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FOOD SECURITY REGARDING GRAINS AND OILSEEDS: UKRAINIAN REALITIES IN WARTIME

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Abstract. It is evident that grains and oilseeds represent a pivotal component within the agricultural sector of Ukraine, playing a crucial role in ensuring the nation's food security on a global scale. The *purpose* of the present paper is to evaluate the impact of the ongoing Russian-Ukrainian war on the cultivation of wheat, maize, barley, soya beans, rapeseed, and sunflower seeds, in comparison with the period of the pandemic of COVID-19. The *research methodology* employs econometric tests, optimal modelling, and relevant charts based on official statistics for the years 2019-2024. The research findings reveal that crop yields have remained stable. The judicious management of natural risks in farming has engendered more stable yields of maize and selected oilseeds, thereby demonstrating adaptability and mitigating the adverse effects of hardships. The research *results* support the *hypothesis* of substantial harvest losses (ranging from 22% to 37%) and a decline in export revenues (exceeding 65%) due to a reduction in harvested areas in the eastern regions of Ukraine that are situated within the military conflict zone. There has been a noticeable drop in production volumes for wheat and barley. Ukrainian exporters have suffered from disrupted supply chains and have had to change their logistics, relying on major importers from Spain, Poland, Romania, Turkey and China instead. Research *recommendations* emphasise the importance of strategic crop choices, including eco-friendly and more productive rapeseed and soya beans, which have partly displaced sunflower seeds. It is also advisable to adhere to optimal proportions when producing grains, taking into account the beneficial prevalence of maize, which can help to tackle the volatility of harvests and export incomes, which varied by up to 69%. The research *concludes* that the war has placed an enormous burden on Ukrainian agriculture, which has been striving to remain resilient and contribute to global food security. The present study highlights practical strategies that could help to overcome future international crises that threaten the sustainable development of the food security system.

Keywords: grains and oilseeds, lost export incomes, natural risks, production optimisation, yield fluctuations.

JEL Classification: C12, C70, Q13, Q17

1. Introduction

A disaster is defined as an event that leads to serious harm to people, property, and the environment. This phenomenon poses a significant threat not only to national economies but also to the well-being of the entire community. Disasters are classified as either natural or human-made, depending on the sources of their occurrence. In the contemporary era, natural and human-made disasters are inextricably linked, particularly with regard to climate change and pollution resulting from anthropogenic activities. Agriculture is susceptible to the deleterious effects of disasters, which have the potential to compromise food security. On February 24, 2022, the Russian Federation instigated a large-scale invasion of Ukraine, which had a significant impact on the national agricultural sector. As of the summer of 2024, it suffered heavy losses of 83.1 billion USD in terms of revenue (Andrienko et al., 2024). This would be extremely detrimental, given that Ukraine is known as one of the world's foremost breadbaskets. It exports grains and oilseeds to many countries in Africa and Asia, including low-income nations that depend heavily on wheat, maize, and sunflower oil from Ukraine. Therefore, the war has an extensive impact on both national and global food security. Undeniably, the cultivation of crops in Ukraine is vulnerable to a range of perils, including the potential for crop freezing, drought, flood, and erratic wind conditions, which have been known to cause substantial destruction on occasion. However, in contrast to the ambiguity surrounding climate change and the pandemic, military

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conflicts are a direct cause of the disruption to the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 16 (Peace, Justice and Strong Institutions) (Ben Hassen and El Bilali, 2022; Galanakis, 2023). Ukrainian farming currently operates under extreme pressure, but it finds ways to adjust to circumstances and work proactively to overcome hardships. This unprecedented experience demonstrates flexibility, resilience and resistance. Therefore, it is worth exploring to help other countries withstand future food crises and shocks with enriched scientific knowledge.

2. Literature Review

Farming is an industry that is vulnerable to a range of natural risks, which are compounded by shifting climatic patterns and environmental factors. These include temperature, precipitation, wind, and outbreaks of pests and crop diseases, which can alter vegetation conditions and the quality of harvests. Yuan et al. (2024) posited that in order to mitigate the deleterious effects of ongoing global warming, agricultural production strategies must incorporate water-efficient irrigation, fertilisers with enhanced nutrient properties, the cultivation of weather-resistant crop varieties, and the implementation of sustainable closed-loop agricultural techniques based on resource recycling. These findings are in alignment with those of Kar et al. (2024). These scholars proved that changing climatic scenarios and an evolving environment impact the performance of all agricultural sectors, including crop production, livestock farming and fisheries. However, smart forecasting of adverse weather patterns can help to address issues such as variations in annual rainfall, heat waves and the uncontrolled spread of weeds.

