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Logistics transformation on grain and oilseeds markets during the war in Ukraine: Marketing approaches and strategies

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Abstract. The Russian military invasion has caused a collapse in food supplies from Ukraine to world markets. The transformation of Ukrainian export logistics has been carried out under critical conditions and extremely limited deadlines. This article evaluated the transformations in logistics in the grain and oilseeds markets due to the war, discussed the impact of international agreements on export and logistics supply chains, and proposed marketing strategies for the trade of grain, oilseeds, and related

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products during wartime. The authors employed various general scientific and special methods and approaches, including a systematic approach, abstract-logical and graphic methods, retrospective and comparative analysis, correlation-regression analysis, and forecasting methods. A periodisation of the export logistical transformation due to the war was used. It included the following stages: the collapse of logistics; the growth of exports due to the impact of international agreements; and the operation of an alternative Ukrainian maritime corridor with the support of international partners. The significant impact of production and sales transformations caused by the war on the growth of wheat export logistics costs for various supply bases was demonstrated. The authors concluded that the export logistics risks were primarily mitigated by low grain and oilseed prices for agricultural producers. An assessment of the grain, oil crops, and processing products export market in Ukraine was also provided. The development of effective marketing strategies was highlighted. The practical value of the study lies in the use of the research results for developing marketing strategies for enterprises and European cooperation development projects in the agrarian sector

Keywords: logistics; food supply chains; prices; costs; agricultural enterprises; food safety; export; international agreements

INTRODUCTION

The stability of production, trade, and logistics chains in Ukraine, which ensured the country's presence in global food markets, has proven to be one of the key prerequisites for maintaining food security in numerous countries worldwide. Several studies have revealed the critical importance of Ukraine's domestic logistics for global food supply chains and the stability of international markets for grain, oilseeds, and related products.

The research by I. Savenko *et al.* (2022) indicates that the production and export potential of the grain and oilseeds market in Ukraine increased significantly due to substantial investments in logistics, including the development of seaport infrastructure. This contributed to Ukraine's growing share in the global trade of these products, reaching 8.7% for grain, 2.7% for oilseeds, and 39.8% for sunflower oil. The study by N. Galunets (2019) demonstrates that Ukraine plays a significant role in addressing food supply issues in import-dependent countries, as well as in ensuring the availability of food products and combatting hunger worldwide. The Russian military invasion of Ukraine and the occupation of parts of the southern regions severely impeded the operations of strategic seaports and disrupted logistics in the supply chain of agricultural products and raw materials for their production. O. Penkova and A. Kharenko (2023) explored the content and role of marketing logistics in exports and identified the challenges faced by crop production exporters due to the full-scale war with the Russian Federation. According to O. Kovalenko and A. Kyrchenko (2023), this led to a decline in the volume of grain, oilseeds, and related products exported from Ukraine and increased price volatility in the global food market. This issue was also highlighted in a publication of the Food and Agricultural Organization by the United Nations (FAO, 2023).

Therefore, it is important to understand how to mitigate such risks through the development of marketing strategies and logistics for agricultural enterprises during crises. O. Krasnorutskyy *et al.* (2023) have emphasised the role of effective marketing strategies

and tools during wartime, which contribute to increasing the competitiveness of agricultural enterprises. Additionally, I. Zhofan *et al.* (2023) have justified the development of marketing strategies for agricultural sector enterprises in Ukraine's grain markets and estimated the economic potential of Ukrainian farmers. Moreover, the issue of global food security is widely discussed among scientists. T. Hassen and H. Bilali (2022) investigated the direct and indirect impact of the Russia-Ukraine war on global food security. They emphasise that the war may jeopardise the implementation of the Sustainable Development Goals. At the same time, W. Leal Filho *et al.* (2023) propose measures to mitigate the conflict's impacts on food security and promote sustainable agriculture.

Despite valuable scientific contributions to research on the impact of armed conflict on global and local food markets, there is a need for a comprehensive study of the new changes in the logistics of food supplies to global markets as a result of military aggression in Ukraine. The purpose of this study was to investigate the transformations in the grain and oilseeds market due to the war, assess the impact of international agreements on the supply of Ukrainian products, and identify strategies to improve marketing strategies and logistics.

MATERIALS AND METHODS

The study was based on official documents and reports from the Ministry of Agrarian Policy and Food of Ukraine (2023), the World Bank (2023), and the Food and Agricultural Organization of the United Nations (OECD, 2022; FAO, 2023). Datasets from the official websites of the United Nations Conference on Trade and Development (UNCTAD, 2022) and the Ukrainian Agrarian Council (2023) were also utilised. Amendments to Ukrainian legislation (Decree of the President of Ukraine. No. 654/2022, 2022) and European legislation regarding the regulation of agricultural trade were also analysed, including Regulation (EU) 2022/870 (2022),

Regulation (EU) 2023/1077 (2023), Commission Implementing Regulation (EU) 2023/903 (2023), Commission Implementing Regulation (EU) 2023/1100 (2023), and other relevant regulations.

The method of logical generalisation was employed to assess the potential for developing production, trade, and logistics chains, which was strategically important under martial law and for ensuring Ukraine's food security. Price volatility in the agricultural markets was identified using statistical methods. Logistic transformations in the grain and oilseed markets during the war in Ukraine were illustrated through statistical tables and graphs. Abstract-logical and graphical methods were utilised to evaluate the impact of international initiatives and agreements on the functioning of export logistics in the grain, oilseeds, and processed products markets during the war in Ukraine. The systematic approach and retrospective analysis revealed the impact of the Black Sea Grain Initiative on the export of grain, oil crops, and processed products from Ukraine during the war. The comparative analysis method was applied to assess the effectiveness of wheat trade through the Grain Corridor within the framework of the humanitarian aid provided by the UN World Food Programme (2023).

