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Trends of the Development of the Meat Processing Industry of Ukraine and Practical Approaches to the Optimization the Recipe of Sausage Products

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► **Abstract.** Today, Ukraine is forced to perform a complex geopolitical task in order to guarantee not only military, but also food security. Therefore, the issue of increasing the efficiency of the meat processing industry, as one of the components of this task, is significant and relevant. The purpose of the article is to substantiate the economic aspects of increasing the efficiency of the functioning of meat processing enterprises of Ukraine as a result of improving the recipe of sausage products in order to reduce their cost price. The research was conducted using general scientific methods and techniques: logical and qualitative analysis and synthesis, monographic method, system-structural analysis method, cause-and-effect analysis method, experimental method, economic-statistical method, calculation-constructive method and method of logical generalization. The results of the research in the form of practical recommendations for reducing the cost of sausage products as a result of changing the cost norms and improving the product formulation can increase the economic efficiency of meat production. In order to reduce the cost of meat products, the recipe of products has been changed due to the rejection of expensive ingredients. The scientific novelty of the research results lies in the development of practical approaches to the study and analysis of dynamic processes in the meat processing industry based on the policy of stimulating demand for competitive products both in the Ukrainian and foreign markets. The article highlights the problems of the current state of the meat industry in Ukraine, the prerequisites and the main causes of this situation. The article deepens practical approaches to improving the recipe of sausage products, evaluates their updated recipe in order to reduce the cost of production and increase its efficiency, which lays the foundation for future research for other types of products

► **Keywords:** production, consumption, quality, cost price, efficiency, level of profitability

► Introduction

Today, Ukraine is going through a very difficult period. The protracted events in the East and Russia's military invasion, the uncertainty of the future, and the sharp and dynamic devaluation of the UAH could not but affect the meat processing industry. Among the main problems, there are constant decline in the purchasing power of meat products, disruptions in the supply of quality raw materials and its rise in price. The enterprises of the branch buy the majority of raw materials abroad. As a result of the devaluation of the UAH, its price is rising, which has led to higher prices for meat processing products. Declining incomes and purchasing power had a negative impact on sales [1].

The meat industry provides the population with meat, semi-finished products, and finished products. In terms of the cost of production, this

industry ranks first in the food industry. In large cities, there are meat-processing plants, which comprehensively process livestock products. However, it is necessary to locate such enterprises closer to the areas of developed livestock to reduce the cost of transportation. The promotion of Western companies and increased competition on the Ukrainian market, as well as the movement towards the creation of a common economic and informational environment, require a quick response of Ukrainian enterprises to market changes. Moreover, competitive are those companies that are flexible and dynamically developing, apply innovations to reduce costs and increase business efficiency. It should be noted that currently meat-processing enterprises operate in conditions of shortage of raw meat, its high cost and inability to choose the quality [2]. This

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situation is exacerbated by hostilities, which lead to the death of animals, destruction of enterprises and disruption of logistics chains.

The deepening of various economic transformations in Ukraine is carried out against the background of complex and dynamic changes in the external environment and is accompanied by unpredictable risks and uncertainty of production processes in almost all sub-sectors. This leads to the need to learn to carry out economic activities in unstable conditions. An important role in solving the problems of food security, saturating the market with high-quality and highly nutritious meat products and satisfying the needs of the population, and the maximum use of all production capacities of meat processing enterprises is played by the intensity of the development of the livestock industry [3].

The inhibition of agrarian reform did not develop interaction and mutual support of commodity producers, intermediaries, processing enterprises and product consumers, which led to a decline in the meat processing industry. Current issues and strategic goals today are ensuring resource security with food products by increasing production by food enterprises, stable supply of products, in particular meat, in various market conditions, availability of quality food products for all segments of the population, regardless of income. The current consumption of meat products by the population is at a rather low level, in addition, its taste qualities deteriorate and its value as a food product decreases [4]. The low capacity of the domestic meat market does not contribute to the improvement of the quality of products of meat processing enterprises, their effective production activity.

Given the above, measures to increase the efficiency of the functioning of enterprises of the meat product sub-complex are specifically important. Cattle breeding, pig breeding and poultry farming play an important role in solving the problems of increasing the production of meat and meat products. The issue of matching supply and demand on this market, as well as establishing parity relations between agricultural and processing enterprises, also needs to be resolved.

The need and urgency of comprehensive research into the meat product sub-complex of Ukraine is indicated by the instability of the economic and social situation and development, adequate state support for animal husbandry, weak export potential and slow modernization of the livestock industry [5].

The market of meat and meat products occupies an important place in the socio-economic development of Ukraine, being at the same time one of the factors of efficiency of the meat sector. The meat industry is the basis of the national economy, which provides food production, which is an important condition for the development of society. Its main strategic objectives are to increase the efficiency of meat processing enterprises and to support intensive development in order to improve product quality, better meet the needs of industry in raw materials and consumers in food.

However, to this day, the issues of creating appropriate conditions for the sale of meat and meat products that would meet the needs and interests of sellers and buyers in this market remain unresolved.

A significant scientific work dedicated to the study of aspects of the functioning and development of the meat sub-complex as a system of economic relations, the purpose of which is to provide the population with meat and meat products, was made by I. Svytnous [6], V. Mesel-Veselyak [7], M. Heigermoser and T. Glaubien [8], M. Ibatulin [9] etc.