Khatri et al. (2024) and Tingey-Holyoak et al. (2024) demonstrated that climate risks, manifested through floods, droughts, and other natural hazards, lead to the depletion of limited agricultural resources, such as arable land and water. This results in significant crop losses and farmer bankruptcy, thereby undermining food security. To address this issue, agricultural stakeholders must reconsider policy frameworks for sustainable agriculture and address the food system in terms of its social, environmental and economic dimensions. Verma et al. (2025) and Alotaibi (2023) recommended alleviating the multifaceted impacts of irregular heatwaves, floods, devastating pest infestations, and other disastrous extremes through interdisciplinary integration. This approach encompasses advanced biotechnological achievements and climate-smart practices, ensuring the long-term adaptation of food systems in risky environments. Similar ideas were proposed by Benitez-Alfonso et al. (2024). They created a roadmap that covers current knowledge on crop cultivation and management strategies, which can be used to boost the intensification of sustainable agriculture and climate resilience. This is a powerful response to the intensification of natural disasters and the increasing risks to farming.

Misaal et al. (2023) investigated the impact of climate change on crop production in South Asia. They identified extremely cold winters, severe hot summers, shifting seasons and unpredictable precipitation as the strongest evidence of global warming leading to dramatic natural disasters. Therefore, farmers must be equipped with cutting-edge practices to address emerging food insecurity. Schmidt and Felsche (2024) analysed the impact of climate change on the yields of key grain crops such as wheat, maize and barley. Their findings provided in-depth insights into the climatic factors behind harvest anomalies observed in European countries. Similar risks apply to Ukrainian grain and oilseed production. Therefore, the European mitigation strategies offered and those employed by Ukrainian farmers are mutually beneficial in helping them to withstand natural disasters and climatic challenges.

Military conflicts are among the most powerful factors that jeopardise food security. Therefore, it is urgent, timely and relevant to explore the repercussions of the Russian-Ukrainian war in different countries. The corresponding research analysed lessons from previous threats to the food sector, highlighting effective approaches that can be implemented when food security is at risk, food markets are in turmoil and poor households cannot survive without external assistance (Abay et al., 2023). Mukhtar (2023) observed that the rapid escalation in food prices provided indisputable evidence of the economic spillover effects of the war, which was being experienced on a global scale. Conversely, scholars have posited that the most pronounced deleterious cascading effects on food security can be averted through the provision of energy security, diversified sources of agricultural inputs, transparent trade, and unlimited exports (Zhou et al., 2023; El Bilali and Ben Hassen, 2024). A considerable number of scientists have expressed concern regarding the ecological ramifications of the hostilities, as they are inflicting substantial harm on the environment in the Black Sea region, which is renowned for its fertile soils and favourable climatic conditions conducive to the cultivation of staple crops (Portner et al., 2022; Chowdhury et al., 2023). Land contamination caused by this disaster contributes to the irreversible depletion of the Earth's resources. Alongside other negative climate change patterns, the implications of this military disaster significantly hinder the inevitable task of feeding 50 billion people by 2050.

Chepeliev et al. (2023) and Waldl et al. (2024) concluded that the observed and expected consequences appeared to be less severe in developed EU countries.

Meanwhile, Glauben et al. (2022) emphasised that soaring grain and oilseed crop prices pose a critical risk to countries in the Middle East, North Africa, and sub-Saharan Africa, whose populations rely heavily on food imports. As noted by Kozielec et al. (2024) and Shevchuk et al. (2023), supply shocks caused by the war spread to low-income countries, worsening the availability and affordability of nutritious meals and exposing many people to acute food insecurity. A comprehensive bibliometric analysis of studies on the impact on the food sector concluded that strategies and initiatives to support food security during crises and shocks must be adapted to the specific characteristics and limitations of the countries in which they are implemented (Filho et al., 2023). This is particularly pertinent in the case of Ukraine, which is at the heart of the conflict. Ukrainian agriculture is bearing an incredible burden. The **purpose** of the present study is twofold: firstly, to clarify current trends, and secondly, to specify Ukrainian practical developments on how to mitigate food insecurity in the present conditions complicated by natural risks of farming. To a certain degree, the present research endeavours to address this lacuna by seeking to examine, evaluate and categorise this phenomenon from a scientific perspective.

