

Secondary Publication



Kotykova, Olena; Babych, Mykola; Pohorielova, Olena; u. a.

Livestock production losses in Ukraine : economic damages caused by the war

Date of secondary publication: 07.05.2026

Version of Record (Published Version), Article

Persistent identifier: urn:nbn:de:bvb:473-irb-114988x

Primary publication

Kotykova, Olena; Babych, Mykola; Pohorielova, Olena; u. a. (2024): Livestock production losses in Ukraine : economic damages caused by the war, in: Agricultural and resource economics : international scientific e-journal, Kharkiv, Ukraine: Institute of Eastern European Research and Consulting, Vol. 10, Nr. 4, pp. 74–100, doi: 10.51599/are.2024.10.04.04.

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JEL: O11, Q18, Q34

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LIVESTOCK PRODUCTION LOSSES IN UKRAINE: ECONOMIC DAMAGES CAUSED BY THE WAR

Purpose. *The purpose of this study is to assess the economic losses incurred by Ukraine's livestock production sector due to the war in 2022. The research focuses on quantifying the scale of food losses and evaluating their economic impact.*

Methodology. *The study uses a comprehensive methodological framework developed by the Kyiv School of Economics (KSE). Economic losses were calculated using both national average and regional pricing approaches. The analysis focuses on losses of cattle, pigs, poultry, and other livestock, as well as milk and eggs.*

Results. *The study found that the largest economic losses in Ukraine's livestock production sector in 2022 were concentrated in regions directly impacted by military actions, including frontline areas and territories temporarily occupied by the Russian Federation. Donetsk, Kherson, Zaporizhzhia, and Kharkiv regions suffered the greatest losses. Total economic damages from livestock production losses amounted to over 785.6 million euros based on regional prices and 800.9 million euros based on national prices. While regional price variations and productivity differences played a role in the overall economic losses, the primary driver of these losses was the direct impact of the war on livestock farming in affected area. The findings aim to contribute to the broader discussions regarding reparations and post-war agricultural recovery efforts.*

Originality. *This study offers a novel approach by focusing specifically on war-induced food losses in the livestock sector and assessing both direct and indirect economic impacts. The use of both national and regional pricing provides a more accurate estimate of economic losses, highlighting the regional disparities caused by the conflict. The findings contribute new insights into the economic repercussions of war on agricultural productivity and food security.*

Practical value. *The results of this study are important for policymakers and international organisations working in the field of post-war reconstruction and reparations. A quantitative assessment of economic losses can serve as a basis for developing recovery strategies, allocating aid, and prioritising investments in the agricultural sector. Moreover, the research highlights the need for region-specific approaches to effectively address the unique challenges faced by each affected area.*

Key words: *economic losses, livestock production, war impact, Ukraine, food security, agricultural recovery, reparations.*

1. INTRODUCTION

The ongoing war between Russia and Ukraine, which began in 2022, has caused unprecedented destruction in numerous sectors of the Ukrainian economy; agriculture, particularly livestock production, has been most affected [1; 2]. Ukraine, known for its

role as a major global agricultural producer, has suffered extensive economic losses due to the disruption of farming activities, destruction of infrastructure, and loss of livestock. These losses not only undermine domestic food security but also exacerbate global food shortages, given Ukraine's position as a key supplier of agricultural products to international markets.

The significance of assessing the economic damage from these agricultural losses lies in the broader implications for reparations. Accurate quantification of the economic losses will serve as a critical foundation for determining the reparations that Russia, as the aggressor state, must provide to Ukraine. Specifically, these calculations will inform the scope of economic recovery needed in the post-war period, as well as contribute to global discussions on food security, international aid, and reconstruction efforts.

The term "food losses" takes on a unique definition in times of war. Traditionally, food losses refer to the reduction in the quantity or quality of food available. However, in wartime, these losses arise not only from inefficiencies but also from the inability to access or use essential production resources. Such obstacles are a direct consequence of military actions, including occupation, destruction of infrastructure, and damage to production facilities. This paper aims to examine the economic losses from livestock production, focusing specifically on the economic impact caused by war-induced food losses at the production level.

2. LITERATURE REVIEW

The war between Russia and Ukraine in 2022 caused massive destruction across various sectors of the economy, with agriculture suffering some of the most significant losses. Research indicates that conflicts have a devastating impact on agriculture, leading to infrastructure damage, disruption of production processes, and reductions in crop and livestock production. A comprehensive analysis of economic losses in agriculture is key to assessing the overall damage caused by the war and forming the basis for post-war reparations.

The global impact of the war on Ukraine's agricultural sector, particularly in grain and livestock production, has been studied by many authors. Devadoss & Ridley [3] examined the war's effect on the global wheat market, highlighting the serious economic consequences for both Ukraine and world markets. Their research shows that the loss of Ukraine's wheat production led to rising global prices and reduced food availability for importing countries, further exacerbating the global food crisis. These findings underscore the importance of Ukraine's agricultural production for the global food market.

Numerous studies also highlight the challenges faced by Ukraine's agricultural sector due to the war. Shahini et al. [4] emphasise that innovative approaches such as the use of "smart" fertilisers can help mitigate agricultural losses, particularly during the war, when food production is limited. This research is crucial for understanding how new technologies can soften the impact of military conflicts on agricultural production and food security.

He et al. [5] employed quantitative methods to assess crop production losses due to the Russian-Ukrainian war. Their research showed that approximately 7 % of agricultural land was abandoned in 2022, resulting in a loss of about 8.19 million tons of grain. They also pointed out that the regions most affected by the fighting, such as Kherson and Donetsk, experienced the greatest crop losses. The loss of access to land and the destruction of infrastructure further exacerbates the negative impact on livestock farming.

The economic assessment of agricultural sector losses as a result of the war is actively researched. Rexhepi et al. [6] noted that Ukraine's agricultural sector is one of the key economic drivers but has suffered catastrophic losses due to the war. This includes the death of livestock and the destruction of farms and livestock infrastructure. The inability to provide veterinary services and a shortage of feed became common problems in occupied and frontline areas. This research also demonstrates how the war disrupts supply chains, leading to increased product costs and decreased production.

Studies conducted by Skydan et al. [7] focus on the impact of the war on farming households. Their findings show that while some agricultural producers managed to adapt to wartime conditions, others suffered significant losses and were forced to cease operations. An important conclusion is that future agricultural recovery will require not only financial resources but also innovative approaches to managing agricultural enterprises in conditions of instability.

Another important aspect is research conducted by Dziurakh et al. [8]. They explored how the war affected food security in Ukraine and beyond, noting that the loss of agricultural production in Ukraine caused food shortages in many importing countries. Their work emphasises the importance of supporting agricultural producers through government policy and international aid, which will help overcome the consequences of the war and ensure food security at the global level.

Scientific papers also discuss the role of international aid and reparations in rebuilding Ukraine's agricultural sector. Zalizko et al. [9] emphasise that post-war recovery in Ukraine should include new economic strategies aimed at reindustrialising the agricultural sector and attracting foreign investment. They also highlight the importance of loss assessment to determine reparations from Russia as a key part of recovery. Their research underscores the need for scientifically grounded loss assessments to ensure fair compensation for Ukraine's livestock losses.

The livestock sector, as a significant component of agriculture, is largely related to the sustainable management of natural resources, including soil, water, and biodiversity, to ensure both productivity and environmental health. Unsustainable agricultural practices can lead to adverse outcomes such as soil degradation, reduced fertility, and erosion, all of which threaten long-term productivity and ecosystem stability [10]. Intensive livestock production, if improperly managed, contributes to environmental issues, including water contamination from nutrient runoff and excessive manure application, posing a risk to both agriculture and public health [11].

Sustainable practices in livestock farming, such as precision agriculture and rotational grazing, are essential for maintaining ecosystem balance. These methods

optimise land use and help prevent issues like overgrazing and soil erosion [12]. Livestock management also has notable ecological implications, as high-density grazing requires careful oversight to protect grasslands and prevent biodiversity loss, an issue that remains critical for maintaining both land productivity and environmental integrity [13].

The environmental impacts of livestock and crop production are particularly significant in regions with resource limitations, where sustainable methods can mitigate the sector's ecological footprint. For instance, rotational grazing, which involves moving livestock between pastures to allow vegetation recovery, has proven effective in balancing livestock needs with environmental sustainability [14].

In the context of armed conflict, these environmental pressures are often exacerbated. Agricultural disruptions and unsustainable practices adopted due to logistical challenges can intensify issues such as soil degradation, reduced productivity, and resource depletion, magnifying the need for environmental resilience in conflict-affected areas. The impact of these factors on agricultural sustainability is evident, as regions affected by war are forced to adopt emergency measures, often at the expense of long-term ecological stability.

Thus, the literature points to the multidimensional nature of the economic losses caused by the Russian-Ukrainian war. A significant focus is placed on the war's impact on agriculture and food production. Research highlights the need for international cooperation, technological innovation, and strategic management to restore Ukraine's agricultural sector and ensure global food security.

This article builds on these studies, providing a focused analysis of livestock losses in Ukraine due to the war, contributing to the understanding of long-term economic damage and implications for reparations and recovery.

3. METHODOLOGY

The methodology for this study is based on the framework developed by the Kyiv School of Economics (KSE) [15; 16], which provides a structured approach to assess economic losses in the agricultural sector, particularly in the context of war-induced disruptions. The assessment focuses on the livestock industry, where significant losses have occurred due to the Russian-Ukrainian war, with special attention to regional variations in production and pricing.

However, there are key distinctions between the KSE approach and the methodology proposed by the authors of this study, specifically aimed at providing a more accurate and regionally sensitive estimate of livestock production losses. These distinctions are as follows:

1. Approach to determining regional losses. The KSE methodology uses general regional coefficients to estimate losses, based on the share of territory controlled by Ukraine, the proportion of undamaged assets, and other high-level indicators.

