МАГІСТЕРСЬКА КВАЛІФІКАЦІЙНА РОБОТА

12.01 – МКР. 69 “С” 2023.01.12. 16 ПЗ

БАЛАЦЬКОГО ОЛЕКСАНДРА ВАСИЛЬОВИЧА

2023 р.

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ

Факультет аграрного менеджменту

УДК 656.073:664.7(477)

ПОГОДЖЕНО
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«___» _____ 2023 р.

МАГІСТЕРСЬКА КВАЛІФІКАЦІЙНА РОБОТА
на тему «Логістика експорту зерна в Україні»

Спеціальність 073 «Менеджмент»
(код і назва)

Освітня програма «Менеджмент зовнішньоекономічної діяльності»
(назва)

Орієнтація освітньої програми освітньо-професійна

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КИЇВ – 2023

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ

Факультет аграрного менеджменту

ЗАТВЕРДЖУЮ
Завідувач кафедри
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«__» _____ 2023 року

З А В Д А Н Н Я
ДО ВИКОНАННЯ МАГІСТЕРСЬКОЇ КВАЛІФІКАЦІЙНОЇ РОБОТИ СТУДЕНТУ

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Орієнтація освітньої програми освітньо-професійна

Тема магістерської кваліфікаційної роботи **«Логістика експорту зерна в Україні»** затверджена наказом ректора НУБіП України від «12» січня 2023 р. №69 "С"

Термін подання завершеної роботи на кафедру 2023.11.10
(рік, місяць, число)

Вихідні дані до магістерської кваліфікаційної роботи: Закони України, укази Президента України, постанови Кабінету Міністрів України, матеріали Міністерства аграрної політики і продовольства України, статистична інформація Державної митної служби України, FAO та Міністерства сільського господарства США (USDA), власні спостереження автора.

Перелік питань, що підлягають дослідженню:

1. Теоретико-методичні основи функціонування логістичної системи експорту зерна
2. Сучасний стан та основні тенденції розвитку логістики експорту зерна в Україні
3. Перспективи розвитку експорто-орієнтованої зернової логістики України

Перелік графічного матеріалу (за потреби): табл. – 7; рис. – 22.

Дата видачі завдання «24» січня 2023 р.

Керівник магістерської кваліфікаційної роботи _____ **Лариса ДІБРОВА**
(підпис) (прізвище та ініціали)

Завдання прийняв до виконання _____ **Олександр БАЛАЦЬКИЙ**
(підпис) (прізвище та ініціали студента)

РЕФЕРАТ

Структура магістерської кваліфікаційної роботи. Магістерська кваліфікаційна робота на тему «Логістика експорту зерна в Україні» викладена на 93 сторінках друкованого тексту, включає 7 таблиць і 22 рисунки. Робота складається зі вступу, трьох розділів і висновків. Для написання магістерської роботи використано 77 літературних джерел.

Основний зміст магістерської кваліфікаційної роботи. В першому розділі магістерської кваліфікаційної роботи «Теоретико-методичні основи функціонування логістичної системи експорту зерна» обґрунтувана роль та значення логістики для зовнішньоекономічних операцій, визначені сутність та особливості логістичної системи та окреслені чинники формування ефективної логістичної системи.

У другому розділі «Сучасний стан та основні тенденції розвитку логістики експорту зерна в Україні» проведено оцінку ресурсних можливостей для виробництва та експорту зерна в Україні, досліджено систему логістичного забезпечення експорту зерна в Україні; систематизовано трансформаційні процеси в агропродовольчих ланцюгах на мікро і мезо рівнях та обґрунтовані заходи щодо їх інтеграції у глобальні ланцюги вартості в умовах війни;

У третьому розділі - «Перспективи розвитку експорто-орієнтованої зернової логістики в Україні» досліджені процеси перебудови логістичного ринку під час воєнного стану в Україні та визначені можливості для відновлення зруйнованої логістичної інфраструктури в процесі відбудови України, обґрунтовані напрями диверсифікації логістичних шляхів експорту зерна в умовах повномасштабної агресії російської федерації.

Мета і завдання магістерської кваліфікаційної роботи. Метою дослідження є обґрунтування теоретико-методичних підходів та розробка науково-практичних рекомендацій щодо відновлення, формування та функціонування логістичної системи експорту зерна в Україні.

Відповідно до поставленої мети в роботі передбачено вирішення наступних **завдань:**

- обґрунтувати роль та значення логістики для зовнішньоекономічних операцій;
- з'ясувати сутність та визначити особливості логістичної системи;
- окреслити чинники формування ефективної логістичної системи;
- визначити особливості формування логістичних витрат в умовах воєнного стану;
- оцінити ресурсні можливості для виробництва та експорту зерна в Україні;
- дослідити систему логістичного забезпечення експорту зерна в Україні;
- систематизувати трансформаційні процеси в агропродовольчих ланцюгах на мікро і мезо рівнях та обґрунтувати заходи щодо їх інтеграції у глобальні ланцюги вартості в умовах війни;
- дослідити процеси перебудови логістичного ринку під час воєнного стану в Україні та визначити можливості для відбудови зруйнованої логістичної інфраструктури в процесі відбудови України;
- виявити напрями диверсифікації логістичних шляхів експорту зернових в умовах повномасштабної агресії російської федерації.

Об'єктом дослідження є процес формування експорторієнтованої зернової логістики.

Предметом дослідження є теоретико-методичні і практичні аспекти впливу внутрішніх і зовнішніх факторів на функціонування логістики експорту зерна.

Методи дослідження. Теоретичною і методологічною основою проведених в магістерській кваліфікаційній роботі досліджень стали основні положення теорії формування та функціонування логістичної системи експорту зерна. Із спеціальних методів дослідження в роботі використані: абстрактно-логічний, монографічний, розрахунково-конструктивний, економіко-статистичний, а також табличний і графічний методи відображення інформації.

Наукова новизна одержаних результатів полягає у здійсненні комплексної оцінки особливостей формування та функціонування логістичної системи експорту зерна під час повномасштабного вторгнення росії в Україну.

Практичне значення одержаних результатів полягає у тому, що рекомендації та пропозиції, наведені у магістерській кваліфікаційній роботі, спрямовані на удосконалення процесу формування та функціонування логістики експорту зерна.

Апробація результатів магістерської кваліфікаційної роботи.

Основні положення та результати, викладені в магістерській кваліфікаційній роботі були оприлюднені на IV Міжнародній науково-практичній онлайн-конференції студентів, аспірантів і молодих вчених «Сучасний менеджмент: виклики та можливості». (м. Київ, НУБіП України, 25-26 жовтня 2023 р.).

Публікації. Основні положення та результати дослідження були відображені у матеріалах конференцій:

1. Балацький О.В., Діброва Л.В. Логістика експорту зерна з України в умовах військової агресії російської федерації. Матеріали IV Міжнародної науково-практичної конференції студентів, аспірантів та молодих вчених, присвяченої 125-річчю НУБіП України «Сучасний менеджмент: виклики та можливості»: 25-26 жовтня 2023 р. – К.: НУБіП України, 2023.

КЛЮЧОВІ СЛОВА: ЛОГІСТИЧНА СИСТЕМА, ЕКСПОРТ, ЗЕРНОВА ГАЛУЗЬ, ЕКСПОРТНА ЛОГІСТИКА, ВОЄННИЙ СТАН.

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Faculty of Agricultural Management

UDK 656.073:664.7(477)

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«___» _____ 2023 p.

IS ALLOWED BY
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«___» _____ 2023 p.

MASTER'S THESIS

Topic «Export logistics of grain in Ukraine»

Specialty 073 «Management»

Educational program «Management of foreign economic activity»

Orientation of the educational program educational and professional

Guarantor of the educational program:
PhD in Economics, Associate Professor _____ **Larysa DIBROVA**

Head of the master's of qualification work
PhD in Economics, Associate Professor _____ **Larysa DIBROVA**

Performed by: _____ **Oleksandr BALATSKYI**

KYIV - 2023

ABSTRACT

Structure of the master's qualification work. The master's thesis on «Export logistics of grain in Ukraine» is presented on 93 pages of printed text, includes 7 tables and 22 figures. The work consists of an introduction, three chapters and conclusions. To write the master's thesis, 77 literary sources were used.

The main content of the master's thesis. In the first chapter of the master's thesis "Theoretical and methodological foundations of the logistics system of grain exports" the role and importance of logistics for foreign economic operations are substantiated, the essence and features of the logistics system are defined, and the factors of formation of an effective logistics system are outlined.

In the second section «Current state and main trends in the development of grain export logistics in Ukraine», the article assesses the resource opportunities for grain production and export in Ukraine, studies the system of logistics support for grain exports in Ukraine; systematizes the transformation processes in agri-food chains at the micro and meso levels and substantiates measures for their integration into global value chains in the context of war;

The third section – «Prospects for the development of export-oriented grain logistics in Ukraine» - examines the processes of restructuring the logistics market during martial law in Ukraine and identifies opportunities for restoring the destroyed logistics infrastructure in the process of rebuilding Ukraine, substantiates the directions of diversification of logistics routes for grain exports in the context of full-scale aggression of the Russian Federation.

Purpose and objectives of the master's thesis. The purpose of the study is to substantiate theoretical and methodological approaches and develop scientific and practical recommendations for the restoration, formation and functioning of the logistics system of grain exports in Ukraine.

In accordance with this goal, the paper aims to solve the following tasks:

- to substantiate the role and importance of logistics for foreign economic operations;

- to clarify the essence and define the features of the logistics system;

- to outline the factors of formation of an effective logistics system;
- determine the features of the formation of logistics costs in martial law;
- to assess resource opportunities for grain production and export in Ukraine;
- to study the system of logistics support for grain exports in Ukraine;
- to systematize the transformation processes in agri-food chains at the micro and meso levels and to substantiate measures for their integration into global value chains in the context of war;
- to study the processes of restructuring the logistics market during martial law in Ukraine and identify opportunities for rebuilding the destroyed logistics infrastructure in the process of rebuilding Ukraine;
- to identify areas of diversification of logistics routes for grain exports in the context of full-scale aggression of the Russian Federation.

The object of research is the process of forming export-oriented grain logistics.

The subject of the study is the theoretical, methodological and practical aspects of the influence of internal and external factors on the functioning of grain export logistics.

Research methods. The theoretical and methodological basis of the research conducted in the master's qualification work were the main provisions of the theory of formation and functioning of the logistics system of grain exports. The special research methods used in the work include: abstract-logical, monographic, calculation and design, economic and statistical, as well as tabular and graphical methods of displaying information.

The scientific novelty of the results obtained is a comprehensive assessment of the peculiarities of the formation and functioning of the logistics system of grain exports during Russia's full-scale invasion of Ukraine.

The practical significance of the results obtained is that the recommendations and proposals contained in the master's thesis are aimed at improving the process of formation and functioning of grain export logistics.

Testing of the results of the master's thesis. The main provisions and results presented in the master's thesis were presented at the IV International Scientific and

Practical Online Conference of Students, Postgraduates and Young Scientists "Modern Management: Challenges and Opportunities" (Kyiv, NULES of Ukraine, October 25-26, 2023).

Publications. The main provisions and results of the study were reflected in the conference proceedings:

1. Balatskyi O.V., Dibrova L.V. Logistics of grain exports from Ukraine in the conditions of military aggression of the Russian Federation. Proceedings of the IV International Scientific and Practical Conference of Students, Postgraduates and Young Scientists dedicated to the 125th anniversary of NULES of Ukraine "Modern Management: Challenges and Opportunities": October 25-26, 2023 - K.: NULES of Ukraine, 2023.

KEYWORDS: LOGISTICS SYSTEM, EXPORT, GRAIN INDUSTRY, EXPORT LOGISTICS, MARTIAL LAW.

OVERVIEV

INTRODUCTION

Relevance of the research topic. On February 24, 2022, our lives were divided into periods before and after the war. These tragic events for Ukraine and the entire Ukrainian people have affected all spheres of life and the economy. The suspension of air transportation and delivery of goods by sea, huge delays in rail and road transportation due to the critical situation on the roads, and the reorientation of logistics exclusively to humanitarian cargo indicate dramatic changes in this area. Russia's full-scale invasion is blocking Ukraine's access to the Black Sea ports, which typically account for about 90% of food exports. This problem is especially important for the export of Ukrainian grain, the absence of which on the world market could lead to a global food crisis, especially in the Middle East and Africa.

As global agricultural prices have already reached historic highs due to COVID-19 and adverse weather conditions caused by climate change, the side effects of the Russian war have caused a sharp rise in prices for bread, animal feed, and fertilizers. Disruptions in the supply of grains, oilseeds, and other commodities transported through the Black Sea region will have significant implications for food security in countries that import these goods. This is especially true for countries in North Africa and the Mediterranean region that depend on imports from Ukraine. Therefore, the issue of resuming grain exports by rail is extremely relevant at the moment.

Many scientists and scholars have been studying the export of grain crops and their products. In particular, D. Semenda, V. Bilichenko, A. Pedorchenko, O. Muradian, R. Rustamov, who raise the issue of analyzing the grain market in Ukraine, assess the possibilities of increasing production and export of grain crops, consider the main problems of logistics transportation of grain crops in Ukraine, and analyze the demand for transportation services by modeling and forecasting the development of grain transportation processes; study in detail the impact of the consequences of Russia's invasion of Ukraine on the logistics chains of grain supply to world markets. However, all these issues need to be studied in more detail, as this problem is not

sufficiently researched due to the rapid change in external factors, and therefore the topic of the master's qualification work is extremely relevant and necessary.

Purpose and objectives of the master's thesis. The purpose of the study is to substantiate theoretical and methodological approaches and develop scientific and practical recommendations for the restoration, formation and functioning of the logistics system of grain exports in Ukraine.

In accordance with this goal, the paper aims to solve the following tasks:

- to substantiate the role and importance of logistics for foreign economic operations;
- to clarify the essence and define the features of the logistics system;
- to outline the factors of formation of an effective logistics system;
- determine the features of the formation of logistics costs in martial law;
- to assess resource opportunities for grain production and export in Ukraine;
- to study the system of logistics support for grain exports in Ukraine;
- to systematize the transformation processes in agri-food chains at the micro and meso levels and to substantiate measures for their integration into global value chains in the context of war;
- to study the processes of restructuring the logistics market during martial law in Ukraine and identify opportunities for rebuilding the destroyed logistics infrastructure in the process of rebuilding Ukraine;
- to identify areas of diversification of logistics routes for grain exports in the context of full-scale aggression of the Russian Federation.

The object of research is the process of forming export-oriented grain logistics.

The subject of the study is the theoretical, methodological and practical aspects of the influence of internal and external factors on the functioning of grain export logistics.

Research methods. The theoretical and methodological basis of the research conducted in the master's qualification work were the main provisions of the theory of formation and functioning of the logistics system of grain exports. The special research methods used in the work include: abstract-logical, monographic, calculation and

design, economic and statistical, as well as tabular and graphical methods of displaying information.

The scientific novelty of the results obtained is a comprehensive assessment of the peculiarities of the formation and functioning of the logistics system of grain exports during Russia's full-scale invasion of Ukraine.

The practical significance of the results obtained is that the recommendations and proposals contained in the master's thesis are aimed at improving the process of formation and functioning of grain export logistics.

Structure of the master's qualification work. The master's thesis on «Logistics of grain exports in Ukraine» is presented on 94 pages of printed text, includes 7 tables and 22 figures. The work consists of an introduction, three chapters and conclusions. To write the master's thesis, 77 literary sources were used.

CHAPTER I. THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF THE EFFICIENCY OF THE LOGISTICS SYSTEM OF EXPORTS

1.1. The role and importance of logistics for foreign economic operations

In the context of globalization, the role of foreign economic activity remains a priority, creating the basis for the development of efficient trade and a favorable investment climate. That is why the proper organization of foreign economic operations is extremely important and requires considerable attention.

Logistics is the search for ways to rationally move a product through the chain: from the manufacturer to the final recipient, so the costs of various logistics operations make up a significant part of the price of the finished product, it is the management of material resources during their purchase or production, transportation and storage.

There is no single definition of «logistics» among scholars. While some authors believe that it is a science that helps to optimize cooperative relationships, others consider that the main application of logistics is in-house production processes, including the planning of equipment loading, determining batch sizes and launching parts.

According to Western scholars, logistics is seen as the integration of transportation processes with the production sector and includes loading and unloading operations, storage, transportation of goods and the necessary information processes [1, p. 25].

Business conditions include conducting effective logistics activities in the field of world trade, as the expansion beyond national borders and international markets is becoming increasingly rapid. And in the emergence of international trade relations, considerable attention is paid to increasing competitiveness.

Practical experience shows that operations to organize and sell commodity flows on the world market are much more expensive and complex than operations in the domestic trade on the national market.

Thus, according to expert data, the cost of moving material flows in the field of international exchange is up to 25-35% of the value of sales of export-import products, while such costs in the domestic market do not exceed 8-10% of the value of goods intended for shipment [2, p. 20]. Given that the widespread use of logistics methods can reduce the time of movement of goods by 25-30% and reduce the level of stocks of goods at their consumers by 30-50% [3, p. 5], we can conclude that the use of logistics in international trade will contribute to a significant increase in the efficiency of foreign economic operations.

The need to use logistics at modern enterprises is justified by several reasons: active market development, ensuring competitive advantages of logistically organized systems of goods movement by improving the quality of supplies and reducing production costs, development of scientific and technological progress, energy crisis and computerization of the management process.

Logistics in foreign economic activity is the science of managing material and related documentary, financial, information and other flows in economic systems in the field of international exchange of goods in their tangible form and complex services related to the implementation of this turnover in order to effectively use all types of resources [4].

The use of logistics will increase the efficiency of foreign economic operations and will help in solving the following issues: orientation with an appropriate range of products to the relevant markets, increasing competitiveness, increasing revenues in the markets, increasing the growth rate of employee productivity, reducing the cost of production and its sale, efficient use of financial resources, obtaining the optimal effect from the use of profits from economic activity, concluding effective contracts, taking into account the

Logistics in foreign economic activity has its own specifics in international operations, such as customs formalities, regulation of the terms of delivery of goods under sales contracts based on Incoterms and international transportation rules, execution of shipping documents, insurance, etc. The directions of development of foreign trade logistics are shown in Fig. 1.1.

A large number of domestic and foreign economists are engaged in the study of logistics support of foreign economic activity. It is necessary to highlight the works of such as: L. Titenko [6], E. Krykavsky, L. Kharsun, B. Kholod, V. Dykan, N. Akimenko [7], M. Hryhorak [8], in their works they highlight the concepts of logistics systems and strategic development in accordance with the needs of domestic enterprises engaged in foreign economic activity.

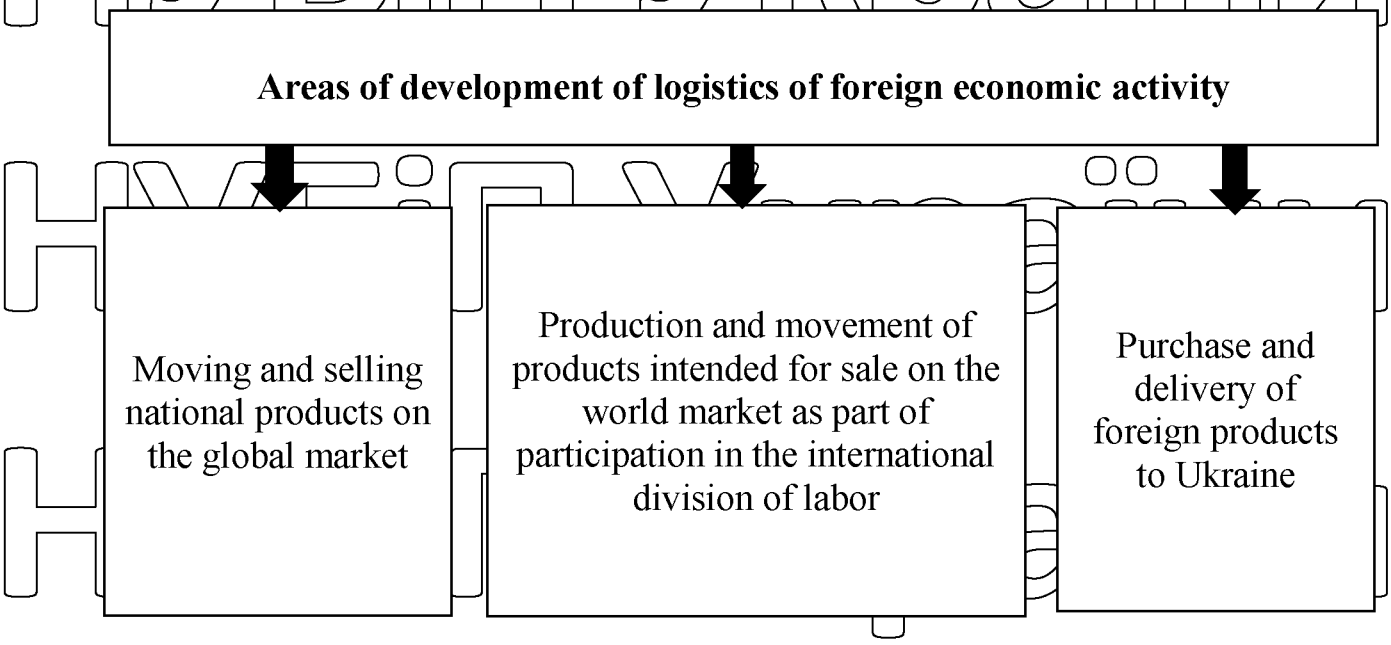

Fig. 1.1. Directions of development of foreign trade logistics

Source: compiled by the author on the basis of [5]

The introduction of the concept of «logistics system» in foreign economic activity is of practical importance, as it allows to introduce logistics based on a systematic approach and system analysis. The systematic approach determines the consideration of all elements of the logistics system of foreign economic activity as interconnected and interacting to achieve a common management goal. The key feature of the systematic approach is optimization of the functioning of the whole logistics system rather than individual elements, which results in the so-called synergistic effect.

The purpose of the logistics system of foreign economic activity is the realization of material, information and related flows in the performance of export operations based on the requirements of logistics [9, p.103-108].