3. Methodology

The **research focused** on the production of grain and oilseed crops in Ukraine. The **subject of the research** was the dynamics of the production and trade of these crops from 2022 to 2024. The study **hypothesised** that the war (rather than climatic risks) had a more negative impact on the yields, harvests and export volumes of the major grain and oilseed crops in Ukraine.

In line with the stated objective, the paper is structured as follows. The **first research task** was to investigate the yields of grain and oilseed crops. These indicators are crucial for efficient farming, which is the key industry in rural areas. The **second task** involved assessing harvests as stepping stones for profitable agribusiness. Finally, the **third task** involved comparing the current Ukrainian agricultural export with the 2019–2021 benchmarks. This part is essential in light of providing global food security and ensuring livelihoods for people in rural areas.

Statistical data analysed for the period 2019–2024 was retrieved from official websites and reliable online sources (State Statistics Service of Ukraine, 2025). The study's methodological framework relied on statistical tests, an optimisation model, comparative analyses and charts to illustrate and support the research conclusions.

Firstly, we applied one-way analysis of variance (Witte and Witte, 2017) to samples of crop yields in M=2 periods – before (2019-2021) and during (2022-2024) the war. The aim of these calculations was to recognize essential differences in yields variations which are caused by the factor other than natural risks. Analysed indicators were distributed into M groups, each containing Nm observations Ynm of the explored indicator, n=1,…,Nm, m=1,…,M. The total sample size was by $N = \sum_{m=1,\ldots,M} \text{Ynm}$. The overall mean over the entire sample was denoted as follows:

$$\bar{\text{Y}} = \sum_{m=1,\ldots,M} \sum_{n=1,\ldots,Nm} \text{Ynm} / \text{N}.$$

The mean over group m was:

$$\overline{\text{Ym}} = \sum_{n=1,\ldots,Nm} \text{Ynm} / \text{Nm}, \ m=1,\ldots,M.$$

The Fisher ratio was calculated by the formula:

$$\text{Fcalc} = \Big(\sum_{m=1,\ldots,M} \text{Nm}\left(\overline{\text{Ym}} - \bar{\text{Y}}\right)^2 / \text{f1}\Big) /,$$

$$/\Big(\sum_{m=1,\ldots,M} \sum_{n=1,\ldots,Nm} \left(\text{Ynm} - \overline{\text{Ym}}\right)^2 / \text{f2}\Big)$$

where f1 = M–1 was the number of degrees of freedom of the between-group variance explained by the influence of the analysed factor, and f2 = N–M was the number of degrees of freedom of the within-group variance not explained by the influence of the analysed factor.

The critical value of the Fisher ratio with the significance level α=0.05 and degrees of freedom f1 and f2 was denoted Fcrit. If the inequality Fcalc >Fcrit holds, then the explored indicator is dependent on the analysed factor with probability (1–α). And vice versa, if the inequality Fcalc ≤ Fcrit is true, then the analysed factor does not cause a significant impact on the explored indicator with probability (1–α).

Yield fluctuations were detected via their covariance over the studied periods, namely:

$$\text{COVm} = \text{SDm} / \overline{\text{Ym}} \cdot 100,$$

where SDm was the standard deviation calculated by the formula:

$$\text{SDm} = \sqrt{\sum_{n=1,\ldots,Nm} \left(\text{Ynm} - \overline{\text{Ym}}\right)^2 / \left(\text{Nm} - 1\right)},$$

m=1,…,M.

Secondly, the paired two sample T-test (Witte and Witte, 2017) was utilised to compare the mean harvests before in 2019-2021 (100%) and in 2022-2024 (Hj in %), j=1,…,J=3. T-test value was calculated by the formula:

$$\text{Tcalc} = \left(100 - \bar{\text{H}}\right)\sqrt{J} \sqrt{\left(\text{J} - 1\right) \sum_{j=1,\ldots J} \left(\text{Hj} - \bar{\text{H}}\right)^2},$$

where $\bar{\text{H}}$ designated the mean of the sample Hj, j=1,…,J.

The one tail critical value with the significance level α=0.05 and degrees of freedom f=J-1 was denoted Tcrit. If the inequality $|Tcalc| > Tcrit$ is true, then $\bar{H}$ differs significantly from 100%, in other words the harvests in 2022-2024 were essentially different from those in 2019-2021 with probability $(1-\alpha)$. And vice versa, if the inequality $|Tcalc| \leq Tcrit$ holds.

