



Optimisation of the logistics chains of Ukrainian agricultural enterprises in the context of military operations

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► **Abstract.** Extensive damage to transport hubs, the blockage of traditional deep-water ports and the sharp rise in the cost of fuel and energy resources caused by hostilities on Ukrainian territory necessitate a fundamental rethinking of existing approaches to the organisation of sales operations. The aim of this article was to conduct a comprehensive assessment of the disruptive changes in the logistics chains of Ukrainian agricultural enterprises during the war and to justify the strategic priorities for their optimisation in order to strengthen food security. The methodological basis of the study comprised methods of systemic-structural, comparative and economic-statistical analysis, expert assessment tools, as well as methods of cause-and-effect modelling of infrastructure constraints. The study found that, as a result of the armed aggression, over 42,000 km of roads were lost and over 600 km of railway tracks were damaged. The decline in gross harvest in 2022 was followed by a recovery in 2023 to 23.0 million tonnes and 32.0 million tonnes respectively. Spatial analysis revealed a shift in the centre of agricultural production towards the central and western regions, which has overburdened local infrastructure. It has been demonstrated that the Black Sea blockade in 2022-2023 reduced the share of maritime exports from 98% to 75-76% and led to a 40% fall in wheat exports and a 38% fall in maize exports, forcing an increase in the share of rail transport to 17%, and road transport to 8%. The recovery of the share of sea and Danube shipments to 93% in 2024-2025 confirmed the compensatory nature of land routes. The need for agribusiness to adapt has been substantiated through the expansion of sunflower cultivation to reduce unit transport costs, the development of railway terminals, the implementation of WMS and TMS systems, and the mobilisation of international support. The practical value of the findings lies in the possibility of the proposed recommendations being directly implemented by the management of agricultural enterprises and trading companies to rapidly reconfigure logistics flows and minimise financial losses in the context of high military risks

► **Keywords:** supply chains; agricultural sector; the Russia-Ukraine war; food security; transport infrastructure

► Introduction

The agricultural sector accounts for the bulk of Ukraine's foreign exchange earnings and plays a key role in maintaining food security. The stable operation of agricultural enterprises depends directly on the reliability of transport chains. Traditional logistics have suffered significant disruption as a result of the hostilities. The blockage of deep-water Black Sea ports, damage to railway lines and roads, and rising fuel costs have forced agricultural producers to seek alternative routes. The re-routing of freight flows has led to a significant increase in transport costs, prolonged delays at borders and a decline in the profitability of exports. Under such conditions, optimising logistics chains through the diversification of routes

and the introduction of modern management technologies becomes critically important for maintaining the sector's competitiveness.

The methodological basis for researching the architecture of modern distribution channels and their adaptability to exogenous shocks is formed by the fundamental concepts of foreign scholars. In particular, the work of M. Christopher (2022) substantiates the paradigm of flexibility and resilience in logistics networks, which defines the systems' capacity for operational efficiency and the restructuring of routes in response to critical fluctuations in the external environment. The specifics of restructuring supply routes for agricultural products under

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martial law were thoroughly investigated by M. Bezpar-tochnyi *et al.* (2023), who substantiated the adaptation of export logistics via the EU's "Solidarity Lanes". The authors demonstrated that, despite the blockade, maritime transport retained its leading position (69.4% of shipments), whilst rail and road transport became key alternatives on routes through Poland, Romania and Slovakia. However, the researchers focused primarily on the macroeconomic level (transit and borders), whilst the adaptation of specific agricultural enterprises' internal logistics chains in the context of hostilities and the destruction of warehouses requires further investigation. By contrast, the specific nature of how export agri-logistics operates when traditional transport corridors are blocked is covered in detail in the works of M. Nehrey *et al.* (2025). The researchers have demonstrated the need for the synchronised combination of the tactical reconstruction of grain storage and transport-distribution capacities with the introduction of digital logistics tools and Big Data analytics, which is identified as a fundamental prerequisite for minimising the geopolitical and financial risks faced by agribusiness entities.