Material flow is cargo, parts, and inventory that are considered in the process of applying logistics operations to them and are assigned to a time interval.

The material flow of foreign economic activity at enterprises can be characterized by a certain set of parameters that are classified according to various criteria.

Parameters of material flows of foreign economic activity may include:

- Nomenclature, assortment and quantity of products.
- Weight characteristics (total weight, gross weight, net weight).
- Physical and chemical characteristics of the cargo.
- Dimensions (volume, area, linear dimensions).
- Characteristics of packaging (containers), carrier, vehicle (cargo capacity, carrying capacity).
- Cost characteristics.
- Terms and conditions of the purchase and sale agreement.
- Terms of transportation and insurance.

Information flow is the external and internal information required to manage and control logistics operations. The information flow may lag behind or be ahead of the material flow. Traditionally, the accounting system performs analytical and control functions of information accounting and performs appropriate tasks aimed at achieving the goal. Equally important in the logistics of foreign economic activity of export operations is the transport component and delivery terms [8, p. 11-13].

Financial flow is a directed movement of financial resources in the logistics system, which is necessary to ensure the efficient movement of the corresponding commodity flow.

Therefore, the logistic approach to management at enterprises engaged in foreign economic activity is of great importance, since these enterprises represent Ukraine in the system of international division of labor, so they compete not only with enterprises within the national boundaries, but also with the whole world. It allows to comprehensively consider an extensive range of economic, marketing, political and social indicators of an enterprise subject to foreign economic activity.

The logistics approach, as a tool for optimizing and reorganizing the activities of enterprises, is an important component of a holistic approach to solving the main problems of enterprises engaged in foreign economic activity:

- reduction of costs,
- increase of competitiveness,
- specification of the very concept of performance efficiency,
- substantiation of the relevance of the factors of enterprise activity,
- identification of the main approaches to its improvement.

The use of the logistics approach in solving the issue of increasing the competitiveness of an enterprise is now more often the subject of special consideration from theoretical and practical aspects. Enterprises that have secured strategic advantages through efficient logistics determine the nature of competition in their industries. Over the past few years, logistics managers or logistics departments have appeared in almost every company.

1.2. The essence and factors of the logistics system formation

Foreign companies and enterprises have long been successfully using logistics approaches in their own operations. In contrast, Ukrainian business entities are only taking the first steps in this direction. As of today, domestic business entities, compared to other developed countries, pay insufficient attention to the use of logistics mechanisms, although the realities of the current economy indicate their necessity.

According to M. O. Naumenko, logistics is defined as a scientific and practical tool for joint management of many economically independent market structures, which makes it possible to rationally organize flow processes carried out in a spatial and temporal sequence in order to identify and realize potential reserves for management and obtaining additional income by these structures mainly through socially useful, mostly production, sources and factors [10, p. 131].

We believe that, according to V. I. Perebyinis, it is successfully proposed to consider logistics as «a complex (systemic) method of developing strategies and a

mechanism for optimizing economic relations on the basis of inter-functional and inter-enterprise economic compromises» [11, p. 190].

Table 1.1

Author's definitions of the term «logistics system»

Author (source)	Definition
N.M. Tyurina, I.V. Goi, I.V. Womanizer [12, p. 50] Тюріна Н. Логістика: навчальний посібник ЦУЛ, 2019. 392 с.	A relatively stable set of links (suppliers, divisions enterprises, logistics intermediaries and consumers), which interconnected by logistics flows and unified management for the implementation of a common strategy of business organization
I.H. Smirnov [13, p. 115] Смирнов І., Косарева Т. Транспортна логістика: навч. посібник. Київ: Центр навчальної літератури, 2018. 224 с.	A complex organizationally completed (structured) economic system, formed from parts - links interconnected in a single process of managing material and accompanying flows, the combination of which, tasks and limits of activity are combined by internal and (or) external goals of enterprises
V.I. Perebijnis [11, p. 120] Перебийніс В. І., Перебийніс О. В. Транспортно-логістичні системи. Полтава: РВВ ПУСКУ, 2014. 312 с.	An adapted (self-organized and self-adjusting) system with an inverse relationship, which implements logistics operations and logistics functions, is formed, for the most part, from several subsystems and has developed connections with the external environment
T.O.Kolodizev [14, p. 35] Колодізєва Т.О., Руденко Г.Р. Методичне забезпечення оцінки ефективності логістичної діяльності підприємств: монографія. Харків: Вид. ХНЕУ, 2012. 292 с.	A complex system is formed from a combination of elements-links of the logistics system, between which there are certain functional connections and relationships
A.G. Kalchenko [15, p. 23] Кальченко А.Г. Логістика: підручник. Київ: КНЕУ, 2012. 284 с.	An adaptive system with feedback that implements certain logistic functions (operations), is formed from subsystems and has developed intra-system connections and connections with the external environment
V.G. Banko [16, p. 16] Банько В.Г. Логістика: навч. посіб. Київ: КНТ, 2013. 345 с.	Deliberately organized integration of logistics elements (links) within some economic system in order to optimize the processes of material flow transformation
V.G. Alchemy [17, p. 56] Алькема В.Г., Сумець О.М. Логістика. Теорія та практика: навч. посібник	Organizational and management mechanism of coordination, which allows to achieve an effect through the coordinated and clear actions of specialists of

Київ: «Видавничий дім «Професіонал», 2008. 272 с.

various services, which are participants in the management of the material flow.

The phrase «logistics system» indicates the need for systematic use of logistics activities. Scientists offer various interpretations of this concept (Table 1.1).

Having considered the popular interpretations of the concept of «logistics system», it can be generalized that it is characterized by compatibility of all components, their interconnection, as well as flexibility and adaptability.

Scientists divide logistics into the following main types (Figure 1.2). Some of the types listed below are specific to micro logistics, such as procurement, or macro logistics, such as customs, but the vast majority are characteristic of both logistics levels.

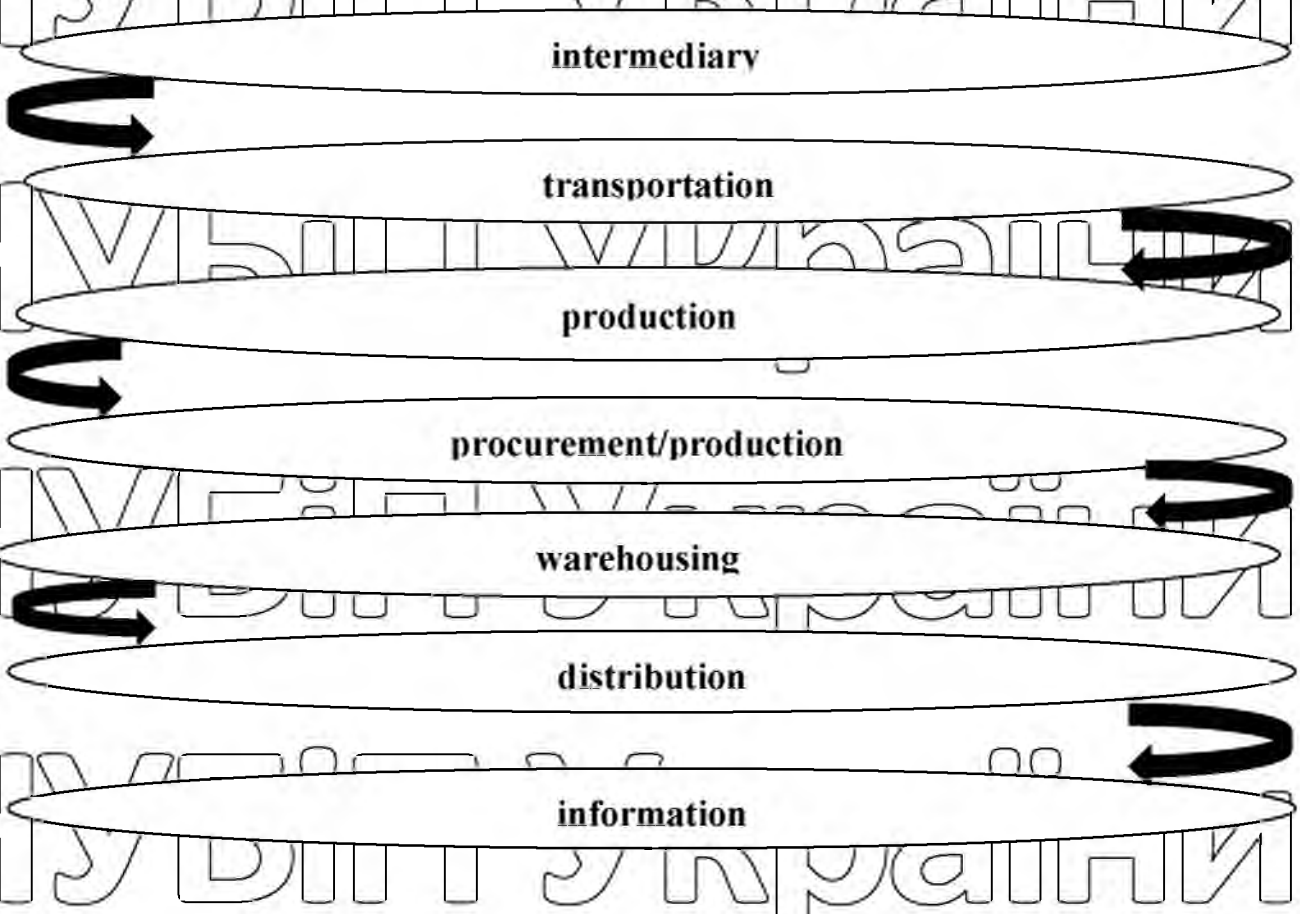

Fig. 1.2. Main types of logistics

Source: created by the author according to [11].

All the above-mentioned types of logistics determine the mandatory presence of a logistics information flow that ensures the movement of data on the material flow,

transfer, processing and systematization of the latter with the subsequent issuance of ready-made information.

«The system of views on the rationalization of economic activity through the optimization of supply processes is called the concept of logistics» [15, p. 14]. According to the conceptual approach to the development of the logistics system, it is necessary to create and manage logistics systems on the basis of the overall goal - to achieve the maximum efficiency of the business entity [14, p. 49].

Logistics systems are characterized by properties that are inherent in economic systems as a whole (Appendix B). The mechanism of the logistics system is summarized in Fig. B.1, Appendix B. In Fig. C.1 shows that the system's input is the total logistics costs. The formation of logistics services or, as it is also called, a logistics product is the result of the functioning of the logistics system, which has a three-level internal structure:

1) physical properties of the goods, in accordance with the market needs;

2) goods in the form of cargo, which has intermediary transport production procurement/procurement component distribution information some weight, packaging, labeling, shape;

3) logistics product in the form of a complex of logistics services, which aims to meet the requirements of consumers (movement and storage of cargo along with other additional functions, in particular, supply insurance, lending, warranty service, repair, etc. [18, c. 301].

The logistics system of a business entity consists of external (insurance companies, trade intermediaries, supplier companies, banks, transport business entities) and internal links.

Let us define the essence of the concept of "logistics activities of an enterprise". According to I. G. Klimova, the logistics activity of a business entity is considered in accordance with the point of view of implementation of key logistics processes - coordination: intra-plant movement of raw materials, materials, finished products and spare parts, loading and unloading operations, transportation and warehousing of work in progress; activities with an operational and calendar plan for the supply of raw

materials, semi-finished products and materials; economic activities with a marketing plan for the sale of products, forecasting, service, operational and calendar planning, processing of customer orders, warehousing and transportation; activities with a physical distribution plan in the production process; transportation and warehousing of supplies, etc. [19, p. 74].

Thus, to summarize, a logistics system is a set of subsystems that are interconnected and perform certain functions.

The efficiency of the logistics system of a business entity depends on many factors. For example, according to E. V. Krykavsky, it is noted that the following determining factors influence the organization of effective logistics activities [20, p. 104] (Fig. 1.3).

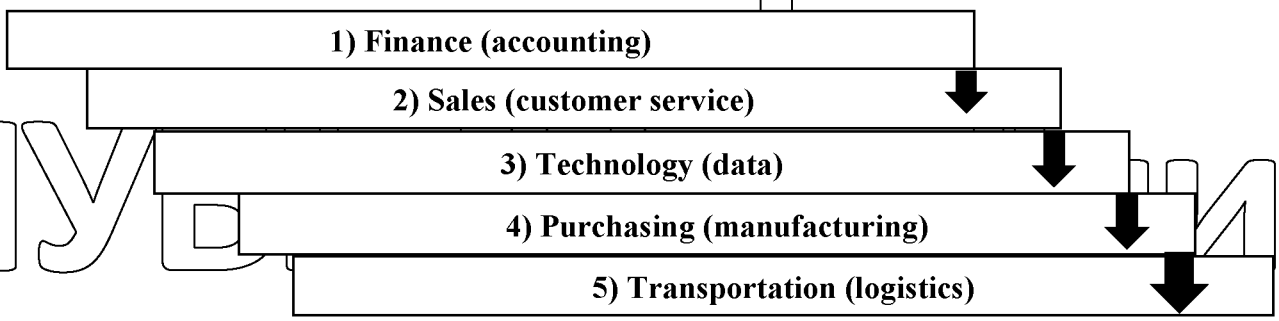

Fig. 1.3. Key factors of organization of effective logistics activities of the enterprise

Source: built by the author according to [11, p. 104-106].

Let's take a closer look at each factor identified by the author:

1) Reducing shipping costs allows businesses to increase sales and expand their customer base, and opens up markets that were previously inaccessible. In addition, technology - from tracking to route optimization to data transparency - enables shippers to fulfill orders more efficiently and quickly [14].

2) Accounting, budgeting, negotiating contracts with carriers, and managing the delivery of parcels, including reimbursement for service failures, are usually performed by the accounting and finance staff of the entity. The CFO or controller is one of the most important people in the company, while the business is concerned with

determining the structure and amount of the costs of supplying goods. Since the exact distribution of costs for the transportation of goods and transportation of goods to the right places plays a significant role in creating an effective logistics system of the business entity [21, p. 41].

3) Tracking of raw materials and incoming products, as well as outgoing deliveries and sales, and inventory management is a key driver of cost and profitability management. Thus, providing the employees of the logistics department of the business entity with the technological capabilities and data necessary to make the right decisions is one of the key factors in the effective operation of the logistics system of the business entity [22, p. 540].

4) The basis of the production entity's life is raw materials and components, the purchase and delivery of which to the facility where the latter will be processed is calculated and planned in advance. Ensuring that suppliers comply with the process of organizing the logistics activities of the business entity, transport policy and procurement conditions, provide the organization with advantages over competitors and help to increase the level of efficiency [20, p. 105].

5) The effective activity of the transport department of an entity is extremely important in the context of building an effective logistics system. Nowadays, supply chain and logistics managers need to have time to adapt their activities to the developing and rapidly changing market and work in a team with other managers and decision makers in the company [24, p. 83].

According to N. V. Khvyshchun, the key indicator for assessing the effectiveness of the logistics system of an economic entity is profit, which, according to the author, reflects the results of all logistics activities [33, p. 128]. According to N. V. Khvyshchun, the key factors and indicators that reflect the efficiency of logistics systems in accordance with logistics functions are presented in Appendix D. The formation and implementation of an effective logistics system of an economic entity determines a certain sequence of actions, presented in Fig. 1.4.

Thus, scientists do not have a consensus on the factors of formulating the goal of creating a logistics system determining the structure and elements of the system

functioning of the system and the interaction of the latter with the external environment evaluating the results of the system functioning and comparing the latter with the goal that was set Thus, scientists do not have a consensus on the factors of forming an effective logistics system, but it is possible to identify a number of efficiency criteria that are most common: assets and time, customer satisfaction, and customer service.

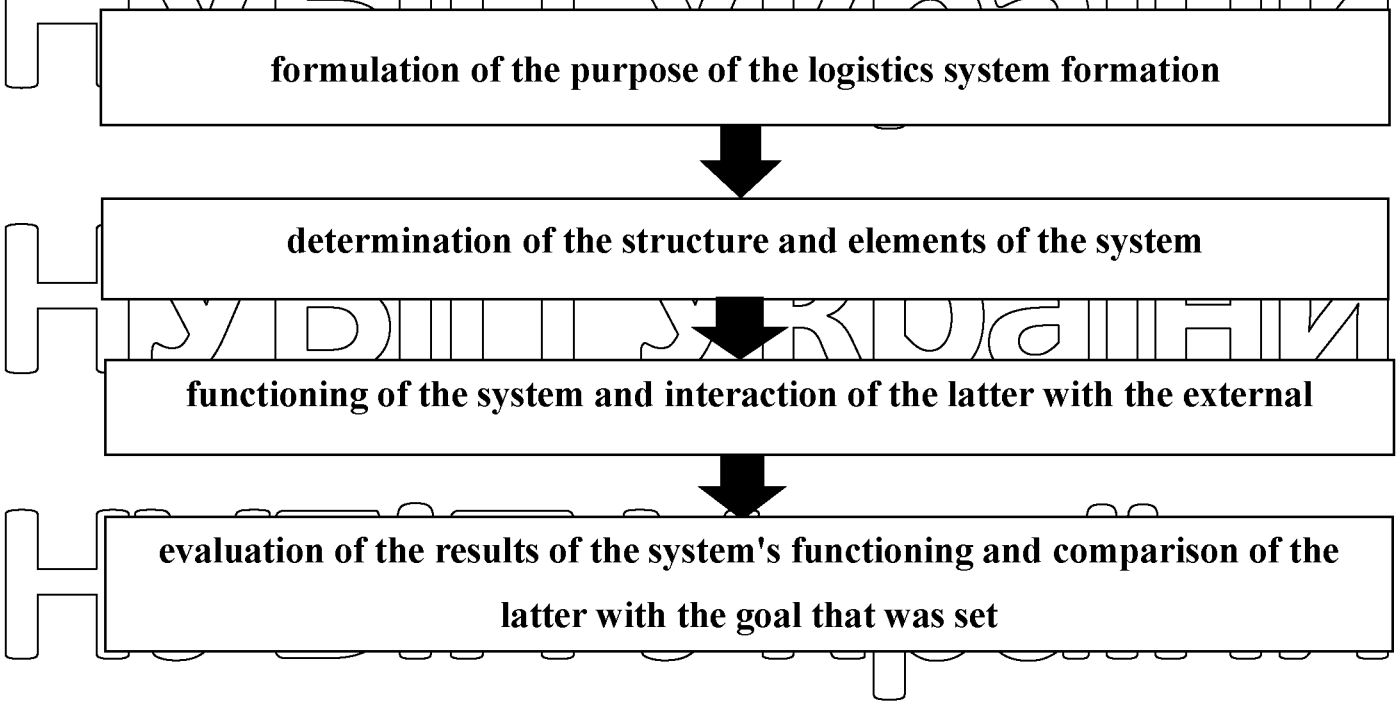

Fig. 1.4. The main stages of building a logistics system of an enterprise

Source: built by the author according to [16, p. 45].

The key among these criteria is the level of logistics costs, but no less important is the orientation of the business entity towards the consumer and the achievement of the required level of logistics service.

1.3. Peculiarities of formation of logistics costs under martial law

The logistics system is a complex and well-organized (structured) economic system that covers the production and circulation of material resources, management of materials and related flows, and is aimed at optimizing logistics functions and operations created in the supply chain. In this regard, the task of forming an effective

link between the trade and logistics system is of great importance. The logistics transportation chain may take the form of direct transit, sale of goods through a warehouse system, or establishment of warehousing facilities in the country of sale. This assessment includes not only the direct transportation costs of delivery, but also the cost of sales, competitive, current operating costs in the industry, and the costs of the assembly plant.

A full-scale war has become a huge challenge for Ukrainians, which, in addition to countless tragedies, has created a number of problems for the functioning of many industries. Logistics was no exception, as it intersects with many others, and as a result, it was one of the first to feel the devastating effects of the war.

Both domestic and foreign scholars have studied the problems of logistics costs under martial law and analyzed the impact of military conflicts on the economy as a whole: T. Bogdan, O. Borzenko, V. Horbulin, J. Keynes, N. Rubini. Aspects of the formation of logistics systems were studied by: B.M. Andrushkiva, A.V. Yevdokimova, E.V. Krykavsky, T.V. Kosareva, G.I. Mykhailichenko and others. Despite the significant scientific achievements of domestic and foreign scientists, research into new areas of logistics formation is gaining significant relevance today, as the situation in the country is extremely unstable [17].

The world of logistics has changed dramatically over the past few years. It all started long before the war in Ukraine.

As the author of the Harvard Business Review noted, due to the Sino-US economic war and the epidemic of recent years, the market has begun to rapidly localize, meaning that supply chains are getting as close as possible to the country where the product is manufactured or sold.

Global logistics networks concentrate cargo flows in optimal directions. In total, there are about 80 international transport corridors (ITCs) on the globe, which carry out the bulk of the world's transportation activities. The European market plays a leading role in the formation of global networks, which has enormous potential.

The transportation and logistics services market is an important part of the Ukrainian economy. This is because logistics is key to delivering products from

producer to consumer, and without a functioning logistics structure, trade becomes virtually impossible.

The challenges faced by the logistics industry arose years before the Russian-Ukrainian war entered a new phase. Due to the pandemic, the market is beginning to accelerate the localization and shift of supply chains closer to the country where the product is manufactured or sold. But in 2022, companies will have to make decisions as soon as possible. Fig. 1 shows the problems faced by the logistics business in Ukraine [25].

Before the full-scale invasion, 2/3 of Ukraine's exports and imports were shipped by sea. Subsequently, this possibility became more difficult due to the blockade of ports by Russia [26]. For example, until February 24, the logistics costs for grain from the central regions to the ports of Odesa were about $30 per ton. Now, the cost of logistics to the ports of neighboring countries reaches about $180. In fact, shipping costs in many cases amount to about 2/3 of the price of grain. This makes its production in Ukraine unprofitable. At the same time, the increase in logistics costs is largely due to rail transportation within Ukraine. The cost of rail transportation in Ukraine is formed from several elements, as shown in Fig. 1.5 [27].