Thirdly, the Pareto charts were employed to compare the lost export revenues in 2019-2021 and in 2022-2024. The highest export incomes over the 2019-2024 period were used as benchmarks to rank the explored grain and oilseed crops according to their unrealised commercial potential.

Another research outcome, a model of optimal sown areas, was intended to mitigate risks of growing grain crops and provide higher export incomes concerning K=6 annual scenarios for 2019-2024. The model under consideration comprised three non-negative sought variables, denoted S1, S2 and S3, which corresponded to the shares of cultivation of wheat, maize, and barley, with S1+S2+S3=1. The minimal shares of sown areas of wheat (A1), maize (A2), and barley (A3) were included into restrictions:

$$S1 \geq A1, S2 \geq A2, S3 \geq A3 .$$

CEI denoted the combined export income per ha that was supposed to be the model output. Cik was the export income per ha of the i-th crop under the k-th scenario, i=1,…,I, k=1,...,K. The constraints, which included export income CEIk under the k-th scenario,

$$CEIk = \sum_{i=1,\dots,I} Cik \cdot Si \geq CEI \text{ , k=1,...,K,}$$

assumed CEI to be the guaranteed combined export income per ha. The objective function

$$CEI \rightarrow max$$

meant CEI to be the maximal possible combined export income per ha. The model under discussion encompassed climatic risks and relied on export market prices that are more predictable and stable than wholesale and retail prices in Ukraine. This is due to the current hardships and inflation witnessed before (Vasylieva, 2021). The fluctuations of the combined export incomes by annual scenario (ΔCEIk) were assessed by the formula:

$$\Delta CEIk = (CEIk - CEI) / CEI \cdot 100 \text{ , k=1,...,K.}$$

It is important to note that a similar model for oilseeds requires oil extraction rates that were not available. The preceding theoretical approaches have yielded the ensuing practical outcomes.

4. Results

Ukrainian agriculture encompasses crop and livestock production (Vasylieva, 2016). Growing crops is much more efficient and profitable here, thanks to the fertile soils, favourable climate and hard-working farmers. There are two types of agricultural holdings in Ukraine: agricultural enterprises and households. The latter usually lack resources and often rely on outdated farming technologies. This is why competitive agricultural enterprises are the main producers of grain and oilseed crops, making a significant contribution to global food security (Karamushka et al., 2018). Ukraine is famous for its production of wheat, maize, barley, soya beans, rapeseed and sunflower seeds.

Firstly, in accordance with the research methodology, a one-way analysis of variance and a calculation of the coefficients of variance were employed to analyse the yield dynamics and compare their fluctuations for the period 2019–2024. The results of the calculations are displayed in Table 1 and Figure 1.

Secondly, the dynamics of growing the analysed crops between 2022 and 2024 were assessed using a paired two-sample t-test. Tables 2 and 3 and Figure 2 present the implications of the war for grain and oilseed crop harvests.

Thirdly, Table 3 shows how the map of Ukrainian exports has changed with regard to the main importers of the grains and oilseeds studied.

In accordance with the research methodology, Figure 3 illustrates the deterioration of export losses caused by natural risks during wartime.

Table 4 summarises the results of the model calculations on the possible optimisation of grain crop cultivation. The minimum shares of sown areas under wheat, maize and barley were A1 = 0.458, A2 = 0.346 and A3 = 0.135. The optimal values of the variables found were S1 = 0.458, S2 = 0.407 and S3 = 0.135. The combined export income obtained was CEI = 821.8 (USD/ha).

Table 1
One-way analysis of variance for crop yields

Period	Indicator	Wheat	Maize	Barley	Soya beans	Rapeseed	Sunflower seeds
2019-2021	Mean	41.6	68.3	34.9	23.3	26.0	23.5
	St. Dev.	3.7	10.8	3.1	3.0	3.2	2.9
2022-2024	Mean	43.9	69.2	35.7	24.3	28.8	22.6
	St. Dev.	4.0	7.8	3.1	1.7	0.4	1.6
2019-2024	Fcalc	0.5155	0.0137	0.1107	0.2777	2.3720	0.1915
	Fcrit	7.7086	7.7086	7.7086	7.7086	7.7086	7.7086

