus on Ukraine's rural sectors (Bocz & Błażejczyk-Majka, 2022). By focusing on Ukraine's agriculture within this context, this article aims to bridge this gap, providing preliminary insights into the immediate disruptions and challenges faced by Ukrainian farmers and rural communities as they contend with the impact of military actions and economic sanctions.

In this regard, this article does not seek to offer a theoretical model but rather aims to present an empirically grounded overview of the current state of Ukraine's agricultural sector. This approach aligns with emerging studies that stress the importance of real-time monitoring and assessment of conflict zones to ensure that timely data is available for international policy responses (Dziurakh et al., 2022; Skribans et al., 2024). The present study thus serves as a foundation for further empirical and theoretical explorations of how prolonged conflicts affect agricultural systems and rural communities in the affected regions.

3. Methodology

The methodology employed in this study integrates quantitative and qualitative research methods to examine the multifaceted impacts of the war on Ukraine's agricultural sector. To ensure a comprehensive analysis, the study focuses on three distinct time periods:

First Period (2006–2013). This timeframe precedes the initial Russian Federation invasion of Ukraine, providing a baseline for agricultural performance.

Second Period (2014–2021). This period reflects the impact of the ongoing conflict following the annexation of Crimea and partial occupation of Donetsk and Luhansk regions. Data exclude temporarily occupied territories of Crimea and parts of Donetsk and Luhansk regions.

Third Period (2022). The period marks the beginning of the full-scale invasion by Russia. Data exclude territories occupied by the Russian Federation and regions where active hostilities occurred during 2022.

Data were collected from various sources, including:

State Statistics Service of Ukraine. Primary data on agricultural production, land use, and demographic changes.

International Organizations. Reports from FAO, UN, and Kyiv School of Economics provided insights into economic, environmental, and infrastructural losses.

Scholarly Publications and Reports. Previous studies and analytical reports on the agricultural and socio-economic impacts of war in Ukraine.

The analysis focused on four major dimensions:

1. Human capital. Examination of workforce reductions due to migration and conscription, with comparisons drawn from demographic data across the selected periods.
2. Loss of agricultural land. Evaluating reductions in arable land and production capacity due to occupation and contamination.
3. Production volumes. Analysis of changes in crop and livestock production, employing comparative assessments across the three periods.
4. Economic and environmental losses. Quantification of direct and indirect economic damages, as well as environmental impacts such as land contamination and loss of biodiversity.

The study employs a comparative approach to evaluate structural changes over time:

Sown Area Analysis. Assessing trends in cultivated land from 1990 to 2022, with a focus on war-induced declines.

Production Trends. Comparing crop and livestock production volumes before and after the war periods.

Data for the study were restricted to the latest available figures as of 2022. Future updates with post-war statistics will be necessary to provide a complete picture of the long-term consequences.

4. Results

The full-scale invasion of Ukraine by Russia in February 2022 caused significant damage to the agricultural sector and, consequently, to rural communities in Ukraine.

4.1 Loss of human capital

Due to the military actions, many farmers were forced to cease their agricultural activities. According to the Food and Agriculture Organization (FAO), more than 150,000 farmers and food system workers were directly affected by the war or forced to migrate. Small-scale producers, who played a vital role in seasonal crop production and in providing employment and income for rural populations, were particularly hard-hit. Displacement of the population and conscription of men into the Armed Forces of Ukraine led to a labor shortage and an increased burden on women (Espreso, 2023). According to FAO's 2022 report, around 25% of rural households engaged in agricultural production reduced or stopped their activities because of the war. The situation is especially dire in frontline regions such as Sumy, Mykolaiv, and Chernihiv, where over 40% of rural households have been affected (FAO, 2022).

A large portion of the rural population has left their homes. According to Ukraine's Ministry of Social Policy, nearly 5 million people have been officially registered as internally displaced persons (IDPs), of which 2.5 million are unable to return to their homes. Around 6 million Ukrainian refugees are registered across Europe, and 6.5 million worldwide. Additionally, Russia has forcibly relocated people from occupied Ukrainian territories; as of July 2023, over 1 million Ukrainian refugees were reported in Russia (Ukrinform, 2023a).

Estimates from the International Organization for Migration (IOM) in Ukraine show that as of September 25, 2023, only 21% of internally displaced persons (IDPs) resettled in rural areas or farms, while the majority moved to large cities (44%) or smaller towns (28%) (Table 1).

Tab 1. Share of IDPs by type of settlement, %. Source: based on data from the International Organization for Migration (2023) and the State Statistics Service of Ukraine.

	Percentage, %	Unit	People, million
Rural area/village or farm	21	28369	12.47
Small town or urban-type settlement	28	881	1.29
Large city	44	461	27.41
Suburb of a large city	7	…	…

Note: Suburban population included in "Large city" group

These indicators reveal even greater risks when considered alongside data on the dynamics of the country's permanent population composition and internal migration processes prior to the war.

Between 2014 and 2021, the permanent population of Ukraine decreased by 1.8 million people, representing a decline of 4.1 percentage points. This rate of population decline exceeds that of the first period – 2006 to 2013 – by 1.5 percentage points. At the same time, the rural population declined even more significantly: by 5.2 percentage points between 2006 and 2013 and by 5.9 percentage points between 2014 and 2022 (Table 2).

Tab 2. Population size and composition of Ukraine's permanent population. Source: calculated based on data from the State Statistics Service of Ukraine

Indicator	2006	2013	2014	2021	Growth rate			
					2013 compared to 2006		2021 compared to 2014	
					thousand persons	percentage points	thousand persons	percentage points
Population size, thousand persons								
Total	46465.7	28372.5	42759.7	40997.7	-1219.8	-2.6	-1762.0	-4.1
men	21434.7	13796.8	19787.8	19007.0	-516.4	-2.4	-780.8	-3.9
women	25031.0	14575.7	22971.9	21990.7	-703.4	-2.8	-981.2	-4.3
Rural population	14943.9	8442.1	13325.3	12542.9	-779.0	-5.2	-782.4	-5.9
men	6973.9	4271.7	6284.7	5972.8	-300.0	-4.3	-311.9	-5.0
women	7970.0	4170.4	7040.6	6570.1	-479.0	-6.0	-470.5	-6.7
Composition of permanent population – total, %								
men	46.1	48.6	46.3	46.4	x	0.1	x	0.1
women	53.9	51.4	53.7	53.6	x	-0.1	x	-0.1
Composition of rural permanent population, %								
men	46.7	50.6	47.2	47.6	x	0.4	x	0.5
women	53.3	49.4	52.8	52.4	x	-0.4	x	-0.5
Share of rural population in total permanent population, %								
Total	32.2	29.8	31.2	30.6	x	-0.9	x	-0.6
men	32.5	31.0	31.8	31.4	x	-0.6	x	-0.4
women	31.8	28.6	30.6	29.9	x	-1.0	x	-0.7

Between 2006 and 2021, the migration balance in rural areas was positive in only four years – 2014 to 2017 – while in urban areas, it was negative only in 2016 (Figure 1). This outflow of rural population to cities is associated with greater employment opportunities and a more comfortable lifestyle in urban areas. For young people, an additional factor is education at higher education institutions, after which qualified workers are more likely to seek employment and settle in cities. Naturally, all else being equal, this trend does not contribute to building human capital in rural areas, which serve as a primary potential source of human resources for the agricultural sector.