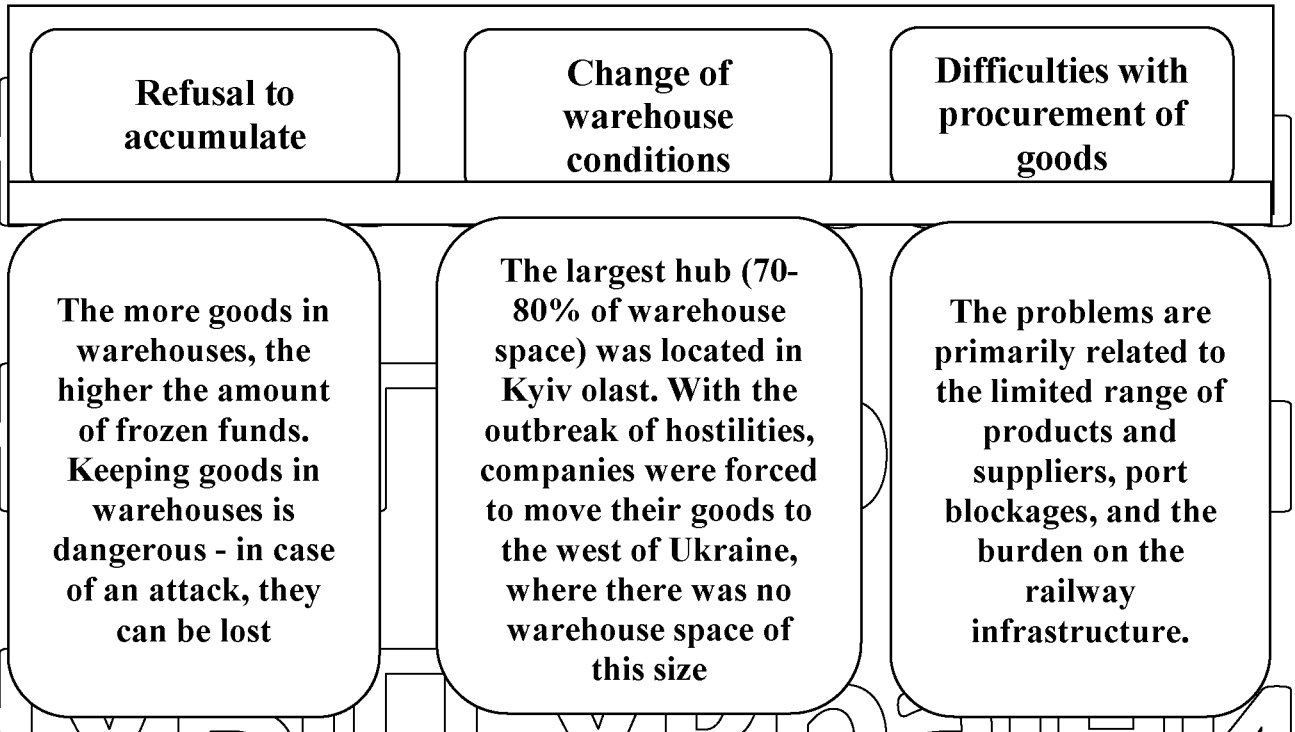

Figure 1.5. Factors that complicate logistics in Ukraine

Source: created by the authors based on [28]

As for powerful land bases, they were concentrated in the central regions. In Kyiv region, in the early stages of the war, the rapid advance of enemy forces paralyzed access to many supply depots, some of which were destroyed.

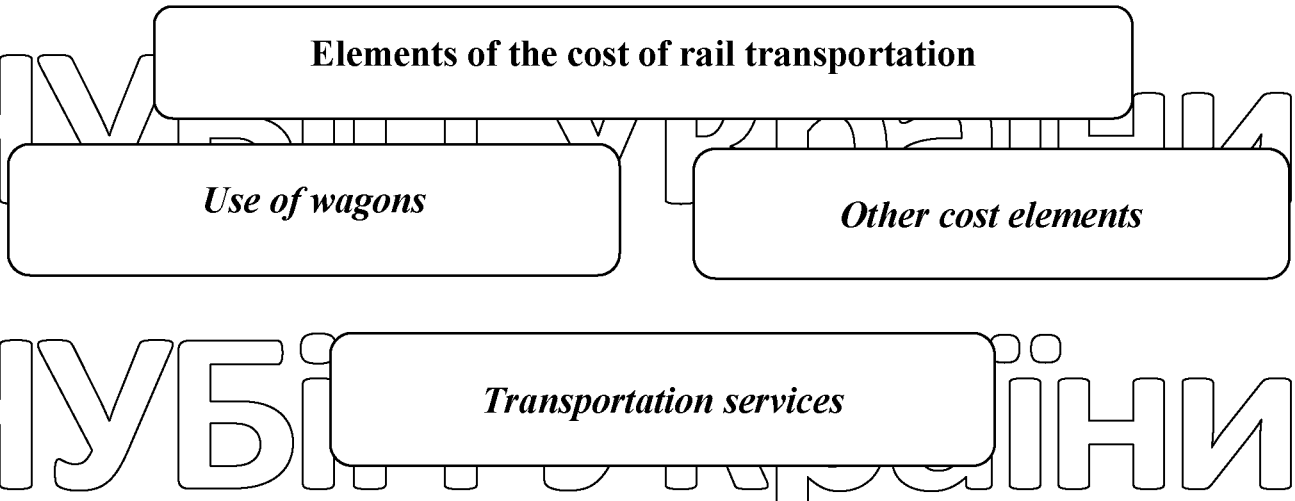

Fig. 1.6. Elements of railroad transportation cost

Source: built by the authors on the basis of [26].

In the early days of the war, the freight forwarding industry faced difficult challenges. Many imported goods were brought to Ukraine in containers. They had to be unloaded in ports of other countries, and the processing was expensive. A new logistics chain was formed, which included ports in other countries (Constanta, Gdynia, Gdansk, Klaipeda, and sometimes Istanbul and Bremerhaven). When the port of Greater Odesa was completely blocked, alternative routes had to be found to export Ukrainian grain and other products. Several routes were found. They passed through the ports of Izmail, Leni, and Ust-Dunaisk to the Romanian port of Constanta and other ports in other countries with which they interacted in the form of direct connections. Despite the fact that at the beginning of spring, the region was not in good shape and the ports could not handle the cargo, Ukrainian freight forwarders asked their Romanian colleagues for help and received it. Road transport took over the rest of the export cargo.

In the summer of 2022, Ukraine decided to increase the tariff coefficient for rail transportation by 70% for all tariff classes, including agricultural products. This tariff

increase was introduced to cover 43% of Ukraine's budget deficit by the end of 2022 [29].

The speed of transportation also has a significant impact on the cost structure, as the wagon rental fee increases with the number of days it takes to transport a wagon. Ukrzaliznytsia has set a standard speed for calculating the wagon rental fee. Overall, since the beginning of the war, logistics costs for the use and transportation of Ukrzaliznytsia's grain hoppers alone have increased to USD 85 per ton (based on average distance and average standard speed), which is 4,5 times higher than before February 24. Later, at the initiative of Ukraine and the UN, as well as with the mediation of Turkey, a temporary Grain Corridor project was launched, during which some of the blocked ports were unblocked and Ukrainian grain exports became possible. At the same time, this project should not be idealized, as it has been repeatedly used as a pretext for provocations by Russia. Changes in the cargo transportation system are shown in Fig. 1.7 and Fig. 1.8 [29].

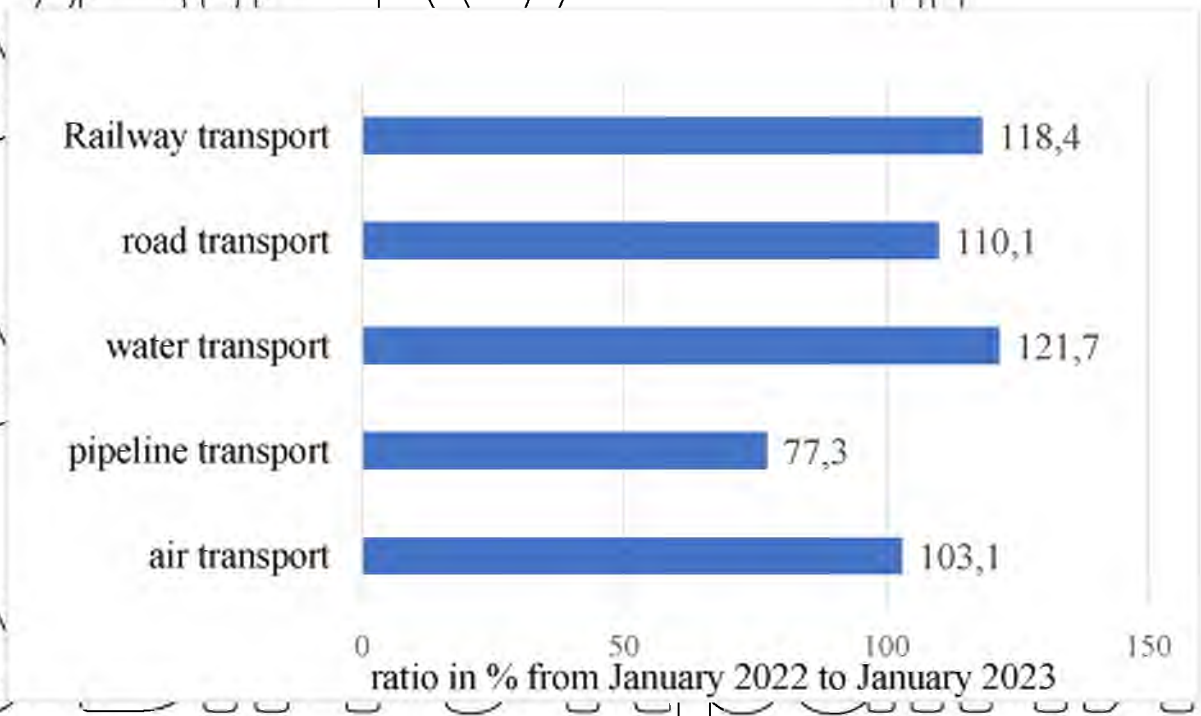

Fig. 1.7. The percentage of cargo transportation by different types of transport in January 2021 to January 2022

Source: compiled by the author based on data from the State Statistics Service of Ukraine

When the transportation of Ukrainian grain became impossible, the world started talking about the food crisis and the threat of famine. This provided an opportunity for a serious rethinking of our country's role in maintaining global food security. Therefore, the Grain From Ukraine initiative was a timely and powerful idea: On November 26, 2022, President of Ukraine Volodymyr Zelenskyy officially launched the Grain From Ukraine initiative to supply grain to the poorest countries in Africa as part of a humanitarian food program. The program aims to provide grain to at least 5 million people by the end of spring 2023 [30].

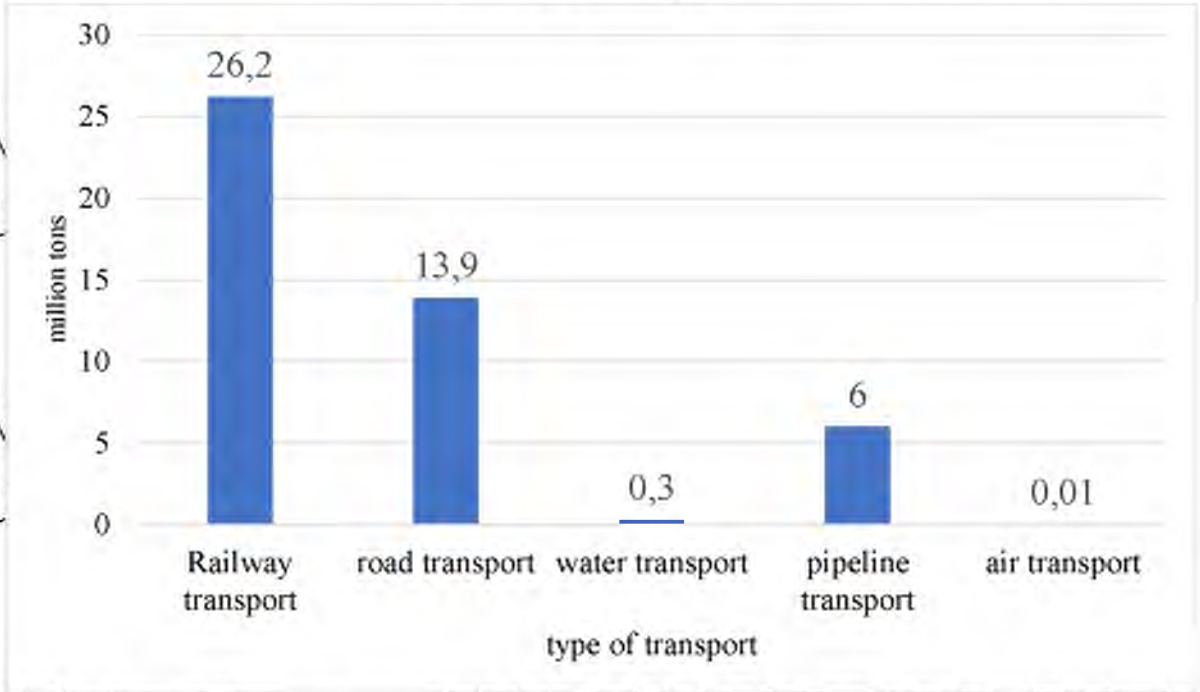

Fig. 1.3. Volumes of transported cargo in millions of tons

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

Despite the many challenges, Ukrainian businesses and the government have managed to develop a number of alternative routes. As of October, several terminals, mostly in the western regions of Lviv, Ternopil, and Chernivtsi, are being used to support logistics. The port of Izmail also uses barges to Constanta and the open Adriatic route to the Italian port of Trieste, which connects logistics from the port of Odesa via neighboring countries to the west, Slovakia and Hungary. After all, there are many export containers that need to be delivered to recipients, and the ports are still unable

to handle such a large number of vessels. According to Ukrzaliznytsia statistics, more than 80 manufacturing companies have ceased operations in Ukraine since the beginning of the war, and domestic rail transportation has also stopped. Until recently, there were only four ports in Ukraine. Kyria, Izmail, Leni, and Ust-Dunai. However, they cover only a tenth of the pre-war transshipment capacity. The ports of Leni and Izmail are overcrowded, but to get to the port of Izmail, you need to go through the territory of Moldova. There are also delays at the ports due to irregular loading at Leni. The port terminal cannot cover the entire load with infrastructure and personnel. However, we must also take into account the fact that in order to get to Izmail by rail, you need to cross the Dniester Bridge, which has already been damaged several times by the occupiers. There are currently several alternative options. They involve the use of border railroad crossings. There are thirteen of them in total: two with Slovakia, four with Poland, two with Hungary, three with Romania, and two with Moldova, with cargo volumes at the crossings currently reaching 3-4 million tons [31].

Despite the fact that the north has been completely liberated from occupation forces and the controlled south no longer faces the threat of occupation, Ukrainian businesses continue to move westward. This means that a partial redistribution of domestic demand will continue. While economic activity in the industrialized southeast and south is declining, business activity in the west is growing, and as a result, interest in investing in resources is also increasing. There is a growing demand for fulfillment among companies, as any crisis requires businesses to «shed ballast», i.e. get rid of non-core activities. Fulfillment is a set of operations from the moment a customer places an order to the moment the purchase is received. As a business service, fulfillment is most in demand by online retailers and is often outsourced to fulfillment centers, whose functions are shown in Table 1.2.

As a result, it becomes unprofitable to run your own logistics. Fixed costs, such as warehouse rent, electricity, utilities, and salaries for couriers and logisticians, occur regardless of turnover. Therefore, companies are starting to look for fulfillment operators and pay them for each shipment of goods, turning logistics into a variable

cost. By outsourcing logistics, companies are relieved of this burden and can rely on professionals with an already established supply chain [32].

Table 1.2

Elements included in the fulfillment service

	Components of fulfillment services
1.	warehouse storage of goods
2.	reception and processing of orders
3.	receiving payment from customers
4.	order picking and packaging
5.	delivery of orders
6.	working with returns

Another option to improve supply chain efficiency is to shift the cost of shipping to the center of gravity to the manufacturer. This can have a positive effect, even if it may cause downtime in some areas. Use of flexible automated transport management systems. The situation has changed rapidly in recent months. Every day, new rules are introduced or some rules are relaxed, delivery routes and distribution centers are closed or opened, fuel costs are rising, and the need for goods and components is changing dramatically. This trend will continue in the near future [33].

CHAPTER 2. CURRENT STATE AND MAIN TRENDS IN THE DEVELOPMENT OF GRAIN EXPORT LOGISTICS IN UKRAINE

2.1. Estimation of grain production, consumption and exports in Ukraine

Grain production and consumption in Ukraine

A significant share (more than 40%) of Ukraine's grain production is made up of winter wheat, barley and rye. Given that these crops were planted before the war started in the country, it is advisable to start with the prospects of the winter wedge. Over the past 3 years, winter wedge crops averaged 51% in the structure of grain crops and ranged from 7,6-8,2 mln ha (Fig. 2.1 and Fig. 2.2).

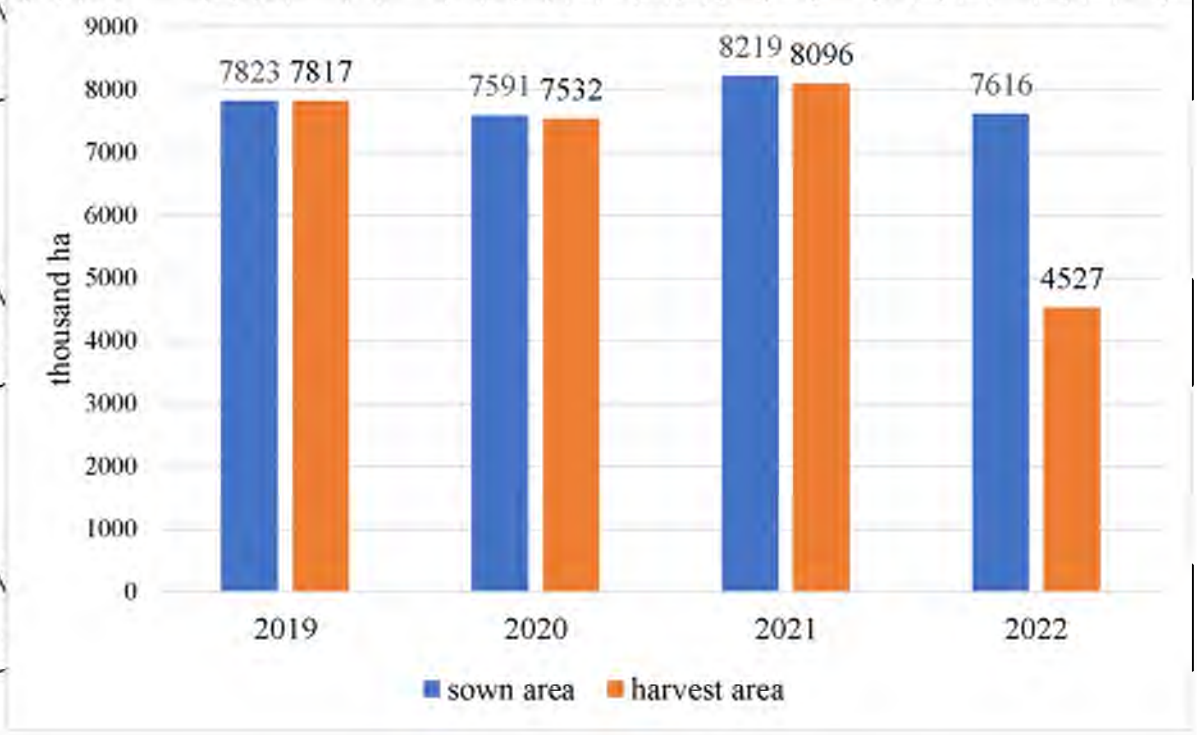

Fig. 2.1. Dynamics of sowing and harvesting areas under winter cereals in Ukraine, thousand ha

Source: compiled by the author on the basis of [28].

The winter wedge to some extent also shapes the structure of spring grain crops. After all, those fields where the condition of winter crops was unsatisfactory in spring or where no seedlings were obtained at all are sown with spring crops, if possible. But this season, the winter agro-climatic conditions were quite favorable for winter crops.

Accordingly, even if some regions recorded crop losses, these losses are not comparable to the loss of areas due to military operations.

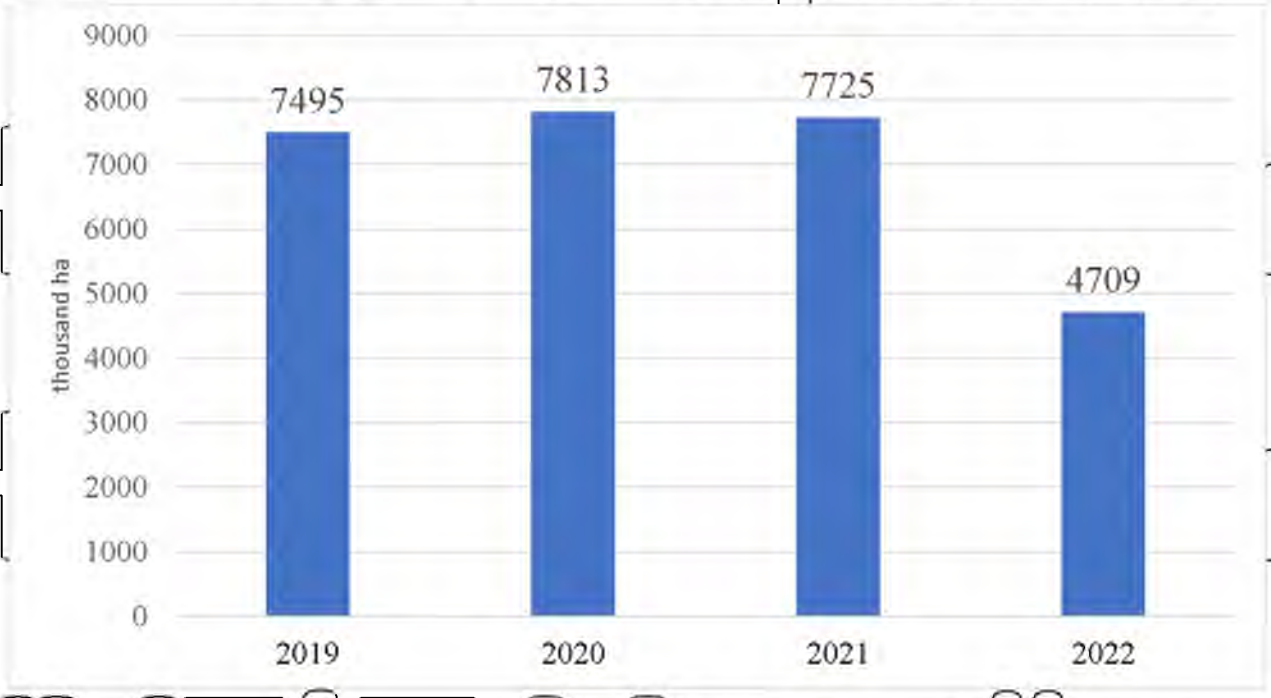

Fig. 2.2. Dynamics of sown areas under spring grain crops in Ukraine, thousand ha

Source: compiled by the author on the basis of [28].