The method of cause-and-effect analysis helped to identify the challenges in transport infrastructure in the European direction and assess the impact of the EU-Ukraine Solidarity Lanes Initiative on the export of grain and oil crops (European Commission, 2022). The method of correlation-regression analysis was applied to determine the potential of using Danube region ports as alternative routes for exporting grain, oilseeds, and their processed products during the war. Single-factor models were employed to identify changes in export logistics. The standard deviation indicator (STDEV) (as a built-in MS Excel function) was used to compare export volatility in the grain, oilseeds, and processed products markets across different transport routes. Marketing analysis enabled the assessment of the impact of the war on the cost of wheat export logistics in Ukraine, based on data from SE "Sangrant Plus" (2023) and

Barva Invest (2023). The method of analysis was used to forecast the logistics capacities for exports in the grain, oilseeds, and processed products markets for the 2023/2024 marketing year (MY).

RESULTS

The initial period of the war (March-April 2022) critical challenges for the logistics of the grain and oilseeds markets, causing significant disruptions in supply chains. At the onset of the Russian invasion, four deep-water seaports were occupied (Kherson, Skadovsk, Berdiansk, and Mariupol), and six others ceased operations due to military threats (Bilhorod-Dnistrovskiy, Odesa, Mykolaiv, Chornomorsk, including Olvia and Pivdennyi). The blockade of seaports resulted in a logistical collapse. In the pre-war period, 93-98% of the exports of grain, oilseeds, and related products were handled through these ports (Bielashov, 2022). Monthly exports had reached 7.8 million tonnes by November 2021. With the outbreak of war, these figures declined to 56-270 thousand tonnes. Only the river ports of the Danube region (Reni, Izmail, Kilia, and Ust-Dunaisk) remained operational, ensuring monthly exports of the aforementioned products, but up to 1 million tonnes until June 2022. Overall, the export of grains and sunflower oil decreased by 1.3 times in 2022 compared to 2021 (Trade Map data, 2023).

Disruptions in Ukraine's food supply chains increased price volatility in the global food market. In particular, the FAO food price index soared from 136 points in January 2022 to 158 points in May 2022. This represents the largest increase in the past decade (FAO, 2023). During this period, grain and oilseed prices on the European market rose by 1.4-1.5 times. Despite this, there was a sharp decrease in prices on Ukraine's domestic market for grain, oilseeds, and related products. For example, before the war (January 2022), prices for 3rd class wheat on an EXW basis were USD 314 per tonne, but during the first seven months of the war, these prices collapsed to USD 148 per tonne, representing a more than twofold decrease (Fig. 1).

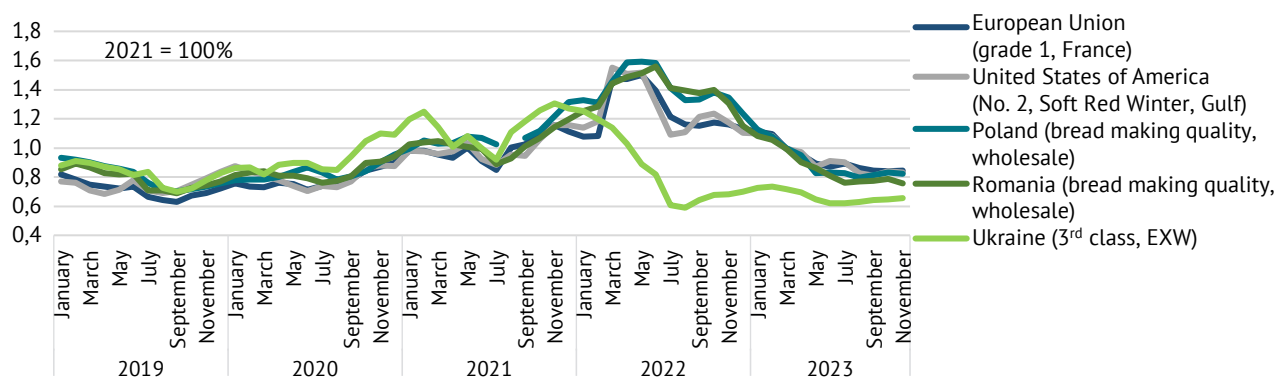


Figure 1. Dynamics of food wheat price indices, %

Source: developed by the authors based on Food Price Monitoring and Analysis (2023)

As a result, there was a forced and urgent transformation of export chains. In particular, export volumes were redistributed among different means of transportation. During the first year of the war, there was a significant increase in transportation by land.

The share of road transport increased to 23%, and rail transport to 22%, depending on the type of cargo. Waterway transportation decreased significantly, accounting for only 59-72% of the export structure (Table 1).

Table 1. Changes in the transport logistics of grain, oilseeds, and related products exports during the war period in Ukraine, %

| Type of transport | Grain | Oilseeds | Sunflower oil |
|--|-------|----------|---------------|
| War period (March 2022-January 2023) Share in total transportation, % | | | |
| Road | 6 | 23 | 18 |
| Railway | 22 | 17 | 15 |
| Marine | 72 | 59 | 64 |
| Other | 0 | 1 | 3 |
| Changes in the share of transportation compared with the pre-war period (2021), pp | | | |
| Road | 5.9 | 18.4 | 15.8 |
| Railway | 21.5 | -1.0 | 13.7 |
| Marine | -27.3 | -19.4 | -32.5 |
| Other | 0.0 | 1.0 | 3.0 |

Source: calculated by the authors based on Barva Invest data (2023)

It must be acknowledged, that the process of restoring the destroyed logistics infrastructure was supported by international initiatives and agreements. These documents aimed to preserve Ukraine's presence in global supply chains and maintain the stability of

the world food market. An analysis of the dynamics of export volumes for grain, oilseeds, and related products from Ukraine during the war reveals the significant impact of these agreements on the functioning of Ukraine's export logistics (Fig. 2).