The study by N. Sharata *et al.* (2026) is also devoted to the issues of spatial diversification and the optimisation of transport flows. The authors have substantiated the regional asymmetry in infrastructure development and econometrically demonstrated that the level of logistics costs and transport duration are key factors undermining the sector's financial and economic stability. To minimise these risks, the researchers proposed the implementation of a security-oriented supply model based on integration into European transport networks and the digitalisation of freight flows. International experience in overcoming infrastructure imbalances and enhancing the resilience of agri-logistics through digitalisation tools is highlighted in the work by M. Remondino & A. Zanin (2022). Using the Italian agricultural sector as an example, the authors argue that the implementation of Internet of Things, Big Data and blockchain technologies is a strategic imperative for bridging regional logistical gaps and minimising the financial risks faced by agribusiness operators. However, whilst in European practice these technological solutions are geared towards achieving traditional parameters of environmental and economic sustainability, under martial law in Ukraine the digitalisation of freight flows takes on security significance, serving as a means of preserving the physical viability of distribution channels.

It should also be noted that, in wartime, the primary objective for agribusiness is not to reduce costs, but to ensure survival and maintain supply chains. Z. Xu (2026) demonstrated that during large-scale crises, enterprises are forced to abandon their usual cost-saving models in favour of developing alternative logistics options. For the Ukrainian agri-food sector, which has faced the blockading of seaports and the destruction of warehouses, this means the need to expand the transport network. Instead of relying on a single familiar route, companies must simultaneously utilise rail, road and river routes, as well as establish new transshipment hubs in secure areas to safeguard exports. The issue of optimising wartime agricultural logistics is examined in the work by V.A. Panchenko (2024). The author analysed structural changes in grain transport,

notably a 34.4% reduction in rail transport and a 40.1% increase in road transport. The study estimates the total investment required to restore the agri-industrial complex's infrastructure at USD 6.0 billion, and demonstrates that the introduction of digital platforms can reduce logistics costs. At the same time, this work focuses primarily on the macroeconomic level and national measures to support the sector. Algorithms for minimising local risks at the level of individual enterprises were not included in the analysis. This highlights the need to develop practical tools for optimising agribusiness's internal logistics chains.

Despite the existence of substantial research, many questions remain unanswered. Most authors consider logistical problems in a fragmented manner, limiting themselves to analysing a single mode of transport or a specific border crossing. There are virtually no studies offering a comprehensive analysis of the dynamics of agribusiness logistics costs over the entire period of prolonged military impact. The effectiveness of combining the capabilities of dry ports with digital freight distribution systems also requires further study. These unresolved aspects determine the relevance of the research and form the scope of this article. The aim of the article was to analyse changes in the structure and functioning of the logistics chains of Ukrainian agribusinesses under the influence of military operations at the level of individual stages of product supply and distribution, as well as to develop practical recommendations regarding the diversification of routes, the development of multimodal transport and the digitalisation of management processes.

► Materials and methods

The methodological framework was based on a combination of systemic-structural analysis, which enabled the identification of destructive factors affecting logistics chains, and economic-statistical methods for assessing structural shifts in transport costs. The application of the comparative analysis method enabled a comparison of the operational parameters of logistics systems in the pre-war period and under martial law, whilst the abstract-logical method was used to formulate recommendations on route diversification and the introduction of multimodal technologies to ensure food security. The research was based on official statistical data from the State Statistics Service (2026) on the gross harvests of major crops and the regional structure of agricultural production for 2020-2025, as well as data from the Ministry of Agrarian Policy and Food of Ukraine (n.d.) on the volumes and commodity structure of agri-food exports for 2021-2025 and the distribution of freight flows by mode of transport (sea, rail, road) for the same period. The indicators presented in these sources concerning the shares of different transport modes in total agri-food exports and the annual dynamics of production and exports were used to compare the pre-war period with the period of active hostilities and the period of partial adaptation of the logistics system. In addition, academic publications by Ukrainian and foreign researchers on the issues of agri-logistics and the resilience of supply chains under martial law were analysed, which enabled the statistical data obtained to be compared with the results of related studies in the discussion section.