The approach proposed by the authors relies on actual, measured losses specific to each region, including the direct impact on animal numbers and production. This region-specific data enables a more precise assessment of economic losses in each area,

which is essential for determining fair reparations and investment needs for regional recovery.

2. *Use of prices for calculations.* KSE calculates losses using pre-war national average prices applied uniformly across all regions, which provides a standardised measure but does not account for variations in local market conditions.

The proposed methodology applies both regional and national prices, allowing for a dual perspective on losses. National prices offer a baseline for comparison, while regional prices reflect the true economic conditions in each area, factoring in local wartime disruptions and logistical constraints. This differentiation enhances the accuracy of loss valuations, especially in regions with significant price fluctuations.

3. *Damage coefficients and logistical disruptions.* The KSE approach includes broad damage coefficients that consider factors such as mined or polluted lands and restricted access to inputs like fuel and spare parts, with a 10 % logistics disruption coefficient estimated by the Ukrainian Club of Agrarian Business.

The proposed approach calculates actual losses by region, factoring in specific local conditions and the intensity of disruptions. By focusing on observed losses and conditions in each region, this methodology delivers more accurate data for forecasting and addressing specific regional needs in the post-war recovery period.

4. *Regional weighting for reparations and recovery.* With detailed regional loss and pricing data, the proposed methodology enables the calculation of regional weighting coefficients that reflect the unique economic impact on each area. These coefficients can later inform the distribution of reparations and targeted investments, ensuring that support is aligned with the specific needs of each region.

The primary data for the study was collected from official statistical sources, including the State Statistics Service of Ukraine, regional agricultural departments, and international reports from organisations such as the Food and Agriculture Organization (FAO). Additionally, open-source data from damage reports published by KSE were used to supplement and validate the findings.

Data on livestock losses was gathered by comparing the number of animals and production volumes before the war (baseline year 2021) with those recorded in 2022. Livestock categories considered in this study include cattle, pigs, poultry, sheep, and goats. The production of milk, eggs, and other related products was also assessed.

The calculation of economic losses was conducted using two main approaches:

1) *National average price approach.* This method uses the average price of livestock products (meat, milk, eggs) across Ukraine in 2021 as a baseline for calculating losses.

2) *Regional price approach.* This method adjusts the economic losses based on regional price differences, reflecting the local market conditions that may have changed due to the war (e.g., disrupted supply chains, regional market isolation, or destruction of infrastructure).

The rationale for using both national and regional prices is to enhance accuracy by accommodating for price variances. National prices ensure consistency across regions, while regional prices reflect local realities, including disruptions due to

logistics, access issues, and supply chain breakdowns. The conceptual framework of this dual-pricing approach is illustrated in Figure 1.

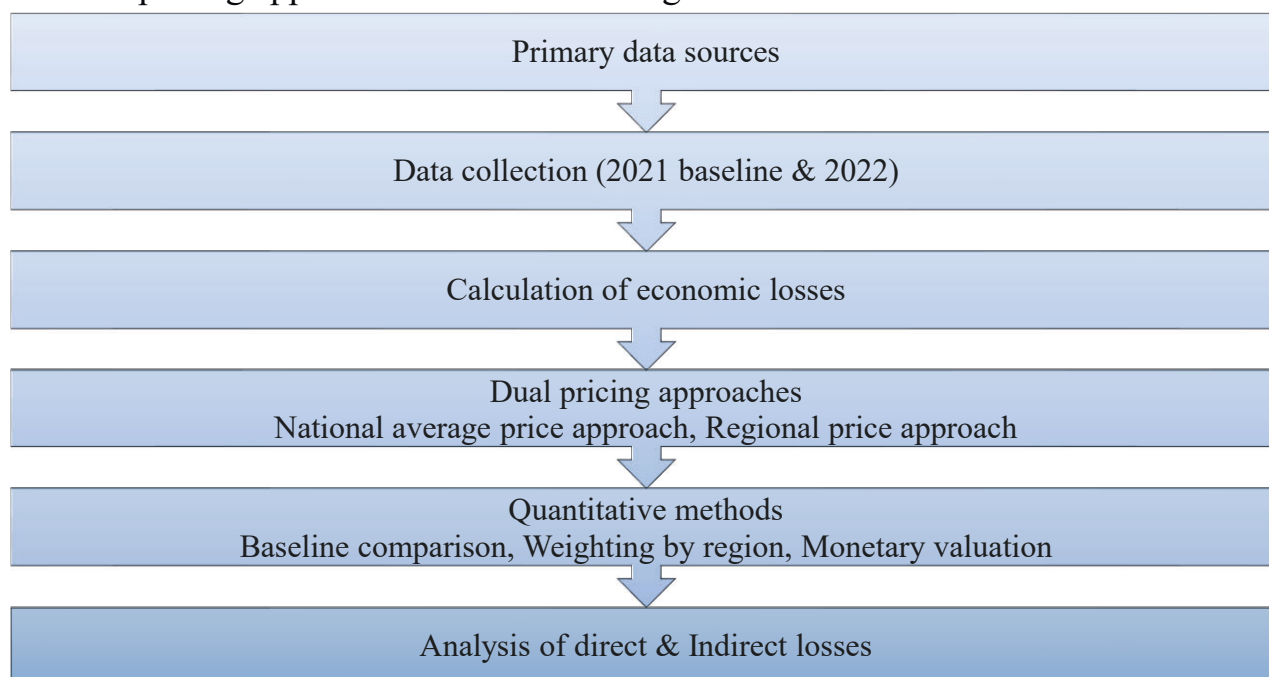


Figure 1. Conceptual framework of the study methodology

Source: created by the authors.

Both approaches were used to ensure a more comprehensive and accurate estimation of losses. When regional price data were not available, national averages were applied to avoid significant gaps in the analysis.

To measure the reduction in livestock production, the following quantitative methods were applied.

1. Baseline comparison. The baseline production volumes from 2021 were used as a reference point. The difference between this baseline and the 2022 production data (post-war) was calculated to determine the total loss.

2. Weighting by region. Since the war's impact varied across regions, we applied a weighting system that considers the share of each region's contribution to national livestock production. For example, regions like Donetsk, Kharkiv, and Kherson, which suffered significant damage, were given higher weight in the final assessment of national losses.

3. Monetary valuation. The volume of lost production (measured in tons for meat, litres for milk, and thousands for eggs) was multiplied by the relevant price for each region or the national average, depending on the method used, to arrive at the total economic loss.

The price index calculations for Figures 3, 4, and 5 were based on the comparison of each region's livestock product prices to the national average price (the averaged national price for 2021). This index for each region was determined using a growth rate calculation principle, assessing the regional price as a percentage above or below the national average. This approach highlights the price variations across regions, with a high index indicating a regional price significantly above the national average and a

low index showing a price below the national average.

In line with KSE's methodology for assessing agricultural war damages, the study distinguished between direct losses (destruction of livestock) and indirect losses (reduced productivity due to factors such as restricted access to feed or veterinary care). This distinction is essential to isolate losses caused specifically by the war from those due to other economic factors.

Direct losses include the destruction or death of livestock due to military actions, such as bombing or occupation.

Indirect losses result from secondary factors, such as displacement of farmers, destruction of supply chains, or reduced access to essential inputs (e.g., feed, medicine).

4. RESULTS

The livestock sector is highly specialised, with a significant portion of farms focusing on specific types of animal production, and it is heavily dependent on other industries, particularly crop production, which supplies essential feed and other resources to sustain livestock operations [17]. This means that even if there are no direct hostilities in a particular area, the livestock sector may not develop or may experience reduced production volumes because feed or medicines for animals, for example, may have been produced in areas where fighting is (or was) taking place or are temporarily occupied by the Russian Federation. The proximity to a frontline zone can also negatively affect livestock farming, as animals are very sensitive to various vibrations and loud noises. The productivity of livestock such as cattle, horses, goats, and sheep are highly dependent on their access to extensive grazing areas, which allows for diverse forage intake essential to their health and productivity [18]. Grazing practices, such as rotational grazing on large tracts of land, enhance forage quality and availability, ultimately supporting livestock productivity [19].

Direct economic losses depend on the amount of lost production and its value. The calculated data as a difference between 2021 and 2022 indicate that the largest losses in 2022 were in poultry and pigs in live weight – 182.5 thousand tons and 148.6 thousand tons, respectively. Regionally, the most significant losses were recorded in Donetsk, Kharkiv, and Kherson regions (Table 1).

The analysis of economic losses due to livestock losses in live weight as a result of the war in 2022 shows significant regional and species-specific differences. Total losses for Ukraine amount to 72.5 million euro for cattle, 143.9 billion euro for pigs, and 168.6 billion euro for poultry, based on national average prices. However, estimates based on regional prices yield somewhat different results, indicating the appropriateness of using regional indicators for a more accurate assessment of economic losses.

The observed increase in certain production indicators in Table 1 can be attributed to several potential factors. One primary reason is the enhancement in livestock productivity, which may result from improved breeding practices, better feed management, or optimised farming conditions in stable regions.