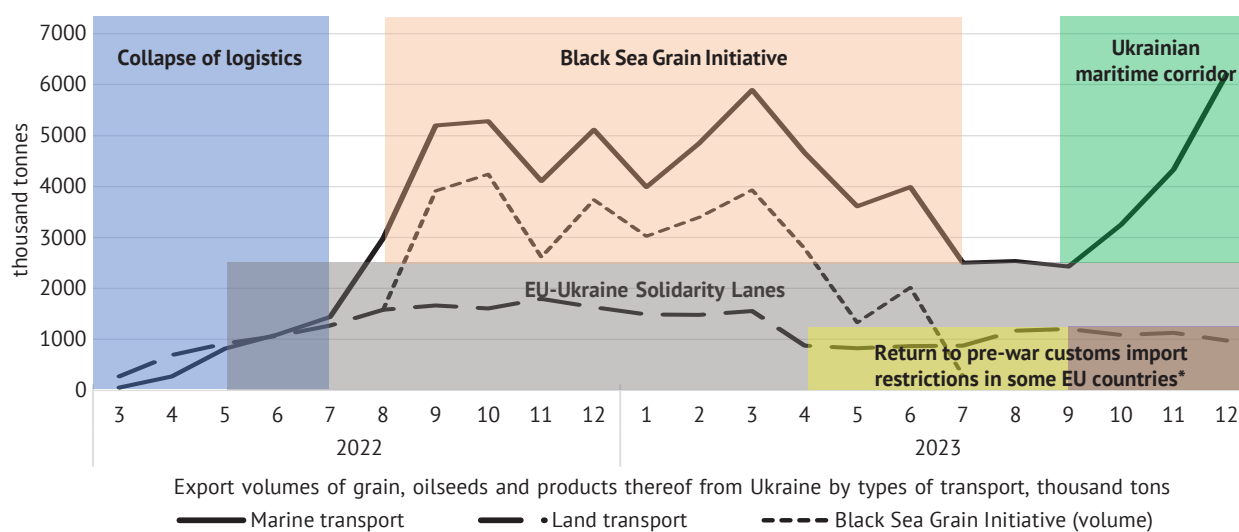


Figure 2. Impact of international initiatives and agreements on the export logistics of the market of grain, oilseeds, and related products of Ukraine during the war **

Note: * April-September 2023 - Bulgaria, Poland, Romania, Slovakia, Hungary. September-December 2023 - Poland, Slovakia, Hungary. **Export includes the following goods: wheat, barley, corn, sunflower seeds, rapeseed, soybean, sunflower oil, soybean oil, and oil cakes

Source: developed by the authors based on data from the Ministry of Agrarian Policy and Food of Ukraine (2023), European Commission (2022), and Barva Invest data (2023)

Firstly, the partial restoration of maritime logistics occurred following the signing in July 2022 of the agreement titled "Initiative for the Safe Transportation of Grain and Foodstuffs from Ukrainian Ports", which

aimed to unblock three Ukrainian ports: Odesa, Pivdennyi, and Chornomorsk. In various sources, this agreement is referred to as the "Black Sea Grain Initiative" (UNCTAD, 2022) or the "Grain Corridor" (Ministry of

Agrarian Policy and Food of Ukraine, 2023). This was a unique type of agreement that required the signing of two mirrored documents – one between Ukraine, the UN, and Turkey, and the other between the Russian Federation, the UN, and Turkey. The parties agreed to establish a safe logistics corridor for the export of grain and other food products from Ukrainian ports. Subsequently, specific routes were established, which were regularly monitored and controlled by the Joint Coordination Centre under the auspices of the UN in Istanbul to ensure compliance with the agreements. The validity period of the agreement lasted 120 days, with provisions for automatic renewal for subsequent periods.

In general, the validity of this agreement was extended twice: in November 2022 and March 2023. However, as of 19 August 2023, the Grain Agreement ceased to be in effect due to the withdrawal of the Russian Federation, which subsequently started the blockade of the Black Sea (Hirnyk, 2023). Consequently, the role of these international agreements in preventing the critical destruction of Ukraine's logistics chains is considered quite significant (UNCTAD, 2022). It should be noted that this agreement served as an effective mechanism for supplying grain, oilseeds, and related products to the global market. During its period of effectiveness, it ensured the operation of the largest export logistics route from Ukraine. Thanks to joint efforts, approximately 32.9 million tonnes of grain, oilseeds, and related products were exported through deep-water ports during the Grain Initiative's effective period. The majority of exports consisted of corn (17 million tonnes, 51%) and wheat (9 million

tonnes, 27%). The export of oilseeds and related products was significantly smaller, totalling 5.6 million tonnes (17%), of which about 1.7 million tonnes (5%) was sunflower oil (Fig. 3).

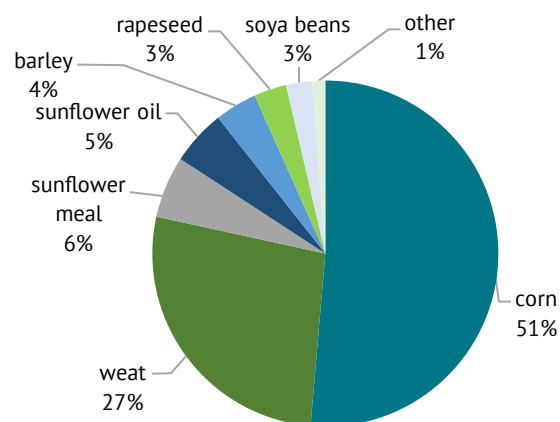


Figure 3. Type structure of the export of grain, oilseeds and related products during the Grain Initiative period (August 2022-July 2023)

Source: developed by the authors based on data from the Black Sea Grain Initiative. Joint Coordination Centre (2023)

Following the results of the export analysis, it was possible to account for more than a third of the total export of grain, up to 14% of oilseeds, and approximately 20% of related products through the deep-water seaports (Odesa, Pivdennyi, and Chornomorsk) during the war (February 2022-December 2023) due to the Black Sea Grain Initiative (2023) (Fig. 4).