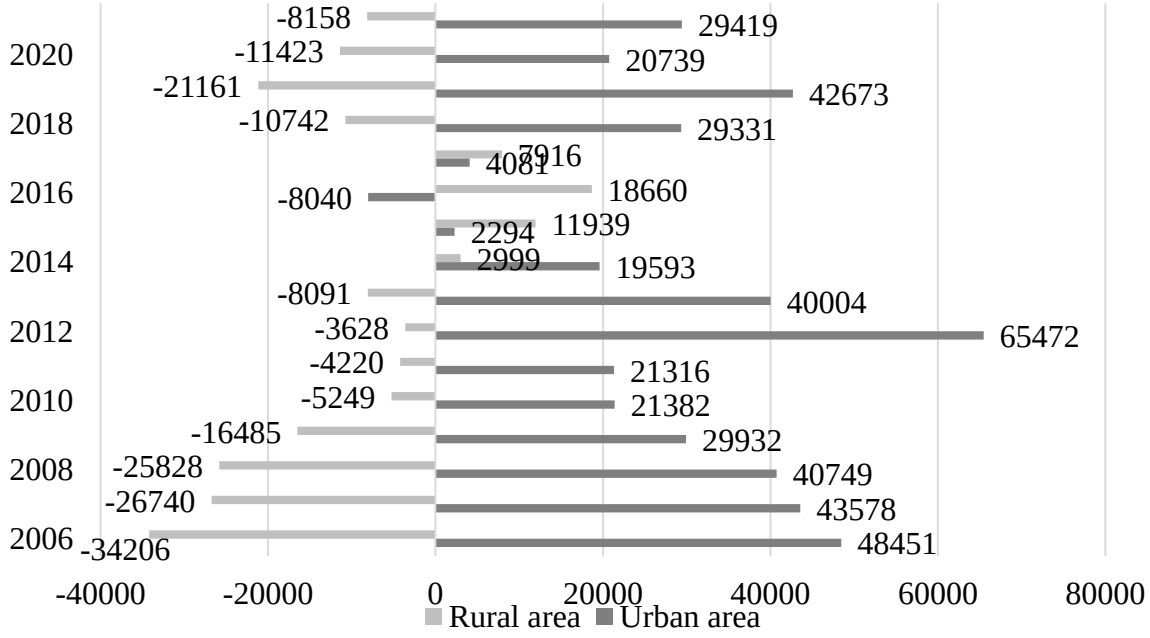


Fig 1. Migration movement of the population by type of locality in Ukraine (2006–2021), persons. Source: developed based on data from the State Statistics Service of Ukraine

Significant differences are observed in the dynamics of employment rates among the population aged 15–70. In agriculture, the number of employed individuals decreased by 2.1 percentage points between 2006 and 2013, whereas during the period from 2014 to 2021, this figure dropped significantly more – by 12.9 percentage points (Table 3). Meanwhile, the share of employed individuals in agriculture, forestry, and fishing in 2021 compared to 2014 even showed a slight increase, rising by 0.1 percentage points.

Tab 3. Dynamics of the number of employed population aged 15–70 in Ukraine's agriculture. Source: calculated based on data from the State Statistics Service of Ukraine

Indicator	2006	2013	2014	2021	Relative growth rate, percentage points	
					2013 compared to 2006	2021 compared to 2014
Employed population aged 15–70 - total, thousand persons	20730.4	20404.1	18073.3	15610.0	-1.6	-13.6
including in agriculture, forestry, and fishing	3652.6	3577.5	3091.4	2692.7	-2.1	-12.9
Share of employed population in agriculture, forestry, and fishing, %	17.6	17.5	17.1	17.2	-0.1	0.1

These data reflect a significant loss of human capital in rural areas, as a substantial part of the rural population has been forced to move to urban regions or other countries and is no longer engaged in agricultural production.

4.2 Loss of land in occupied and conflict areas

Over the past 30 years (from 1990 to 2020), the sown area of agricultural crops in Ukraine decreased by 4.3 million hectares (Table 4). However, in 2022 alone, the losses reached 5.2 million hectares, significantly exceeding the decline of previous decades. This sharp reduction in the sown area highlights the unprecedented impact of current crises, particularly military actions and associated economic instability. Overall, compared to the base year of 1990, the sown area in 2022 decreased by 9.0 million hectares, which corresponds to a relative reduction of 27.8%.

Tab 4. Dynamics of sown areas of agricultural crops in Ukraine. Source: calculated based on data from the State Statistics Service of Ukraine

Indicator	1990	2000	2005	2010	2015	2020	2021	2022
Sown area of agricultural crops. million ha	32.4	27.2	26.0	27.0	26.9	28.1	28.6	23.4
Absolute growth rate, million ha								
- compared to 1990	0.0	-5.2	-6.4	-5.4	-5.5	-4.3	-3.8	-9.0
- compared to 2020	x	x	x	x	x	0.0	0.5	-5.2
Relative growth rate, percentage points								
- compared to 1990	0.0	-16.0	-19.8	-16.7	-17.0	-13.3	-11.7	-27.8
- compared to 2020	x	x	x	x	x	0.0	1.8	-18.2

Thus, the reduction in sown areas of agricultural crops in Ukraine in 2022 occurred due to a decrease in the following areas: grain and leguminous crops by 23.9 percentage points; industrial crops by 10.3 percentage points; root and tuber crops, vegetable and melon food crops by 10.3 percentage points; and forage crops by 13.9 percentage points (Table 5). This means that in 2022 alone, due to the war, 7.7 percentage points more of the sown area was lost than over the past 30 years. This shift in sown areas led to an increase in the share of industrial crops at the expense of the reduction in the share of grain and leguminous crops.

Changes in the sown area from 1990 to 2021 are marked by an 11.8 percentage point decrease in the area of agricultural crops. This overall reduction occurred mainly due to a significant decline in forage crops by

87.2 percentage points, as well as a decrease in root and tuber crops, vegetable, and melon food crops by 12.8 percentage points. In contrast, the sown areas for grain and leguminous crops and industrial crops increased by 9.7 and 146.4 percentage points, respectively. Consequently, the share of grain and leguminous crops and industrial crops grew by 11.0 and 20.7 percentage points, while the share of forage crops and root, vegetable, and melon crops decreased by 31.6 and 0.1 percentage points, respectively.