The winter wedge to some extent also shapes the structure of spring grain crops. After all, those fields where the condition of winter crops was unsatisfactory in spring or where no seedlings were obtained at all are sown with spring crops, if possible. But this season, the winter agro-climatic conditions were quite favorable for winter crops. Accordingly, even if some regions recorded crop losses, these losses are not comparable to the loss of areas due to military operations.

In the period from 2019 to 2021, the spring wedge of grain crops in Ukraine ranged from 7,5-7,8 million hectares. However, in 2022, the war and its consequences led to significant adjustments in the structure of sown areas. When planning this year's crop structure, farmers should first of all pay attention to those crops that will be in high demand by processing companies to ensure food security in Ukraine. This primarily concerns wheat, barley, and cereals such as buckwheat, millet, oats, etc. As

for the key grain crop for Ukraine - corn, in the absence of the possibility to fully realize the export potential of the crop in 2021/22 MY with a record harvest of 41,9 mln tonnes, even with high losses, the grain stocks are expected to reach a record high and are estimated at 13,5 mln tonnes, which is 6,6 times higher than in 2020/21 MY. Given the low exports, such supply will be difficult to realize, which will lead to lower prices on the domestic market. External demand for grain can only return to high levels if seaports resume operation and safe access to them, which, given the risks for As for spring wheat, based on the results of the previous season's sowing, the total share of crops in hazardous regions is estimated at 30%. Accordingly, there are prospects for expansion of spring wheat areas in relatively safe regions. First of all, this applies to Zhytomyrska, Ternopilska and Vinnytska regions, which traditionally have close to average spring wheat yields and are among the top 6 regions in terms of spring wheat acreage, which indicates proven technologies.

shipowners and damage to the transport infrastructure in Ukraine, is not a very fast prospect.

A more detailed regional analysis of the distribution of sown areas under major crops shows that for the 2022 harvest in the most dangerous regions, winter wheat was planted on almost 51% of the total sown area (Table 2.1). That is why the forecasted losses of winter crops are so significant.

Analysis of the distribution of corn crops, according to 2021 data, shows that in the regions that are dangerous due to the war this year, more than 36% of the total area under the grain was sown (Fig. 2.3). The most critical are Chernihivska, Sumska and Kyivska regions, where more than 25% of corn was planted. Obviously, this year these regions will be among the leaders in corn production. And given the low market incentives and high energy intensity of the crop, relatively safe areas are unlikely to see an expansion of crops to compensate for the areas unavailable for cultivation.

Table 2.1

The share of oblasts in the total area of winter and spring wheat sowing in Ukraine, %

Region	The share of oblasts in the total area of winter wheat sowing for the 2022 harvest in Ukraine, %	The share of regions in the total area of spring wheat sowing for the 2021 harvest in Ukraine, %
Zaporizhska	10	1,6
Kharkivska	8,8	5,5
Odesska	8,4	2,9
Dnipropetrovska	7,9	1,9
Khersonska	7	0,8
Mykolayivska	6,7	2
Donetska	5,8	0,9
Kirovohradska	5,8	1,6
Luhanska	4,9	0,6
Vinnytska	4,5	5,9
Poltavska	3,9	1,9
Khmelnytska	3,2	4,9
Cherkasska	3	2,8
Ternopilska	2,9	10,7
Kyivska	2,8	8,6
Sumska	2,6	3,9
Chernihivska	2,4	5,9
Lvivska	2,3	10,9
Volynska	2,3	7,2
Zhytomyrska	1,8	11,3
Rivnenska	1,6	3,4
Ivano-Frankivska	0,7	3,1
Chernivetska	0,5	1,4
Zakarpatska	0,3	0,3

Source: compiled by the author on the basis of [28].

As for barley, the situation in this segment is also rather complicated. Firstly, the split between winter and spring crops is 45% to 55%, respectively, and secondly, a significant share of both winter and spring crops is located in hazardous regions. Thus, the total share of winter barley crops for the 2022 harvest in hazardous regions, is

estimated at almost 44% of the total area, while the share of spring crops in the previous season in these regions was estimated at almost 49%.

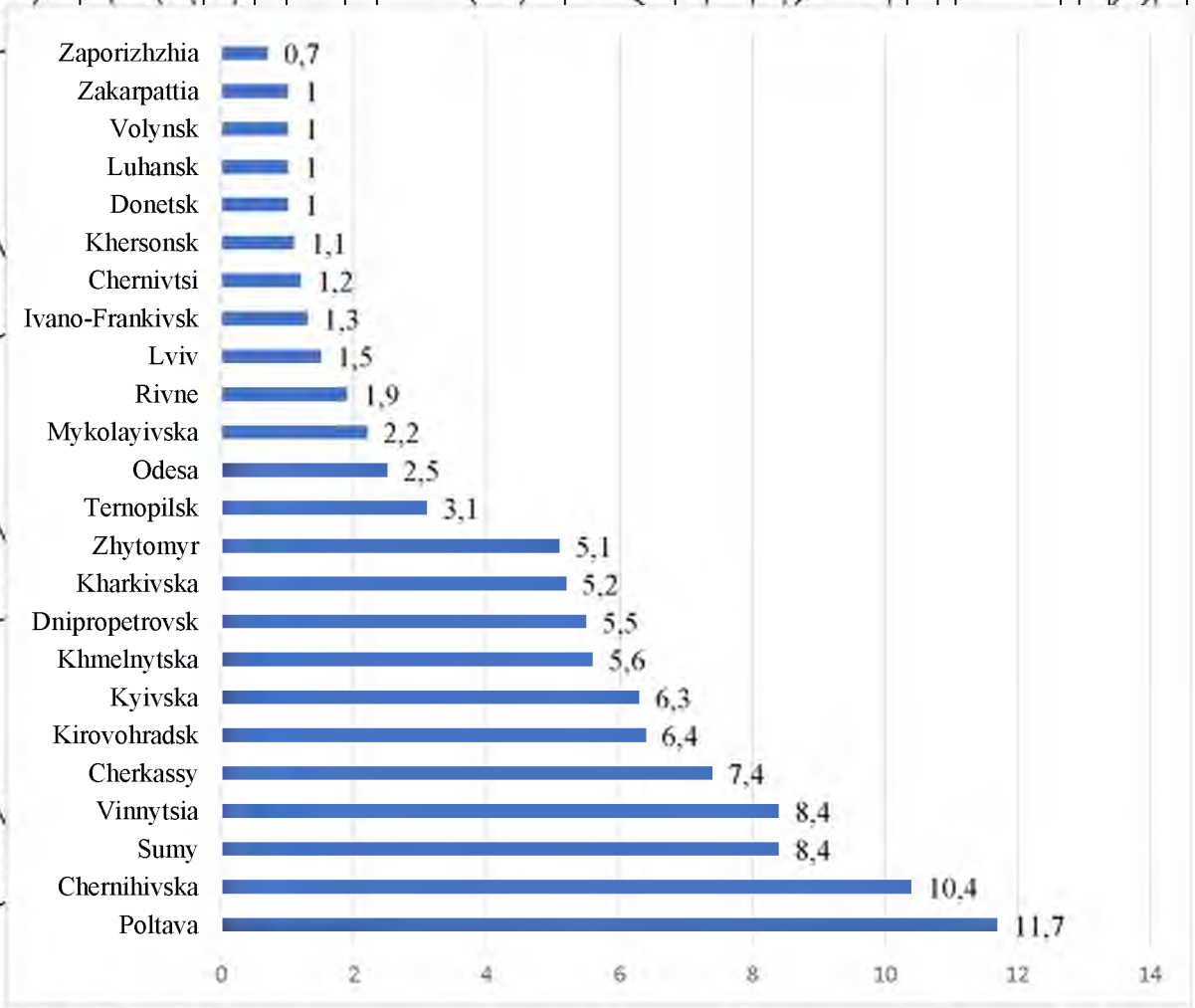

Fig. 2.3. The share of regions in the total area of corn sowing for the 2021 harvest in Ukraine, %

Source: compiled by the author on the basis of [28].

Moreover, the crops are very consolidated, and 5 of the TOP-6 regions in terms of spring barley are currently dangerous. And this is a significant limitation for the expansion of spring barley acreage in the whole country. The key regions where expansion is possible are Poltava, Ternopil, Vinnytsia and Khmelnytsky regions, which traditionally have high spring barley yields (Fig. 2.4).

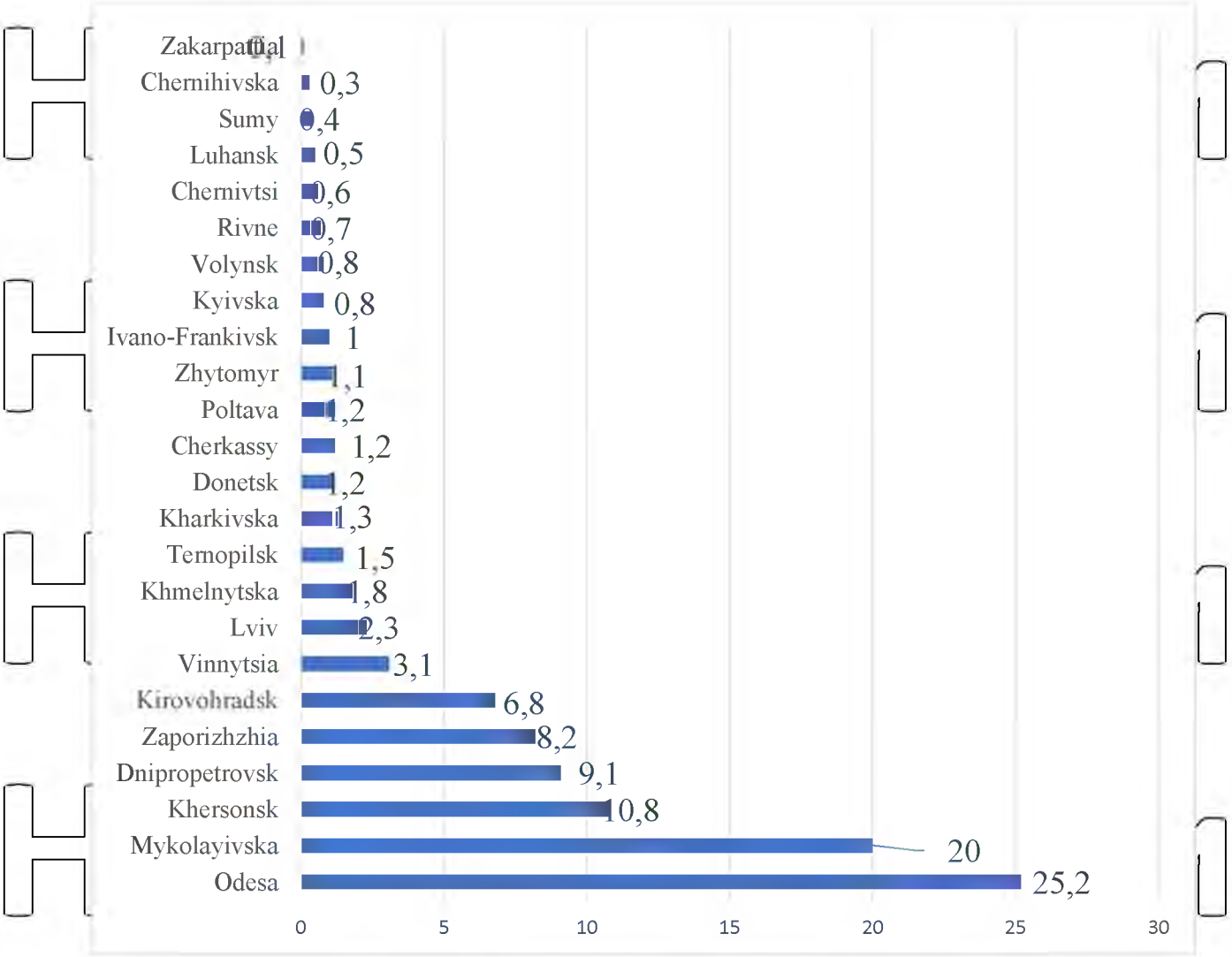

Fig. 2.4. The share of regions in the total area of winter barley sowing for the 2022 harvest in Ukraine, %

Source: compiled by the author on the basis of [28].

Cereals should be singled out separately, as an increase in plantings under these crops could to some extent compensate for the expected decline in plantings under crops such as corn and sunflower. However, a significant share of this segment is also planted in regions that are currently in danger (Table 2.2).

In previous years, most of the oat production was concentrated in the north of Ukraine - Zhytomyrska, Volynska, Chernihivska, Rivnenska and Sumska regions. This year, the losses of the crop in Sumska and Chernihivska regions due to active hostilities can be compensated by expanding the area under the grain. For example, in

Khmelnytsky, Poltavsky, Ternopilsky and Vinnytsky regions, where high oat yields have been recorded in recent seasons.

Table 2.2

The structure of cereal crops by region of Ukraine, %

Region	The share of crops on average for 2019-2021, %			
	Oat	Millet	Buckwheat	Pea
Zaporizhska	0,5	1,9	7,7	2,3
Kharkivska	20,7	1,2	1,7	0,7
Odesska	0,8	9,5	0,8	7
Dnipropetrovska	1,7	6,3	4,9	7,8
Khersonska	17	6,9	19,9	0,8
Mykolayivska	0,8	0	0,3	0
Donetska	0,5	8,5	0,3	26,7
Kirovohradska	2,3	0	1,1	0,1
Luhanska	3,5	3,6	5,4	1,9
Vinnytska	0,2	2,8	1,4	5,1
Poltavska	1,9	2,4	0,3	1,4
Khmelnytska	6,9	0,2	2,9	0,4
Cherkasska	0,6	6,6	3,5	7,5
Ternopilska	0,9	13,6	0,6	9,8
Kyivska	1,4	5,1	2,7	3,1
Sumska	10,9	0,6	3,2	0,2
Chernihivska	6,5	1,8	8,1	1,8
Lvivska	2,7	0,3	7,6	2,3
Volynska	2,9	10,7	7,6	9,6
Zhytomyrska	0,9	8,2	0,4	5,2
Rivnenska	2,5	0,5	10,5	1,4
Ivano-Frankivska	0,6	2,4	1,3	2,3
Chernivetska	0,4	0	0	0,1
Zakarpatska	12,7	6	7	2
Total share in vulnerable regions,%	**29**	**48**	**33**	**56**

Source: compiled by the author on the basis of [28].

In previous years, most of the oat production was concentrated in the north of Ukraine - Zhytomyrska, Volynska, Chernihivska, Rivnenska and Sumska regions. This year, the losses of the crop in Sumska and Chernihivska regions due to active hostilities can be compensated by expanding the area under the grain. For example, in

Khmelnytsky, Poltavsky, Ternopilsky and Vinnytsky regions, where high oat yields have been recorded in recent seasons.

Millet production in Ukraine can be increased by increasing its acreage in Khmelnytsky, Vinnytsky, Cherkasky and Poltavsky regions, where the highest yields were recorded in previous seasons - in the range of 32-25 c/ha - with the average yield in Ukraine at 19 c/ha.

The loss of buckwheat area due to the impossibility of its production in Sumsky, Kyivsky and Chernihivsky regions can be compensated by increasing the area under this crop, for example, in Khmelnytsky, Rivnensky, Vinnytsky regions, which have been recording high yields of 13,6-16,4 c/ha in the last few years.

In general, we estimate that in 2022 the area under spring crops may amount to only 4,7 mln ha, down 39% year-on-year (7,7 mln ha). In particular, we expect corn plantings to decrease by 43% to 3,1 mln ha compared to 2021, spring barley - by 27% to 972,1 thou hectares, spring wheat - by 23% to 147,3 thou hectares.

Also, the area under cereals is expected to decrease significantly: oats - by 28% to 127,4 thou hectares, buckwheat - by 41% to 49,4 thou hectares, millet - by 24% to 59,4 thou hectares, peas - by 51% to 119,2 thou hectares. However, it is possible that farmers will still increase the area under cereals if possible.

Taking into account the above-mentioned and the analysis of the long-term dynamics of the main indicators of grain production in Ukraine, APK-Inform analysts made the forecast of the gross grain harvest in 2022, which is estimated at 38,9 mln tonnes for all grains and pulses, down 55% compared to the figures of 2021 (85,7 mln tonnes). At the same time, the grain yield is expected to reach 42,6 centners per hectare, down 21% compared to 2021 (53,8 centners per hectare) ((Fig. 2.5)).

The expected decline in production of all grain crops is due not only to a reduction in spring crops and significant losses of winter wedge crops, but also to a projected decline in crop yields due to difficulties in securing key inputs such as seeds, fuel, fertilizers, protective equipment, etc. In addition, climate risks remain. Lack of productive precipitation and strong winds have a negative impact on the formation of early spring crops and the resumption of winter crops.

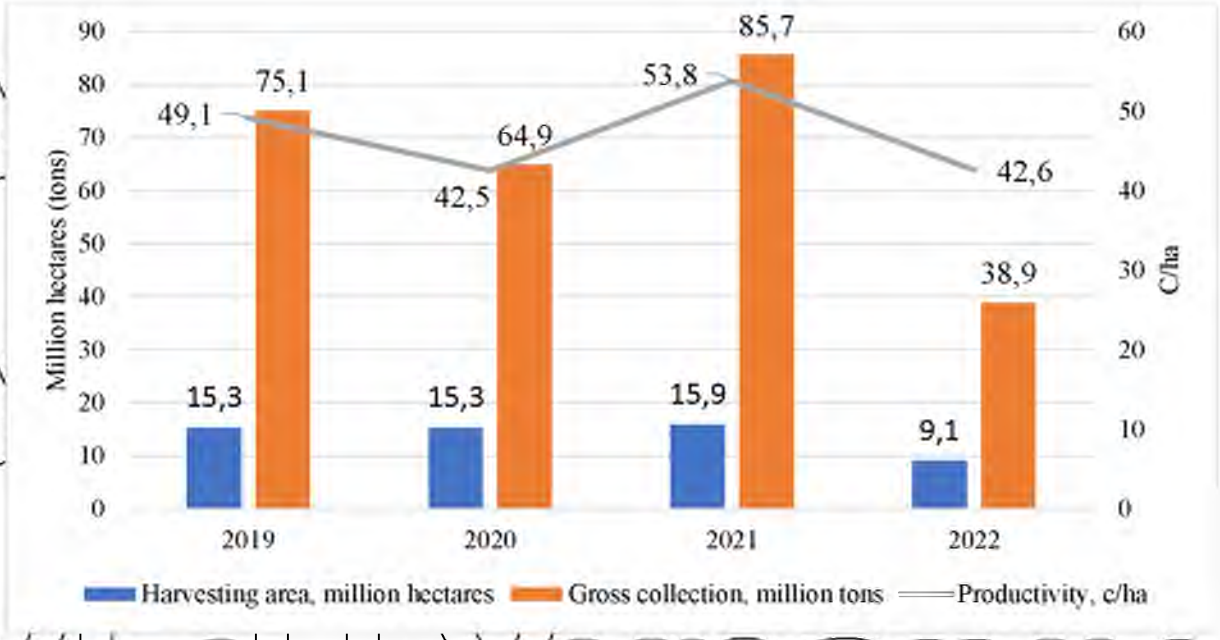

Fig. 2.5. **Dynamics of cereal production in Ukraine**

Source: compiled by the author on the basis of [28]

As a result, this year's gross wheat harvest may amount to only 14,9 mln tonnes (-54% compared to 2021), with a yield of 37,8 c/ha. Barley production is expected to reach 4,6 mln tons (-51% compared to 2021) with a yield of 28,2 c/ha. The corn harvest is forecast at 18,5 mln tons (-56% by 2021) with a yield of 60,4 centners per hectare.

Oat production is expected to reach 256,1 thou tons (-46% by 2021) with a yield of 20,5 centners per hectare, millet production – 79,0 thou tons (-61% by 2021) with an expected yield of 13,5 centners per hectare. The gross harvest of buckwheat is forecast at 52,7 thsd tonnes (-50% by 2021) with a yield of 10,9 c/ha, and peas is estimated at 203,3 thsd tonnes (-64% by 2021) with a yield of 17,2 c/ha.

Summarizing the above estimates and forecasts, the following can be noted:

- ✓ the key factor in shaping the structure of grain and oilseeds for the 2022 harvest will be the physical inaccessibility of more than 30% of the area due to military operations and their consequences;
- ✓ business and the government are actively helping Ukrainian farmers to conduct the sowing campaign in the most efficient way during the war period, which may result in positive changes in estimates and forecasts in the near future;

- ✓ difficulties in obtaining seeds of crops that depend on imported supplies (wheat, corn) will further reduce the plantings of these crops;
- ✓ the lack of exports through ports of corn and sunflower oil creates significant stocks of these crops in Ukraine with low demand, which will reduce margins and interest in growing;
- ✓ complicated access to basic resources (fertilizers, plant protection products and fuel) makes growing energy-intensive crops (primarily sunflower and corn) even less interesting;
- ✓ compensation in the spring wedge should be made by crops for which there are seeds available that require fewer resources to grow and will be in demand in wartime and post-war times. Among cereals, these include wheat, barley, and cereals such as buckwheat, peas, and oats. Among the oilseeds, soybeans and, to a lesser extent, flax can become compensatory crops;
- ✓ when forming crops, one should also take into account the storage characteristics of the crops to be grown to minimize losses.