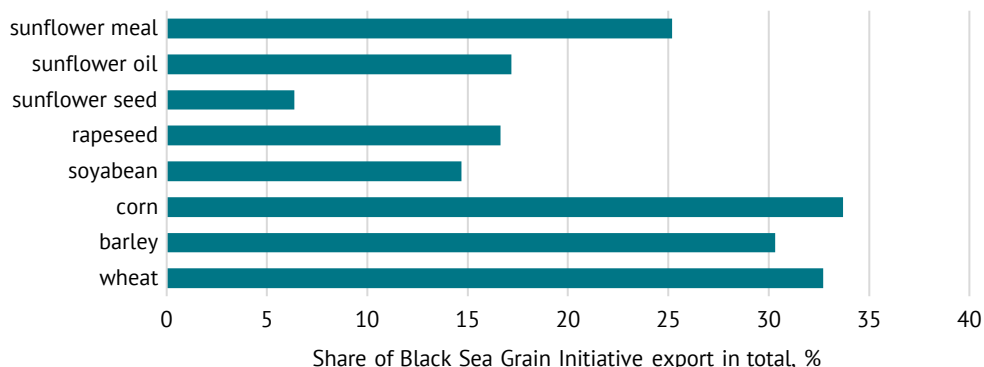


Figure 4. Significance of the Black Sea Grain Initiative in the export of grain, oilseeds and related products from Ukraine during the war *

Note: * February 2022-December 2023

Source: developed by the authors based on data from the Ministry of Agrarian Policy and Food of Ukraine (2023), Black Sea Grain Initiative. Joint Coordination Centre (2023)

The Black Sea Grain Initiative enabled the elimination of the domestic market surpluses in Ukraine during the 2022/23 marketing year. Monthly export volumes through seaports reached 3.0-4.2 million tonnes (Fig. 2). Consequently, this led to a reduction in product stocks at the beginning of the 2023/24 marketing

year by almost 2.5 times compared to the previous year. However, pre-war export volumes via this logistical route were not achieved, as sea routes accounted for only about 46% of the export of these products during the agreement's validity. Importantly, the signing of this agreement resulted in a rising price trend in Ukraine's

domestic market, which lasted until February 2023. In particular, prices for 3rd class food wheat based on Ex Works (EXW) delivery increased by 25%, reaching USD 184 per tonne. Nonetheless, alignment with global trends was not achieved, as in the pre-war period, as logistics costs remained relatively high and exerted pressure on domestic prices (World Bank, 2023).

At the same time, it is important to acknowledge the risks associated with exporting through the Grain Corridor due to the potential for blockage by the Russian side. During the period of the Grain Initiative from August 2022 to August 2023, the Russian Federation systematically threatened to terminate the agreements. The necessity of extending the agreement every 120 days created additional risks due to the unpredictability of reaching new agreements among the parties involved. However, one of the most critical risks during wartime was the high probability of shelling of the seaports engaged in the implementation of the Grain Initiative. Specifically, the ports of Chornomorsk and Odesa (July 2022, July 2023), as well as the infrastructure of the Danube region ports, sustained significant damage. According to experts' estimates, 167 port infrastructure facilities and 7 civilian ships were damaged, and around 300,000 tonnes of grain were destroyed (Muravskiy, 2023). In the early stages of the war, the indirect losses due to the blockade of Ukraine's Black Sea ports by the aggressor country's naval forces, including those caused by the decline in domestic prices and the increase in transport costs for export-oriented products, amounted to approximately USD 14.5 billion (World Bank, 2023).

The significant risks associated with this logistical route and the official withdrawal of shipping safety guarantees by the Russian side necessitated the search for alternative access to Black Sea routes. The ports in the Danube region were considered one of the key

components of Ukrainian logistics for the supply of grain, oilseeds and their processed products to global markets. This became possible through the partial restoration of the ports of Izmail, Reni, Ust-Dunaisk, and Kilia. Logistical routes in this region were established through Romania and the Republic of Moldova. Notably, international agreements with the Republic of Moldova led to discounts being granted for the transit of products by rail to the port of Reni. Specifically, grain was discounted by 27% and sunflower oil by 39% (Ministry of Agrarian Policy and Food of Ukraine, 2023). The main objective of these efforts was to mitigate the effects of the blockade of deep-water ports.

However, the capacity of this logistical route is significantly lower. In the ports of the Danube region, the majority of vessels, carrying loads of up to 5,000 tonnes, were heading to Romania, where they were transhipped at the port of Constanta onto larger sea vessels, particularly Panamax vessels. According to expert estimates, the potential throughput capacity of the Danube region ports for transshipping grain, oilseeds, and related products is up to 3 million tons per month (Ukrainian Agrarian Council, 2023). In the pre-war period (2019-2021) the volume of cargo handling in the Danube seaports of Ukraine, particularly Izmail, Reni, and Ust-Dunaisk, was insignificant, accounting for only 2.5-4.2% of the total volume. During the war, actual maximum monthly export shipments through these ports reached 2.0 and 2.2 million tonnes in March and May 2023, respectively. At the beginning of the war, mainly grain was exported through the Danube region ports, primarily wheat. Since the beginning of 2023, the export of sunflower oil and oil cakes has increased (Fig. 5). Overall, this logistical route managed to facilitate the export of about 21 million tonnes of grain and oil products.

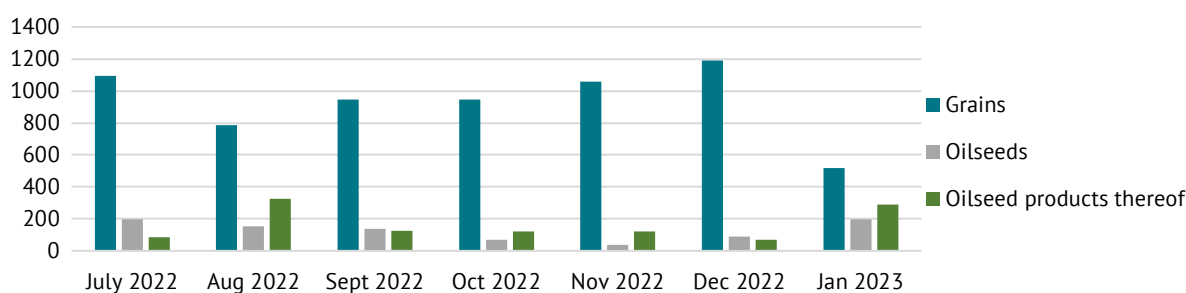


Figure 5. Dynamics of the export of grain, oilseeds, and related products through the Danube ports of Reni, Kilia, and Izmail between July 2022 and January 2023 (thousand tonnes)

Source: developed by the authors based on Barva Invest data (2023)

Therefore, despite the only partial utilisation of the Danube region ports, during the 2022-2023 marketing year (MY), they provided an alternative for the export of grain and oilseeds to some extent. This is also supported by the regression models constructed (Table 2). Based on the calculated correlation coefficients, it was

found that during the studied period, there was an inverse relationship between export volumes through the Danube seaports and the use of highways, railways, or Black Sea ports. Specifically, for land transportation, the data shows a strong inverse relationship between export volumes (road transport: -0.74, rail transport: -0.67).