Tab 5. Sown area of agricultural crops and their structure in Ukraine. Source: calculated based on data from the State Statistics Service of Ukraine. Source: calculated based on data from the State Statistics Service of Ukraine

Indicator	1990	2000	2010	2015	2020	2021	2022	Relative growth rate, percentage points	
								2021 compared to 1990	2022 compared to 2021
Actual sown area of agricultural crops, thousand ha									
Agricultural crops	32406.0	27173.3	26951.5	26901.8	28147.5	28580.9	23404.6	-11.8	-18.1
Grain and leguminous crops	14583.4	13646.5	15090.0	14738.4	15392.2	15994.8	12171.1	9.7	-23.9
Industrial crops	3751.3	4186.8	7295.8	8350.3	9223.8	9244.5	8292.2	146.4	-10.3
Root and tuber crops, vegetable and melon food crops	2072.5	2276.9	1966.6	1822.9	1854.3	1806.6	1619.7	-12.8	-10.3
Forage crops	11998.8	7063.1	2599.1	1990.2	1677.2	1535.0	1321.6	-87.2	-13.9
*Structure of sown area of agricultural crops, **%***									
Agricultural crops	100.0	100.0	100.0	100.0	100.0	100.0	100.0	x	x
Grain and leguminous crops	45.0	50.2	56.0	54.8	54.7	56.0	52.0	11.0	-4.0
Industrial crops	11.6	15.4	27.1	31.0	32.8	32.3	35.4	20.7	3.1
Root and tuber crops, vegetable and melon food crops	6.4	8.4	7.3	6.8	6.6	6.3	6.9	-0.1	0.6
Forage crops	37.0	26.0	9.6	7.4	6.0	5.4	5.6	-31.6	0.2

The assertion that the loss of sown areas in 2022 was due to the war is supported by the fact that significant and unnatural reductions in sown areas occurred specifically in temporarily occupied and frontline regions of Ukraine (territories where hostilities are or were ongoing) (Table 6).

The evolutionary reduction in the sown area over the past 30 years (4.3 million hectares or 13.1%) and the reduction in arable land available for cultivation and harvesting due to temporary occupation by the Russian Federation, as well as restricted access to agricultural land due to contamination from

aggressive military actions (5.2 million hectares or 18.1%), present serious challenges for Ukraine's agriculture. Ensuring an adequate level of agricultural production and, consequently, the country's food security, in light of the current reduction in sown areas, requires the implementation of effective measures to increase productivity in the sector.

The primary factors influencing production volumes are traditionally the sown area and the yield of agricultural crops. While the impact of Russian military aggression on the latter is somewhat limited, though not entirely negligible, the first factor is highly dependent on military actions. Changes in the sown area of one crop may occur at the expense of another due to the physical limitations of available land. The occupation of territory by the Russian Federation or active combat on this land serves as an unnatural physical constraint.

Tab 6. Absolute growth rate of harvested area of agricultural crops by regions of Ukraine in 2022 compared to 2021, thousand ha. Source: calculated based on data from the State Statistics Service of Ukraine

Country/Oblast	Grain and leguminous crops	Sunflower	Soybeans	Rapeseed	Potatoes	Vegetables
Ukraine	-4175.5	-1427.1	204.3	151.7	-78.9	-85.9
Vinnytsia	-87.4	20.1	22.9	27.9	3.8	0.6
Volyn	-23.5	2.2	6.5	-1.5	4.2	1.1
Dnipropetrivsk	-129.8	-7.7	-1.6	52.8	4.8	-3.8
Donetsk	-412.1	-248.5	…	…	-20.9	-9.6
Zhytomyr	-93.5	27.2	67.9	5.2	-8.1	-1.4
Zakarpattia	-3.8	1.2	6.5	…	1.0	0.3
Zaporizhzhia	-728.0	-365.8	…	-41.2	-7.8	-6.1
Ivano-Frankivsk	-10.0	9.1	7.6	-1.2	0.6	0.1
Kyiv	-64.0	1.5	11.4	18.2	-0.5	0.7
Kirovohrad	-39.6	-3.2	11.5	39.7	0.5	-0.3
Luhansk	-307.4	-369.3	…	…	0.5	-0.3
Lviv	10.4	2.8	16.2	-5.5	3.4	0.9
Mykolaiv	-245.3	-112.9	-0.3	37.1	-4.7	-9.1
Odesa	-59.7	6.0	3.5	26.5	-2.9	-1.4
Poltava	-124.8	54.8	13.6	12.3	0.1	0.0
Rivne	-37.7	14.1	10.5	-4.5	-0.9	0.0
Sumy	-183.3	67.2	24.4	8.0	0.1	-0.1
Ternopil	-44.6	21.7	11.4	8.4	0.1	0.4
Kharkiv	-483.1	-278.3	-7.9	…	-29.0	-15.5
Kherson	-768.3	-337.2	-78.3	-83.9	…	…
Khmelnytsky	-71.9	37.2	38.3	2.2	0.3	0.4
Cherkasy	-60.2	-11.4	25.9	32.0	1.5	-1.8
Chernivtsi	2.7	-3.0	1.1	0.3	0.2	0.1
Chernihiv	-210.6	45.1	24.6	4.8	-3.0	-0.4

An analysis of production volume changes during the study periods revealed the following. By the end of the first period (2006–2013), positive growth rates in production volumes were recorded for all types of agricultural products except for industrial sugar beet (Table 7).

By the end of the second period (2014–2021), a positive growth rate in production volumes was observed for all types of agricultural products, except for industrial sugar beet and potatoes. Overall, during the second period, more agricultural products were produced compared to the first period, with the exception of industrial sugar beet.

Tab 7. Production volume (gross yield) of agricultural crops in Ukraine. Source: calculated based on data from the State Statistics Service of Ukraine

Indicator	Grain and leguminous crops	Sugar beet (industrial)	Sunflower	Potatoes	Vegetable crops	Fruit and berry crops
Total produced in 2006–2013, thousand tons	368156	124622	57269	166242	69044	13653
Average produced in 2006–2013, thousand tons	46019.5	15577.8	7158.6	20780.3	8630.5	1706.6
Growth rate in 2013 compared to 2006, percentage points	84.0	-51.9	107.6	14.3	22.5	106.0
Total produced in 2014–2021, thousand tons	548133	99135	106099	173457	76269	17156
Average produced in 2014–2021, thousand tons	68516.6	12391.9	13262.4	21682.1	9533.6	2144.5
Growth rate in 2021 compared to 2014, percentage points	34.7	-31.0	61.8	-9.9	3.1	11.8
Growth rate in 2014–2021 compared to 2006–2013, percentage points	48.9	-20.5	85.3	4.3	10.5	25.7
Total produced in 2022, thousand tons	53864	9942	11329	20900	7512	1995
Growth rate in 2022 compared to 2006–2013, percentage points	17.0	-36.2	58.3	0.6	-13.0	16.9
Growth rate in 2022 compared to 2014–2021, percentage points	-21.4	-19.8	-14.6	-3.6	-21.2	-7.0

In 2022, compared to the first period (2006–2013), a reduction in production volumes was observed for two types of products: industrial sugar beet, which declined by 36.2 percentage points, and vegetable crops, which decreased by 13.0 percentage points. Compared to the second period (2014–2021), 2022 saw a decline in production across all types of products: grain and leguminous crops fell by 21.4 percentage points; industrial sugar beet by 19.8 percentage points; sunflower by 14.6 percentage points; potatoes by 3.6 percentage points; vegetable crops by 21.2 percentage points; and fruit and berry crops by 7.0 percentage points.