Stocks and losses. Official information on grain stocks in Ukraine as of February 1, 2022: according to the SSSU, the total availability of grain in reporting storages as of that date was almost 26,3 million tons, or more than 30% of total grain production in 2021. Taking into account the consequences of Russia's military invasion (significant reduction in exports and damage to production infrastructure), we estimate that in February-March 2022, Ukraine exported and prepared for export slightly more than 6,4 mln tons of grain, and processed and consumed about 2,6 mln tons of grain on the domestic market. Thus, as of April 1, the accountable amount of stocks can be estimated at 17,3 million tons.

To understand the availability of stocks for further export and processing, several key factors should be taken into account:

- a significant part of the stocks (20-30% depending on the crop) remains unreported, which increases the overall availability of grain in Ukraine;
- on average, about 60% of grain stocks are formed directly at agricultural producers' enterprises, which forms the distribution of small batches over a larger

territory of the country than in the case of consolidation in large elevators, and also increases the likelihood of stocks being preserved in case of military operations;

- analysis of the structure of stocks as of February 1 shows that currently about 43% of the volumes can be concentrated in dangerous and conditionally safe regions, and about 16% - in regions that remain dangerous as of April 10;

- an analysis of the existing elevator base shows that about 39% of storage capacities are located in hazardous and conditionally safe regions, and 16% are located in the most hazardous areas.

Placing stocks in dangerous regions does not mean their complete loss. But it does limit access to them, primarily for export. At the same time, the risks of physical loss of some stocks remain high.

Taking into account these factors, as well as limited exports, we estimate that the level of grain losses in 2021/22 MY may reach 5,8 mln tonnes, which is 3,9 times higher than last season and the average of the previous 5 seasons (Fig. 2.6).

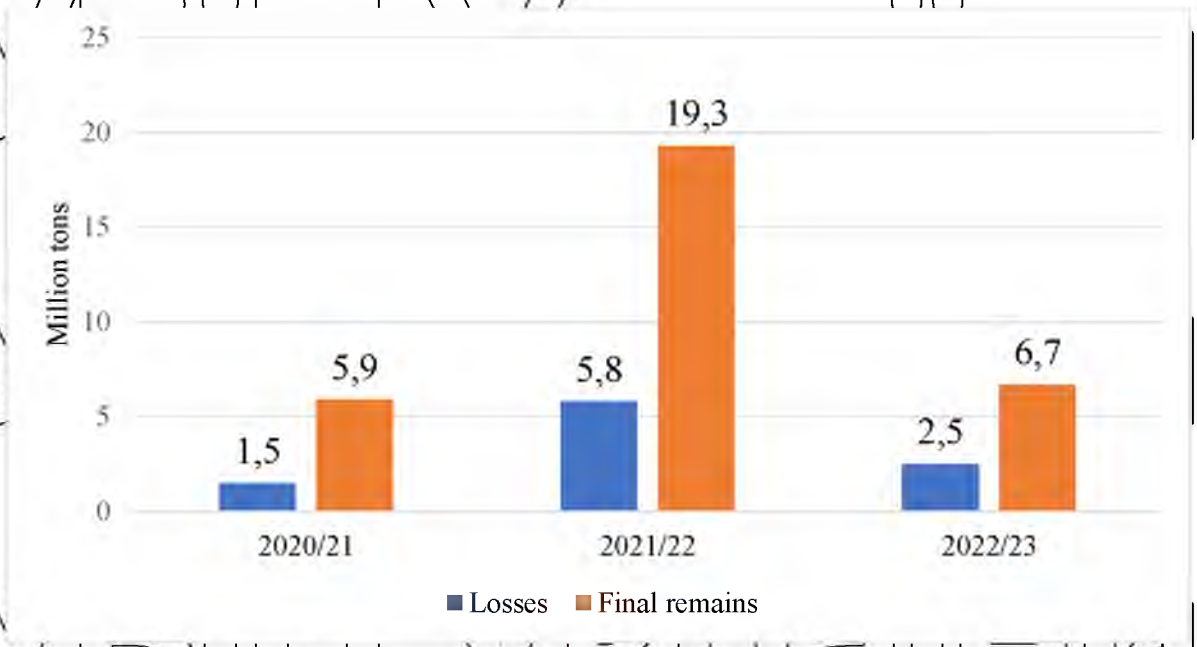

Fig. 2.6. **Assessment of formation of losses and final grain residues in Ukraine, million tons**

Source: compiled by the author on the basis of Source: compiled by the author on the basis of [34].

In addition, in the absence of active exports, the ending stocks for the season may reach a record level of 19,3 mln tonnes, but how much of it will be available for movement and use remains a big question.

In the next 2022/23 MY, due to the forecasted lower gross harvest, the level of carry-over stocks may stabilize and reach 6,7 mln tonnes. However, the level of losses may remain quite high, including as a result of losses of some carry-over stocks in the current season.

Domestic consumption. Traditionally, in Ukraine, the lion's share of the gross grain harvest was exported, while the share of the harvest required for domestic needs did not exceed 36% over the past 5 seasons, including only about 6% for food consumption and 18% for feed.

A significant excess of export potential over domestic demand is typical for major grains such as wheat, barley, and corn, while in the niche crops segment, domestic consumption often exceeds exports.

According to APK-Inform analysts, the domestic consumption of wheat averaged 32% of the grain production in 2018/19 to 2020/21 MY. In the current season, in absolute terms, the figure may reach 10,5 mln tonnes (+38% up from 2020/21 MY due to the possible growth of feed consumption and the expected increase of storage losses at elevators located in hazardous regions), which is 33% of the total grain harvest in 2021. In 2022/23 MY, the domestic consumption of the crop is forecasted at 8,5 mln tonnes (-19% compared to 2021/22 season), which is 57% of the expected harvest (14,9 mln tonnes) and 42% of the total supply (20,1 mln tonnes due to high expected carry-over stocks of 5,2 mln tonnes) (Fig. 2.7).

Over the last 3 seasons, the domestic demand for barley averaged 48% of its production and ranged from 3,6-4,0 mln tonnes. In 2021/22 MY, the domestic consumption of the grain is expected to reach 3,8 mln tonnes (+6% compared to 2020/21 season), accounting for 40% of the harvest. Next season, this figure is expected to decrease by 8% to 3,6 mln tonnes (76% of the future harvest, 63% of the total supply).

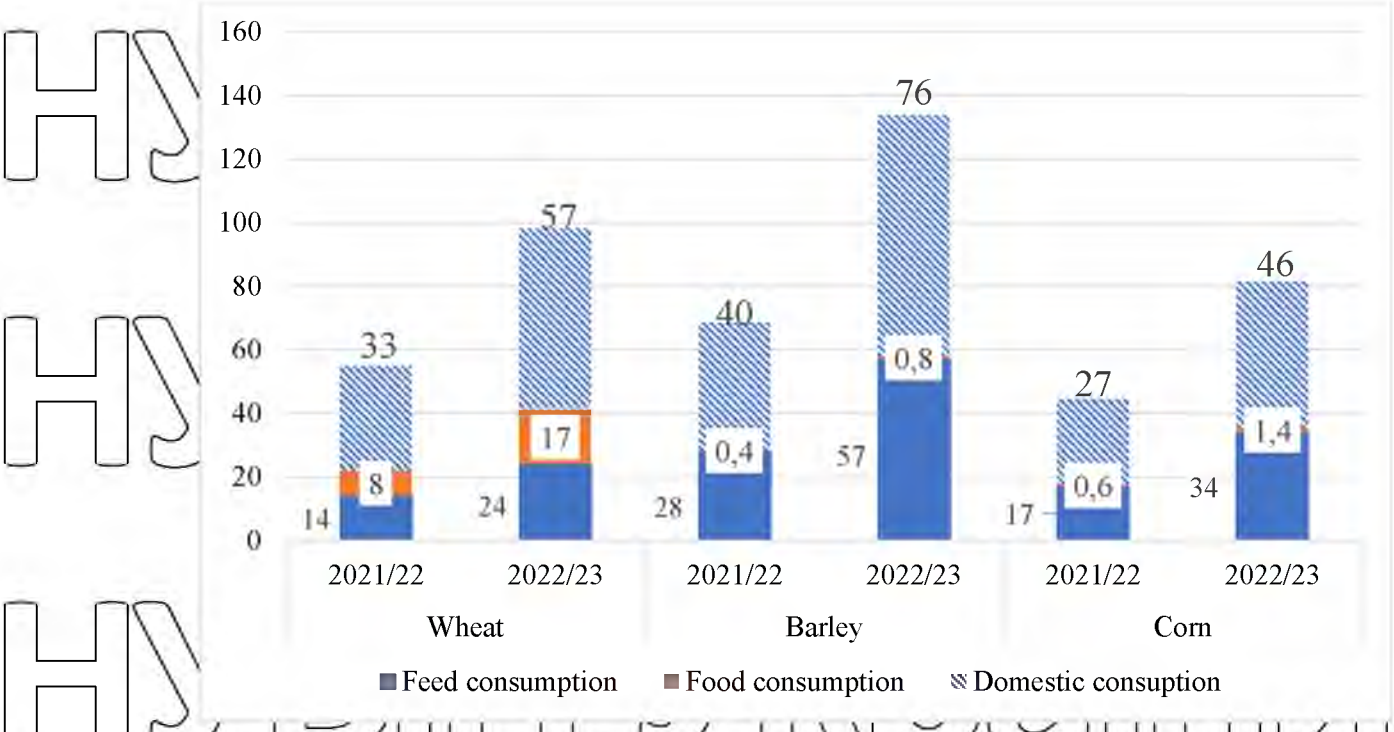

Fig. 2.7. The share of domestic consumption of major crops in production, %

Source: compiled by the author on the basis of Source: compiled by the author on the basis of [34].

Domestic consumption of corn in the last 3 seasons did not exceed 6,4 mln tonnes and averaged about 20% of the harvest. In 2021/22 MY, the figure is expected to reach 11,1 mln tonnes (+85% compared to 2020/21 season due to the expected growth of feed consumption and high losses in the hazardous regions) and account for 27% of the production. In 2022/23 MY, the domestic consumption of corn is forecasted at 8,6 mln tonnes (-23% compared to 2021/22 season), which is 46% of the expected harvest (18,5 mln tonnes) and 28% of the total supply (30,8 mln tonnes due to high expected stocks of the grain at the end of 2021/22 MY at 12,3 mln tonnes).

As for niche crops, Ukraine's domestic demand for oats, millet, and peas is covered by its own production, while the buckwheat segment is currently in need of active imports.

In the current season, the domestic consumption of oats is expected to reach 430,0 thsd tonnes (91% of the crop production, 78% of the total supply). In 2022/23

MY, with the expected production of 256,1 thsd tonnes (-46% compared to 2021), the domestic consumption is expected to reach 300,0 thsd tonnes (-30% compared to 2021/22 MY), which is 80% of the total supply (373,0 thsd tonnes), but 17% higher than the forecasted harvest.

The domestic demand for millet in 2021/22 MY may reach 74,0 thsd tonnes (36% of the crop production, 30% of the total supply), and next season – 73,0 thsd tonnes (-1% compared to 2021/22 MY), which is 92% of the future harvest (256,1 thsd tonnes) and 43% of the total supply (373,4 thsd tonnes).

The consumption of peas in the current season is expected to reach 150,0 thsd tonnes (26% of the crop production, 24% of the total supply). In 2022/23 MY, the domestic consumption of pulses is expected at 140,0 thsd tonnes (-7% compared to 2021/22 season), which is 69% of the forecasted harvest of 203,3 thsd tonnes and 40% of the total supply (349,4 thsd tonnes).

The domestic demand for buckwheat in 2021/22 MY is forecasted at 103,0 thsd tonnes, up 3% compared with the harvest (106,0 thsd tonnes), and accounts for 72% of the total supply (151,6 thsd tonnes), with the expected imports of 14,0 thsd tonnes. In 2022/23 MY the consumption of the grain may reach 95.0 thsd tonnes (-13% compared to 2021/22 season), which is 80% higher than the forecasted production of 52,7 thsd tonnes and accounts for 91% of the total supply, provided the imports of the crop will be within 10.0 thsd tonnes.

Feed consumption. As already mentioned, feed consumption of grain crops accounts for a significant share of domestic distribution. This segment is also characterized by certain changes during the war. First of all, the changes are due to the regional structure of livestock. According to available statistical information, as of January 1, 2022, the majority of livestock was formed outside the regions that are currently the most dangerous. According to our estimates, in terms of conditional livestock, about 28% of the total number of farm animals is located in hazardous and conditionally safe regions. Accordingly, for the most dangerous regions, this figure is 12% of the total number. It should be noted that the presence of livestock in hazardous areas does not mean its complete loss and will also require feeding.

On the other hand, it is advisable to analyze the regional distribution of fodder production in Ukraine. From this point of view, the situation is somewhat more complicated. According to the State Statistics Service, in 2021, the total production of feed for cattle, pigs and poultry amounted to more than 5,6 million tons. At the same time, imposing the military realities of today, it can be stated that about 32% of feed production is concentrated in dangerous and conditionally safe areas, 11% - in areas that remain the most dangerous.

The most critical situation may be with the production of pig feed, as about 48% of this product was produced in hazardous and conditionally safe regions. Poultry feed production may suffer the least damage, as only 4% of it was produced in the regions that are currently the most dangerous. At the same time, poultry farming is the segment most dependent on feed production, and the relevant feed production sector should operate most stably. In addition, the issue of supplying premixes for feed production is important, which is again critical for the poultry industry.

Under the current conditions, the ration of agricultural animals is expected to change, given the difficulties in obtaining meals and oilcakes amid a reduction in oilseed processing, as well as the presence of significant transitional grain residues that can be used as concentrated feed. This is based on the results of the season and may lead to a projected increase in feed consumption of grain.

Exports of grain crops. Ukraine is one of the key exporters of wheat, corn, and barley to the foreign market, with domestic production far exceeding domestic consumption. However, Russia's military invasion of Ukraine has led not only to disruptions in the domestic agricultural supply chain, but also to the shutdown of Ukrainian seaports, which account for about 99% of total grain exports, and as a result, to the paralyzation of grain supplies to the foreign market, expectations of high carry-over stocks and a reduction in spring crops in 2022, which will lead to a significant decrease in grain production and export potential in 2022/23 MY.

Export geography. Traditionally, the lion's share of Ukraine's gross grain harvest was exported and averaged 70-73% over the last three seasons, while the share of the harvest required for domestic needs did not exceed 30%.

A significant advantage of exports over domestic demand is typical for major grains, wheat and corn, while the opposite trend is observed for niche crops, and in the barley segment, the share of exports slightly exceeds domestic consumption.

It should be noted that prior to the military invasion of Ukraine by the Russian Federation, the export potential of barley was 95% realized (in February it was estimated at 6,0 million tons), wheat - 81% (22,5 million tons), and corn - 60% (30,0 million tons).

Since the beginning of the war, the Government of Ukraine has imposed a ban on exports of certain grains such as oats, millet, buckwheat and rye to ensure food security in the country during martial law, and introduced mandatory licensing for wheat and corn exports. Subsequently, this procedure was canceled for corn at the request of market participants due to a significant excess of the grain harvest over domestic demand and expectations of record high carryover stocks at the end of 2021/22 MY amid limited opportunities for further realization of its export potential.

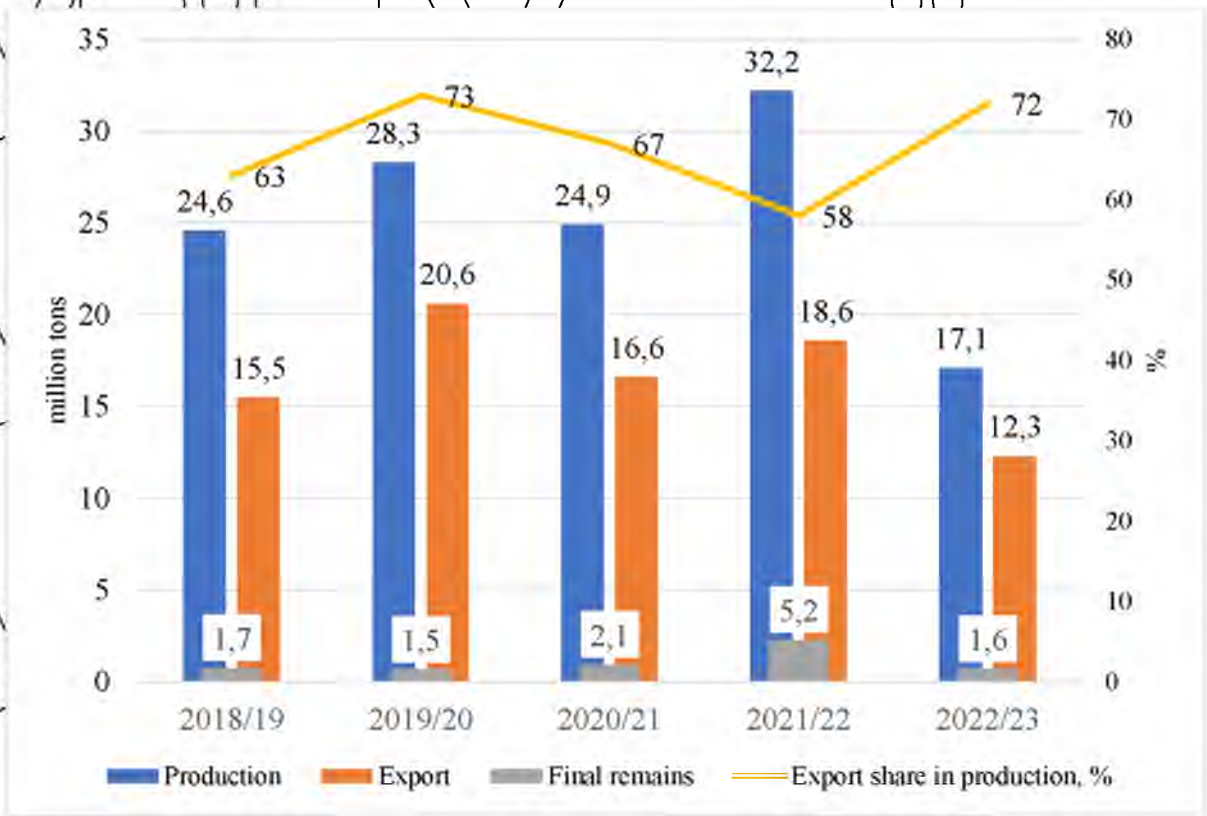

Fig. 2.8. Dynamics of production and export of Ukrainian wheat, million tons

Source: compiled by the author on the basis of [28].

Wheat. Ukraine is among the top 5 major wheat exporters. According to the USDA, its share in the global market averaged 9% over the last three seasons. From 2018/19 to 2020/21 MY, the ratio of the grain shipped to the foreign market to its production in the country ranged from 63-73%. In 2019/20 MY, Ukraine exported a record 20,6 mln tonnes of wheat against the harvest of 28,3 mln tonnes (Fig. 2.8).

The 2021/22 season was marked by a new high in gross harvest (32,2 mln tonnes, +29% compared to 2020/21 MY), and a new record level of grain exports was expected. But the war made its own adjustments. As a result of the shutdown of ports in the Azov and Black Seas, wheat shipments to the foreign market have virtually stopped, as the main buyers of the grain are North Africa, Southeast and South Asia, and the Middle East, where grain is delivered by sea. Thus, in 2021/22 MY Ukraine's wheat exports are expected to reach 18,6 mln tonnes (+12% compared to 2020/21 season).

Egypt and Indonesia have been the main importers of wheat from Ukraine for several seasons, their share in the total volume of grain shipments to the foreign market is about 15-16%.

Over the p (Fig. 2.9) ast three seasons, Indonesia has covered 24-27% of its import needs with Ukrainian wheat. As Indonesia's purchases of grain from our country peak in August-November, Ukraine has already covered 24% of the expected import demand in this direction in 8 months of 2021/22 MY, which, according to USDA experts, is expected to reach 11,0 mln tonnes. The Indonesian wheat market is quite diversified, and the demand for the grain is also covered by supplies from Canada, Argentina, the US and Australia, so if the war in Ukraine prolongs, the presence of these countries in the market may increase significantly.

Ukraine's share in the Egyptian wheat market averaged 22% in 2018/19 to 2020/21 MY and reached the maximum of 29% in 2019/20 MY. During 8 months of the current season, Ukraine managed to export 2,7 mln tonnes of the grain to Egypt, which is 23% of the expected imports (12,0 mln tonnes according to the USDA forecast). The main competitors of our country in this area are Russia (on average, about 60% of total imports over the past three seasons) and the EU countries (about

15% of import needs). However, in the current situation in the Black Sea region, Egypt can compensate for the supply from Ukraine to meet its own demand by increasing purchases of wheat from the EU countries or by looking for other suppliers, such as India and Australia.

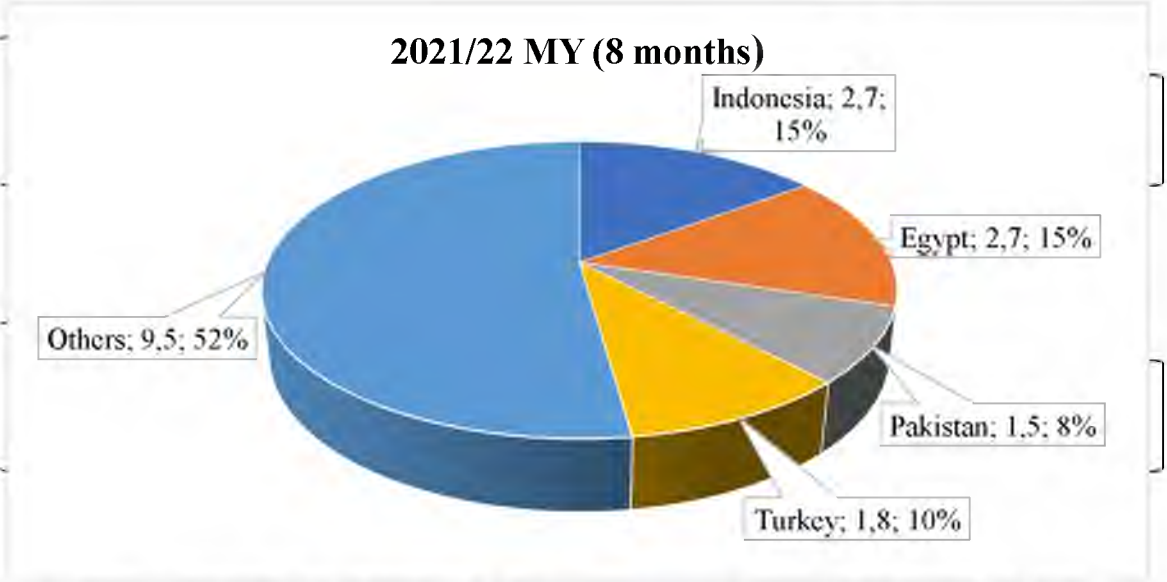

Fig. 2.9 Geography of wheat exports from Ukraine, million tons

Source: compiled by the author on the basis of [28].