Table 1

Livestock losses (in live weight) due to the war in 2022, tons

Region	Cattle	Pigs	Poultry	Sheep & Goats	Horses
<i>Ukraine</i>	-75403.3	-148605.6	-182482.5	-646.7	-1099.3
Vinnitsia	-733.3	-2532.0	-16044.2	-9.0	-92.3
Volyn	294.5	-2325.1	-32252.8	-46.2	-25.0
Dnipropetrovsk	-600.0	-3365.6	-12269.4	-2.7	0.0
Donetsk	-7264.9	-58549.2	-50596.4	-10.0	0.0
Zhytomyr	-3793.8	-2126.2	-1365.9	-316.5	-475.7
Zakarpattia	-1378.1	-483.1	-245.8	17.3	33.3
Zaporizhzhia	-8895.7	-17786.7	-3361.8	-6.6	n/d
Ivano-Frankivsk	-2766.8	3498.1	-247.4	-14.1	-29.9
Kyiv	780.5	131.7	-11879.3	-16.3	-25.0
Kirovohrad	618.2	-1155.2	-784.5	-2.8	-8.3
Luhansk	-3107.8	-4436.9	-1196.0	-15.2	n/d
Lviv	-10332.3	4846.7	-1157.8	-74.5	-173.2
Mykolaiv	-2901.3	-623.1	-4235.5	-4.8	-28.6
Odesa	-940.5	1611.0	-405.7	-11.6	-12.0
Poltava	-322.2	-14511.4	42.8	-2.7	-9.5
Rivne	-788.8	180.0	1028.1	-49.2	-19.9
Sumy	-1851.2	-4067.5	-5821.6	-1.3	-6.9
Ternopil	1327.9	-1705.3	-1351.9	-21.1	-37.0
Kharkiv	-10388.7	-19261.8	-12008.2	-2.1	-38.5
Kherson	-17734.0	-12516.2	-22961.7	-15.2	-80.0
Khmelnyskyi	807.4	910.7	2454.9	-11.2	-23.1
Cherkasy	-286.8	-3160.2	-3092.4	-4.8	-10.0
Chernivtsi	-1060.2	0.0	2483.6	-6.2	-4.5
Chernihiv	-256.9	121.3	-1207.2	-2.7	0.0

Note. n/d – no data.

Source: calculated by the authors based on data from the State Statistics Service of Ukraine.

Another significant factor could be the relocation of production to relatively stable regions, away from areas heavily impacted by military conflict. As producers face disruptions in unstable territories – such as occupied or frontline regions – they may transfer operations to safer locations, allowing production levels to stabilise or even increase in these more secure areas. This strategic relocation can mitigate risks and sustain production continuity despite regional instability.

The largest losses were recorded in the regions most affected by active hostilities. For example, in the Donetsk region, economic losses from the loss of pigs and poultry amounted to 52.4 million euro and 41.6 million euro, respectively (based on regional prices), the highest figures in the country. Significant losses were also recorded in Kherson and Kharkiv regions (Table 2).

Table 2

Economic damages resulting from the loss of livestock (in live weight) caused by the war in 2022, by types of livestock and poultry

Region	Economic damage (-), million euros									
	Calculated based on:									
	Average price in Ukraine					Regional price				
	Cattle	Pigs	Poultry	Sheep and goats	Horses	Cattle	Pigs	Poultry	Sheep and goats	Horses
Ukraine	-72.5	-143.9	-168.6	-0.7	-0.4	-69.7	-137.0	-169.1	-0.7	-0.9
Vinnitsia	-0.7	-2.5	-14.8	0.0	0.0	-0.7	-2.4	-16.0	0.0	0.0
Volyn	0.3	-2.3	-29.8	-0.1	0.0	0.3	-2.2	-29.7	-0.1	0.0
Dnipropetrovsk	-0.6	-3.3	-11.3	0.0	0.0	-0.6	-3.1	-11.9	0.0	0.0
Donetsk	-7.0	-56.7	-46.7	0.0	0.0	-6.5	-52.4	-41.6	0.0	0.0
Zhytomyr	-3.6	-2.1	-1.3	-0.4	-0.2	-3.6	-2.0	-1.1	-0.4	-0.3
Zakarpattia	-1.3	-0.5	-0.2	0.0	0.0	-1.3	-0.5	-0.2	0.0	0.1
Zaporizhzhia	-8.6	-17.2	-3.1	0.0	0.0	-7.4	-16.2	-1.6	0.0	0.0
Ivano-Frankivsk	-2.7	3.4	-0.2	0.0	0.0	-2.7	3.4	-0.2	0.0	-0.1
Kyiv	0.8	0.1	-11.0	0.0	0.0	0.8	0.1	-11.5	0.0	0.0
Kirovohrad	0.6	-1.1	-0.7	0.0	0.0	0.6	-1.1	-1.5	0.0	0.0
Luhansk	-3.0	-4.3	-1.1	0.0	0.0	-2.8	-3.8	-1.1	0.0	0.0
Lviv	-9.9	4.7	-1.1	-0.1	-0.1	-9.7	5.0	-1.0	-0.1	-0.2
Mykolaiv	-2.8	-0.6	-3.9	0.0	0.0	-2.7	-0.6	-3.4	0.0	0.0
Odesa	-0.9	1.6	-0.4	0.0	0.0	-1.0	1.5	-0.2	0.0	0.0
Poltava	-0.3	-14.1	0.0	0.0	0.0	-0.3	-14.2	0.0	0.0	0.0
Rivne	-0.8	0.2	0.9	-0.1	0.0	-0.7	0.2	0.8	-0.1	0.0
Sumy	-1.8	-3.9	-5.4	0.0	0.0	-1.8	-3.8	-4.2	0.0	0.0
Ternopil	1.3	-1.7	-1.2	0.0	0.0	1.2	-1.6	-0.9	0.0	-0.1
Kharkiv	-10.0	-18.7	-11.1	0.0	0.0	-9.7	-18.3	-10.9	0.0	0.0
Kherson	-17.0	-12.1	-21.2	0.0	0.0	-16.5	-11.5	-28.0	0.0	0.0
Khmelnitskyi	0.8	0.9	2.3	0.0	0.0	0.7	0.9	1.6	0.0	0.0
Cherkasy	-0.3	-3.1	-2.9	0.0	0.0	-0.3	-3.0	-3.3	0.0	-0.1
Chernivtsi	-1.0	0.0	2.3	0.0	0.0	-1.3	0.0	3.2	0.0	0.0
Chernihiv	-0.2	0.1	-1.1	0.0	0.0	-0.3	0.1	-0.9	0.0	0.0

Source: calculated by the authors based on data from the State Statistics Service of Ukraine.

Thus, the economic damages resulting from the loss of livestock (in live weight) caused by the war in 2022 were the highest in Donetsk (100.5 million euro) and Kherson (56.0 million euro) regions (Figure 2). Significant losses were also recorded in Kharkiv, Volyn, Zaporizhzhia, and Vinnitsia regions.

It is worth noting that the amount of economic damages resulting from the loss of livestock (in live weight) significantly depends on the selling price of each type of livestock. In natural terms, the largest losses of livestock are distributed somewhat

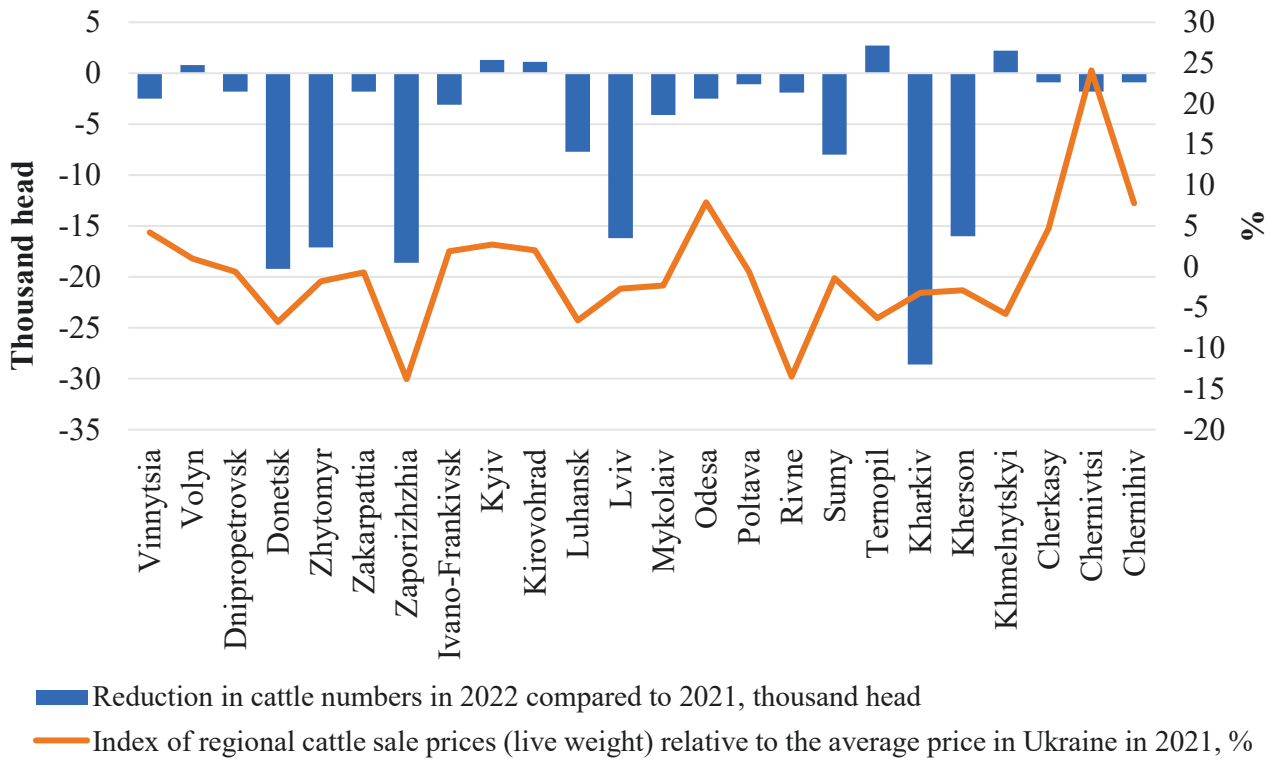


Figure 3. Reduction in cattle numbers and regional cattle selling price index (in live weight) in Ukraine caused by the war