According to experts in 2023. Ukraine's total loss of arable land amounted to 6.5 million hectares (Mkrtchian & Müller, 2024).

These figures demonstrate the severe impact the war has had on Ukraine’s agricultural sector. with substantial reductions in both cultivated areas and production volumes of key crops. Losses of agricultural land cannot be easily compensated, replaced, or restored, unlike other sectors.

4.3 Loss of land due to landmines

One of the key challenges posed by Russian aggression is the loss of agricultural land in Ukraine due to landmines. According to the UN, Ukraine is one of the most heavily mined countries in the world due to Russia’s full-scale invasion (United Nations, 2024). As of February 2024, the State Emergency Service of Ukraine (SES) reported that 156,000 square kilometers of the country’s territory were potentially contaminated with explosive devices, roughly 25% of the entire country, an area comparable to the size of Liechtenstein (Figure 2).



Fig 2. Map of Ukrainian Territories Potentially Contaminated with Explosive Devices. Source: screenshot from the State Emergency Service of Ukraine's website

These figures are consistent with expert data from the Kyiv School of Economics (2024), which estimates that more than 16 million hectares of Ukraine remain mined, covering approximately 40% of the country's territory – an area roughly equivalent to half of Germany's land area. Of these, 11 million hectares are agricultural lands, an area comparable to the total farmland in Germany (Mkrtchian & Müller, 2024; Nivievskyi & Neyter, 2024). This loss has significantly reduced the available arable land, particularly in frontline regions, lowering agricultural production.

By 2023, about 200,000 hectares of agricultural land had been inspected, which is only a small fraction of the total mined area (United Nations, 2024). This process is complicated by varying soil types, which require specialized demining equipment, and some areas remain inaccessible due to ongoing military actions. Ukraine's partners are actively assisting by providing the necessary demining equipment (Euronews, 2023). Additionally, Ukraine has started producing machines for mechanical demining and robotic systems (Ukraine.ua, 2024). However, despite both national and international efforts, the demining process is slow, and full land clearance could take decades (Stokes, 2023; OSW, 2023). The complexity and extent of contamination make demining a time-consuming process that may last for many years (Stern, 2023).

4.4 Loss of livestock

By the end of the first period (2006–2013), the production volumes of livestock products increased across all categories, except for milk (Table 8). However, during the second period (2014–2021), production volumes decreased for all types of livestock products except meat. In 2022, a decline in production was recorded for all types of livestock products without exception: meat (carcass weight) by 7.5 percentage points, milk by 22.4 percentage points, eggs by 26.6 percentage points, and wool by 36.7 percentage points.

The primary cause of these losses is the physical destruction of livestock and poultry due to military actions. Notably, such actions are deliberately targeted by the Russian Federation at agricultural enterprises producing livestock products, large poultry farms, and pig farms with the specific aim of undermining Ukraine's food potential.

Tab 8. Dynamics of production of major types of livestock products in Ukraine. Source: calculated based on data from the State statistics service of Ukraine

Indicator	Meat (carcass weight), thousand tons	Milk, thousand tons	Eggs, million units	Wool, tons
Total produced in 2006–2013, thousand tons	16260.0	94120.2	133628.5	29905
Average produced in 2006–2013, thousand tons	2032.5	11765.0	16703.6	3738.1
Growth rate in 2013 compared to 2006, percentage points	38.7	-13.5	37.8	7.4
Total produced in 2014–2021, thousand tons	19087.1	80114.9	130024.4	15623
Average produced in 2014–2021, thousand tons	2385.9	10014.4	16253.1	1952.9
Growth rate in 2021 compared to 2014, percentage points	3.3	-21.7	-28.2	-42.5
Growth rate in 2014–2021 compared to 2006–2013, percentage points	17.4	-14.9	-2.7	-47.8
Total produced in 2022, thousand tons	2206.7	7767.7	11921.8	1237
Growth rate in 2022 compared to 2006–2013, percentage points	8.6	-34.0	-28.6	-66.9
Growth rate in 2022 compared to 2014–2021, percentage points	-7.5	-22.4	-26.6	-36.7

During the first months of the war, 10 regions of Ukraine, which held over 43% of the total industrial livestock population and nearly 42% of milk production, were caught in conflict zones (Zaborona, 2023). In October 2022, "in Maiaky, Donetsk region, Russian occupiers destroyed an enterprise with constant shelling that produced half a million chicken eggs per day, resulting in the death of over 800,000 chickens" (Ukrinform, 2023b). The largest poultry farm in Europe, located in Chornobaivka, Kherson region, lost 4 million chickens during the occupation (Suspilne Kherson, 2023). At the beginning of March 2022, "due to the occupation of part of Ukraine's territory by Russian forces, the largest poultry farm in Europe, Chornobaivska, was left without electricity, without the ability to feed the poultry, transport workers to their jobs, or deliver finished products. Approximately 4.4 million chickens died from thirst and hunger. The total financial losses from Russian aggression are currently estimated by the agricultural holding at approximately 12 billion UAH, or 330 million USD. It was also emphasized that the destruction of this key production facility for the industry led to a shortage of chicken eggs in Ukraine. The supply on the market decreased significantly, and prices increased" (Ukrainska Pravda, 2023).

In September 2022, targeted shelling destroyed the facilities of the dairy farm and four pig farm buildings of JSC "Plemzavod Stepnoy" in the Zaporizhzhia region. "As a result of the destruction, more than 6,000 pigs and 1,000 heifers were killed" (Association of Milk Producers, 2023). The "Slobozhanskyi" agricultural complex, located in the Chuhuiv district of the Kharkiv region, was under Russian occupation for seven months. "The farm lost 63,000 pigs, valued at approximately 170 million UAH (€4.3 million), due to hunger, disease, and shelling. In total, 38 facilities (around 160,000 m²), including seven warehouses and elevators valued at 167.5 million UAH (€4.27 million), were damaged" (Pigua.info, 2023). In November 2022, during the EuroTier 2022 international conference, First Deputy Minister of Agrarian Policy and Food, Taras Vysotskyi, stated that "due to military actions, an estimated 15–20% of cattle, pigs, and poultry have been lost" (Latifundist.com, 2023).