Source: author's own compilation

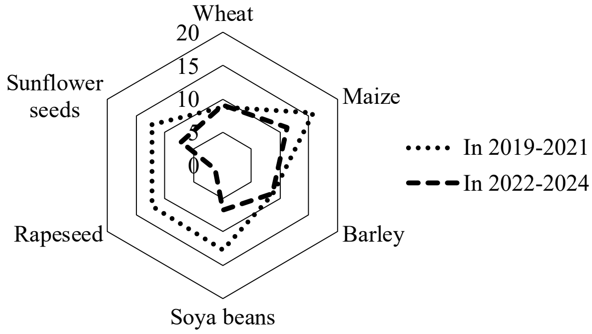


Figure 1. Covariance of crop yields (in %)

Source: author's own compilation

Table 2
Paired two sample T-test on harvests

Indicator	Wheat	Maize	Barley	Soya beans	Rapeseed	Sunflower seeds
Harvest in 2024, %	78.9	74.4	61.3	181.2	122.8	73.4
Harvest in 2023, %	76.0	86.0	63.6	142.4	143.0	85.5
Harvest in 2022, %	72.9	72.6	64.7	133.5	113.4	75.9
Tcalc	-13.864	-5.327	-36.913	3.571	3.022	-5.889
Tcrit	2.920	2.920	2.920	2.920	2.920	2.920

Source: author's own compilation

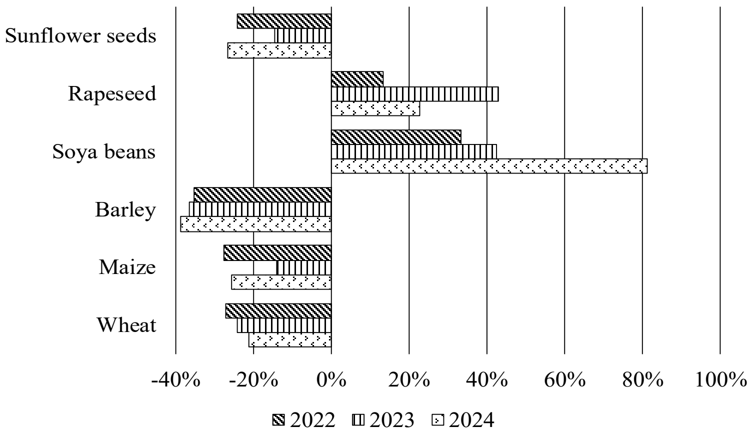


Figure 2. Harvest deviations from the mean level of 2019-2021

Source: author's own compilation

5. Discussion

The calculated results were interpreted as follows. Firstly, according to the true inequality Fcalc >Fcrit for all the crops, their yields demonstrated similar dynamics of the mean in 2019-2021 and 2022-2024 driven by typical natural risks. Indeed, analysis of the data presented in Table 1 indicates that, despite the presence of limited inputs, a decrease in production scale, and a shortage of labour force, there has been negligible change in average yields of these crops compared to their previous values. As demonstrated in Figure 1, there was a notable increase in the stability of maize and all oilseeds during the challenging period of 2022-2024. This can be attributed to a number of factors, including enhanced management strategies and a more pronounced sense of motivation among farmers, who have come to recognise their responsibility to support the nation and contribute to global food security. Furthermore, the yield of rapeseed has increased by almost 11%. This outcome was consistent with higher prices for rapeseed compared to those for the grains. In general, there is high demand for rapeseed due to its multiple uses, including in the production of biofuel and animal feed. It is also beneficial that Ukrainian farmers cultivate winter rapeseed, which has a 25% higher yield than soya beans and sunflower