► Results and discussion

The logistics chain of an agricultural enterprise structurally encompasses the supply of raw materials (seeds, fertilisers, plant protection products, fuel and lubricants, machinery), production, harvesting and primary processing, storage, transport, further processing of produce, and sales via intermediaries and to end consumers. Unlike logistics systems in other sectors of the economy, the operation of each stage is strictly determined by seasonality and agronomic deadlines, which makes the entire chain highly sensitive to disruptions at any individual link: a delay in the supply of resources or a deviation from the optimal harvest dates leads to cumulative losses at subsequent stages. In this context, O. Maltsev (2021) emphasised that supply chains account for the lion's share of agricultural enterprises' logistics costs; consequently, timing deviations or delays in resource supply result in cumulative financial losses and disruptions to subsequent marketing activities.

Prior to the full-scale invasion, the most critical stages from a management perspective were considered to be storage (maintaining temperature and humidity conditions, pest control, and optimisation of warehouse capacity) and transport (selection of transport mode, minimisation of losses, and compliance with transport conditions). Under martial law, the functional burden shifted to the transport stage. In the pre-war period, the efficiency of this stage was determined primarily by economic parameters – delivery speed and transport costs. During the period under study, the decisive factor became the feasibility of physically carrying out transport operations amidst damaged transport infrastructure and spatial transformations in the geography of agricultural

production, a detailed analysis of which is provided in the following section.

In assessing the scale of the destructive impact of hostilities on agricultural logistics, V. Kuziak *et al.* (2023) emphasised that the destabilisation affected all elements of the supply chains. In their study, the researchers argued that the blockage of seaports (through which nearly 90% of agricultural exports had been carried out prior to the full-scale invasion) caused a logistical collapse and forced agribusiness operators to switch to land routes. Based on an analysis of systemic challenges, V.V. Kuziak (2023) identified six key problems affecting the functioning of agri-logistics in wartime:

- low throughput capacity at western border crossings and the build-up of queues;
- an acute shortage of skilled labour due to mobilisation processes and the outflow of human capital;
- rising energy prices;
- power cuts, which have a disruptive impact on warehouse logistics;
- the destruction of production facilities and warehouse infrastructure;
- the risks of losing traditional markets and a decline in the sector's international competitiveness.

Building on the conceptual conclusions of the aforementioned authors regarding the need for a radical adaptation of management models, assessing the scale of the transformation of logistics routes requires, first and foremost, an analysis of production dynamics (Fig. 1) and the geographical distribution of the agri-food sector's production capacity. A clear imbalance between growing regions and traditional shipping points is the main factor driving the restructuring of freight flows.

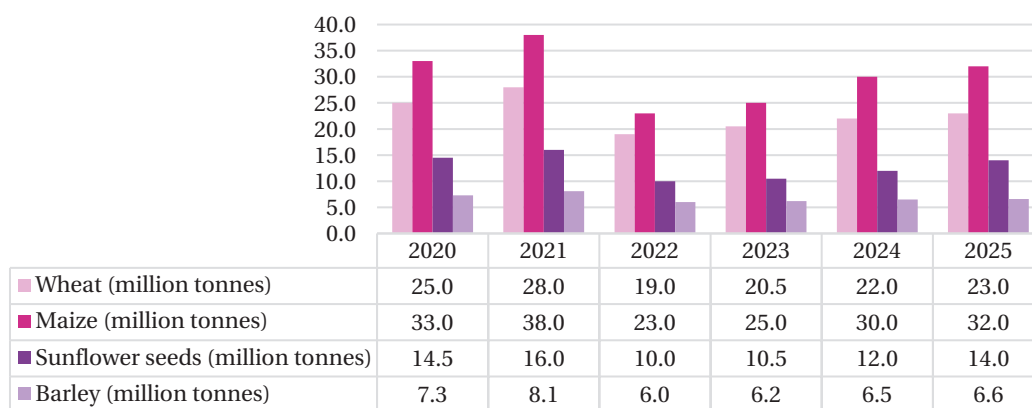


Figure 1. Trends in the production of major crops in Ukraine for 2020-2025

Source: State Statistics Service (2026)