According to estimated data, the percentage of lost livestock is as follows: 31.1 percentage points for cattle, including 30.1 percentage points for cows; 21.5 percentage points for pigs; 24.9 percentage points for sheep and goats; and 13.0 percentage points for poultry (Table 9). While some reduction in livestock numbers may not be directly related to military aggression, it is evident that the majority of the livestock losses are due to destruction or death resulting from the aggressor's military actions.

Tab 9. Dynamics of livestock numbers in Ukraine. Source: calculated based on data from the State statistics service of Ukraine

Indicator	Cattle, thousand heads		Pigs, thousand heads	Sheep and goats, thousand heads	Poultry, million heads
	Total	Including cows			
Total livestock numbers for 2006–2013, thousand heads	39672.1	22311.9	60010.0	13799.7	1553.8
Average livestock numbers for 2006–2013, thousand heads	4959.0	2789.0	7501.3	1725.0	194.2
Growth rate in 2013 compared to 2006, percentage points	-26.6	-25.0	-1.6	7.3	38.3
Total livestock numbers for 2014–2021, thousand heads	26790.3	15480.9	50446.4	10028.3	1658.9
Average livestock numbers for 2014–2021, thousand heads	3348.8	1935.1	6305.8	1253.5	207.4
Growth rate in 2021 compared to 2014, percentage points	-31.9	-31.8	-23.7	-20.2	-5.2
Growth rate for 2014–2021 compared to 2006-2013, percentage points	-32.5	-30.6	-15.9	-27.3	6.8
Total livestock numbers for 2022, thousand heads	2307.1	1352.8	4948.3	941.4	180.5
Growth rate in 2022 compared to 2006–2013, percentage points	-53.5	-51.5	-34.0	-45.4	-7.1
Growth rate in 2022 compared to 2014–2021, percentage points	-31.1	-30.1	-21.5	-24.9	-13.0

Small-scale farms have been hit the hardest by the war's challenges, with their cattle numbers decreasing much faster than those of large enterprises (Figure 3).

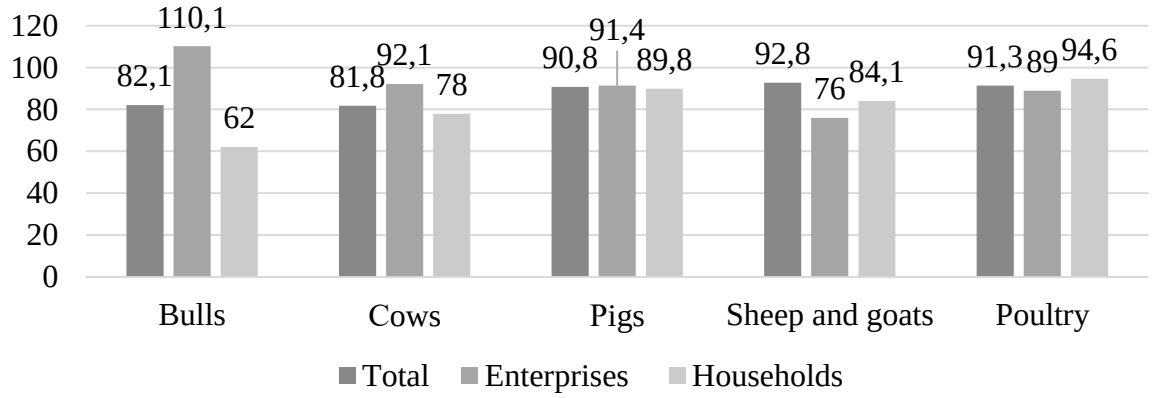


Fig 3. Rate of change in livestock numbers in 2023 compared to 2021 [%]. Source: based on data from the State statistics service of Ukraine

Medium and large enterprises, when necessary, have relocated livestock farms to relatively safe regions in western Ukraine. At the start of the war, many people, when fleeing their homes, simply let their livestock go. Some of these animals perished from shelling, while others died from lack of food or water. Rebuilding livestock populations has been difficult, as the war continues, and many people are uncertain about their future. For rural households, it is especially challenging to transport large animals when relocating, and access to feed, veterinary services, and markets has also become more difficult for smaller farms.

4.5 Destruction of agricultural production, processing, and storage infrastructure

The military actions and occupation of large agricultural areas disrupted the usual production cycle and destroyed much of the infrastructure, complicating recovery efforts in the coming years. More than 300 livestock farms were damaged or destroyed due to Russia's full-scale aggression, with around 7,000 cattle killed (Bizagro, 2023; MilkUA, 2023).

Russia's aggression has also led to widespread destruction of agricultural enterprises and equipment. The main losses include machinery, production facilities, and agricultural equipment, severely reducing the efficiency of agricultural production and processing. This has caused a sharp decline in agricultural activity and the ability to harvest crops (Dibrova et al., 2023). The loss of processing facilities and the disruption of logistics chains due to combat and occupation of certain territories have significantly impacted Ukraine's ability to process agricultural products. This has led to a decline in food production for both domestic consumption and export (Kutsmus et al., 2024).

Russia deliberately targets grain storage facilities, food warehouses, and logistics infrastructure, hindering Ukraine's ability to export its agricultural products (The New York Times, 2023). As of December 2023, the total capacity of destroyed grain storage facilities amounted to 11 million tons, with an additional 3 million tons of damaged facilities (United Nations, 2023; Global Crisis Group, 2023) (Figure 6). This represents 15% of Ukraine's total grain storage capacity.

The destruction or damage to elevators and storage facilities for grain and other agricultural products has led to the loss of a significant portion of the harvest and exacerbated the problem of storage capacity shortages, further hindering export operations (Garafonova et al., 2023; BBC News, 2023). The destruction of production and storage infrastructure has negatively impacted not only Ukraine's food security but also that of many countries dependent on Ukrainian grain exports (McMahon, 2022). To address this issue, 600,000 tons of new elevator capacity have been built in Ukraine's western regions over the past two years (Figure 7). Currently, Ukraine has more than 1,600 grain storage facilities with a total capacity of over 50 million tons (Agriculture Weekly, 2023; Superagronom, 2024).

However, existing storage capacity remains insufficient, and Russia continues to target infrastructure objects. The destruction of production, processing, and storage infrastructure has caused significant losses to Ukraine's agricultural sector, reducing its ability to supply both domestic and global food markets. Restoring this infrastructure is critical for stabilizing the agricultural sector and rebuilding Ukraine's economy in the post-war period.