Table 3
Top-3 importers of Ukrainian grains and oilseeds in 2021-2024

Crop	Countries and their shares in the total export value			
	2021	2022	2023	2024
Wheat	Egypt 16.9% Indonesia 14.4% Turkey 8.8%	Turkey 17.8% Romania 12.4% Egypt 9.0%	Spain 23.1% Turkey 15.2% Romania 14.2%	Spain 26.2% Indonesia 12.7% Egypt 9.6%
Maize	China 31.8% Spain 9.9% Netherlands 9.1%	China 17.8% Romania 13.8% Spain 11.1%	China 21.8% Spain 13.8% Romania 11.5%	Spain 17.2% Turkey 11.9% China 10.9%
Barley	China 31.8% Turkey 16.1% Saudi Arabia 6.2%	Turkey 21.2% Romania 19.9% Spain 19.8%	Turkey 20.7% China 19.2% Spain 16.5%	China 38.0% Spain 11.0% Libya 9.1%
Soya oil	Poland 66.5% China 14.5% Germany 5.1%	Poland 78.0% Germany 5.5% China 3.5%	Poland 72.1% Germany 4.6% UAE 4.5%	Poland 68.9% Netherlands 3.1% UAE 3.0%
Rapeseed oil	Netherlands 41.4% Poland 30.4% China 12.5%	Poland 44.1% Lithuania 33.0% China 6.5%	China 28.8% Poland 20.0% Lithuania 13.0%	Poland 26.3% China 20.3% Belgium 14.2%
Sunflower oil	India 34.0% China 16.1% Netherlands 11.3%	India 17.0% Turkey 14.2% Romania 8.0%	Romania 22.2% Turkey 19.7% China 12.4%	India 16.5% Spain 13.5% Romania 10.4%

Source: author's own compilation

Table 4
Modelled export income for grain crops under scenarios for 2019-2024

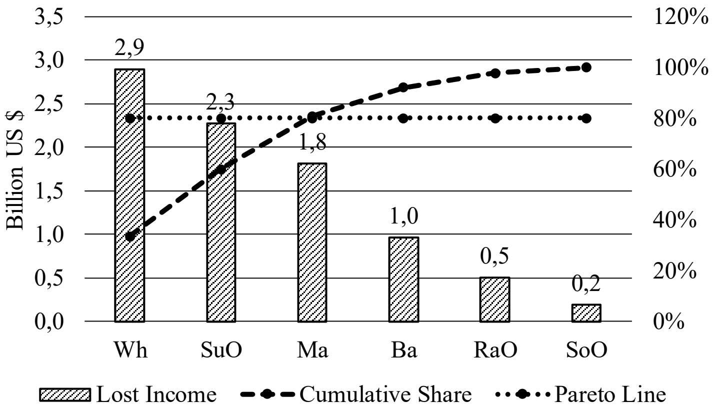
Indicator	2019	2020	2021	2022	2023	2024
C1k, USD/ha	760.1	756.5	1145.4	937.5	844.9	829.9
C2k, USD/ha	1159.9	981.8	1834.0	1510.5	1471.1	1130.1
C3k, USD/ha	586.1	560.0	861.3	671.0	618.5	627.1
CEIk, USD/ha	899.5	821.8	1387.6	1135.0	1069.4	924.8
D	9.5	0.0	68.8	38.1	30.1	12.5

Source: author's own compilation

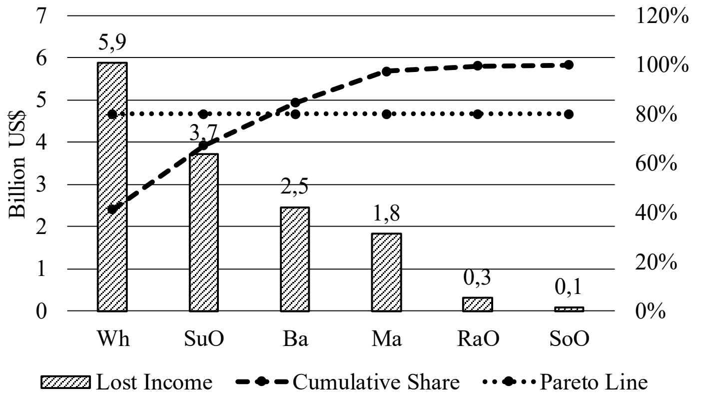
seeds. Furthermore, rapeseed requires fewer pesticides and improves soil structure, enhancing its fertility and water-holding capacity, which aligns with sustainable agricultural practices.

Secondly, based on the true inequalities |Tcalc| >Tcrit, data from Table 1 convinced that the cultivation of wheat, maize, barley, and sunflower seeds reduced by 20-40% in 2022-2024. These losses are consistent with the calculations of Chen et al. (2024). Figure 2 shows that barley suffered the greatest losses. This trend can be attributed to several factors, including lower prices and yields compared to maize and wheat. The drop in Ukrainian wheat production was particularly critical because wheat is a staple crop and a pillar of global food security, especially for people in Asia and Africa. Maize remained the most prevalent grain crop in Ukraine. It was rooted in higher profitability per hectare than wheat, as well as the versatility of maize, which is used for animal feed, food processing and biofuel. However, sunflower seeds were partly displaced by soya beans and rapeseed, whose respective harvests increased by 52% and 26%, thanks to stable demand for these crops.