Table 2. Results of the correlation-regression analysis of the use of the Danube region ports as alternative routes for exporting grain, oilseeds and related products during the war (2022-2023 MY)

| Indicators | Factor signs | | |
|---------------------------|-------------------|-------------------|---------------------|
| | Road | Railway | Deep-water seaports |
| Correlation coefficient | -0.74 | -0.67 | -0.44 |
| Determination coefficient | 0.54 | 0.45 | 0.19 |
| Elasticity coefficient | -5.252 | -2.211 | -0.094 |
| X STDev | 0.18 | 0.19 | 0.95 |
| Regression equation | $Y=2.23 - 1.612X$ | $Y=2.80 - 1.394X$ | $Y=2.05 - 0.187X$ |

Source: calculated by the authors based on data from the Ministry of Agrarian Policy and Food of Ukraine (2023)

The calculated elasticity coefficient indicated that a 1% decrease in the volume of exports by road transport, on average, led to a 5.3% increase in exports through Danube region ports and a 2.2% increase in exports through rail transport. A comparative analysis of the STDEV indicator demonstrates that these routes were less risky compared to exports through deep-water ports from August 2022 to June 2023. The full realisation of the potential of this logistics route is possible with investments in the development of the infrastructure of the Danube region ports, which would increase the throughput capacity of the transport system. Furthermore, European investments are needed for the development of the ports of Galati and Constanta, as well as to enhance the throughput of the Sulina Canal. However, the shelling of the ports of Reni and Izmail, for instance in August 2023, and ongoing military threats undermine progress in this direction, creating conditions where investments carry a high degree of risk. An alternative to sea routes for the export of grain, oilseeds, and related products was land logistics, which has also undergone significant restructuring since the beginning of the war. Notable changes have occurred in internal railway and road transport routes, which were re-directed towards the river ports at the mouth of the Danube (Ust-Dunaisk, Izmail, Reni, Kilia) as well as land border crossings with neighbouring countries: Poland, Romania, Slovakia, Hungary, and Moldova.

To establish alternative logistics routes between Ukraine and EU countries, the European Commission launched the EU-Ukraine Solidarity Lanes Initiative. This initiative aimed to maintain Ukraine's integration into global supply chains and address global food security concerns (European Commission, 2022). It comprises a series of agreements in the areas of trade and logistics designed to expand Ukraine's opportunities for exporting grain, oilseeds, and related products. To this end, in May 2022, the European Parliament introduced temporary trade liberalisation in addition to the trade preferences already applicable to domestic goods under the Association Agreement between Ukraine and the EU. Other measures included the suspension of import duties, customs quotas, and trade protection measures on the import of grain, oilseeds and related

products from Ukraine. These decisions were adopted by the European Parliament until May 2023 and were later extended to May 2024. This was a crucial step in supporting Ukraine's agricultural sector and opened up European markets to trade in domestic products. However, it also created certain contradictions both at the national and European levels.

The urgent transformation of Ukraine's logistics exacerbated several transport infrastructure challenges in the European direction, which increased obstacles to export to global food markets. In particular, regarding railway transportation, the issues include the non-compliance of railway track widths with European standards and the insufficient capacity of transshipment terminals. Road transport flows were limited by administrative obstacles associated with the cross-border movement of vehicles. To avoid these problems, within the framework of the Initiative, customs procedures and the processes for issuing export certificates, as well as veterinary and phytosanitary certificates of product quality, were streamlined and simplified, along with the increased capacities for storing grain and oilseeds near border points, stations along the "broad" track lines, and in EU seaports.

Furthermore, a Special Agreement on the liberalisation of freight transportation by road was concluded, which has been renewed until June 2024. This agreement provided for the abolition of the requirement for Ukrainian carriers to obtain permits for road transport (Decree of the President of Ukraine No. 654/2022, 2022). European transport corridors to Ukraine were also expanded. Through amendments to the Trans-European Transport Networks (TEN-T), the North Sea-Baltic Corridor and the Baltic-Black-Aegean Seas Corridor were extended (Regulation of the European Parliament No. 2022/870, 2022). This will create opportunities to eliminate logistical obstacles and attract future investments in modernising Ukraine's transport infrastructure (European Commission, 2022).

During the period of the Initiative, with the complete removal of tariff restrictions on the export of grain, oilseeds, and related products from Ukraine to European countries, export volumes increased significantly. In particular, between May 2022 and March 2023, grain

exports to the EU increased by 2.4 times compared to the same period the previous year, oilseeds by 2 times, and sunflower oil by 1.2 times (Table 3). Simultaneously, the share of imports from Ukraine in total EU imports for the studied period reached 15% for grain, 9.6% for oilseeds, and 31.5% for sunflower oil. Most export flows were directed to EU countries that were the first link

of the “Solidarity Lanes”, including Poland, Hungary, Slovakia, Romania, and Bulgaria. For example, grain exports to Poland increased by 10 times compared to the previous period, oilseeds by 5.9 times, and sunflower oil by 3.2 times. Grain exports to Romania increased by 23.8 times, oilseeds by 217.7 times, and sunflower oil by 4.9 times.

Table 3. Export of certain types of agricultural products from Ukraine to EU countries within the framework of the EU-Ukraine Solidarity Lanes

| | Grain | Oilseeds | Sunflower oil |
|---|-------|----------|---------------|
| Relation to the similar period of the previous year (May 2021-March 2022) times | | | |
| Poland | 10.0 | 5.9 | 3.2 |
| Hungary | 44.4 | 7.2 | 8.2 |
| Slovakia | 71.8 | 33.9 | 1.9 |
| Bulgaria | 18.3 | 58.6 | 9.8 |
| Romania | 23.8 | 217.7 | 4.9 |
| EU countries, total | 2.4 | 2.0 | 1.2 |
| Export volume from Ukraine (May 2022-March 2023) USD million | | | |
| Poland | 711 | 523 | 475 |
| Hungary | 539 | 279 | 87 |
| Slovakia | 154 | 90 | 23 |
| Bulgaria | 10 | 462 | 278 |
| Romania | 1645 | 813 | 79 |
| Import share from Ukraine in total EU import, % | 15.0 | 9.6 | 31.5 |
| EU countries, total | 5,385 | 3,362 | 2,462 |