4.6 Disruption of environmental and humanitarian security

Landmines, detonation of ammunition, destroyed military equipment, burial of the dead, movement of military vehicles, and scorched soil have caused irreparable damage to Ukraine's land. Due to landmines, more than 10 million Ukrainians are at risk (International Academy of Astrobiology, 2023). The explosion of any ordnance releases toxic compounds into the soil. According to experts, the contamination levels of Ukrainian soils have exceeded safe limits by 6–8 times. Burnt-out black soils and more than 9,000 units of destroyed military equipment have polluted the land with heavy metals, with some areas seeing pollution levels 25 times higher than normal (Dnister, 2024). Approximately 835,000 hectares of agricultural land require reclamation (Agravery, 2024).

In June 2023, Russia caused a global environmental disaster by blowing up the Kakhovka Hydroelectric Power Plant dam. The destruction of the Kakhovka Hydroelectric Station in June 2023 triggered a severe environmental and humanitarian catastrophe. This disaster led to the flooding of thousands of hectares of agricultural land and residential areas, resulting in the death of people and significant damage to the region's flora and fauna. Moreover, the broken dams led to the leakage of industrial waste and water contamination. It may take years to restore the affected territories, and even after the reconstruction of damaged infrastructure, ecosystems will remain vulnerable to further changes (Spears et al., 2024; United Nations Environment Programme, 2023).

As a result of military actions and the use of explosive devices, vast areas of nature reserves and parks have been devastated. Massive destruction of wildlife, plant life, and ecosystems has occurred. In conflict zones, cases of rare species disappearing due to environmental changes have already been recorded. Forests and soil degradation continue to accelerate in these regions (Ukrinform, 2024).

4.7 Economic losses in the agricultural sector

According to the Food and Land Use Research Center of the Kyiv School of Economics, the total damage (excluding lost income) is estimated at nearly $9 billion (Mkrtchian & Müller, 2024). This accounts for thirty percent of Ukraine's entire agricultural capital before the war. The greatest losses are concentrated in the eastern and southern regions of Ukraine. The largest category of losses involves agricultural machinery and equipment, amounting to nearly $5 billion (Figure 4). Losses caused by the destruction and theft of agricultural products are estimated at almost $2 billion, including around four million tons of grain and oilseeds.

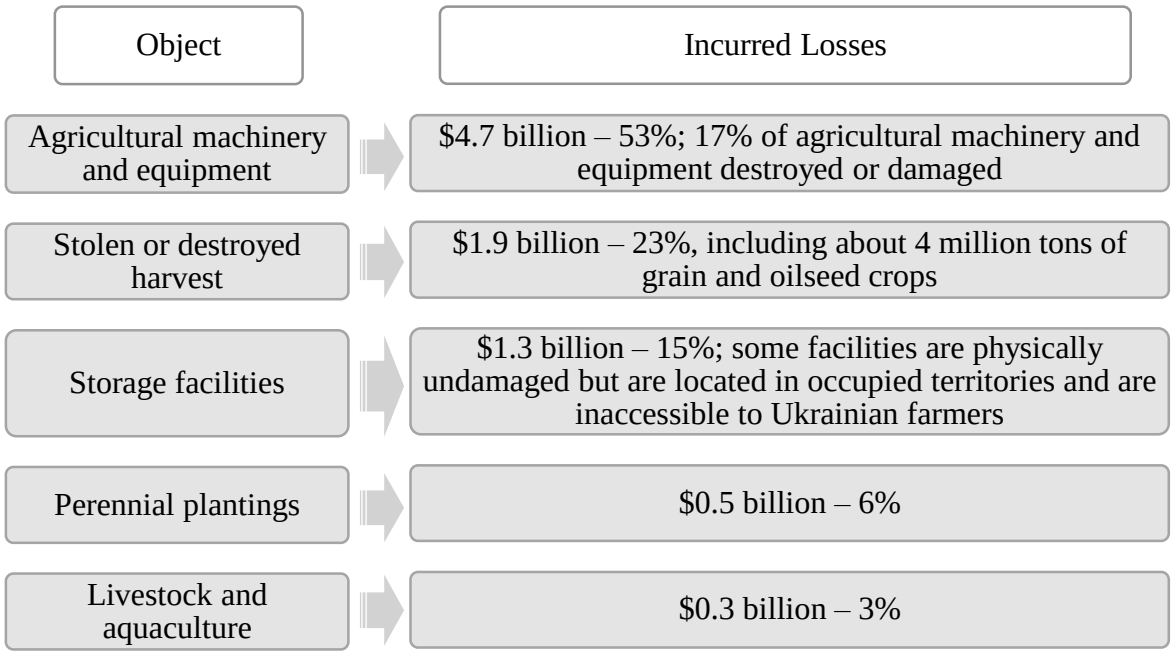


Fig 4. War-related economic losses in Ukraine without accounting for lost income. Source: based on data from Mkrtchian & Müller (2024); Nivievskyi & Neyter (2024)

The total agricultural losses, including lost income due to decreased production and increased production costs, amount to more than $40 billion, according to the Food and Land Use Research Center of the Kyiv School of Economics (Figure 5). This figure exceeds Ukraine's agricultural gross product in 2021. The largest category of losses is related to the decline in crop production, which amounts to $23 billion. The second-largest category is losses related to export disruptions. Another challenge for Ukrainian producers has been the rising production costs due to increased prices for fertilizers and fuel (Mkrtchian & Müller, 2024; Nivievskyi & Neyter, 2024).

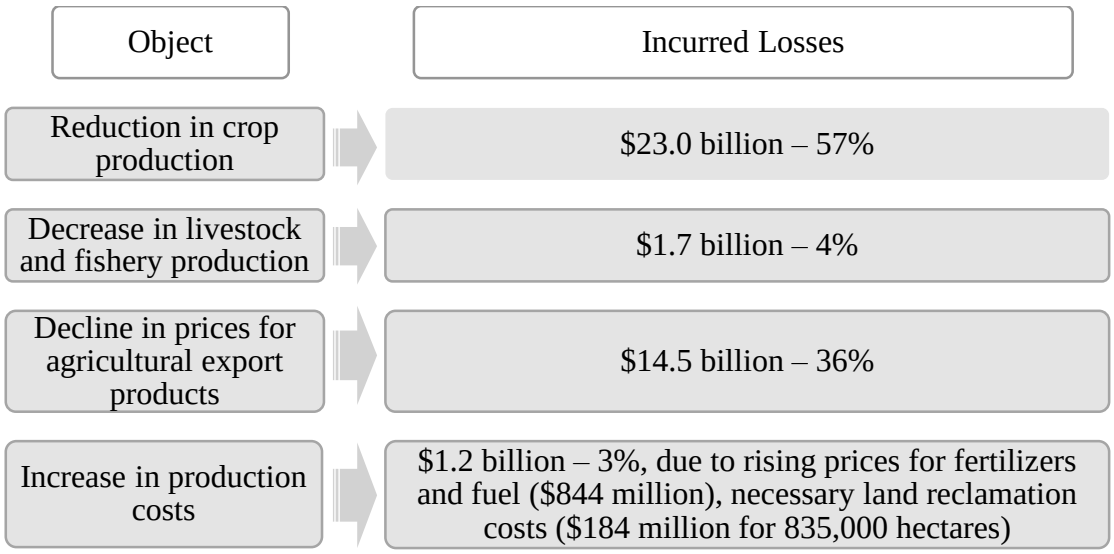


Fig 5. Economic losses due to the war in Ukraine, including lost income. Source: based on data from Mkrtchian & Müller (2024); Nivievskyi & Neyter (2024)