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

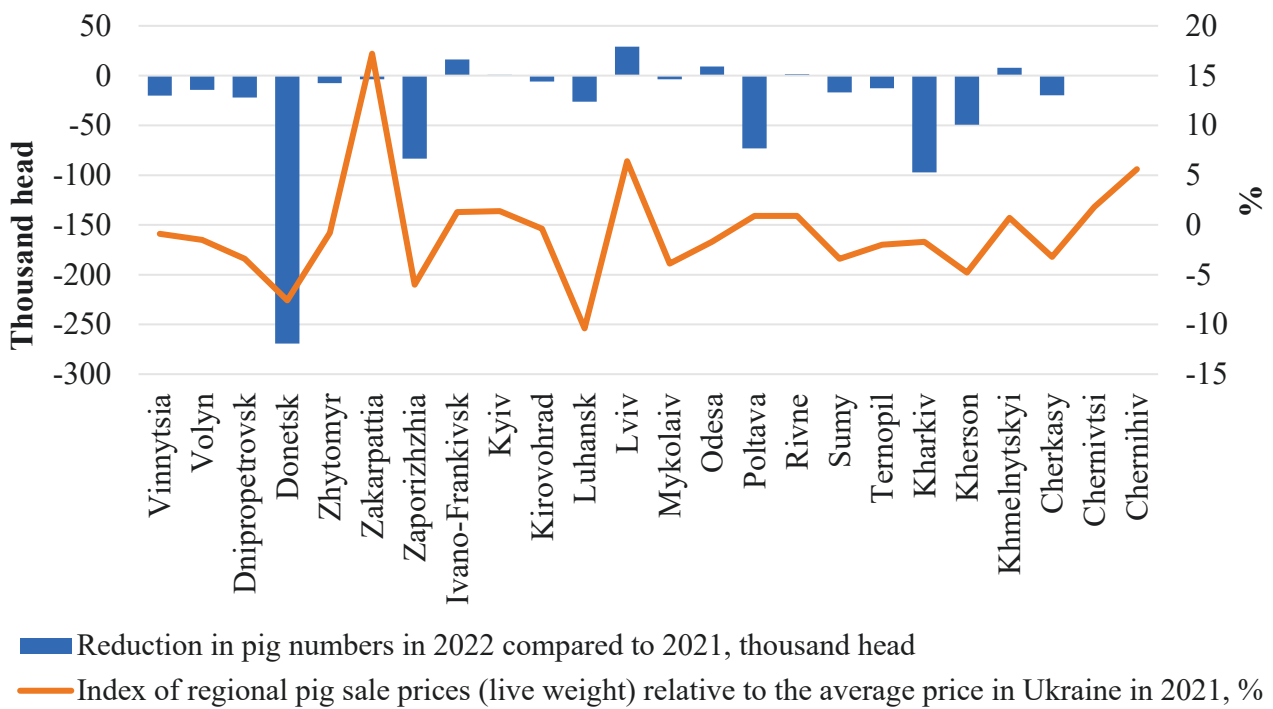


Figure 4. Reduction in pig numbers and regional pig selling price index (in live weight) in Ukraine caused by the war

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

The largest losses in poultry numbers (over 1.0 million heads) were recorded in the Volyn (2.1 million heads), Donetsk (3.4 million heads), Kharkiv (3.6 million heads), and Kherson (3.7 million heads) regions (Figure 5). At the same time, the actual selling price for poultry (in live weight) in these regions is lower than the national average: in Volyn by 0.4 %, Donetsk by 11.1 %, and Kharkiv by 2.0 %. An exception is the Kherson region, where the actual selling price for poultry (in live weight) was 31.8 % higher than the national average.

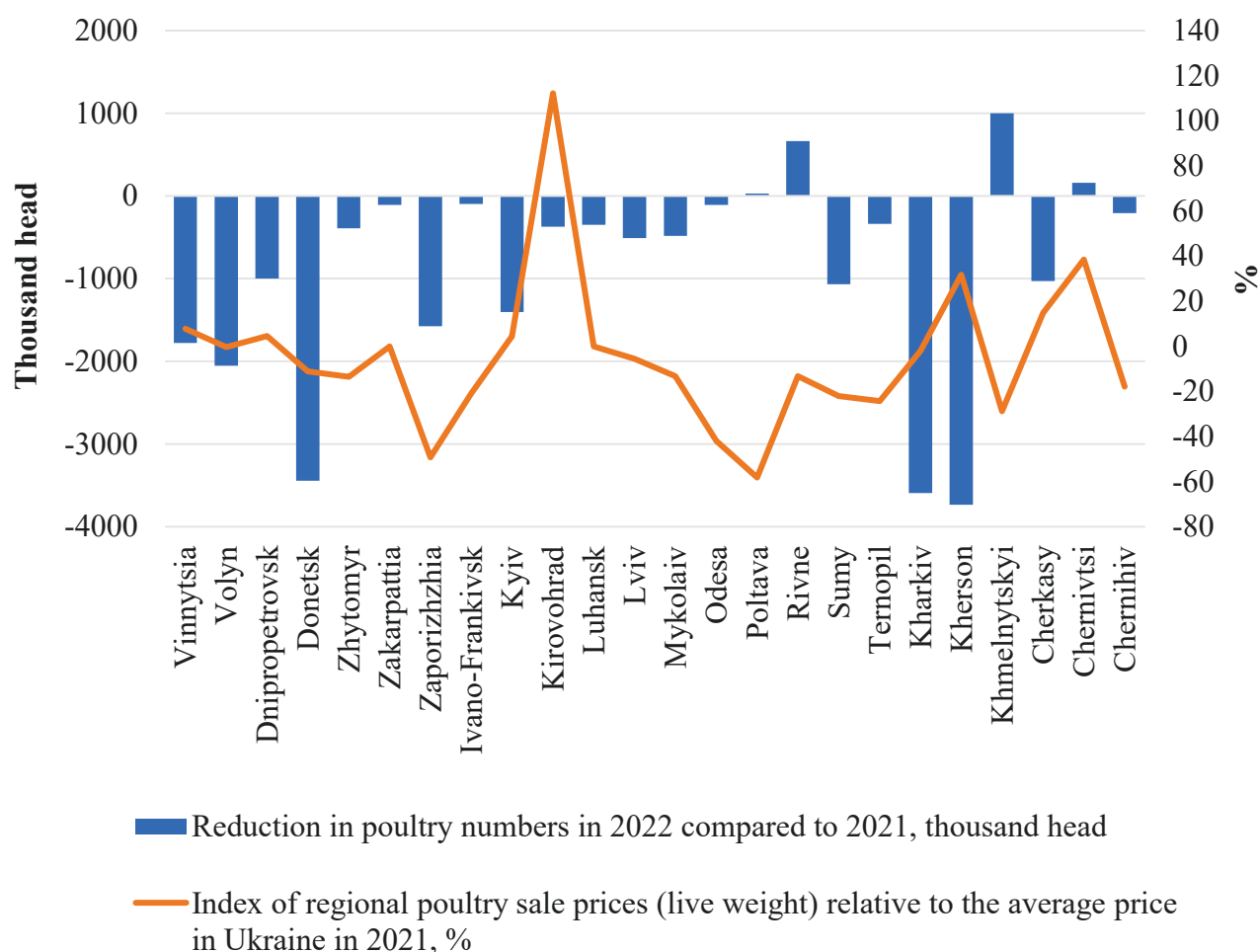
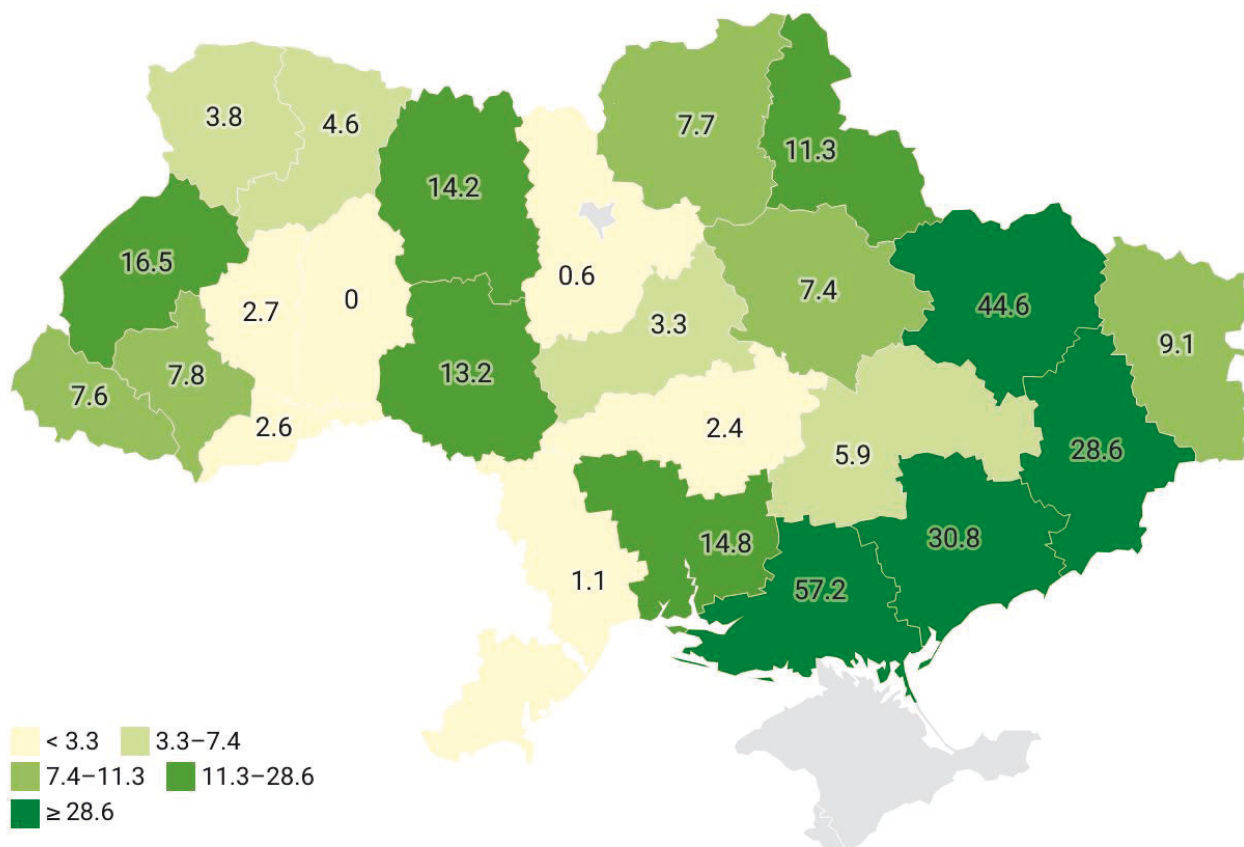


Figure 5. Reduction in poultry numbers and regional poultry selling price index (in live weight) in Ukraine caused by the war

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

The highest volumes of economic damages (over 28 million euros) based on regional prices due to milk losses in Ukraine’s regions in 2022 were recorded in three regions: Donetsk – 28.6 million euros, Zaporizhzhia – 30.8 million euros, Kharkiv – 44.6 million euros, and Kherson – 57.2 million euros (Figure 6).