Since August 2020, Pakistan also started to buy Ukrainian grain actively (in 2020/21 MY, the government of this country allowed private businesses to import wheat to stabilize domestic prices and build up stocks to ensure food security due to the coronavirus pandemic in the world), and, according to the results of 2020/21 MY,

its share in the total exports of Ukrainian grain amounted to 8% (1,4 mln tonnes), while Ukraine's presence in the Pakistani wheat market amounted to 39%. In 2021/22 season, Pakistan managed to import 1,5 mln tonnes of the grain from our country (+5% compared to 2020/21 MY), which corresponds to 77% of its expected imports (1,9 mln tonnes according to USDA forecasts). Due to the blockade of Ukrainian seaports, this country may switch to purchasing wheat, for example, from India, Australia or the EU.

As for Bangladesh, the volumes of wheat exports from Ukraine to this destination are gradually decreasing every season, and if in 2020/21 MY the country was the fourth in the ranking of the main importers, it has dropped to the seventh place in the first 8 months of the current season.

Turkey's entry into the TOP-3 of the main importers of Ukrainian grain in 2021/22 MY is temporary, as the sharp increase in its purchases is related to the significant decrease of domestic wheat production in 2021. Traditionally, Turkey compensated the lion's share of import demand with the grain from Russia (81% on average over the last three seasons), while Ukraine's presence in this market, except for 2021/22 MY, did not exceed 13%.

As for 2022/23 MY, due to the possible reduction of the grain production by 47% to 17,1 mln tonnes compared to the current season, the export potential may be only 12,3 mln tonnes, which is 34% lower than in 2021/22 MY. Reduction of Ukrainian wheat shipments will reduce the presence of our country in the markets of its main importers, and buyers will have to look for alternative suppliers of the grain to cover the import demand.

Corn. According to USDA, Ukraine has been consistently among the top 5 major corn exporters since 2008/09 MY. In 2018/19 MY, shipments of the grain reached a historic high, amounting to almost 30.0 mln tonnes, which corresponds to 17% of the total global exports of the crop (Fig. 2.10). In 2021/22 season, the new record of gross corn harvest was reached, which, according to the State Statistics Service, amounted to 42,1 mln tonnes (+39% compared to 2020/21 MY), and the export potential of the Ukrainian grain was estimated at 30,0 mln tonnes in February this year. However, against the background of blocking of Ukrainian seaports due to

the military invasion of Russia, the forecast of corn exports was lowered to 20,8 mln tonnes (-13% compared to 2020/21 MY), and the carry-over stocks at the end of the current season are expected to reach a record high (12,3 mln tonnes, up 6,1 times compared to 2020/21 MY).

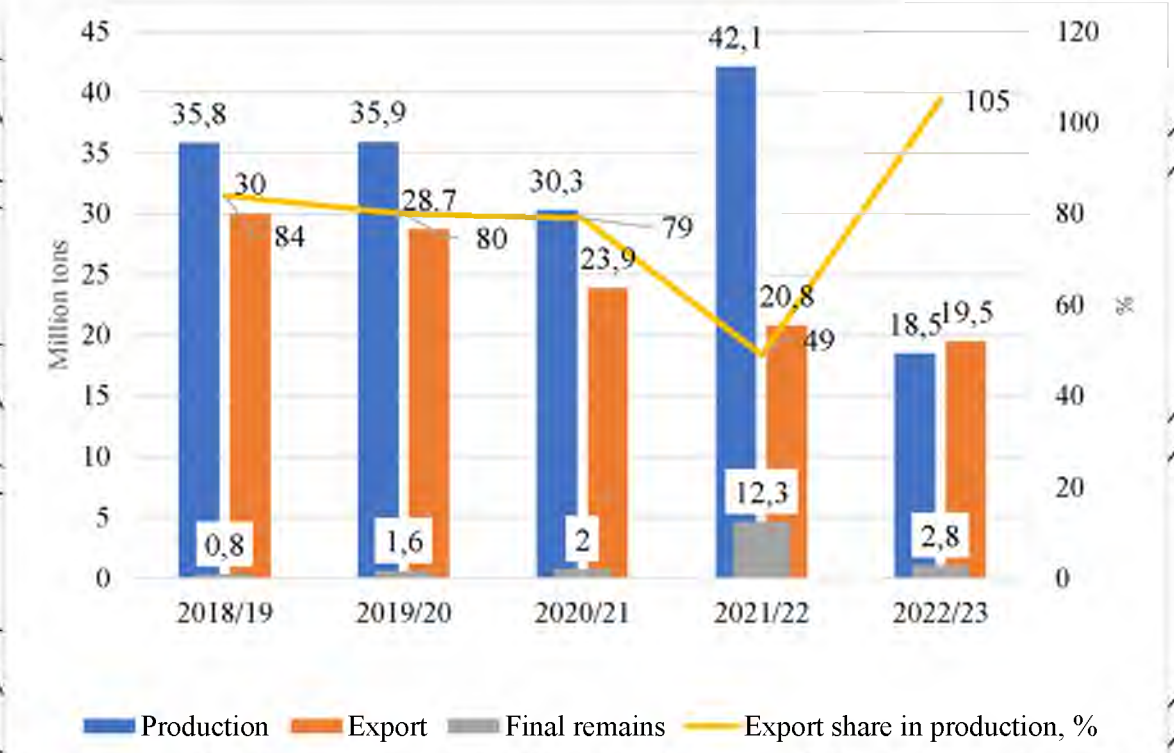

Fig. 2.10. Dynamics of production and export of Ukrainian corn, million tons

Source: compiled by the author on the basis of [28].

Traditionally, China and the EU are the main importers of Ukrainian corn, and in 2020/21 MY their shares in the total exports amounted to 36% and 24%, respectively (Fig. 2.11).

From 2018/19 to 2020/21 MY, Ukraine's exports of the grain to China more than doubled, from 3,8 mln tonnes to 8,5 mln tonnes, while according to USDA, the Chinese market demand for imported raw materials increased 5 times in the same period, from 4,5 mln tonnes to 29,5 mln tonnes, which led to the decrease of the share of Ukrainian corn in the total imports of China from 85% to 29%. During 5 months of the current season, Ukraine managed to export 5,5 mln tonnes of the grain, which is 17% more than the same indicator of the previous season and accounts for 24% of the expected imports by China (23,0 mln tonnes according to the USDA forecast). Further exports

of Ukrainian corn to this destination are still impossible due to the suspension of seaports as a result of constant shelling of our country's territory. Therefore, it is likely that the Chinese market will see an increase in the presence of American corn this season, and purchases of the grain from the EU and Argentina are also possible.

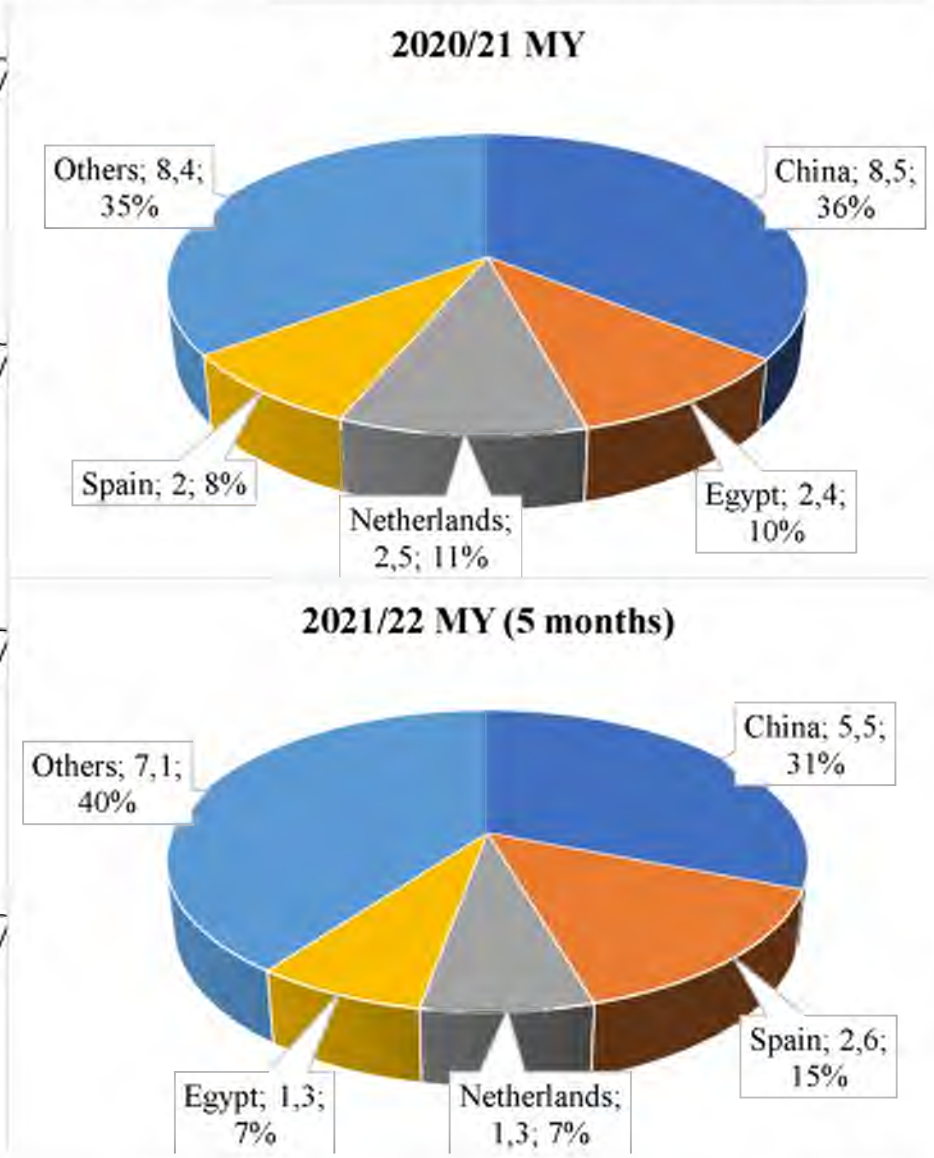

Fig. 2.11. Geography of corn exports from Ukraine, million tons

Source: compiled by the author on the basis of [28].

Over the past three seasons, the EU countries have covered an average of 60% of their import needs with Ukrainian corn. About 59% of the total volume of the grain went to the key buyers Spain and the Netherlands. In 5 months of 2021/22 MY, these countries managed to import 2,6 mln tonnes and 1,3 mln tonnes of corn from Ukraine,

respectively, up 82% and 5% compared to the same period last season. At the same time, the total shipments of Ukrainian corn to the EU in October-February of the current season amounted to 7,4 mln tonnes, up 69% compared to 2020/21 MY. Currently, the EU countries remain the only available destination for Ukrainian grain exports.

Egypt also holds a significant place in the ranking of the key importers of corn from Ukraine, but the volume of its purchases is gradually decreasing every season. In 2018/19 MY, the share of Ukrainian grain in the total imports of Egypt amounted to 32%, while in 2020/21 MY it decreased to 24%. Egyptian imports of corn are quite diversified, besides Ukrainian, the country buys Argentine, Brazilian and Romanian grain in significant volumes, so if the war in Ukraine prolongs, their presence in the market may increase significantly.

As for the forecasts for 2022/23 MY, with the expected reduction of corn production by 56% compared to the current season's harvest, to 18,5 mln tonnes, and due to the record carry-over stocks of the crop at the end of 2021/22 MY at 12,3 mln tonnes, the export potential may reach 19,5 mln tonnes, which is 6% lower than in 2021/22 MY.

2.2. Analysis of logistics support for grain exports in Ukraine

The logistics support of the grain market is the process of planning, coordinating and controlling the movement of grain from the sowing areas to the end users. It includes various functions such as harvesting, storage, transportation, production, processing, distribution and sale of grain crops.

In the grain sector, logistics support is important because grain is one of the most massive and valuable products moved around the world. Ensuring efficient logistics helps to ensure the availability of the product on the market and helps to reduce the cost of transportation and storage of grain crops.

Grain logistics includes the following stages:

- Harvesting of grain crops.

- Transportation of harvested grain from the field to storage warehouses.
- Storage of grain in warehouses before its further processing or transportation.
- Processing grain into cereals, flour, feed, ethanol and other products.
- Transportation of grain to various markets.
- Distribution and sale of grain products on the market.

All of these stages are interconnected and require high efficiency and accuracy to ensure timely and high-quality product delivery to the market.

Ukraine has long been known for its strong agricultural sector and grain exports. However, since 2014, the country has been the scene of a military conflict in the east, which has negatively affected the development of the agricultural sector and the logistics of the grain market. And the beginning of the full-scale invasion was accompanied by the loss of control over parts of the territory, in particular over ports, which are key elements of the grain market's logistics infrastructure. This led to difficulties in ensuring the export and storage of grain crops, as well as to changes in the direction and volume of exports. In the context of the war, the analysis of the logistics support of Ukraine's grain market becomes particularly relevant, as it determines the country's capabilities in the foreign market and its competitiveness.

As for logistics and problems related to military operations, the first thing that comes to mind is access to agricultural land. After the invasion of Ukraine by the Russian Federation, a significant amount of our territory, including agricultural land and the territories of agro-industrial enterprises, was occupied. Although the military situation changes almost every week, in general, the occupied territories are located in the east and south of the border with Russia.

The greatest pressure of Russian troops is on those areas of Ukraine where there are constant hostilities, which prevents the sowing of crops in full. Areas close to military lines pose a risk to agricultural operations, as there may be rocket fragments, unexploded ordnance, mines and tripwires, which pose a danger to people and equipment. The occupation of these territories has led to a reduction in the total area under crops such as wheat, barley, corn, sunflower and others, which are important for Ukraine's food security and export potential. In total, more than 5 million hectares of

agricultural land in Ukraine cannot be sown because they are mined, contaminated with explosive remnants, or are subject to military operations [42].

The next problem is machinery. Agricultural machinery and equipment are also damaged by shelling, air strikes, and hostilities taking place in the immediate vicinity. Tractors and trucks are at a higher risk of damage than other types of agricultural machinery. The estimated cost of replacing and repairing damaged machinery is USD 926.1 million. There are indications that Russia is deliberately destroying elevator capacities in order to weaken the Ukrainian agricultural sector [43].

Another problem is fuel. Among all sectors of Ukraine's national economy, agriculture is one of the largest consumers of fuel. This sector uses more than 25% of diesel fuel and 5% of gasoline in total. The annual consumption of diesel fuel in agriculture is about 1300 thousand tons, and motor gasoline - more than 85 thousand tons. During the military operations in March-April 2022, the cost of fuel increased due to macroeconomic factors - higher oil prices, changes in the national currency - and other factors, in particular, higher logistics costs, increased dealer costs and gas stations' own costs [44].

In addition to the price increase, there was a fuel shortage. Already from the beginning of the Russian invasion, it became apparent that Ukraine might face fuel shortages because a significant amount of petroleum products were purchased from Russia and Belarus. In 2021, before the war, 62% of diesel fuel and 50% of gasoline were imported from these countries, while another 10% was purchased in Lithuania and delivered by sea. Overall, imports of petroleum products covered up to 80% of Ukraine's needs. However, after the supply of petroleum products from Russia and Belarus stopped, the government and experts claimed that the crisis was temporary. It was noted that the oil products market is very dynamic and can be replaced by increased supplies from Europe. In this regard, in mid-March, the excise tax on fuel was zeroed and the VAT rate was reduced from 20% to 7% to ensure that imports could be replaced.

As expected, the Kremenchuk refinery could have supplied the rest of Ukraine's petroleum products needs. According to the government, before the war, it supplied up

to 18% of Ukraine's needs. After the war began, private consumption declined, and the refinery said it could cover all domestic demand. However, on April 2, the refinery was hit by rockets, causing damage that could not be repaired by the end of the year [46].

Roads and bridges that ensure the movement of grain from fields to elevators and other storage facilities were heavily damaged by the shelling. In Ukraine, 23 thousand kilometers of roads and 273 artificial structures, including bridges and overpasses, were destroyed as a result of the hostilities. The total amount of damage reached UAH 874 billion [45].

Another problem faced by farmers at the beginning of the war was grain storage. Approximately one in six Ukrainian grain storage facilities (or 15.73% of the total) - silos, elevators, grain bins, and warehouses for storing grain and seeds such as wheat, barley, and sunflower - have been destroyed, damaged, or taken over by Russia and its proxies since the beginning of the invasion on February 24 [41].

Also, the largest hub (70-80% of professional warehouse space) was located in Kyiv region. With the outbreak of hostilities, companies were forced to move their goods to the west of Ukraine, where there was no warehouse space of this size [48].

Blockade of ports. The blockade of the Black and Azov Seas began even before the full-scale invasion of Ukraine. On February 8, Russia deployed six large warships to the Black Sea, allegedly to participate in military exercises, and then began blocking all commercial trade to and from Ukrainian ports. After the invasion began on February 24, Russian troops threatened ships transporting grain with direct attacks and mining of the Black Sea. Some ports were occupied (Mariupol, Berdiansk, Skadovsk, and Kherson), while others were attacked or blocked (Pivdennyi, Mykolaiv, Olvia, Odesa, Chornomorsk, and Bilhorod-Dnistrovskyi). Russian forces have damaged export and storage infrastructure, including many elevators across the country, as well as port infrastructure needed to transfer grain to ships, including the Nika-Tera elevator in Mykolaiv and the port of Odesa.

Before the war, 75% of Ukraine's exports abroad went through seaports [50]. A seaport is a territory and water area defined by boundaries and equipped for servicing ships and passengers, cargo, transportation and forwarding operations, as well as other

related economic activities [51] After Russia launched a full-scale war against Ukraine, farmers, including grain producers, were unable to sell their products on traditional markets. The main ports through which most of Ukraine's grain was exported ceased to operate. On the western land border, the crossing points were effectively blocked due to limited capacity and the large number of vehicles and cargo.

Before the war started, grain in Ukraine was transported by rail, road and river transport, in particular towards ports. After river transport was halted, grain owners redirected transportation to road and rail, but they also faced problems. In the regions that were caught in the war zone, road freight transportation practically stopped in the first days of the war for numerous reasons. Drivers did not know which roads were still safe to travel and which were not. There were many mine threats on the roads, so drivers did not want to take any risks and go on a trip.

As can be seen from the diagram (Fig. 2.12), the largest number of terminals falls on Mykolaiv, Odesa, and Pivdennyi ports.

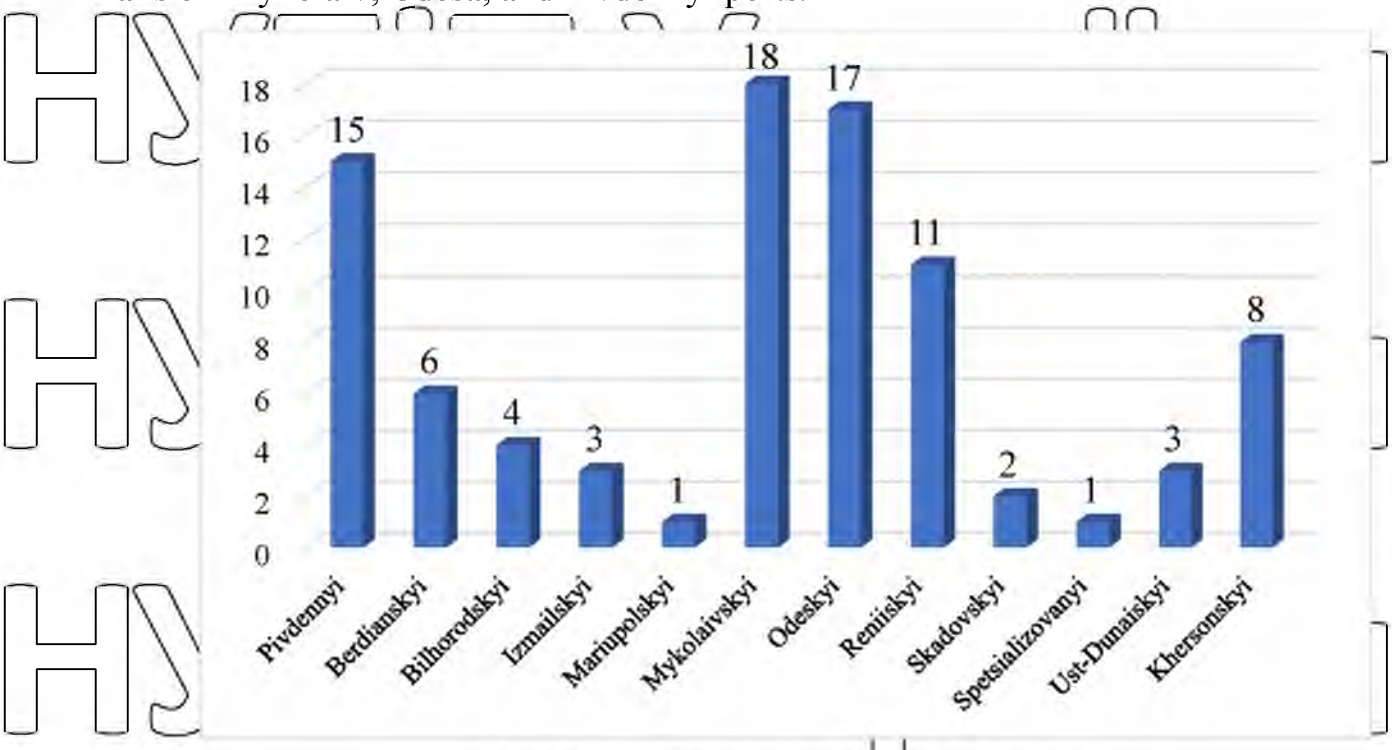

Fig. 2.12. Terminals of Ukrainian ports.