Particular attention should be given to the damage inflicted on agriculture by the destruction of the Kakhovka dam and the mining of territories. Figure 6 illustrates the financial losses sustained by the agricultural sector, as estimated by the Kyiv School of Economics. The total losses amount to $1.15 billion, with damages reaching $25.7 million, and direct losses from crop damage and livestock flooding estimated at $1.2 million. The projected losses over the next five years include disruptions in irrigation, losses in fishing, and the loss of livestock.

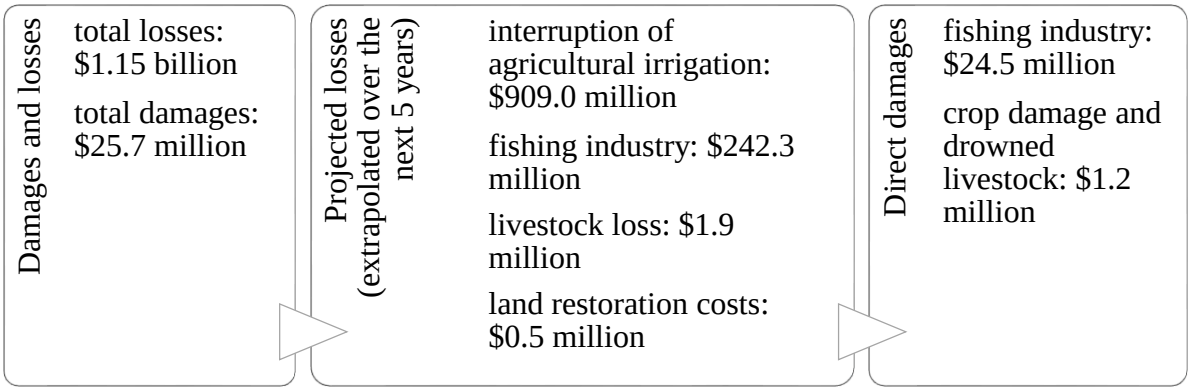


Fig 6. Economic losses in agriculture due to the war in Ukraine: destruction of the Kakhovka Dam (June 6, 2023). Source: compiled from Nivievskyi & Neyter (2024)

According to estimates by researchers from the Kyiv School of Economics, the demining of agricultural lands is expected to occur in three stages: non-technical survey, technical survey, and actual demining. The total demining area covers 9.25 million hectares (84% for non-technical survey), 1.75 million hectares (16% for technical survey), and 0.5 million hectares for actual demining. The cost of these operations ranges from $8 per hectare for non-technical surveys to $25,600 per hectare for actual demining, highlighting the immense financial burden of restoring agricultural potential (Figure 7).

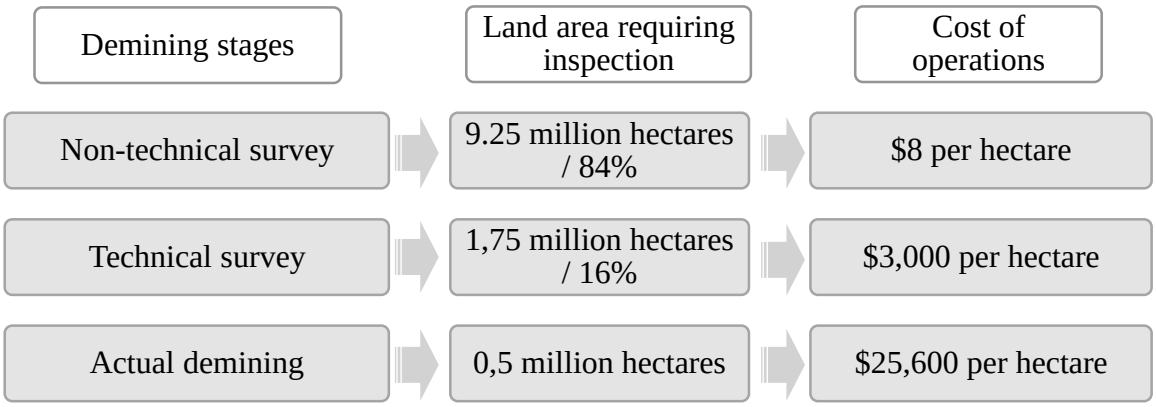


Fig 7. Economic losses in agriculture due to the war in Ukraine: demining of agricultural lands. Source: based on data from Mkrtchian & Müller (2024); Nivievskyi & Neyter (2024)

The previously mentioned key negative impacts of the war on the country's agricultural sector are summarized in Figure 8.