In the dairy cattle sector, the volume of economic losses, unlike the cattle, pig, and poultry farming sectors, is much less dependent on regional pricing policies, as price differences between regions are insignificant. Notably, in three out of the four regions with the highest economic losses (Donetsk, Zaporizhzhia, and Kharkiv regions), the price of milk was lower than the national average (Figure 7).



Created with Datawrapper

Figure 6. Economic damages (based on regional prices) resulting from milk losses in Ukrainian regions in 2022 caused by the war, million euros

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

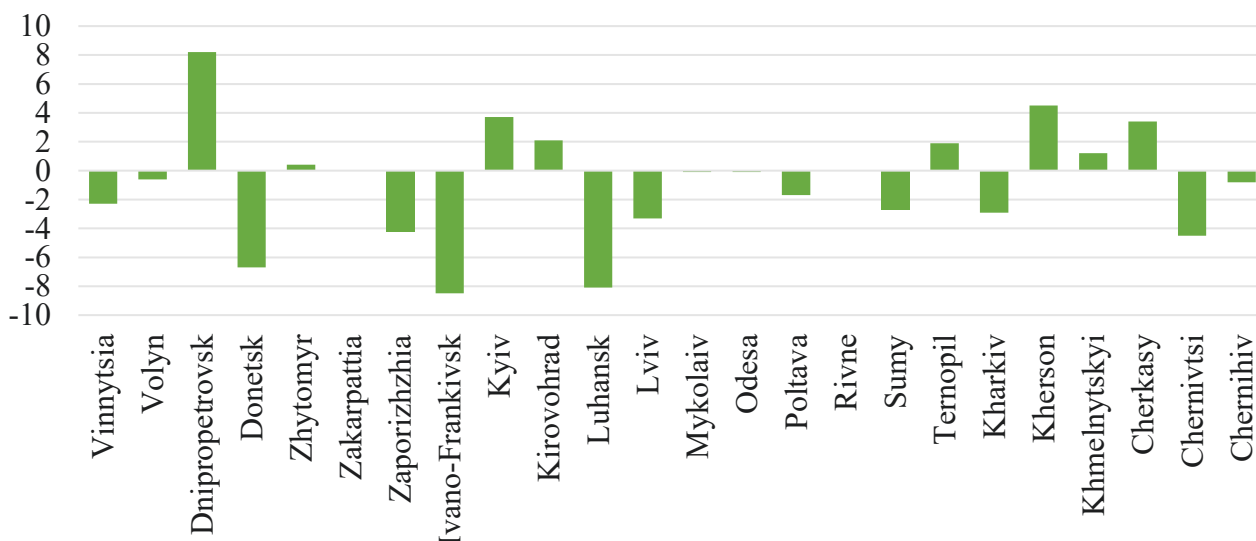


Figure 7. Regional milk selling price index relative to the national average in Ukraine in 2021, %

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

Economic damages are closely correlated with the losses in cow numbers and milk production, which, in turn, depend on cow productivity (Figure 8). The largest losses in cow numbers (over 15,000 heads) were recorded in the Donetsk (19.0 thousand heads), Zaporizhzhia (19.2 thousand heads), Kharkiv (26.4 thousand heads), and Kherson (32.2 thousand heads) regions, where active hostilities are ongoing (or have occurred) or which are temporarily occupied by the Russian Federation. The highest volumes of milk losses (over 100,000 tons) were also recorded in these regions: Donetsk – 115.6 thousand tons, Zaporizhzhia – 121.2 thousand tons, Kharkiv – 173.4 thousand tons, and Kherson – 206.7 thousand tons. The Figure presents the actual milk yield for 2022 rather than an index relative to 2021. This indicator is shown to explain the partial discrepancy between milk losses and livestock losses, as regional differences in cow productivity significantly influence milk output.

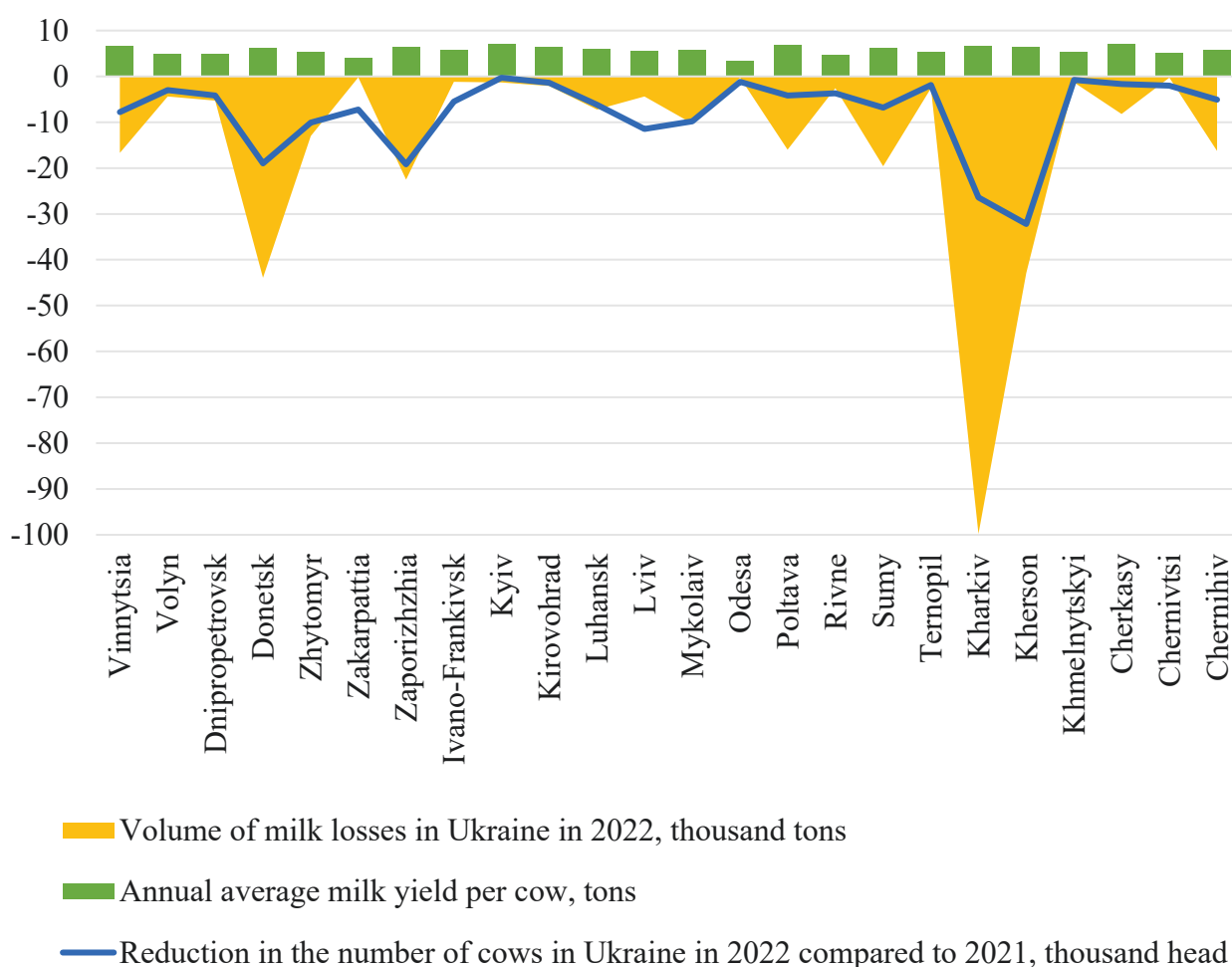


Figure 8. Reduction in cow numbers, milk loss volumes, and cow productivity in Ukraine caused by the war

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

The largest economic losses (over 10 million euro) due to egg production losses in Ukraine’s regions caused by the war in 2022 were recorded in Donetsk (23.5 million euro), Kyiv (10.3 million euro), Kharkiv (13.3 million euro), and Kherson (29.4 million euro) regions (Figure 9).