The trend in gross crop yields for 2020-2025 reflects the direct impact of security factors on the agri-food sector's logistics system. The sharp decline in production in 2022 (a 32.1% reduction in the wheat harvest and a 39.5% reduction in the maize harvest) was a consequence of the occupation of territories, the laying of landmines and the naval blockade, which led to a shortage of storage capacity due to the accumulation of carryover stocks. In this context, K. Mazur *et al.* (2023) argued that the high risks of air strikes on port infrastructure forced the agribusiness

sector to reassess its warehousing logistics – to move away from stockpiling significant volumes of produce in ports and to shift storage to rail and land-based terminals. The gradual recovery in volumes between 2023 and 2025 (reaching 23.0 million tonnes of wheat and 32.0 million tonnes of maize in 2025) has shifted the critical burden onto western land crossings and Danube ports. At the same time, the increase in the sunflower harvest to 14.0 million tonnes confirms the findings of K. Mazur *et al.* (2023) regarding the adaptation of the agribusiness sector through

an increase in the share of high-profit crops to minimise unit transport costs in the face of rising tariffs and logistical risks. Consequently, the key constraint on the functioning of the agri-industrial complex is not production capacity, but rather the throughput capacity and security resilience of alternative export corridors.

One of the consequences of the hostilities has been a shift in the regional distribution of agricultural production. The southern and eastern regions, which prior to the war were the main centres of cereal and oilseed production, have largely lost their production capacity. During and after the war, an increase in production has been observed in the central and western regions, particularly in the Cherkasy, Vinnytsia, Lviv and Poltava regions (Fig. 2). This is because these regions did not suffer such extensive destruction as the southern regions and have retained their agricultural infrastructure, which allows produce to be stored and processed in a timely manner.

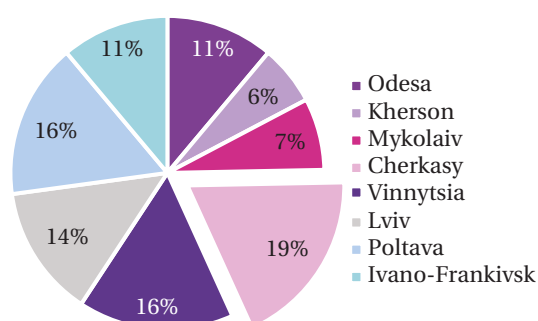


Figure 2. Structure of agricultural production by region in 2025 (% of the total)

Source: State Statistics Service (2026)

An analysis of the regional breakdown of gross harvest figures for 2025 reveals a geographical shift in the centre of agricultural production towards the western and central regions of Ukraine. The decline in the share of the southern and eastern regions in the national total has placed an unprecedented additional strain on the grain elevator, storage and transport infrastructure in Central and Western Ukraine. In their work, S.M. Tkachenko *et al.* (2025) demonstrated that, in the event of a blockade of traditional deep-water Black Sea ports, it is precisely the geographical optimisation of storage capacity and the development of border agro-logistics hubs in the western regions that become the decisive factor in preserving export potential. Such a spatial transformation requires a radical restructuring

of logistics routes, as traditional logistics hubs and trunk routes oriented towards the deep-water ports of the Black Sea have lost their primary functionality, giving way to rail and road border crossings on the western border.