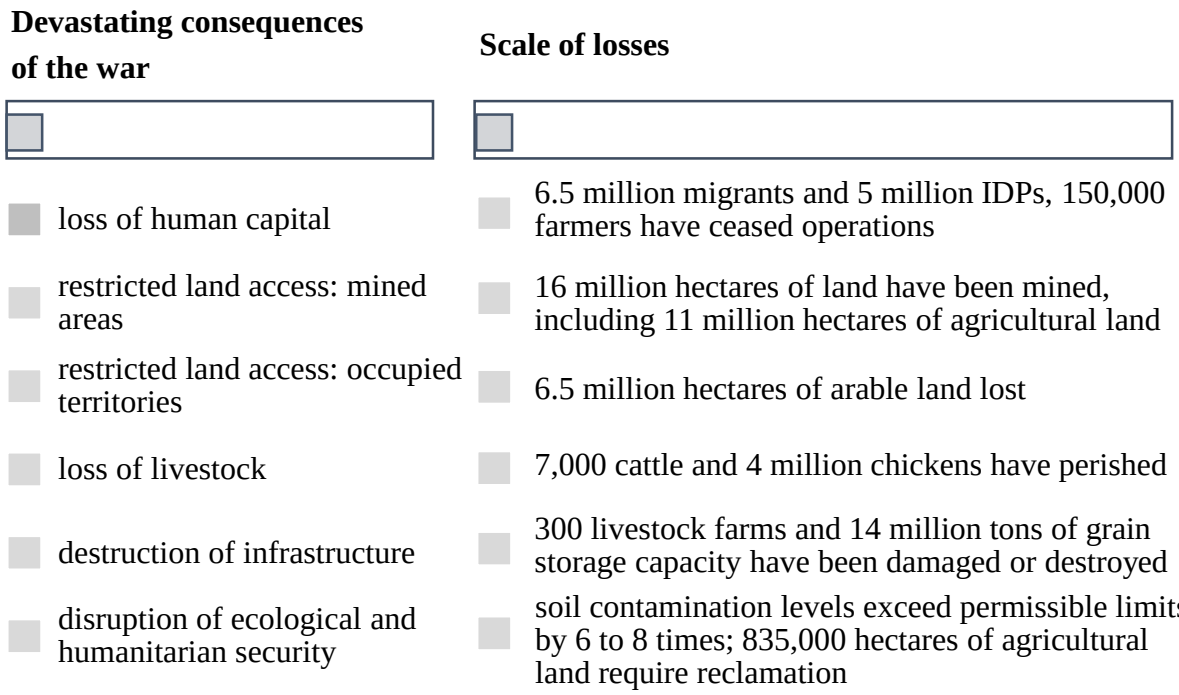


Fig 8. Agricultural losses caused by the war in Ukraine. Source: developed by the authors

The main losses include reduced income from agro-exports, destruction of equipment, loss of crops, reduction in arable land, damage to infrastructure, and adverse effects on soil and ecological balance. Some of these losses have already been subject to economic analysis, where they are classified as direct damages or projected economic losses that are likely to occur in the future. This includes the costs of restoring infrastructure, equipment, and arable land, as well as the decline in agro-exports. However, other aspects, such as the loss of human capital (skilled workers, farmers, and scientific experts) and land, are difficult to accurately assess from an economic perspective. The loss of human resources has a long-term impact on the industry's productivity as well as the innovative development of the agricultural sector, significantly complicating and slowing down the recovery process. Replenishing these losses requires not only financial investments but also time to train new personnel and restore expertise. Land resources are a fundamental component of the agricultural sector's production function, and unlike other resources such as machinery or financial capital, land is finite and cannot be easily restored or replaced.

Its fertility, structure, and ecological condition determine the long-term prospects for agricultural production. Damage to land due to the war, contamination, or ecosystem disruption can lead to irreversible losses, jeopardizing food security and the region's economic stability. Soil restoration is a lengthy process that demands comprehensive efforts, and even under the best conditions, returning to the initial level of productivity may take years, if it is possible at all. Land, as a non-renewable resource, holds special importance for the sustainable development of agriculture, and its loss or degradation results in irreversible consequences for the entire agricultural sector. Such losses severely undermine the potential for the recovery of Ukrainian agriculture, with long-term repercussions for the country's economy.

5. Discussion

The war in Ukraine has brought into sharp focus the risks posed by geopolitical instability to global food systems. One major consequence has been the significant reduction in sown areas, as vast agricultural lands are now inaccessible due to occupation, active combat, or contamination with unexploded ordnance. Recent studies emphasize that the demining process is both time-intensive and costly, further delaying the return of these lands to agricultural use (Dmytruk et al., 2023). The inability to utilize these lands has disrupted planting cycles, resulting in reduced output across key crops, such as wheat and sunflower, both of which are essential to global food markets.

Beyond physical damage, the war has exposed structural vulnerabilities in Ukraine's agricultural trade infrastructure. The destruction of storage facilities, transport networks, and export terminals has undermined the country’s capacity to meet international demand for grains and oilseeds (Jiang & Chen, 2024). The blockade of Black Sea ports further intensified these challenges, forcing Ukrainian exporters to rely on less efficient overland routes, which significantly increased costs and reduced export volumes.

The loss of human capital also presents a formidable obstacle to recovery. Studies show that the migration of agricultural workers to safer regions or abroad has left farms struggling to operate with reduced labor forces (Garafonova et al., 2023). Many rural communities have been depopulated, weakening the social fabric that underpins agricultural activities. Rebuilding these human networks will be as critical as restoring physical infrastructure.

International comparisons illustrate the broader implications of such crises. Research on the impact of conflicts and climate change in Sub-Saharan Africa has shown that disruptions to agricultural systems often lead to prolonged periods of food insecurity and economic hardship (Ouko et al., 2023). For Ukraine, this underscores the need to adopt a proactive approach, including investments in climate-resilient practices and robust contingency planning for future crises.

Despite these challenges, Ukraine's agricultural sector retains significant potential for recovery. Lessons can be drawn from the European Union’s Common Agricultural Policy, which prioritizes resilience and sustainability through financial support and innovation (Haniotis, 2023). Establishing partnerships with international organizations and donors could provide Ukraine with the resources needed to rebuild and modernize its agricultural sector, ensuring that it emerges stronger and more sustainable in the long term.

6. Conclusions

This study provides a preliminary assessment of the war's consequences for Ukraine's agricultural sector, highlighting significant reductions in sown areas, human capital losses, infrastructure destruction, and economic damage. By analyzing key indicators across three distinct periods (pre-conflict, partial occupation, and full-scale invasion), the research identified the following key findings:

The war has led to a substantial decrease in the sown area due to occupation, contamination of land with mines, and destruction of arable land. This disruption has had severe implications for both domestic production and Ukraine's export capabilities.

The displacement of rural populations and migration of skilled workers has resulted in significant labor shortages, complicating recovery efforts in agriculture. Policies to address this loss will be critical for long-term sectoral recovery.

Targeted attacks on farms, storage facilities, and processing plants have caused immense economic losses and reduced the operational capacity of the agricultural sector. Immediate investments in infrastructure rebuilding are necessary.

The war has disrupted supply chains and global trade, with far-reaching implications for food security in dependent regions, such as the Middle East and North Africa. These disruptions highlight the importance of restoring Ukraine's role in the global agricultural market.

While this study provides valuable insights, its focus on immediate consequences means that some areas remain less explored. For instance:

A broader analysis of global ripple effects on food security would require additional empirical data.

Recovery strategies, particularly related to labor and land demining, require deeper investigation as they evolve over time.

Directions for further research:

Expanding the analysis to include the long-term effects of war on Ukraine’s agriculture and rural communities.

Investigating the global ripple effects of Ukraine’s agricultural disruptions on food security and market stability.

Developing detailed strategies for demining and restoring agricultural land.

Exploring innovative solutions for labor recovery and infrastructure rebuilding to ensure resilience against future crises.

This study lays the foundation for further research by documenting the immediate consequences of the war and identifying critical areas requiring intervention. It emphasizes the need for a coordinated international response to restore Ukraine's agricultural potential and ensure food security globally.

Acknowledgments

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