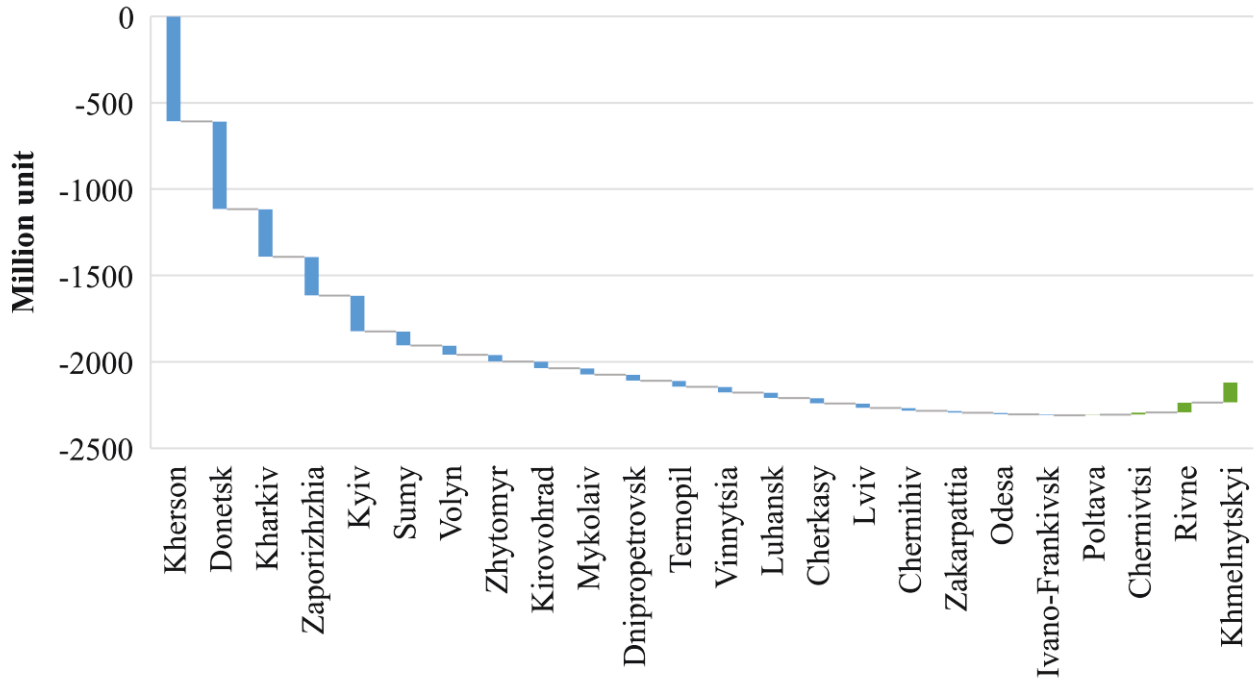


Figure 10. Egg loss volumes in Ukraine caused by the war in 2022, million units
 Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

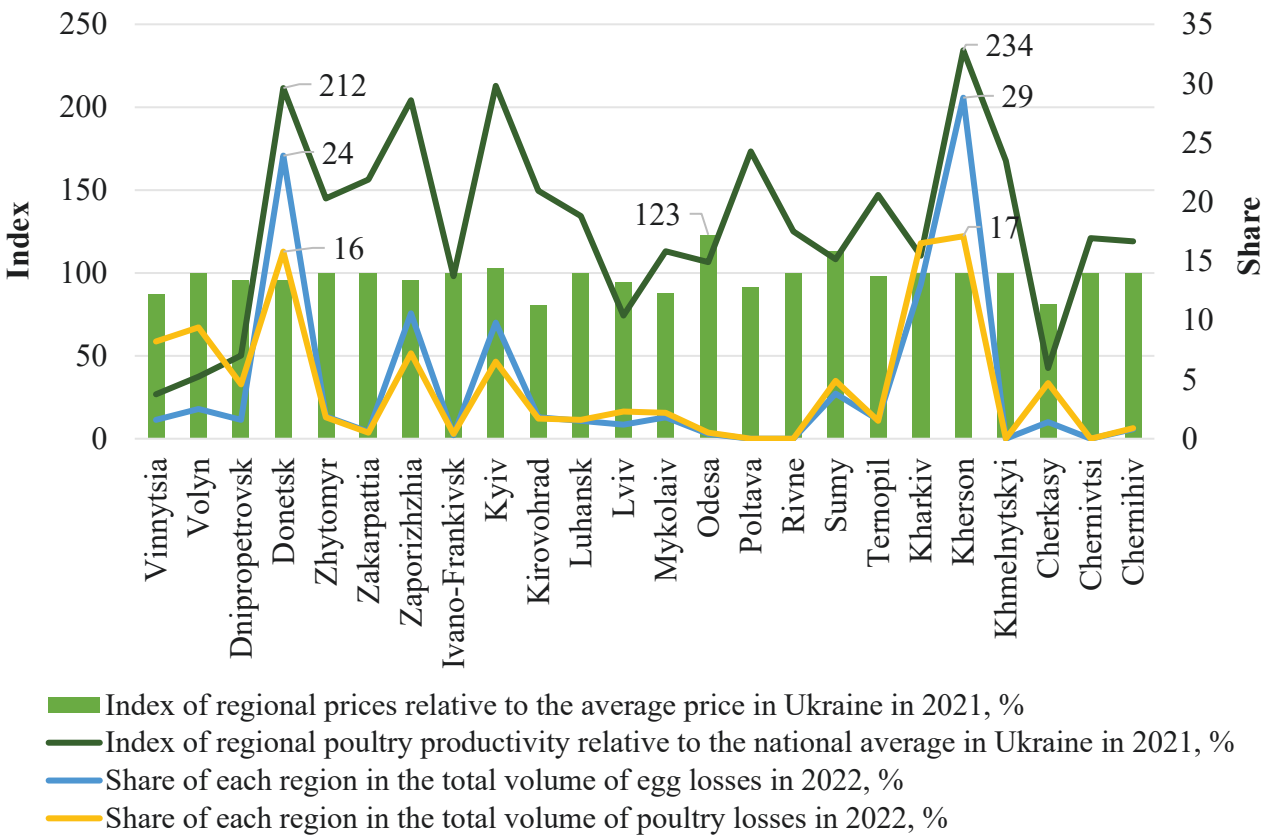


Figure 11. Share of Ukrainian regions in the total reduction of poultry numbers and egg loss volumes, regional price and productivity indices
 Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

In the Rivne region, poultry stock and productivity growth reached 663.2 thousand heads and 25.1 %, respectively, in Khmelnytskyi – 1,000.1 thousand heads and 67.7 %, and in Chernivtsi – 160.1 thousand heads and 21.1 %.

According to the calculations, economic losses from livestock production losses in Ukraine due to the war in 2022 amount to over 785 million euro based on regional sale prices and over 800 million euro based on national average sale prices (Table 3). The data demonstrate significant losses in Ukraine’s agricultural sector. These losses, both in quantitative and economic terms, highlight the large-scale damage the war has caused to the country’s agri-food complex.

Table 3

Economic damages resulting from livestock production losses in Ukraine caused by the war in 2022

Product type	Food loss, thousand tons	Economic damage					
		Million euros		Share of losses, %			
		National sale price	Regional sale price	Total share of livestock losses		By product type	
				National sale price	Regional sale price	National sale price	Regional sale price
Livestock (in live weight) – total	408.2	386.1	377.4	48.2	48.0	100.0	100.0
Cattle	75.4	72.5	69.7	9.1	8.9	18.8	18.5
Pigs	148.6	143.9	137.0	18.0	17.4	37.3	36.3
Poultry	182.5	168.6	169.1	21.1	21.5	43.7	44.8
Sheep and goats	0.6	0.7	0.7	0.1	0.1	0.2	0.2
Horses	1.1	0.4	0.9	0.0	0.1	0.1	0.2
Milk	1144.7	303.2	298.6	37.9	38.0	x	x
Eggs, million units	2309.6	111.5	109.6	13.9	14.0	x	x
Total	x	800.9	785.6	100.0	100.0	x	x

Source: calculated by the authors based on data from the State Statistics Service of Ukraine.

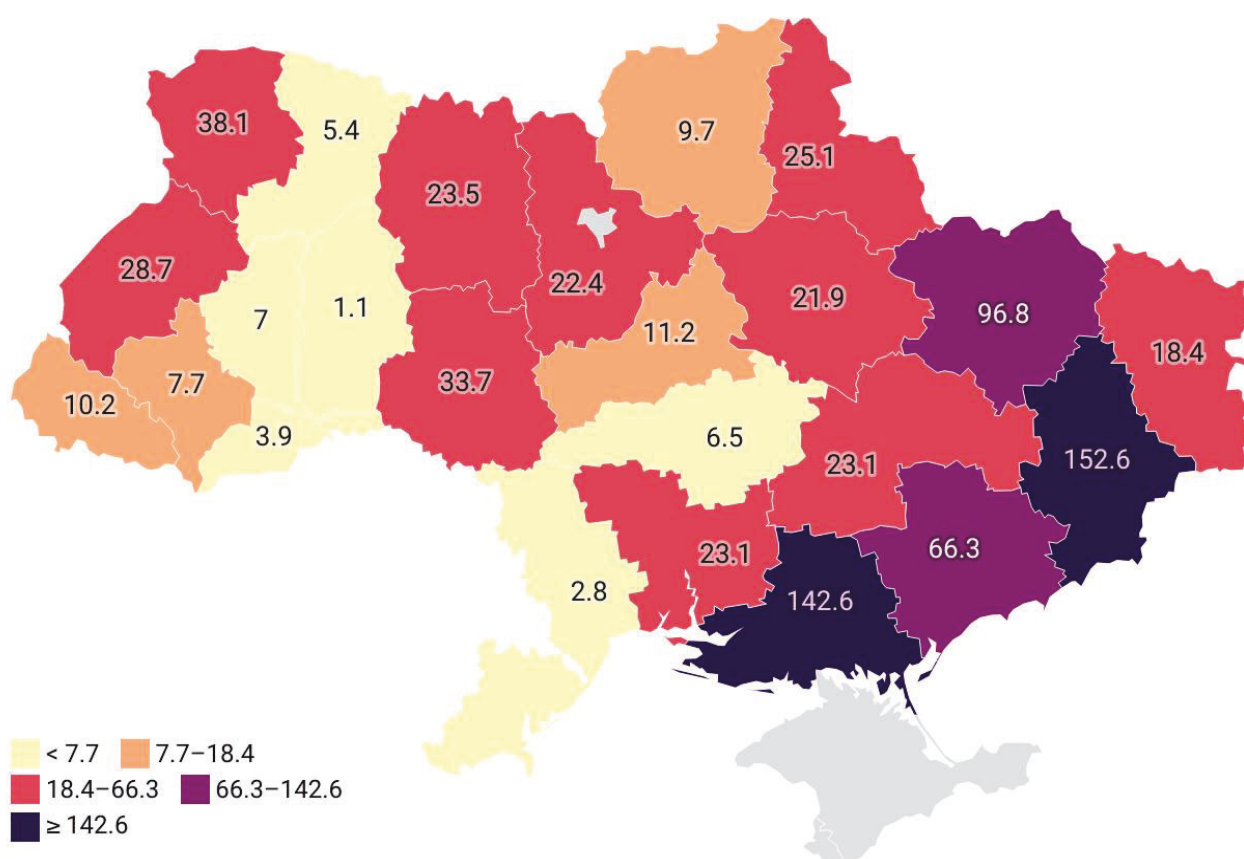
According to the data, the largest losses were recorded in the livestock category (408.2 thousand tons in live weight), leading to economic damages of 386.1 million euros based on national selling prices, representing over 48 % of total losses in the livestock sector. In this category, poultry losses were the most significant, amounting to 182.5 thousand tons, which accounted for more than 43 % of the total livestock losses in live weight. Pig losses were also substantial, reaching 148.6 thousand tons, corresponding to 37 % of the total losses. In the cattle sector, 75.4 thousand tons were lost, making up over 19 % of the total losses. Losses in other livestock categories, such as sheep, goats, and horses, were minor compared to the main categories but still highlight the widespread nature of economic damages.