The logistics chain is a system of interlinked elements that facilitate the movement of material, information and financial flows from suppliers to end consumers. For agricultural enterprises, the logistics chain comprises the following main stages: supply of raw materials; production; harvesting; storage of produce; transport; and sale of produce. In their study of the effectiveness of agribusiness management systems under conditions of military conflict, Y. Lopatynskyi *et al.* (2023) noted that the destructive impact of war leads to systemic complications in the functioning of each of these stages – primarily due to the critical destruction of grain storage facilities, the loss of agricultural machinery and the blockade of traditional port and logistics routes. In their research, A.L. Bykova & I.V. Yefimenko (2024) emphasised that disruptive factors within the transport and logistics system pose direct threats to the economic security of enterprises due to disruptions in supply chains and financial losses.

Rail transport has become crucial for ensuring the export of agricultural produce. At the same time, by the end of 2024, damage to 600 km of railway tracks and infrastructure had significantly reduced transport efficiency (KSE Institute, 2024). Maritime transport, which prior to the outbreak of hostilities accounted for a significant share of agricultural exports, has virtually lost its importance due to the blockading of ports and the destruction of infrastructure.

The practical relevance of these approaches is confirmed by the study of V. Kuziak *et al.* (2023), which emphasises that a shift towards land-based corridors, flexible strategic planning and the creation of buffer stocks are decisive factors in ensuring the resilience of logistics chains in crisis situations. From a methodological perspective, this transformation requires adherence to clear management principles, which were systematised by R. Molyboha (2024), who justified the need for coherence in goal-setting, economic viability, the adaptability of organisational structures, and periodic monitoring of the effectiveness of transport and logistics systems. The implementation of these measures has directly transformed the physical and cost parameters of foreign trade. The loss of access to deep-water Black Sea ports has shaped a new structure for agricultural exports, centred on the throughput capacity of land transport routes and the Danube cluster (Table 1).

Table 1. Trends in exports of key agricultural products from Ukraine (2021-2025), million tonnes

Products	2021	2022	2023	2024	2025
Wheat	20.0	12.0	16.5	19.9	13.3
Maize	29.0	18.0	20.0	28.0	17.6
Sunflower oil	5.4	2.9	3.1	5.8	4.3
Barley	5.0	2.1	2.0	2.5	1.6

Source: Ministry of Agrarian Policy and Food of Ukraine (n.d.)

The data in Table 1 show how exports depend on the functioning of transport infrastructure. In 2022, due to the outbreak of hostilities and the blockage of ports, wheat exports fell by 40% and maize exports by 38%. Subsequently, thanks to the development of transport routes across the

western border, the Danube ports and the operation of the maritime corridor, shipments increased significantly in 2023-2024. In particular, in 2024, exports of maize (28.0 million tonnes) and sunflower oil (5.8 million tonnes) almost reached pre-war levels. The decline in figures in 2025

indicates that existing land and river routes have reached their capacity limits, whilst high transport costs, border congestion and the risk of shelling remain the main

obstacles to exports. The structural shift in the shares of individual modes of transport within the total volume of agricultural exports is clearly illustrated in Figure 3.

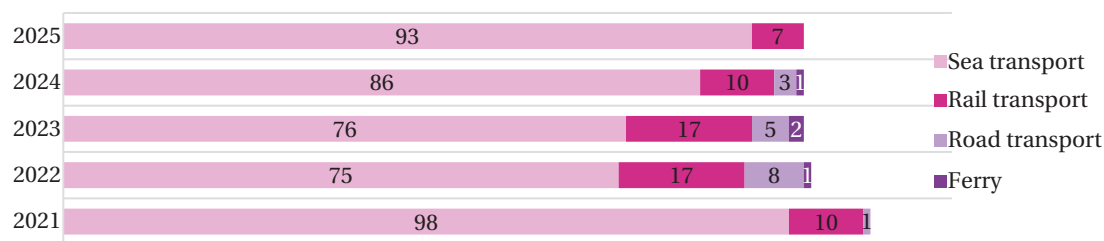


Figure 3. Structure of export logistics routes for the period 2021-2025, %

Source: Ministry of Agrarian Policy and Food of Ukraine (n.d.)