Source: compiled by the author on the basis of [41]

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Transportation problems arose not only in the combat zones, but also in areas far from the frontline. Roads were densely blocked by checkpoints across the country, many of which heavy vehicles could not pass due to their size. The number of available trucks and drivers decreased significantly as they were massively deployed to defense tasks and redirected to the transportation of critical life-support supplies.

In general, road transport remained the most accessible mode for grain transportation, but it had its own problems, which were overcome within a few months. This led to changes in transportation routes and tariffs. While in the pre-war period, road transport transported grain over average distances of about 400 km, it was more expedient to use railways for longer distances. Nowadays, grain carriers are sent on trips over 1,000 kilometers, including transportation abroad. The tariff for long-distance grain transportation has increased to an average of UAH 2 per ton-kilometer, while for local transportation the tariff has risen to UAH 4-5 per ton-kilometer and sometimes even to UAH 8-10 per ton-kilometer during peak periods. To reduce the cost of road transportation, the first step was to abolish the excise tax and reduce VAT on fuel, which made it more affordable. This allowed farmers not only to save money on transportation of their products but also to successfully complete the spring sowing season.

The agreement on the liberalization of road freight transportation with the EU, which was signed in late June, helped boost grain exports by road. The growth was also facilitated by the development of border infrastructure, in particular, by increasing the capacity of existing road crossing points on the western border.

In March-April, many countries, including not only Ukraine's bordering countries, but also Lithuania, Bulgaria, Greece, and Turkey, stopped requiring export permits, allowing grain producers to export their products. Many of the partner countries have also lowered the environmental requirements for vehicles entering their territory to the Euro-3 standard [52].

Since the beginning of the war, Ukraine has managed to increase grain exports by 20-30% per month using all available means. The railroaders deserve a lot of credit for this, as Ukrzaliznytsia and the Ministry of Infrastrueture have been doing everything possible to increase the export of agricultural products from the country by rail. As early as March, Ukrzaliznytsia began to develop the logistics of grain delivery to the borders with Romania, Hungary, Slovakia, and Poland, from where the grain was to be delivered to EU ports and logistics hubs.

In the first 20 days of April, Ukrzaliznytsia transported 801 thousand tons of grain, up 116 thousand tons from March. In addition, 275 thousand tons of grain were transported for export. In July, the amount of grain loaded into railcars amounted to 1206 thousand tons, of which 905 thousand tons were exported via land crossings and ports, which is 100 thousand tons more than in June.

"Ukrzaliznytsia has focused its strategy on increasing grain transportation for export by expanding border railroad crossings. Since the start of the war, several new crossings have been opened on the borders with Poland, Slovakia, Moldova, and Romania, and the capacity of existing ones has been increased. By the end of October, there were 13 freight border crossings with five neighboring countries. This made it possible to increase the transfer of grain wagons through them from 200 per day in March to 560-580 in July. In total, 22,400 grain railcars are running in Ukraine.

Also in July, the UN and Turkey proposed the creation of a corridor in the Black Sea, which would allow for the safe supply of Ukrainian grain to the world market. For

this purpose, separate agreements were signed with Ukraine and Russia, which provided for the operation of such a corridor for 120 days with the possibility of its further extension. A Joint Coordination Center for Grain Exports was established in Istanbul, which was responsible for inspecting ships and controlling their movement through the grain corridor. Ship handling and loading was scheduled to take place in three ports - Odesa, Chornomorsk, and Pivdennyi [53].

According to the Ministry of Infrastructure of Ukraine, 5,5 million tons of agricultural products were shipped to Europe, Asia and Africa in the first two months of the grain initiative. In total, 241 vessels with agricultural products left Ukrainian ports. In September, compared to August, the number of exported products increased more than 2 times, and the number of vessels leaving ports increased almost 3 times, see Figure 2.13 for more details. Such indicators demonstrate the world's confidence in the «grain corridor» and the readiness of global institutions and businesses to participate in the purchase and transportation of Ukrainian agricultural products [55].

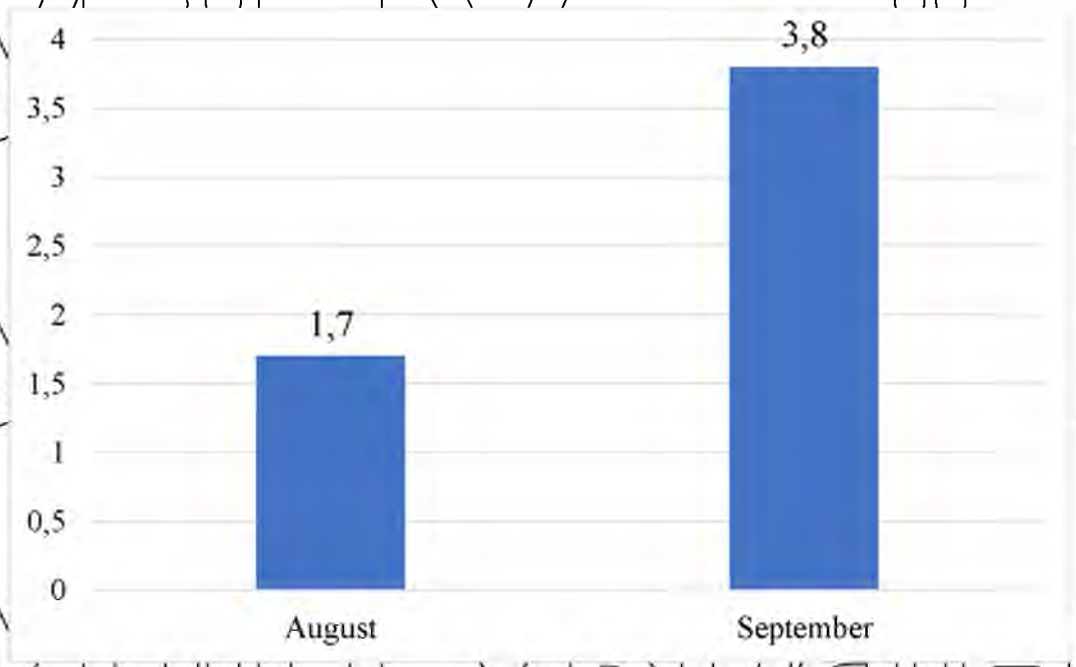

Fig. 2.13. Exports of agricultural products in the first two months of the Grain Initiative, 2022, mln. tons

Source: compiled by the author on the basis of [44]

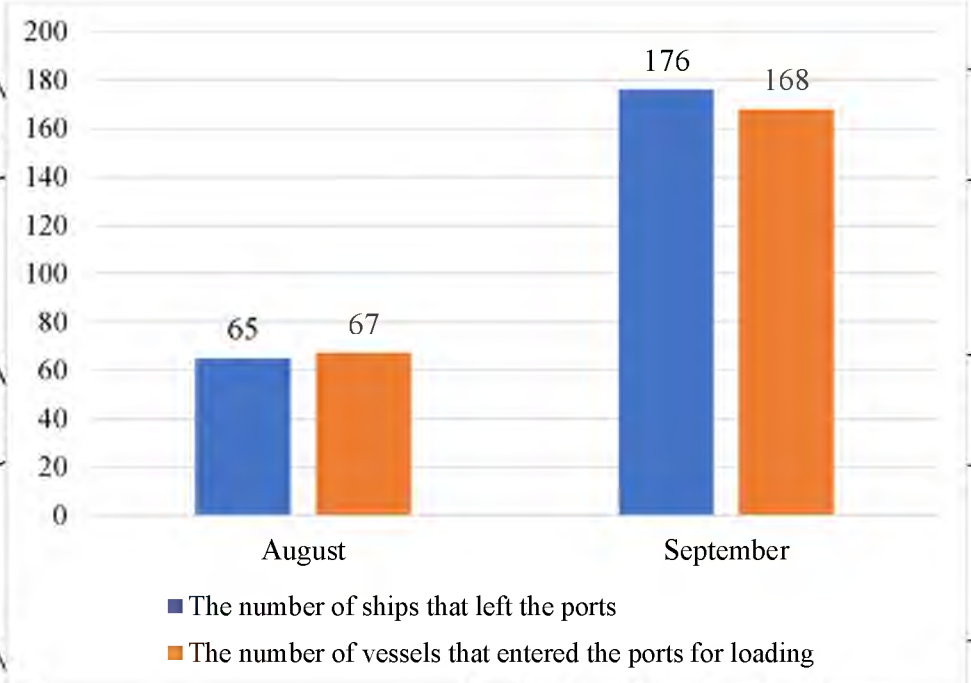

Fig. 2.14. Number of vessels in the first two months of the Grain Initiative, 2022

Source: compiled by the author based on [44]

Summarizing, according to the Ministry of Agrarian Policy, as of mid-November, since the beginning of the war, 29,1 million tons of grains, legumes, oilseeds and their products have been transported across the Ukrainian border. During the 2,5 months of autumn, 16,6 million tons of agricultural products were exported to other countries, including 2,8 million tons in the first 15 days of November, which is 800 thousand tons less than in the first half of October [55].

Let's analyze the channels of grain exports, which we can examine using the data in Table 2.3.

As can be seen from the data in Table 2.3 52 million tons of agricultural products were exported between March 2022 and April 16, 2023.

The data in Table 2.3 show that ports were still the main sales channel through which products were exported.

Railroad transportation has achieved significant agricultural exports, which has never been seen before in the history of independent Ukraine, allowing for the export of almost 1 million tons of products per month. Road transport also contributed,

allowing for the export of about 400 thousand tons of produce per month. In the first five months of the war, without sea transportation, exporters focused their efforts on river ports across the Danube, rail, and road transport. The railroad became the second largest export channel, directing the main flows of products through Poland and Hungary.

Table 2.3

Channels for the sale of agricultural products for export from Ukraine, from March 2022 to April 16, thousand tons

Type of product	Total	Sales channels (type of transport)			
		ports	railroad	car	ferry
Corn	26 680 824	18 244 429	7 057 134	1 333 704	45 557
Wheat	13 911 622	11 617 965	1 427 190	825 696	40 771
Rapeseed	3 342 051	1 847 330	710 410	764 649	19 662
Sunflower seeds	3 265 336	1 849 968	381 971	951 141	82 255
Barley	2 467 061	2 258 332	76 880	116 900	14 950
Soybeans	2 965 314	1 936 871	494 724	488 253	45 467
Total	52 632 208	27 298 695	10 148 309	3 146 639	248 662

Source: compiled by the author based on [55]

So, the main problem is the occupation of ports. One of the consequences is the restriction of access to maritime transportation and the increase in the cost of grain delivery. This leads to a decrease in the competitiveness of Ukrainian grain on the foreign market, which may affect export volumes and the profitability of agricultural enterprises.

2.3. Transformation of grain chains in the context of the war in Ukraine

The intensification of competition in local and international markets as a result of increased globalization processes actualizes the study of the peculiarities of the formation and development of agri-food chains, the formation of links between

stakeholders of the agribusiness ecosystem: producers, processors, logistics operators, trade intermediaries (traders), suppliers and distributors of consumables, equipment and technologies, researchers, market experts, educational and financial institutions, public organizations, and government agencies.

The newest transformations of agri-food chains in the wartime period, the expectations of stakeholders and the market, and possible prospects for their further reformatting after the war require the study and development of models that can be economically feasible for micro and small agricultural producers and will form the basis for the formation of long-term strategies for sustainability and innovative development, help to overcome the crisis in the economy faster and give impetus to the creation of added value for both consumers of agri-food products and stakeholders.

The relevance of value chain research is determined by the dynamism and uncertainty of the environment in which market participants operate. Making effective management decisions that meet modern challenges requires sound tools for their adaptation, application of modern methods and approaches to the management of production resources, communications, logistics flows, etc. To this end, it is necessary to systematize both the theoretical foundations and principles of creating and operating chains, as well as the principles and components of business processes that ensure their viability. Systematization will allow to clearly identify the structure, understand the logic of building chains, identify internal and external factors and understand the consequences of their impact and effectively manage them [45].

In the theory of the chain approach, as a method of scientific knowledge, there are many concepts and approaches that essentially reflect the set of business processes and market operators involved in the creation of products and services, their distribution and feedback. The definition of "agri-food chain" is somewhat complicated due to the use of similar terms in the scientific literature, in particular:

- «value chain» - an approach (according to M. Porter), according to which a company can be represented as a set of different activities (main and auxiliary, aimed at the development, production, marketing, delivery and service of its products). All these activities are combined into a value chain (VC). The value created for the

consumer is the market price that customers are willing to pay for the product offered by the company [46, p. 44]. This approach has gained wide popularity, but it does not reflect the influence of other market participants - distributors, suppliers, competitors, etc. on the formation of value for the consumer;

- «supply chain» (SC) - is identified with a physical network that runs from the initial supplier to the customer [47, p. 97]. The supply chain is considered by the object and process approaches. According to the object approach, the LP is formed as a group of manufacturing enterprises, logistics operators, processors, wholesale and retail trade operators that interact in information, financial and material flows and service flows from raw material sources to the end consumer. The logic of the process approach defines the LP through a set of flows and the corresponding processes of cooperation and coordination between different participants of the LCS in order to meet consumer demand for goods and services [48, p. 54].

The processes of globalization, free trade and outsourcing actualize the application of the concept of Supply Chain Management, which was developed in the 80s of the twentieth century and is still being transformed from chain management to supply chain network management. Some authors equate the network approach to supply chain management with the cluster approach. This approach is quite controversial, since a cluster is a natural formation that arises on the basis of smart specialization of the region; the basis of cooperation under this approach is joint research and development activities of the cluster members [49, p. 46];

- «logistics chain» (LC) is formed on the basis of cooperation of producers and distributors of raw materials, materials, carriers, warehouses, intermediaries, subcontractors who carry out logistics operations in order to bring the material flow from one logistics system to another or to the end user in order to jointly coordinate their activities [50, p. 164; 51, p. 18]. In the modern scientific paradigm, LL is a part of LP;

- The «local food supply chain» represents all the processes associated with the movement of local food from farm to consumer, including marketing, markets, distribution, aggregation, processing, packaging, procurement, preparation, resource

recovery and waste disposal [52, p. 2]. This concept is interpreted as a short supply chain that is social in nature and has geographical limitations [53, p. 34]. The formation of local agri-food supply chains is intended to meet the needs of consumers in the most efficient way and meet the goals of sustainable rural development [54, p. 14]. The marketing trend to popularize the consumption of local food has contributed to the development of this type of chain in recent years, and has become especially noticeable during the COVID-19 pandemic;

- «smart chain» is a European prototype of a model of local agri-food supply chains designed to increase the competitiveness of rural areas, promote job creation and value addition. Such chains are supported by subsidies from the EU government [55, p. 322] and, unfortunately, are an innovation for Ukraine;

- «agri-food chain» - a set of agricultural producers and organizations that consistently, in a coordinated manner, ensure the creation of added value through the production of specific types of agricultural products and their processing in order to obtain food products sold to the end consumer, ensuring profitability at each stage of promotion, creating benefits for society without permanent depletion of natural resources [19, p. 8]. At the same time, market participants unite to increase productivity and equitable distribution of benefits [56, p. 25].

- «global agri-food chains» or "global supply chains" is a network of interconnected enterprises, resources and processes around the world that create and supply products and services to end consumers in order to optimize the costs of international trade [57, p. 35]. The processes of globalization and integration create the preconditions under which powerful international companies control and vertically coordinate the market through agri-food chains [58, p. 2].

Despite the depth and multidimensionality of existing studies of global agri-food chains, this concept most fully corresponds to the key trends in modern economic relations, characterized by the growing complexity of new formations and hybridization of relations between market participants, which are denoted by the term coopetition, which means cooperation between market participants and does not negate healthy competition between them and the number of parameters that shape the

international environment. These features of relations between stakeholders in the agrarian market motivate further research in this area, especially given their radical transformations under the influence of security factors.

Our goal is to systematize the transformation processes in agri-food chains at the micro and meso levels and their integration into global value chains in wartime.

Domestic agricultural enterprises are participants in globalized agri-food chains, however, military actions taking place at the national level directly determine their ability to produce added value. The changes that have become irreversible during the period of military operations are reflected in the model of agri-food chains on the example of micro and small enterprises in Ukraine specializing in the cultivation and sale of grain and oilseeds. The developed model is based on a process approach, which includes such basic business stages as supply, procurement, production, transportation and sale [59, p. 34].

At the national level in the prewar period, agri-food chains corresponded to the six most common models visualized in Appendix A.

Each of the participant interaction models included in the holistic design model has its own advantages and is clearly differentiated from the others (Table 2.4).

In a market economy, the choice of a business model for agricultural enterprises is governed by market factors, such as

- production capacity (size of the land bank, availability/accessibility of agricultural machinery, availability/accessibility to storage and drying facilities, etc.);
- geographical location and accessibility of logistics infrastructure;
- management competencies and access to market information, business contacts;
- access to financial resources, exchange rate fluctuations and inflationary processes, price levels in the country and on foreign markets (including commodity exchanges). All of these factors allow to make decisions on entering into contracts (including forward contracts) for the supply of agri-food products to market operators (grain traders) or directly to processors in the country and on foreign markets.

Table 2.4

Differentiation of agri-food chain models

No.	Name	Characteristics
1.	«Field-to-fork»	The simplest model in which the producer carries out business processes for growing and harvesting and ships it to the buyer at the point of harvest, i.e. on the field.
2.	«Sales to the operator market operator»	It involves the production, harvesting, processing of the crop, or temporary its storage and further sale to a market operator company (i.e., an intermediary). In this case, the process of harvesting can be considered as the creation of added value.
3.	«Sales to domestic Processors»	Not only focused on storage and processing, but also includes the processes of transportation and direct sales to processors that create value added within the country.
4.	"Sales of products with added value"	The model is characterized by a closed production cycle from field to shelf, with raw materials is stored and processed by the manufacturer at its own facilities, and the added value is created within the country.
5.	«Realization through international intermediaries»	Under this model, the producer company enters into contracts (including forward contracts) with market operators (grain traders) with market operators (grain traders) for the supply of products to a seaport, while the added value is created outside the country.
6.	«Realization to processors abroad»	The producer enters into direct contracts (including forward contracts) for the supply of products to the buyer's warehouse abroad, while the added value is created outside the country.

Source: compiled by the author on the basis of [48].

Agricultural market operators note that they were forced to choose a "survival" strategy due to the military actions in Ukraine (most of them - 98%). They motivate their decision by the influence of external and internal factors that have the greatest impact on the choice of strategy (Table 2.5).

Table 2.5

Factors influencing the choice of strategy of agricultural enterprises in wartime

Factors of the external environment:	Factors of the internal environment:
- inflationary processes, currency restrictions and risks; - sharp increase in prices for fuels and lubricants and energy prices; - rising logistics costs and physical restrictions on access to logistics flows; - outflow of economically active population outside the country; - changes in the domestic grain and oilseeds market and oilseeds market; - decrease (multiple) of domestic purchase prices for grains and oilseeds; - decrease in effective demand within the country; - instability of the economic and political environment; - increased risks and restrictions due to the martial law the military situation.	- a sharp drop in revenues (inability to overcome the breakeven point) break-even point); - lack of/limited access to logistics flows (including due to prices) and consumables (fertilizers plant protection products, spare parts, etc;) - search for new ways of storage and sales channels production; diversification of production - cultivation of niche crops (cereals, legumes); - limited access to external sources of of financing; - military mobilization and migration of highly skilled and specialized workers; - sharp (forced) optimization of technological operations and costs through the automation of business processes and optimization of the number of employees.

Source: compiled by the author on the basis of [48]

Under the influence of the above-mentioned external and internal factors, agri-food chain models have been transformed, and the visualization of changes is shown in Appendix B.

Limited access to logistics flows due to their blocking (destruction) and a multiple increase in the cost of transportation services were the biggest challenges of the martial law period, as noted by 99% of respondents, excluding security issues.

Due to the outbreak of full-scale military operations, maritime transport terminals in Ukraine were temporarily blocked (from February 24, 2022, until the

signing of the «Initiative for the Safe Transportation of Grain and Food from Ukrainian Ports» on July 22, 2022), and producers were forced to use alternative channels of transportation of agri-food products - rail and road, which led to the formation of another model of the agri-food chain No. 7 (Appendix B). The capacity of such logistics flows has increased significantly, but it is not sufficient to sell the 2022 harvest and the remnants of last year's harvest, and the nearest elevator capacities of neighboring countries, in particular Poland and Romania, do not meet the needs and, for a number of objective reasons, cannot be quickly scaled up, which leads to the formation of so-called "bottlenecks" and, as a result, dumping by intermediaries. According to experts, the logistics costs for grain exports in July 2022 generally amounted to USD 150-180 per 1 ton or 3.5% of the total. USD per 1 ton or 2/3 of the cost of grain [60, p. 1].

Due to the decline in domestic procurement prices for grains and oilseeds amid rising logistics costs, chain models 1 and 2 are not economically viable (sales revenue does not cover production costs), but this situation favors models 3 and 4, which involve the creation of value-added products within the country. Models 5 and 6 are mainly realized through the obligation to fulfill forward contracts, which are also not always economically feasible.

The majority of agricultural producers (90%) made an attempt to optimize costs by replacing fertilizers with cheaper ones and reducing application rates, minimizing the amount of plant protection products, reducing the cost of seed and staff salaries, reducing the number of technological operations, and suspending innovation and research. At the same time, companies that have access to BigData technologies (their own and partner databases) note that this tool has allowed them to manage costs and make effective management decisions for each land plot separately and plan the optimal crop rotation for 2023.