Note: * excluding transit

Source: calculated by the authors based on Trade Map data (2023)

The influx of grain and oilseeds from Ukraine overwhelmed the domestic markets of neighbouring countries, exceeding the capacity of their transport and storage infrastructure. The excess of products was also due to increased logistics costs during the transit of these crops to EU countries. Moreover, the situation was complicated by a trend of price dumping in the global food market, which was replicated in EU markets (Fig. 1). In May 2023, the European Commission adopted a decision to limit the export of wheat, corn, sunflower seeds, and rapeseed from Ukraine to Poland, Hungary, Slovakia, Romania, and Bulgaria. This was done at the request of the national governments of these countries to protect domestic producers of grain and oilseeds from price reductions and to avoid unprofitable production (European Commission, 2022). These measures were extended in June 2023 and remained valid until September 2023, reducing the number of tariff items from 17 to 6 for certain types of products. It should be noted that there were no restrictions on the transit of products from Ukraine through these countries.

Starting in September 2023, the governments of Poland, Hungary, and Slovakia continued, at the national level, a de facto ban on the import of wheat and wheat flour, corn, rapeseed, sunflower seeds, oil cake, and oil meal from Ukraine to protect their domestic markets for these products (Laws of the Republic of Po-

land, 2023; Ministry of Economy of Ukraine, 2023). Following the restrictions placed on the export of grain, oilseeds, and related products, the monthly volume of deliveries from Ukraine through the Solidarity Lanes decreased by nearly half. In particular, in April 2023, these amounted to 874 thousand tonnes, compared to 1,560 thousand tonnes in March 2023 (Fig. 2). During the 2023 harvest period, a certain revival of export deliveries is evident, but the levels of the previous year (1.6-1.8 million tons per month) have not been reached.

Overall, due to the implementation of the EU-Ukraine Solidarity Lanes Initiative, Ukraine successfully established alternative opportunities for maintaining food supplies to global markets. During the period of its validity until December 2023, exports of grain, oilseeds, and related products from Ukraine by land routes amounted to 25 million tons. Along with the capabilities of the Black Sea Grain Initiative (Black Sea Grain Initiative..., 2023), it was possible to achieve maximum monthly export deliveries of products at 7.5 million tons (March 2023). However, a stable result was not consistently maintained.

The Ukrainian Alternative Sea Corridor demonstrated high effectiveness in exporting grain, oilseeds, and related products. This logistics route became operational thanks to the efforts of the Ukrainian Armed Forces and the support of international partners,

particularly Romania, Bulgaria, and Turkey. The corridor was launched in September 2023 and ran through the territorial waters of Romania and Bulgaria. As a result, monthly exports by sea transport became stable. In particular, it was no less than 5.5 million tonnes from December 2023 to March 2024, and reaching 6.4 million tonnes in February 2024, the highest figure of the war period (Fig. 2). However, this logistics route remained highly risky due to military threats and the danger of mines. Thanks to these measures, it was

possible to avoid a collapse in the domestic market of grain, oilseeds, and sunflower oil from Ukraine during the 2022/2023 MY. As a result, grain exports reached 49 million tonnes, oilseeds 9 million tons, and sunflower oil 5 million tons (Fig. 6). These figures include products from the 2022 harvest as well as significant stocks from the previous year. Consequently, the share of exports in production volumes was slightly higher than in the pre-war period reaching 91%, 50% and 113%, respectively.

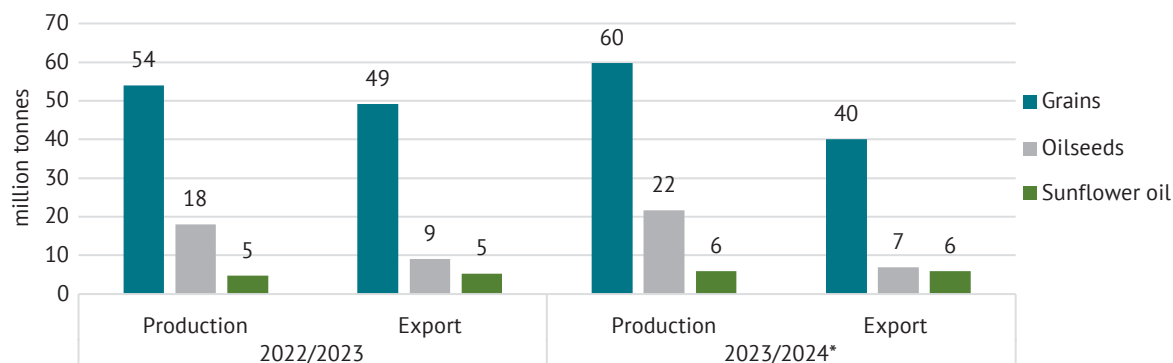


Figure 6. Assessment of the export volume needs for grain, oilseeds, and sunflower seeds from Ukraine in 2023/2024 MY (as of April 2024)

Note: * Forecast of production of grain and oilseeds according to the Ministry of Agrarian Policy of Ukraine, forecast of production of sunflower oil according to the data of the Association "Ukroliaprom"

Source: prepared by the authors based on data from the Ministry of Agrarian Policy and Food of Ukraine (2023), the Association "Ukroliaprom" (2023), and authors' forecasts

The logistical transformations in the grain, oilseed, and related product markets amid the war, alongside the significant risks of export disruptions or delays due to military threats, resulted in a sharp increase in transport costs. According to this research, the average wheat logistics costs sea route

(EXW-DAP Reni-FOB Constanta) were USD 140 in 2023. This represents a 1.9-fold increase compared to the pre-war period for deliveries to the Kherson Seaport (2021). The share of these costs in the export price rose to 44%, compared to only 22% in 2021 (Table 4).