Losses in milk production amounted to 1,144.7 thousand tons, accounting for 37.9 % of the total losses, while losses in the egg category reached 2,309.6 thousand units (13.9 % of total livestock losses).

The analysis also reveals significant variations in economic damages based on selling prices in Ukraine and across regions, indicating regional differences in food

losses and economic damages. These disparities may be attributed to local market conditions, infrastructure damage, and the level of military activity in specific regions.

A significant differentiation in economic damages resulting from food losses caused by the war in 2022 has been identified across various regions and product types. The largest volumes of economic damages due to food losses in 2022 were recorded in regions where active hostilities are ongoing (or have occurred), regions temporarily occupied by the Russian Federation, as well as frontline areas. The first group of such regions includes Donetsk (152.6 million euros) and Kherson (142.6 million euros) regions, while the second group includes Zaporizhzhia (66.3 million euros) and Kharkiv (96.8 million euros) regions (Figure 12).



Created with Datawrapper

Figure 12. Economic damages resulting from food losses in Ukrainian regions caused by the war in 2022, million euros

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

In the majority of regions, the primary portion of economic damages was incurred due to milk losses (Figure 13). Specifically, in 9 regions (Zhytomyr, Zakarpattia, Ivano-Frankivsk, Lviv, Mykolaiv, Rivne, Khmelnytskyi, Chernivtsi, and Chernihiv), the share of economic damages resulting from milk losses exceeds 70 % of the total economic damages sustained in these respective areas. In Vinnytsia, Volyn, Dnipropetrovsk, Kyiv, and Cherkasy regions, considering their natural and climatic zones and specialisation, the highest share of economic damages was caused by poultry

losses (in live weight), while in Donetsk and Poltava regions, it was due to pig losses (in live weight).

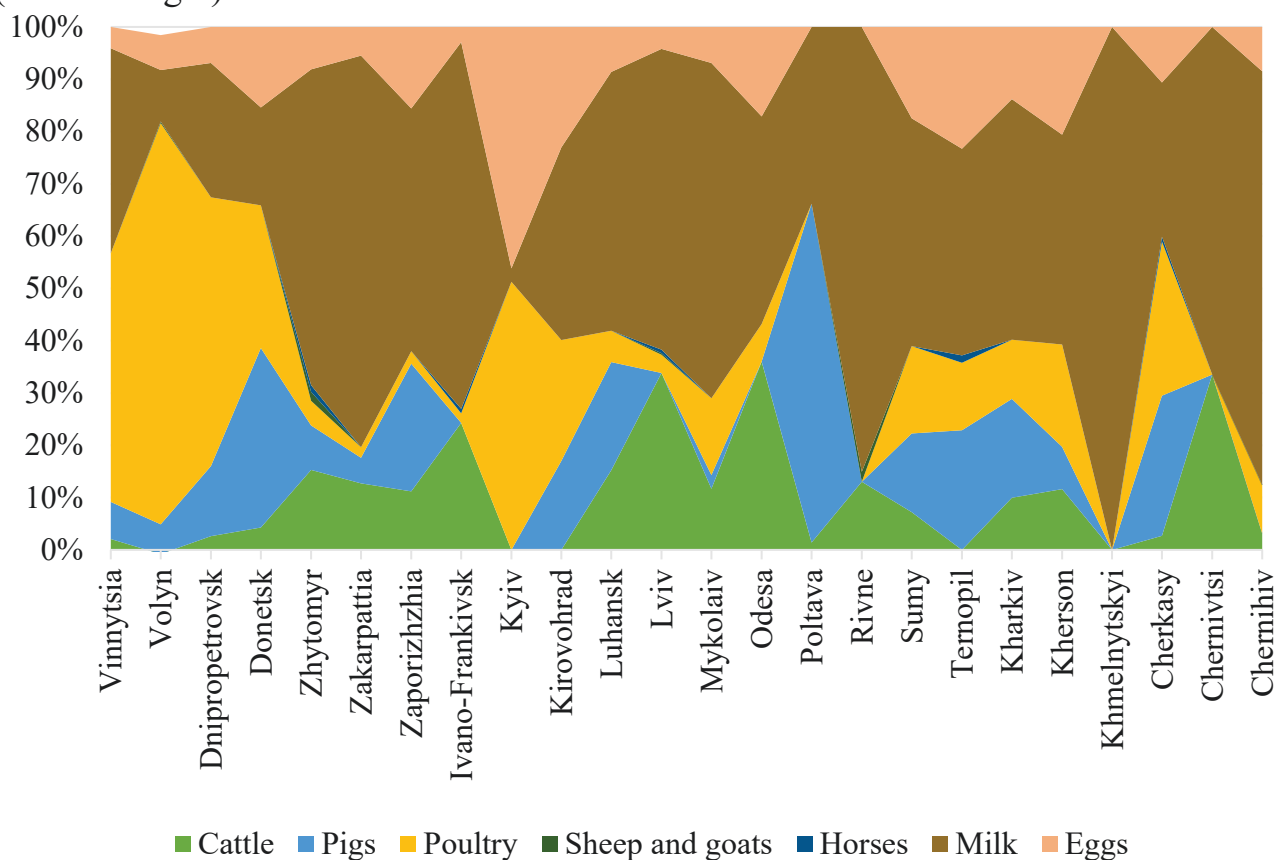


Figure 13. Share of economic damages by product type in the total amount of economic damages from food losses by region, %

Source: calculated and created by the authors based on data from the State Statistics Service of Ukraine.

Thus, the obtained data indicate that the war has significantly weakened Ukraine's agricultural sector, causing substantial losses both in livestock production and economically. Additional recovery measures will be aimed at supporting agricultural enterprises, modernising infrastructure, and enhancing safety under the martial law to minimize future losses.

5. DISCUSSION

The ongoing war between Russia and Ukraine has caused significant damage on Ukraine's agricultural sector, particularly the livestock industry. The war has disrupted agricultural activities through the destruction of infrastructure, loss of livestock, and significant regional disparities in production. In regions such as Donetsk, Kharkiv, Kherson, and Zaporizhzhia, which have been the focus of military actions, the economic losses have been the most pronounced. These regions directly affected by the hostilities or occupation have seen a significant decline in livestock numbers and the destruction of critical agricultural infrastructure, with profound economic consequences. According to the Food Security Cluster, direct and indirect damages in Ukraine's agricultural sector, including livestock, are estimated at billions of euros,

with livestock losses being one of the most severe components of these damages [20].

Several studies have confirmed the sharp decline in production across these regions [21; 22]. The studies highlight that around 25–30 % of agricultural fields remain unsown or abandoned due to active hostilities, and the loss of livestock was especially severe due to the limited access to feed and veterinary services [23]. This corresponds with findings from FAO, which emphasise that ongoing conflicts in key agricultural areas significantly hinder recovery efforts and access to food supplies [24]. Furthermore, disruptions in logistics and supply chains have exacerbated the situation, making it challenging to sustain farming operations, especially in the regions most affected by the war [25].

The war's impact has also been analysed in the context of food security and global market consequences. Research conducted by He et al. quantified the abandonment of cropland and its effect on grain production, estimating that grain production losses in eastern Ukraine amounted to around 31.5 % in 2022 [5]. This dramatic decline in agricultural output extends to livestock production, further endangering both local and global food security. As the Center for Strategic and International Studies notes, the war has transformed food into a “silent weapon”, with Russia capitalising on Ukraine's diminished agricultural capacity to exert influence on global markets [26].

At the regional level, pricing and productivity differences have contributed to the overall economic losses, but these factors play a secondary role to the direct physical impacts of the war. As noted by Rexhepi et al., the agricultural sector's losses are not only financial but also include a severe degradation of productive capacity, which will take years to restore [6]. The severity of these losses underscores the need for substantial post-war recovery efforts, which must include the rehabilitation of agricultural infrastructure, the provision of support for farmers, and the reestablishment of supply chains.