In the 2022 sowing campaign, companies used carry-over balances of commercial products as seed material and reduced purchases of seeds of elite varieties and hybrids based on forecasts of changes in market conditions towards lower demand and a sharp drop in purchase prices for commercial products. Due to the oversupply of

grain on the market, payment for the delivered products is postponed for 1-1.5 months, which will further affect the financial condition of farms, some of which, according to the experts surveyed, are likely to go bankrupt, as commercial lending will be severely limited in 2022-2023. Wheat and corn production is threatened with a 30-40% decline, which will lead to a loss of export potential and a decrease in Ukraine's share of global markets such as China, Asia, and Africa. Instead, some agricultural producers see oilseeds as promising export-oriented crops, and cereals as the most promising for the domestic market. At the same time, the rapid growth of cereal crops may lead to lower prices in this segment due to overproduction.

Given the results of our research, we can say that growth prospects are real for niche crops and functional products (naked barley, colored wheat, etc.), whose market value is higher than traditional grain crops. Those producers who already have experience in growing such crops and special tillage equipment will be able to quickly reorient their production to a niche option. This approach will allow them to move away from the model of selling raw materials to creating value-added products (such as cereals, flour, pasta, etc.). The formation of a full cycle of the production process will significantly save on logistics costs, as the transportation of 1 ton of raw materials and 1 ton of finished products has the same cost, but the income will differ significantly.

The situation is somewhat different for agri-food producers who use organic technology. Our research has shown that the demand for organic soybeans and rapeseed in the European Union is growing. In addition, the reorientation to land transportation allows fulfilling contracts for the supply of organic products to the EU, and the higher premium for organic certification covers the increase in transportation and logistics costs. In general, most agricultural market experts note that in the next production season, changes in business models will be even more significant, as in 2022 most companies supported their operations with carryover balances.

Thus, the results of the study suggest that from the point of view of systematizing the set of existing definitions of the concept of «agri-food chain», it can be presented

as an integral approach to creating added value based on the realization of the economic interests of each participant.

The transformation processes caused by the military actions in Ukraine have led to a complication of the relationships between the participants and the emergence of new links in agri-food chains at both the local and global levels [61].

It is established that the most influential factor in the formation and functioning of agri-food chains in Ukraine is the logistics crisis, the solution of which determines the choice of strategy for the further development of agricultural enterprises. The economic relations between the actors of the agri-food system of Ukraine in the context of full-scale military operations require further research and systematization, and the research results will serve as a basis for the development of sustainable business models for the post-war period.

CHAPTER 3. PROSPECTS FOR THE DEVELOPMENT OF EXPORT-ORIENTED GRAIN LOGISTICS IN UKRAINE

3.1. Rebuilding logistics under martial law in Ukraine

The war in Ukraine has significantly affected the logistics of grain exports. In particular, destroyed infrastructure, the risk of terrorist attacks and blockades of delivery routes have become significant obstacles to ensuring export flows. In such circumstances, diversification of logistics routes is an important task to maintain the competitiveness of Ukrainian grain on the global market.

During the war, the main logistics routes that ensure grain exports were formed, but as the war continues and instability continues, new challenges for grain export logistics may arise. Therefore, developing new logistics routes and improving existing ones is an important task to ensure the reliability and stability of grain export flows.

Most EU countries that share a common border with Ukraine have responded positively to the establishment of alternative logistics routes for grain exports from Ukraine to third countries, as well as to the ease of freight clearance and customs procedures. Countries that have introduced liberal conditions for grain exports from Ukraine include: Poland, the Baltic States, Slovakia, Hungary, Romania, Italy, Turkey, Bulgaria, Georgia, Denmark, Greece, and Austria.

Poland is speeding up border procedures and logistics for grain exports from Ukraine, and the G7 countries are creating new supply chains for grain exports. Slovakia and Austria have lifted restrictions on the transportation of grain crops from Ukraine through their territory without the need for permits, allowing for easy delivery of agricultural products to seaports in Italy. Also, the EU has exempted imports of Ukrainian grain from the requirements of veterinary or phytosanitary certificates to facilitate transit [58].

Let's look at the logistics routes for grain exports from Ukraine through the EU under martial law.

The way through Slovakia. Grain crops were transported from Ukraine to Slovakia by rail to the river port in Bratislava, and then by the Danube to the Romanian port of Constanta, from where they were delivered to African countries. This logistics route is shorter, cheaper and more environmentally friendly.

Slovakia has an efficient logistics potential, which consists of developed logistics chains with European rail, road and river networks. The port of Bratislava is located in the middle of the Rhine-Main-Danube waterway, which provides convenient access to many regions. The railway network has sufficient capacity to increase the volume of traffic in the south-north and east-west directions, which is an advantage of this country in the field of transport logistics.

The way through Poland. Poland has a 400-kilometer-long railroad that connects Ukraine and Silesia. Poland and Ukraine have signed an agreement to establish a joint freight company and simplify border rules to facilitate the formation of logistics routes for grain exports and increase transportation volumes. However, there are obstacles, such as congestion of Polish ports to the Baltic states, the urgent need for more railcars and the development of transport infrastructure, which hinder the development of this area.

The way through Romania. Ukraine exports grain crops via Romania by rail, road, sea and river transport. This logistics route is promising and a priority for development. The Romanian authorities are taking measures to increase the volume of grain transportation from Ukraine on their territory, including providing direct support through their own mechanisms. The main logistics hub for exports from Ukraine through Romania is the port of Constanta, which is an alternative route that bypasses the blocked Ukrainian seaports. After that, grain crops are transported to third countries [62, 64].

The route through Lithuania. The transit of grain crops from Ukraine through Lithuania to third countries takes place via the port of Klaipeda on the Baltic Sea and the Polish railroad. However, the shipment of products from Ukraine to Lithuania takes a significant amount of time [63].

These data indicate the formation of four main logistics routes for grain exports from Ukraine to third countries to ensure food security under martial law. Despite the joint efforts of Ukraine and the EU countries to establish alternative logistics routes for the transportation of grain crops, there are problems that complicate the transit of agricultural products. In particular, there is a lack of truck drivers, different railroad gauges in Ukraine and the EU, overloaded customs infrastructure such as ports in Romania and Poland, and a lack of qualified personnel.

To remove obstacles and create «solidarity routes», the Commission will work with Member States and stakeholders on the following priority actions in the short term:

- Additional freight rolling stock, ships and trucks: The Commission calls on EU market participants to provide additional vehicles as a matter of urgency. In order to match supply and demand and establish relevant contacts, the Commission will set up a logistics platform for matching and ask Member States to designate dedicated Solidarity Lanes (single window) points of contact.

- Capacity of transport networks and transshipment terminals: Ukrainian agricultural exports should be prioritized and infrastructure managers should provide rail slots for these exports. The Commission also calls on market players to urgently relocate mobile grain loaders to appropriate border terminals to speed up transshipment.

- Customs operations and other checks: The Commission encourages national authorities to use maximum flexibility and ensure adequate staffing to speed up procedures at border crossings.

- Storage of goods in the EU: The Commission will assess the available storage capacity in the EU and coordinate with Member States to help provide more temporary storage capacity for Ukrainian exports.

In the medium and long term, the Commission will also work to increase the infrastructure capacity of new export corridors and establish new infrastructure connections as part of Ukraine's reconstruction [64].

The conditions of hostilities between Ukraine and Russia pose significant challenges for grain exports from Ukraine. However, diversification of logistics routes for grain exports through the EU can be an effective way to reduce risks and maintain the competitiveness of Ukrainian producers.

This strategy could provide additional opportunities for grain exports, including access to new markets and reduced dependence on a single transportation corridor. At the same time, it is necessary to take into account the technical and legal aspects of grain transportation through the EU, such as documentation, certification, and customs procedures. Ukrainian grain producers should consider diversification of logistics export routes as a strategic direction of business development that can maintain their competitiveness in difficult conditions.

3.2. Restoration and development of transport infrastructure

Since the beginning of the Russian Federation's war against Ukraine, significant amounts of transportation infrastructure have been damaged. Thus, as of early May 2022, 41 railway bridges were destroyed, 21 railway stations ceased to function, more than 23,9 thousand kilometers of roads and more than 304 artificial structures were destroyed. Due to the continuation of hostilities in certain areas of our country, the total final amount of damage is currently impossible to determine [62].

Seaports located in the Black Sea are blocked. The Order of the Ministry of Infrastructure of Ukraine No. 256 «On Closing Seaports» dated April 28, 2022, registered with the Ministry of Justice of Ukraine on April 29, 2022, under No. 470/37806, closed the seaports of Berdiansk, Mariupol, Skadovsk, Kherson from the date the order came into force until the control over the said seaports is regained. Also, 5 seaports of the Autonomous Republic of Crimea have been closed, and the consequences of the occupation are not yet known. On the Danube River, only 3 ports (Reni, Izmail, Ust-Dunaisk) are operating normally [60].

In 2021, the volume of cargo handled amounted to 153,3 million tons, and the volume of cargo traffic forecasted for 2022 was expected to reach 161,2 million tons.

Also, to date, Ukraine's airspace is closed to civil aviation, making it impossible for both Ukrainian and foreign airlines to operate, and leading to the suspension of air navigation services provided by UkSATSE.

In January-April 2022, 65,9 million tons of cargo were transported by rail, which is only 69% of the level of the same period in 2021.

At the same time, since the beginning of martial law, the road and rail infrastructure has performed important functions, such as ensuring the evacuation and relocation of the population, the movement of military equipment and humanitarian supplies, and ensuring the functioning of the country's economy, social sphere, and industries.

At the same time, challenges related to changes in transport and logistics routes and the destruction of transport infrastructure necessitate increasing the capacity of western border crossings and transport infrastructure, including the development of multimodal terminals.

This work should be coordinated with Western partners (Poland, Slovakia, Hungary, Romania, and Moldova) [65].

Currently, Ukrzaliznytsia's railway infrastructure has 13 operating railway border crossings with Western countries, of which 4 are on the TEN-T network, directly connecting to EU countries (3 more connect Ukraine and Moldova).

The actual average daily delivery of export goods is 1904 cars (about 124 thousand tons), or 55,8% of the potential capacity. This includes 314 cars (about 20 thousand tons) of grain cargo, or 43%.

Today, up to 80 thousand people and 20 thousand vehicles cross the state border with the EU countries per day.

The key problem of logistics by rail is the uneven distribution of freight traffic through the western border crossings on the state border of Ukraine (the crossings with Poland are overloaded, while there is almost no traffic at the checkpoints with Hungary).

For road transport, there are currently about 60 checkpoints (except for closed checkpoints with Russia and Belarus), of which 18 are with EU countries (8 with Poland, 5 with Hungary, 3 with Romania, 2 with Slovakia) [66].

The reorientation of cargo flows and the increased load on the western border crossings for automobile traffic led to long waiting times at the state border (up to 3-5 days) due to the discrepancy between the scope of control by the relevant services of Ukraine and those of neighboring countries, insufficient number of scanning customs control systems, etc. One of the main tasks is to ensure unimpeded export (by providing carriers with appropriate permits) and prompt import of humanitarian and defense cargo into the territory of Ukraine.

Key challenges in the sector:

- ensuring prompt response and fulfillment of government orders for the transportation of passengers and cargo;

- establishing clear coordination with friendly countries on the organization of the transportation process and the creation of a network of transport routes;

- forced change in approaches to the formation of transport logistics in connection with the closure of a number of seaports, the destruction of transport infrastructure and, as a result, the breakdown of transport and logistics chains;

- restoring domestic and international access to the transportation services market for passengers and cargo owners in Ukraine;

- eliminating technical and technological gaps in the organization of transportation, including the lack of effective interaction between different modes of transport in multimodal transportation, development of the necessary transport infrastructure and border crossing points (development of transport and logistics terminals, increase in capacity, use of modern technologies for transportation clearance, etc.);

- increased risks for investments due to military operations, lack of own financial resources and the need to attract new sources of funds, and reduced interest of private investors in participating in PPP investment projects in Ukraine due to security and financial risks;

- iInsufficient integration of Ukrainian transport networks into the European Transport Network TEN-T;

- the need to liberalize the pricing system in the construction, current repair and operational maintenance of infrastructure facilities, including public roads;

- simplification of the mechanism for conducting procurement procedures for works and services related to the restoration of destroyed property and infrastructure.

Key opportunities:

- improving the technological capacity of multimodal transportation (including the development of transport and logistics terminals for passenger and freight transportation), ensuring the coordinated functioning of all parts of the supply chain using several modes of transport;

- establishing clear coordination with EU countries on the organization of transportation and development of the TEN-T network;

- improving the efficiency of border crossing points, synchronizing work with the customs and border authorities of EU countries and implementing projects to develop the infrastructure of border crossing points, increase their capacity, switch to paperless technologies, use modern equipment and reduce corruption risks;

- upgrading equipment and rolling stock to ensure efficient interaction between different modes of transport;

- transition to sustainable and smart mobility in line with the European Green Deal;

- attracting private investment, including foreign direct investment in Ukraine's infrastructure facilities by harmonizing sectoral legislation and standards with the EU;

- opportunities to reform and improve the investment climate in the long term by introducing additional incentives, the possibility of using significant resources of donor countries to support Ukraine's development, the possibility of attracting retail (portfolio) investments or donations for the country's recovery;

- implementation of European approaches to pricing, which will simplify the forms of reporting documentation to increase competition in the market of road works

and services, reduce the pressure of regulatory authorities on business, and stimulate innovation.

Key constraints:

- russia's ongoing large-scale military aggression against Ukraine, lack of objective information on the extent of destruction of transport infrastructure;

- lack of a single center at the government level for operational analysis and resolution of transport logistics issues;

- lack of sustainable financing for the restoration/construction/modernization of transport and logistics (multimodal) terminals in accordance with the requirements of radical changes in cargo flows;

- different legal and regulatory framework regulating the transport industry and control procedures at the state border crossing compared to the EU countries;

- technical and technological backwardness of checkpoints at the state border, limited capacity (some of them have reached the limit of their design capacity);

- uncoordinated development of checkpoints on the state border with the EU countries in terms of their construction sites and capacity;

- lack of capacity and standards for creating a list of investment infrastructure projects [74].

CONCLUSIONS

As a result of our research on grain export logistics in Ukraine, we have made the following conclusions:

1. Over the past decade, Ukraine has been a leader in the rankings of the world's major grain producers and exporters (corn, wheat, barley). However, as a result of Russia's full-scale aggression in Ukraine, the agricultural sector of the economy has suffered significant losses and destruction. A number of companies in the areas of hostilities and occupation have shut down, a large number of production facilities have been destroyed or damaged, and access to resources and raw materials and markets has been hampered. Agricultural activities are not possible on a large part of the land; the blocking of seaports has made it impossible to export agricultural products through traditional trade routes; there are problems with food supply in the frontline areas. in 2022, the Russian invasion of our country led to negative consequences and risks for the development of the grain industry. In particular, the sown areas for the upcoming harvest have decreased due to mining, occupation and hostilities in the south and east of the country; prices and, accordingly, the income of grain producers have decreased due to rising fuel costs and disruption of logistics chains; Ukraine's export opportunities have decreased due to Russia's blockade of the Black Sea ports. The situation in our country has a direct impact on the global grain market and may cause famine in many countries in Asia and Africa.

2. Logistics is the science that fills the space between the seller and the consumer, performing the functions of planning, time and resource management, movement, etc. In other words, it facilitates the flow of goods, turning them into sales. Macrologistics and micrologistics are distinguished by the scale of the problems being solved. By the nature of the management areas: external and internal. By functional areas: procurement, production, and sales. By the content of operations: transportation, warehousing, information. By areas of activity: agro-logistics, industrial, customs, construction, etc. At the same time, logistics has four stages or levels of development.

3. Russia's full-scale invasion of Ukraine has already caused and continues to cause enormous damage to the people and infrastructure of Ukraine. Given this, there is an objective need to quickly rebuild the logistics system, form new cargo delivery chains, and change the direction of trade flows due to the blockade of Ukrainian seaports and the partial loss of the railroad network. Logistics chains, international trade, and the purchasing power of Ukrainian consumers are affected not only by victories at the front, but also by currency fluctuations, the adaptability and professional flexibility of logistics professionals, and the resilience of the Ukrainian people to support the international community. The open confrontation with Russia has become a serious challenge for our country, requiring overall consolidation and optimization of all social processes in general and reformatting of logistics in particular.

4. In times of war, logistics activities are important both at the state and business levels. Despite changes and challenges, logistics always works and never stops. Today, logistics is a key factor in ensuring the competitiveness of companies. Thanks to the latest logistics methods, innovative software, and the use of modern equipment, companies are able to respond quickly to changes.

On the one hand, you can be sure that logistics will not stop, as its functioning is ensured by highly qualified specialists. On the other hand, the industry is affected by a number of objective factors that cannot be accurately predicted.

Thanks to the latest logistics methods, innovative software and the use of modern equipment, companies have been able to respond quickly to market changes and ensure efficient operations under martial law.

The war has clearly highlighted the shortcomings of the current situation. First and foremost, it is the storage of large volumes of cargo only in certain regions of the country and the use of routes through dangerous areas and near strategic facilities. Logistics has become more integrated, as this approach proved to be the only way to survive the crisis. Reorganizing storage systems, anticipating risks, and developing new routes will be the starting point for the post-war logistics recovery.

5. The development and stabilization of the grain market in Ukraine should be addressed by joint efforts of the international community and include the following measures - State support for grain producers: providing free assistance and preferential loans to rebuild grain storage facilities, purchase seeds and fuel and lubricants; - Buying grain at economically reasonable prices. Implementation of measures not only for grain production but also for grain processing, thereby providing the population with jobs and additional revenues to the country's budget. In addition, it will be possible to move from being a raw material exporter to an exporter of finished products. Production of grain types that are efficient and environmentally friendly will reduce the burden on soils and increase the use of biological plants for the needs of grain producers and the population. Mine clearance of the territory of Ukraine as soon as possible to allow for a safe start of the spring sowing campaign.

6. The future of Ukraine's agricultural exports will largely depend on the cessation of hostilities and the unblocking of ports in Ukraine. At the same time, it is important to resolve the problems associated with domestic rail transportation to maintain the competitiveness of Ukrainian producers. Potential solutions that could be implemented by the Government include - complete revision of the tariff setting system for transportation services (equalization of coefficients for tariffs of different classes); - reduction of the cost of using grain carriers, which can be achieved by (1) introducing a price ceiling at auctions, (2) introducing restrictions on participation in auctions for certain market players engaged in speculation (in particular, through the introduction of a fixed electronic bid), (3) reducing starting rates for the use of grain carriers; - improvement of the transportation planning system of Ukrzaliznytsia, including the restoration of the practice of conducting - The option of subsidizing Ukrainian agricultural producers when exporting their products should not be ruled out (it can be organized as a reimbursement of part of the logistics costs both within Ukraine and in the EU).

7. The results of the study suggest that from the point of view of systematizing the set of existing definitions of the concept of "agri-food chain", it can be presented

as an integrated approach to creating added value based on the realization of the economic interests of each participant.

The transformation processes caused by the military actions in Ukraine have led to a complication of the relationships between the participants and the emergence of new links in agri-food chains at both the local and global levels.

It is established that the most influential factor in the formation and functioning of agri-food chains in Ukraine is the logistics crisis, the solution of which determines the choice of strategy for the further development of agricultural enterprises. The economic relations between the actors of the agri-food system of Ukraine in the context of full-scale military operations require further research and systematization, and the research results will serve as a basis for the development of sustainable business models for the post-war period.

8. The Great War dealt a significant blow to Ukraine's economy. By the third month of the full-scale invasion alone, total losses had reached $100 billion, which is equal to 50% of the total GDP in 2021. A good solution for the country's recovery will be the integration of the Ukrainian economy into the EU economic system. Various European logistics and infrastructure projects can help with this. For example, the inclusion of Ukrainian logistics routes (road, rail, air, and water) in European logistics networks under the TEN-T program (in July 2022, the European Commission included Ukrainian logistics routes in the project's indicative maps), the reconstruction of existing and opening of new checkpoints on the borders with European countries, the transition of the railway to the European gauge standard, etc. While the hostilities are ongoing, Ukraine and the EU countries are negotiating the liberalization of freight transit from Ukraine to Europe, the creation of "Solidarity Roads" for grain exports and imports of necessary goods, support for Ukrainian exports of goods by European ports, etc. A promising area for further research is to study the impact of the war on geopolitical processes that create new formats of cooperation, such as "friendshoring" - cooperation with countries that share the norms and values of the modern global economy. This will make it possible to resume work in the logistics sector at lightning speed after the cessation of hostilities. However, it is necessary to keep in mind not

only the need to optimize logistics, but also the risk of corruption. Therefore, it is necessary to combine the advantages of concentrated state power, take into account the initiative of the public, the feedback mechanism and the choice of the best way of organization. Post-war reconstruction in Ukraine is an opportunity to reconsider the transport and spatial aspects of planning that are future-proof and better meet the needs of people.

9. The main strategic directions for the restoration and development of transport infrastructure in Ukraine in the post-war period include: increasing the technological capacity of multimodal transportation (including the development of transport and logistics terminals for passenger and freight transportation), ensuring the coordinated functioning of all parts of the supply chain using several modes of transport; establishing clear coordination with the EU countries on the organization of transportation and development of the TEN-T network; increasing the efficiency of border crossing points, synchronizing work with the customs and border authorities of the EU countries and implementing projects to develop the infrastructure of border crossing points, increasing their capacity, switching to paperless technologies, using modern equipment and reducing corruption risks; updating equipment and rolling stock to ensure effective interaction of different modes of transport; transition to sustainable and smart mobility in accordance with the European Green Deal; attracting private investment, including foreign direct investment in Ukraine's infrastructure facilities by harmonizing sectoral legislation and standards with the EU; opportunities for reforming and improving the investment climate in the long term by introducing additional incentives, the possibility of using significant resources of donor countries to support Ukraine's development, the possibility of attracting retail (portfolio) investments or donations for the country's recovery; Implementation of European approaches to pricing, which will simplify the forms of reporting documentation to increase competition in the road works and services market, reduce the pressure of regulatory authorities on business, and stimulate innovation.

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