An analysis of data on the distribution of export routes for 2021-2025 shows how transport logistics in the agricultural sector have changed. Before the outbreak of the full-scale war, 98% of all exports passed through sea-ports, whilst rail and road transport played only a supporting role (10% and 1% respectively). The blockade of ports in 2022-2023 forced a reorientation of freight flows towards land borders, causing the share of rail transport to rise to 17% and that of road transport to 8%. The scientific rationale for this forced reorientation is set out in the work by S. Kolosov *et al.* (2025), which demonstrates that the loss of sea routes transformed Ukraine's export model from one of development to one of stabilisation. The researchers emphasised that, with traditional ports blocked, the increased burden on alternative land-based channels was accompanied by significant logistical complications – in particular, the high cost and limited efficiency of road transport, as well as the infrastructural barrier posed by the differing track gauges in Ukraine and the EU. However, the launch of the Ukrainian maritime corridor and the active use of Danube ports made it possible to partially restore the usual routes: in 2024, the share of maritime transport rose to 86%, and in 2025 it reached 93%. This confirms that land routes cannot fully replace ports when export volumes are high, but they remain an important backup channel during crisis situations.

The introduction of modern logistics management information systems, such as WMS (Warehouse Management System) and TMS (Transportation Management System), enables more efficient management of logistics processes and minimises risks. The trends in structural shifts within transport logistics outlined above also point to the directions for the agribusiness sector's future adaptation. As rail transport shouldered the bulk of the load during the port blockade, further increasing its capacity remains a priority: investment in the infrastructure of border terminals, coordination of timetables with rail operators and route optimisation can transform a temporary compensatory channel into a permanent element of a diversified logistics system. In their study of agribusiness development, O. Hrymak *et al.* (2024) identified digitalisation and flexible logistics as its key drivers. The authors divide innovative measures into operational and strategic categories. Operational innovations are needed to sustain production and supply chains during the war. Strategic innovations, on the other hand, are designed for the post-war period

and involve infrastructure reconstruction, energy independence and entry into new markets. Consequently, logistics must evolve from a rapid-response tool into a permanent management system.

Road transport, despite its smaller share, fulfils a function that rail cannot provide – flexible delivery to warehouses and end consumers in regions where the rail infrastructure is either absent or damaged. The efficiency of this channel depends on fleet differentiation (heavy-duty transport over long distances and small lorries for local deliveries) and the modernisation of the vehicle fleet, as well as on safety measures along the routes. The geographical shift of production to the central and western regions makes economic sense for regional logistics centres in these areas: they reduce delivery distances to border crossings and Danube ports, relieve the strain on the overburdened infrastructure of the receiving regions and, at the same time, require modern warehouse management systems.

Digitalisation serves as a cross-cutting tool for all three areas. The implementation of WMS and TMS, as well as analytics for demand forecasting and route optimisation, makes it possible to coordinate disparate channels (rail, road transport, regional hubs) into a single, managed system, rather than a set of isolated workarounds. M. Adelusola (2024) shares a similar view on innovation in agri-logistics. The author noted that IoT temperature and humidity sensors, together with blockchain and smart contracts, help to significantly reduce product spoilage. Without these technologies, losses of perishable goods can reach 30-40%. They also speed up customs clearance and make supply chain information transparent to all participants in the process.

The security aspect warrants separate consideration: in a conflict situation, the loss of cargo or a vehicle poses a risk no less significant than the cost of transport. Convoy escorts, cargo insurance, training for drivers and logistics staff, and real-time transport monitoring directly affect the cost of exports, as these factors are factored into the logistics discount applied to Ukrainian produce. M. Barna & Yu. Ivaniuk (2024) emphasise that wartime conditions require a review of the entire agricultural produce distribution system. The costs of staff training, cargo insurance, alternative logistics and GPS monitoring directly increase the cost price of exports. All these risks ultimately contribute to the logistics discount applied to Ukrainian agricultural produce.