The impact of war on Ukraine's agricultural sector, particularly on livestock, is not only disrupting the country's food supply chain, but also has far-reaching implications for global food security. As Giuliani and Baron highlight, disruptions in one of the world's key agricultural producers like Ukraine cause significant shocks to international food markets, exacerbating price instability and limiting access to essential food products in dependent regions. The war's destruction of livestock farms and associated infrastructure has contributed directly to Ukraine's diminished agricultural output and has had ripple effects across global food supply chains [27].

Furthermore, the economic affordability of food in Ukraine has already been a significant challenge, especially for vulnerable rural households. The war has further exacerbated this issue by reducing food production and disrupting supply chains, which led to an increase in food prices. Households with lower income levels, especially those in rural areas, have been disproportionately affected, with access to essential food products becoming more limited [28]. The authors emphasise that this reduction in food availability, coupled with rising prices, is expected to deepen food insecurity across Ukraine, especially in regions where agricultural production has come to a standstill due to the war.

Another major concern is the environmental consequences of the extensive food losses caused by the war. According to Kotykova et al., food waste and loss contribute to significant environmental degradation, affecting land, water, and other natural resources. The loss of agricultural productivity during the war, coupled with the destruction of crops and livestock, not only exacerbates the environmental strain but also complicates efforts to recover and restore agricultural capacity [29]. The authors stress that reducing food losses could play a critical role in mitigating the environmental impact and should be part of post-war recovery plans.

In addition to the direct agricultural losses, the war has also impacted the broader food systems of Ukraine. Ozturk and Faizi emphasise that the war-induced food price hikes and inflation are not limited to Ukraine but also affect neighbouring countries, which rely on Ukrainian exports. Their research into Turkey's reliance on Ukrainian agricultural imports highlights how disruptions in Ukraine's agricultural sector can cause food price inflation, reduce household purchasing power, and further destabilise regional economies [30]. This underscores the global implications of Ukraine's agricultural crisis, making it clear that the resolution of the war is not only a national concern but a global one.

The Russian-Ukrainian has significantly disrupted the global agricultural sector, impacting both crop and livestock production. Ukraine and Russia are major global suppliers of grains such as wheat, maize, and barley, which are critical components of livestock feed worldwide. The reduction in Ukrainian grain exports has resulted in global feed shortages and increased feed prices, directly affecting livestock production costs and profitability [31]. This surge in feed costs forces many livestock farmers to reduce herd sizes or limit production, leading to a decline in livestock output [32].

The effects of these disruptions extend to international food security, as increased feed costs raise the prices of livestock products globally, creating a compounding effect on food prices [33]. The Food and Agriculture Organization emphasises that such price increases have serious implications for developing countries, where livestock products are essential for nutrition and where price increases have placed significant financial strain on consumers [32].

In addition to direct impacts on livestock production, disruptions in crop production due to the war have created ripple effects across global food supply chains. According to the European Union's analysis, ensuring a stable global food supply requires addressing the feed shortage crisis, as disruptions to feed availability reduce livestock productivity and drive prices higher in both local and international markets [34]. The Organisation for Economic Co-operation and Development (OECD) also highlights that the prolonged war continues to contribute to higher agricultural input costs, including fertilisers and fuel, further burdening livestock producers [31].

These combined pressures highlight the interconnectedness of crop and livestock sectors in global food security. A Carbon Brief report suggests that without stabilising feed supply chains, livestock production will remain vulnerable to shocks in feed costs, which could lead to prolonged high prices for meat, dairy, and other animal products worldwide [35]. The global livestock industry thus faces heightened risks due to feed

shortages and price volatility, underscoring the need for coordinated international responses to stabilise feed and livestock production.

Currently, our conclusions regarding the significance of certain types of products in the overall volume of losses and economic damages seem debatable, given the specialisation of various regions. In this context, we want to emphasise that our conclusions are based solely on food losses in the livestock sector. It is logical to assume that considering the losses in the crop production sector, the conclusions about the significance of losses of certain types of products and economic damages in specific regions may change.

6. CONCLUSIONS

The economic losses caused by the Russian-Ukrainian war in 2022 had a devastating impact on the livestock production sector in Ukraine. Key findings from the study include:

1. **Total Livestock Losses.** The total loss of livestock in live weight amounted to 4,082 thousand tons, leading to economic damages estimated at 800.9 million euros at the national level and 785.6 million euros based on regional prices.

2. **Sector-Specific Losses.** The largest losses were observed in poultry production, with 1,825 thousand tons of live weight lost, accounting for 43 % of the total livestock losses and economic damages of 168.6 million euros (regional pricing). Losses in the pig sector reached 1,486 thousand tons, representing 37 % of the total livestock losses, with economic damages estimated at 143.9 million euros (regional pricing). Cattle losses amounted to 754 thousand tons, or 19 % of total losses, causing economic damages of 72.5 million euros (national pricing).

3. **Regional Disparities.** Regions most affected by the war include Donetsk, Kharkiv, and Kherson. These regions experienced the highest economic losses, with Donetsk region alone suffering damages of 152.6 million euros.

4. **Indirect Losses.** In addition to direct livestock losses, the study highlighted the indirect effects of the war, such as reduced access to veterinary care, feed shortages, and damaged infrastructure, further exacerbating the decline in livestock productivity.

The largest volumes of economic losses as a result of food losses caused by the war in 2022 were recorded in areas where hostilities are (or were) being conducted or territories temporarily occupied by the Russian Federation, as well as in front-line regions. The analysis showed that there are significant differences between the regions of Ukraine in the formation of the volumes of food losses and the corresponding economic losses: 1) the volume of received economic losses from losses of farm animals (in live weight) largely depends on the sale price of a certain type of farm animals; 2) in the fields of dairy cattle breeding and egg production, economic losses are formed not only due to the loss of livestock, but to a lesser extent depend on regional differences in prices. Instead, the key factor is the difference in the productivity of cows and poultry, which significantly affects the amount of milk and egg losses, and therefore the total amount of economic losses.

Based on the findings, several key recommendations emerge to support the

recovery and resilience of Ukraine's livestock sector:

1. Targeted financial aid and investments. Regions with the highest livestock and production losses, particularly frontline and recently liberated areas, should be prioritised for financial aid and investment. This support can facilitate infrastructure rebuilding, restocking, and operational recovery, helping stabilise production in the short term and build resilience against future disruptions.

2. Support for regional price stabilisation. Given the regional price disparities revealed in the study, policies that help stabilise regional markets through subsidies, transportation support, or reduced taxation on feed and other inputs could help mitigate the economic impact on producers and consumers.

3. Enhanced logistics and supply chain infrastructure. To address the challenges of disrupted supply chains, investments in resilient logistics networks are essential. This includes secure transportation routes, storage facilities, and access to essential inputs like feed, fuel, and veterinary supplies, which will improve productivity and reduce losses in future conflicts or disruptions.

4. Promotion of sustainable grazing and livestock management practices. Enhancing livestock productivity through sustainable grazing practices and optimised management of available land resources could help offset losses due to reduced herd sizes. Policymakers could support training programs and financial incentives for sustainable practices.

This research provides crucial data for estimating reparations, informing agricultural recovery policies, and addressing the broader economic impact of the war on Ukraine's food security and agricultural sector.

7. LIMITATIONS AND FUTURE RESEARCH

This study recognises several limitations. The availability of real-time data was restricted due to ongoing conflict, which may result in underreporting or incomplete records in heavily affected regions. The analysis focuses primarily on losses at the production stage and does not account for losses in distribution or retail stages of the food supply chain. The study does not assess losses from food waste, which have been increasing during the war but are outside the scope of this research.

The combined methodological approaches provided a comprehensive estimate of the economic losses in Ukraine's livestock sector due to the war, highlighting the significant regional disparities in the scale of damage and helping inform future policy and reparations decisions.

The study does not examine the social consequences of livestock losses on rural communities due to the lack of available statistical data. Future research should focus on how these losses have affected employment in agriculture, income levels of rural residents, and population migration, providing insights into the social and economic stability of farming communities and the broader rural economy.

The environmental consequences of the war for the agricultural sector, such as impacts on soil health, water resources, and biodiversity, are only briefly addressed. Further research is needed to provide a more comprehensive understanding of these

ecological effects, which are critical for assessing the full extent of war-related impacts on agriculture and natural ecosystems in Ukraine.

Future research should explore the long-term effects of war-induced losses on the agricultural sector, particularly the recovery prospects of livestock production in post-war Ukraine. Additional studies are needed to assess the impact of international aid and investment on the revitalisation of the agricultural industry, as well as the potential role of technological innovations in mitigating future losses.

Funding: this research was partially supported by the DAAD Foundation within the framework of the Scholarship Programme “Future Ukraine: Research Grants for Ukrainian Master’s students and researchers, 2024”. Part of the work was carried out during Olena Kotyкова’s fellowship at the University of Bamberg during the winter semester of the 2024/2025 academic year.

Acknowledgments: the authors would like to express their sincere gratitude to the University of Bamberg for providing the resources and support necessary for conducting this research. Special thanks go to the Editorial Board of the International Scientific E-Journal “Agricultural and Resource Economics” and the reviewers for their valuable feedback and constructive suggestions, which significantly improved the quality of this paper.

Conflicts of interest: the authors declare no conflict of interest.

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Citation:

Стиль – ДСТУ:

Kotykova O., Babych M., Pohorielova O., Nadvynychnyy S. Livestock production losses in Ukraine: economic damages caused by the war. *Agricultural and Resource Economics*. 2024. Vol. 10. No. 4. Pp. 74–100. <https://doi.org/10.51599/are.2024.10.04.04>.

Style – APA:

Kotykova, O., Babych, M., Pohorielova, O., & Nadvynychnyy, S. (2024). Livestock production losses in Ukraine: economic damages caused by the war. *Agricultural and Resource Economics*, 10(4), 74–100. <https://doi.org/10.51599/are.2024.10.04.04>.