Thirdly, the Russian-Ukrainian war has had a disruptive effect on supply chains and logistics, with a consequent effect on the export of harvested and processed crops. Nevertheless, Ukraine remained committed to the Sustainable Development Goal of achieving Zero Hunger. Notwithstanding the unprecedented challenges faced by the agricultural sector, Ukrainian farmers have demonstrated a commendable commitment to their global responsibility for ensuring food security. This commitment has been evidenced by the cultivation and export of their harvested and processed crops to a number of vulnerable and overpopulated countries, including Bangladesh, Egypt, Indonesia, Lebanon, Malaysia, the Philippines, and numerous others. As delineated in Table 3, the fundamental shifts among the leading importers of Ukrainian products have been identified. In particular, India imported a lesser quantity of sunflower oil. Concurrently, China maintained its substantial acquisitions of



a)



b)

Figure 3. Pareto charts of the lost export incomes by grains and oilseeds: a) in 2019-2021; b) in 2022-2024.

Notions: Wh – wheat, Ma – maize, Ba – barley, SoO - soya oil, RaO – rapeseed oil, SuO – sunflower oil.

Source: author's own compilation

maize and barley. Poland demonstrated a high level of interest in the importation of soya and rapeseed oil from Ukraine. Romania, Spain and Turkey were identified as the primary consumers of the studied crops, a finding that was corroborated by Waldl et al. (2024).

As demonstrated in Figure 3, the hypothesis concerning the lost export incomes from the selected crops in Ukraine was confirmed. The data revealed that the export losses amounted to 14.3 billion USD for the 2022-2024 period, in comparison to 8.4 billion USD for the 2019-2021 period. The 80-20 cut-off rule applied to Pareto charts in Figure 3 identified that wheat, sunflowers, oil, and barley were associated with 80% of export losses in 2022-2024. Maize was identified as the most sustainable option. An analysis of the data indicates that soya bean and rapeseed oil have demonstrated positive dynamics. Nevertheless, these measures did not suffice to redress the substantial decline in sunflower oil exports.

The model calculations confirmed ongoing changes in the grain sector, with maize becoming more important at the expense of wheat and barley. This is logical, as data from Table 4 showed maize's clear advantages in terms of export income per hectare compared to the other grain crops. The model constraints also ensured that the areas sown with wheat and barley were kept to a minimum in order to maintain Ukraine's share of the global market. Indicators ΔCEIk revealed a significant fluctuation in export revenues within 68.8% that was observed in 2019-2021. This meant that Ukrainian grain and oilseed producers had to adapt to high natural risks and embrace new technologies that promote sustainable agriculture. This approach has enabled Ukrainian farmers to achieve more stable results by managing limited resources more effectively.

6. Conclusions

Overall, Ukrainian farmers had to reduce the area under cultivation in war-affected regions. Despite limited resources and labour shortages, the average yield of key crops such as wheat, maize, barley and sunflower seeds was similar to that seen in 2019–2021. This resilience can be attributed to efficient management, strong motivation among farmers, and strategic crop choices, particularly rapeseed and soya beans, which demonstrated lower covariance, multiple uses, and environmental benefits.

Significant shifts occurred in the Ukrainian agricultural production landscape between 2022 and 2024. Oilseed production increased, with soya beans and rapeseed displacing sunflower seeds to some extent. Meanwhile, maize remained the dominant grain crop, while barley and wheat production declined significantly due to unfavourable market conditions and resource limitations, particularly in eastern regions at the epicentre of the military conflict.

Consequently, despite rising global food prices, the value of Ukrainian agricultural exports dropped due to the war. This accounted for over 65% of typical export losses due to the natural production risks associated with grains and oilseeds. To some extent, optimal cultivation proportions can mitigate this impact. Ukraine's export destinations became more concentrated, with Romania, Spain, Turkey, China and Poland emerging as major importers. However, Ukraine remains a significant player in the international food market and is committed to global food security, exporting grains and oilseeds to developing countries in Asia and Africa.

Overall, Ukrainian farmers have demonstrated their resilience and adaptability in the face of extreme challenges, offering valuable insights for future food security strategies. Further research on this topic is needed to delve deeper into the ways and methods employed to alleviate the impact of rising input costs, such as fertilisers and fuel.

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