Finally, access to international support remains a resource that agricultural enterprises utilise unevenly. Agreements with international logistics operators, participation in support programmes and the use of the transit capacities of neighbouring countries represent practices that have already demonstrated their effectiveness through the EU's "Solidarity Lanes". At the regulatory and strategic level, the need for such integration is confirmed by Ye.A. Marinov (2024), who notes that Ukraine's National Transport Strategy for the period up to 2030 prioritises the implementation of new digital economic models and convenient information and communication platforms. The academic contribution of Ye.A. Marinov demonstrates that EU Member States' investments in the digitalisation of supply-chain management, automatic product identification, GPS/GPRS monitoring systems and TMS/WMS planning provide the necessary technological foundation for the barrier-free movement of Ukrainian agricultural exports. An example of such support at the primary production level is the FAO and Ministry of Agrarian Policy and Food of Ukraine programme for distributing soybean and sunflower seeds among small and medium-sized farms (10-500 ha) in eight regions, reaching more than 3,000 farmers. Although this programme is more closely related to the restoration of the production base than to logistics directly, its existence demonstrates the broader framework of external support into which a logistics component can also be integrated. The results obtained regarding the disruption and subsequent adaptation of the logistics chains of Ukraine's agri-food sector under martial law are consistent with the main theoretical and applied propositions of contemporary studies, while also possessing their own analytical specificity.

The scientific position regarding the critical impact of military operations on the destruction of infrastructure and the forced reorientation of export routes is consistent with the conclusions of S. Moroz & S. Levchenko (2023), as well as K. Mazur *et al.* (2023). The authors confirmed that the blockade of Black Sea ports triggered a cascade of disruptions across the entire transport system, forcing agricultural exporters to seek alternative routes via western border crossings and Danube ports. The current findings regarding shifts in transport modes (the increase in rail and road shipments in 2022-2023) provide a quantitative breakdown of their general observations.

The assessment of the adaptive recovery of export volumes in 2024-2025, driven by the restoration of the maritime corridor, is consistent with the findings of studies by V.V. Kuziak (2023) and S. Kolosov *et al.* (2025). At the same time, whilst the aforementioned researchers focus more on a general economic assessment of the export potential of cereal crops, this study emphasises a comparative analysis of the throughput capacity of individual modes of transport and the constraints of land-based infrastructure. The authors' conclusions regarding the need to implement digital technologies (WMS, TMS) and modernise warehousing facilities complement the findings of M. Remondino & A. Zanin (2022). These authors argued that digitalisation is a factor in enhancing the competitiveness and resilience of agribusiness. In this study, this aspect is considered as a tool for minimising safety and time losses when planning flexible multimodal routes.

The issues of logistics infrastructure management and regional adaptation in wartime are discussed in the works of S.M. Lykholat & O.M. Myskiv (2022), as well as M.V. Vovk & L.I. Lesyuk (2025). Unlike their works, which focus on a general conceptualisation of agri-logistics, this study presents the authors' findings regarding the shift of production centres to the western and central regions of Ukraine and justifies the need to establish regional logistics hubs there. The examination of the cross-border aspect and the innovative development of agribusiness in the works of M. Bezpartochnyi *et al.* (2023), O. Hrymak *et al.* (2024), and T. Vasylytsiv *et al.* (2025) confirms the importance of international support and logistical integration with the EU. The present findings complement their scholarly achievements by showing that land corridors with EU countries, despite their strategic role during peak crisis periods, have limited capacity and serve as a backup and compensatory channel, whilst maritime transport remains the indispensable foundation for large-scale exports.

Thus, the comparison carried out demonstrates that this study fits organically into the existing academic discourse, whilst making its own analytical contribution to the study of the transformation of Ukraine's agri-logistics. Unlike the works examined, which largely focus on individual aspects of the issue, this study comprehensively integrates an analysis of the dynamics of gross harvest, export volumes and structural shifts in transport logistics into a single analytical model. This makes it possible to trace the interrelationship between the destruction of infrastructure, the reorientation of export flows and the sector's adaptive mechanisms throughout the entire period of martial law.