Table 4. Impact of the war on the cost of wheat export logistics in Ukraine

| Indicators | 2021 (pre-war period) | | 2023 (war period) | |
|---|-----------------------|-----------------|----------------------------|----------------|
| | EXW-FOB Kherson | EXW-CPT Kherson | EXW-DAP Reni-FOB Constanta | EXW-DAP Gdansk |
| Logistic chain | | | | |
| Type of transport | railway | road | railway& freight | road |
| Trade batch volume, tonnes | | | | |
| Silo to port (destination) | 500 | 500 | 500 | 300 |
| Port to shipboard | 1,000 | x | 1,000 | x |
| Type of costs, USD per tonne * | | | | |
| Warehousing costs (incl. delivery, acceptance, additional works and storing products in silo) | 24.6 | 24.6 | 28.1 | 28.1 |
| Domestic certification** | 0.7 | 0.7 | 0.7 | 1.7 |
| Delivery to the point of destination (incl. weighing, loading, costs): | | | | |
| railway | 19.8 | x | 44.1 | x |
| road | x | 31.7 | x | 87.0 |
| Customs clearance and international certification*** | 1.2 | 1.2 | 2.8 | 4.0 |
| Port costs | 25.1 | x | 21.5 | x |

Table 4. Continued

| Indicators | 2021 (pre-war period) | | 2023 (war period) | |
|--|-----------------------|----|-------------------|-----|
| Insurance | 0.4 | x | 4.8 | 1.5 |
| Freight to destination port (Constanta) | x | x | 37.7 | x |
| Total costs, USD per tonne: | | | | |
| railway | 72 | x | 140 | x |
| road | x | 58 | x | 122 |
| Costs increase, times | x | x | 1.9 | 2.1 |
| Share of costs in pricing export chain ****, % | | | | |
| railway | 22 | x | 44 | x |
| road | x | 17 | x | 33 |
| Market price changes | | | | |
| Food wheat price (EXW delivery), UAH per 1 ton, incl. VAT | 318 | | 189 | |
| Price change, times | x | | -1.7 | |

Note: * The costs are calculated according to the NBU exchange rate as of February of the respective year and include VAT. ** Domestic certification includes a phytosanitary certificate and a protocol for testing product samples. *** International certification includes a certificate of origin and a certificate of quality and quantity of an independent surveyor. **** The indicator is determined with the deduction of VAT refunds

Source: calculated by the author based on data from SC "Sangrant Plus" (2023) and Barva Invest (2023)

It should be noted that the growth in logistics costs placed significant pressure on the entire supply chain, which was primarily offset by price reductions for agricultural enterprises. For instance, the food wheat price reduction for agricultural enterprises during the studied period amounted to 1.7 times lower than previous levels. As a rule, the most vulnerable group consisted of small and medium-sized grain and oilseed producers, who had limited access to export logistics, especially during wartime. Compensation in most cases occurred due to a decrease in the profitability of these products. Furthermore, a marketing analysis was conducted to assess the possibilities of export logistics for these products in 2023/2024. It was assumed that all logistical routes in Ukraine were accessible as of January-March 2024. According to forecast calculations, the minimum export to global markets from Ukraine by all modes of transport until the end of the marketing period will be about 42 million tonnes of grain, 7 million tonnes of oilseeds, and 6 million tonnes of sunflower oil. In this case, it will be possible to retain international partners and avoid a deeper decline in production profitability. The distribution of supplies by land and sea transport will depend on Ukraine's military control over waterways.

According to our estimates, these volumes can be achieved if at least 95% of grain, 70% of oilseeds, and 70% of vegetable oil and vegetable oil are exported by sea transport. In addition, resolving the issues of land logistics will require financial assistance from the EU to compensate for transport costs to the deep-water ports of Lithuania, Latvia, Germany, Croatia, Slovenia, and Italy. In this case, transit to the countries of Africa and Asia would become profitable for exporters, thereby ensuring that products are accumulated in neighbouring European countries.

DISCUSSION

Efficient logistics is a crucial factor for a crucial factor for the uninterrupted functioning of food supply chains at both domestic and international levels. The challenges and risks posed by the war in Ukraine necessitate the development of innovative marketing approaches and strategies to promote grain, oil crops, and their derivatives in global markets. However, their sale requires a relevant legal framework based on international agreements. This study examines the positive impact of the Grain Initiative on the recovery of export supplies through Black Sea deep ports and emphasises the need for further development of logistics chains through Danube ports and neighbouring countries in the Black Sea region. A similar conclusion is drawn in the research by B. Kormych and T. Averochkina (2023), which also considers the economic benefits of these logistics routes.

R. Goyal and S. Steinbach (2023), using a method involving the analysis of high-frequency futures-trading price data, concluded that the Grain Initiative had a negligible effect on the level of uncertainty in the futures market amidst the war in Ukraine. In comparison with this research, which is based on a comprehensive assessment of the effectiveness of the Grain Agreement as illustrated by the markets of grain, oil crops, and their derivatives, a positive impact of the same agreement on the competitiveness of domestic agricultural producers has been recognised. The present research is more focused on a detailed analysis of its benefits and economic risks arising from obstacles and violations of agreements on Russia's side. Moreover, the analysis of the logistics routes through the Danube region ports revealed their significant potential, which requires investment.

R. Vos and J. Glauber (2023) also emphasise the importance of the Solidarity Lanes for both the European community and Ukraine. They expand upon the problem of Eastern European markets being oversaturated with Ukrainian grain and its consequences for European farmers. They suggest that comprehensive support for comprehensive support from the European Commission is necessary for the affected EU member states (Poland, Hungary, Romania, Bulgaria, and Slovakia). Therefore, the need to maintain Ukraine's presence in global grain markets is underscored. This research reaches a similar conclusion, despite the congestion in the markets of EU countries neighbouring Ukraine. The Solidarity Lanes remain one of the crucial logistics routes for the export of grain, oil crops, and their derivatives from Ukraine.

D. Poursina *et al.* (2024) employ the econometric analysis to determine the impact of the Black Sea Grain Initiative on price fluctuations in global wheat and corn markets. Both studies conclude on the economic value of the agreement in addressing global food security concerns. However, the present research also outlines an assessment of economic losses resulting from the Russian invasion. Nevertheless, more attention is paid to calculating the losses of the first link in the logistics export chain on the wheat market, i.e. agricultural producers. The research highlights the significant vulnerability of this link due to the transformation of logistics in the market for grain, oil crops and their derivatives. A similar perspective is found in the article by Y. Bielashov (2022). Both studies demonstrate that risk reduction is achievable through the gradual diversification of grain exports from Ukraine.