► Conclusions

The analysis conducted has shown that the functioning of Ukraine's agricultural sector between 2020 and 2025 was accompanied by a structural reorganisation of production and distribution logistics under the influence of martial law, rather than merely fluctuations in production volumes. The decline in gross harvest in 2022 was followed by a recovery to pre-war levels in 2025; however, a concomitant consequence was a geographical shift in production towards the central and western regions (Cherkasy, Vinnytsia, Poltava and Lviv), which placed an additional strain on the regional grain storage network in these areas and highlighted the need to develop border logistics hubs.

A key factor in this restructuring was the blockade of the Black Sea in 2022-2023, which temporarily reduced the share of maritime exports and forced a reorientation of freight flows towards rail and road transport. The subsequent resumption of maritime and Danube shipments confirmed that land routes serve a compensatory rather than an alternative function: they are capable of partially replacing ports during a crisis, but do not provide comparable throughput capacity when export volumes are high. The main barriers remain damage to transport infrastructure, congestion at border crossings and the increased cost of transport.

The findings indicate that optimising the supply chains of agricultural enterprises requires not isolated, ad hoc measures, but a combination of several

approaches: diversifying crop patterns to reduce unit transport costs, developing railway terminals, introducing digital management systems (WMS, TMS) and securing international support. A promising area for further research is the assessment of the economic efficiency of Eastern European “dry ports” and the development of tools to minimise the logistics discount on Ukrainian agricultural produce.

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Оптимізація логістичних ланцюжків українських аграрних підприємств в умовах військових дій

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► **Анотація.** Масштабні пошкодження транспортних вузлів, блокування традиційних глибоководних портів та стрімке подорожчання паливно-енергетичних ресурсів, спричинене бойовими діями на території України, зумовлюють необхідність докорінного переосмислення наявних підходів до організації збутової діяльності. Метою статті було комплексне оцінювання деструктивних трансформацій у логістичних ланцюгах українських аграрних підприємств під час війни та обґрунтування стратегічних пріоритетів їхньої оптимізації для зміцнення продовольчої безпеки. Методологічну основу дослідження становили методи системно-структурного, компаративного та економіко-статистичного аналізу, інструменти експертного оцінювання, а також методи причинно-наслідкового моделювання інфраструктурних обмежень. За результатами дослідження встановлено, що внаслідок збройної агресії втрачено понад 42 тис. км автомобільних доріг та пошкоджено понад 600 км залізничних колій. Скорочення валового збору у 2022 році змінилося відновленням у 2025 році до 23,0 млн т та 32,0 млн. т відповідно. Просторовий аналіз зафіксував переміщення центру агропромисловості у центральні та західні області, що переважило місцеву інфраструктуру. Доведено, що блокада Чорного моря у 2022-2023 роках знизила частку морського експорту з 98 % до 75-76 % і призвела до падіння експорту пшениці на 40 % та кукурудзи на 38 %, змусивши збільшити частку залізничних перевезень до 17 %, а автомобільних – до 8 %. Відновлення частки морських і дунайських відвантажень у 2024-2025 роках до 93 % підтвердило компенсаторний характер сухопутних маршрутів. Обґрунтовано необхідність адаптації агробізнесу через розширення посівів сояшинику для зменшення питомих транспортних витрат, розбудову залізничних терміналів, впровадження систем WMS і TMS та залучення міжнародної підтримки. Практична цінність отриманих результатів полягає у можливості безпосереднього впровадження запропонованих рекомендацій менеджментом сільськогосподарських підприємств та трейдингових компаній для оперативної реконфігурації логістичних потоків і мінімізації фінансових втрат в умовах високих воєнних ризиків

► **Ключові слова:** ланцюги постачання; аграрний сектор; російсько-українська війна; продовольча безпека; транспортна інфраструктура