S. Devadoss and W. Ridley (2024) also estimate the losses incurred by Ukrainian wheat producers based on the Global Spatial Equilibrium Model (SEM) on the production-consumption, and trade of wheat in Ukraine. The study outlines the significant impact of the Russian invasion on the reduction of wheat consumption in importing countries. This conclusion is supported by the present research, which demonstrates that delays in export deliveries have increased threats to food security in import-dependent countries. S. Steinbach and Y. Yildirim (2024) examine the consequences of Russia's withdrawal from the Black Sea Grain Initiative, analyse the indirect volatility of agricultural markets, and demonstrate specific differences in the volatility of futures for various agricultural commodities. Y. Fang and Z. Fang (2022) also examine commodity market prices during the war in Ukraine. Similar to the present research, the authors conclude that the exacerbation of the Russian-Ukrainian conflict significantly affects the risk of market volatility and highlight similar results regarding the relationship between the escalation of the conflict and the level of volatility in commodity markets.

O. Shpychak *et al.* (2021) assess price food chains in crisis conditions, including those involved in the trade

of grain, oil crops, and their derivatives. They emphasise the need to create parity relationships between participants in price chains to increase the effectiveness of food supply chains. The present research also reveals a significant increase in logistics costs amidst the uncertainty and transformation of wheat supply chains to global markets. Both studies conclude that in crisis conditions, compensation for losses is at the expense of agricultural commodity producers. N. Yaloveha (2023) demonstrates the need to shift market segment priorities and proposes measures in the area of marketing communications to promote goods during wartime. Both studies underline the importance of ensuring effective changes in marketing strategies for agricultural enterprises, particularly in logistic supply chains. Furthermore, according to this research, following strategic marketing principles in agribusiness, the export of raw materials should be gradually phased out. Instead, there should be a focus on developing trade in products with higher added value, which can be promoted in global and European markets. In particular, during the war and energy supply crisis, demand for bioenergy resources has increased. This creates opportunities for Ukraine to develop biofuel production and export it to EU countries.

The results of this research align with the conclusions drawn by other Ukrainian and foreign scientists, confirming their importance for the development of supply chains in the grain, oil crops, and derivatives markets.

CONCLUSIONS

The integration of Ukraine into global food chains has been preserved thanks to the introduction of several initiatives and agreements at the international level. As a result, pressure on the domestic market for grain, oilseeds, and related products in Ukraine was significantly reduced, as well as the threats to global food security. The recovery of exports through the Black Sea ports within the framework of the UN-led Grain Initiative facilitated up to 30% of total exports of grain, oilseeds, and their processing products during the war. Nevertheless, this was significantly lower compared to the pre-war period. This reduction occurred against the backdrop of constant uncertainty and the blocking of the Grain Initiative by the aggressor state. The ports of the Danube region provided alternative water transport export routes. However, critically short timeframes for resuming operations, constant military threats, and shelling prevented the realisation of this route's potential. The implementation of the EU-Ukraine Solidarity Lanes Initiative created opportunities to increase land-based exports of Ukrainian products to European and global markets. Railway and road routes were redirected to border crossings with neighbouring countries: Poland, Romania, Slovakia, Hungary, and Moldova. Renewed customs restrictions on exports to neighbouring

countries led to a reduction in supplies. A significant contribution to the restoration of export logistics for grain, oil crops, and their processing products was also made by the Ukrainian Alternate Sea Corridor, which was supported by international partners.

The aforementioned transformations in logistics resulted in a doubling of its cost. This limited access to logistics for small and medium-sized producers. Moreover, it contributed to a decrease in domestic prices for grain, oilseeds, and related products, consequently reducing income from their production. There is an urgent need to rebuild the export model for agricultural products in Ukraine, focusing on products with higher added value. Additionally, developing exports in the European direction requires addressing technical and infrastructural differences in the transport systems of Ukraine

and EU countries. In particular, this can be achieved through the development of multimodal transportation. It is also essential to establish an energy-efficient logistics infrastructure and continue harmonising domestic legislation with European standards. Another direction involves the construction of a network of domestic container terminals in Ukraine, which would improve access to global logistics for small and medium-sized producers and exporters of grain, oil products, and their derivatives.

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CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Логістичні трансформації на ринках зернових та олійних культур під час війни в Україні: Маркетингові підходи та стратегії

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Анотація. Російське військове вторгнення спричинило колапс у постачанні продовольства з України на світові ринки. Трансформація вітчизняної експортної логістики здійснювалася в критичних умовах і вкрай обмежених термінах. Метою статті було оцінити трансформації логістики на ринках зернових та олійних культур внаслідок війни, обговорити вплив міжнародних угод на експортно-логістичні ланцюги поставок, розробити пропозиції щодо маркетингових стратегій торгівлі зерновими, олійними культурами та продуктами їх переробки у воєнний час. Авторами використано низку загальнонаукових і спеціальних методів і підходів: системний підхід, абстрактно-логічний і графічний методи, методи ретроспективного, порівняльного аналізу, кореляційно-регресійного аналізу та метод прогнозування. Запропоновано періодизацію трансформації експортної логістики внаслідок війни, що включає наступні етапи: колапс логістики; зростання експорту під впливом міжнародних угод; функціонування альтернативного українського морського коридору за підтримки міжнародних партнерів. Доведено значний вплив трансформацій виробництва та збуту через війну на зростання вартості логістики експорту пшениці для різних баз постачання. Автори стверджують, що експортні логістичні ризики компенсувалися переважно низькими цінами на зернові та олійні культури для сільгоспвиробників. Запропоновано оцінку експорту на ринку зернових, олійних культур та продуктів їх переробки України. Окреслено формування ефективних маркетингових стратегій. Практична цінність роботи полягає у використанні результатів дослідження при розробці маркетингових стратегій підприємств та проектів розвитку європейського співробітництва в аграрному секторі

Ключові слова: логістика; ланцюги постачання продовольства; ціни; витрати; сільськогосподарські підприємства; безпечність харчових продуктів; експорт; міжнародні угоди