However, a number of important problems in the formation of stable and efficient development of the meat processing industry have not yet been properly resolved. Further research is needed on the development of an effective market mechanism for economic relations between raw meat producers and processors. Therefore, the solution of the above issues may require a comprehensive approach aimed at improving the economic efficiency of meat production.

The purpose of the article is the analysis of the current state of the enterprises of the meat product sub-complex, research and justification of the economic aspects of increasing the efficiency of the functioning of the enterprises of the meat processing industry of Ukraine due to the improvement of the recipe of sausage products caused by the addition of non-traditional raw materials in order to reduce their cost price.

► Materials and Methods

The theoretical and methodological basis of the conducted research is the dialectical method of cognition, a systematic and comprehensive approach to the study of Ukrainian and foreign scientific provisions on the basic principles of analysis and factors influencing the efficiency of the processing enterprises of Ukraine by improving the recipe of sausages to reduce their cost. To achieve this goal, the following methods were used: monographic method – to study and systematize Ukrainian and foreign scientific achievements and practical experience in determining aspects of the functioning and development of the meat industry of Ukraine; method of system-structural analysis – for the analysis of the current state of operations of enterprises in the meat processing industry; method of cause-and-effect analysis – when identifying problems in the activities of enterprises of the meat product sub-complex and the meat industry; economic and statistical method – to study and generalize trends and patterns of dynamics of enterprise efficiency, calculation and design method – to calculate the main financial and economic results, the method of logical generalization – to form conclusions and proposals.

Analytical materials of the article were based on relevant official statistics.

Experimental studies were conducted in research laboratories Department of Meat, Fish and Seafood Technology of National University of Life and Environmental Sciences of Ukraine, Institute of Food Resources of NAAS of Ukraine, and Palladin Institute

Biochemistry of the National Academy of Sciences of Ukraine.

During the experimental studies, the methods of determining the organoleptic, functional-technological, physical and chemical and microbiological parameters of the control and experimental samples were used in order to improve the quality and safety of the finished product. The research was conducted according to regulatory standards. Preparation of samples for organoleptic, physical and chemical, functional-technological and microbiological indicators was carried out in accordance with DSTU 31499-2012 [10], and sampling – in accordance with DSTU 26671-85 [11].

The result of the research was the development and improvement of the recipe of cooked sausages with the addition of non-traditional raw materials and replacement with cheaper ones, the calculation of economic efficiency and price competitiveness of products.

► Results and Discussion

Currently, especially in the conditions of martial law, one of the main reasons for the decrease in the efficiency of meat processing enterprises is the breakdown of economic ties between agricultural and processing enterprises. This led to a reduction in the production of meat products. In order to resolve the current situation, it would be necessary to improve the agro-industrial integration of agro-enterprises with processing.

The food industry is acutely aware of the problem of creating a sustainable competitive advantage, as the reduction in production; livestock and productivity significantly affect the efficiency of the meat complex. Despite the fact that Ukraine has all the necessary conditions for the development of processing, the dynamics of livestock and meat production have a negative trend (Fig. 1, Table 1).

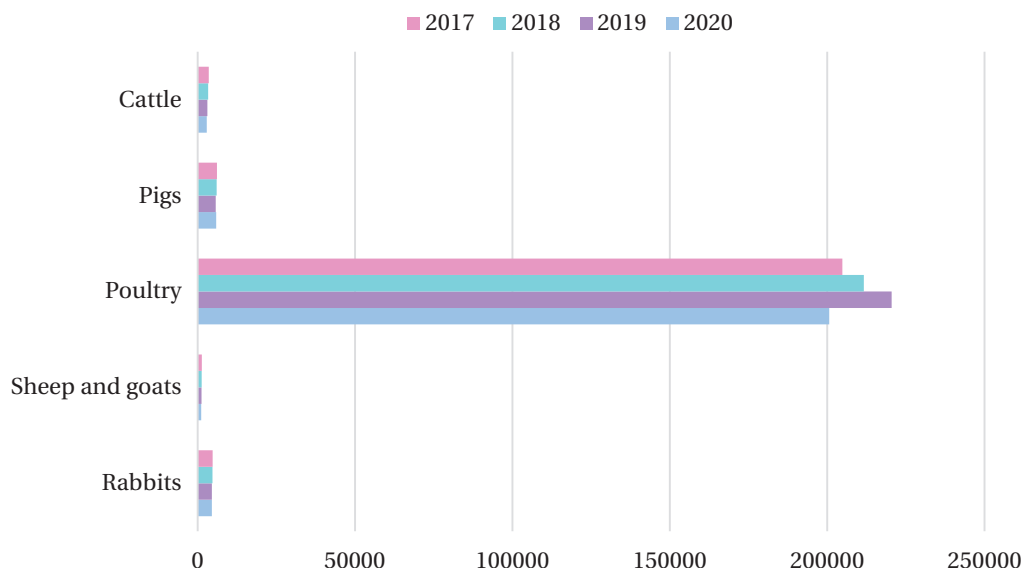


Figure 1. Livestock in 2017-2020, thousand heads

Source: State Statistics Service of Ukraine; Authors' depiction

The analysis of the dynamics of the animal population shows an annual decrease for all animal species for the period from 2017 to 2020. This situation is caused by economic and social factors. In particular, the reduction in livestock happened because of unprofitable production activities, lower sales prices, and long periods of rearing of individual animals (for example, cattle).

The products of meat processing enterprises occupy a significant place in the human diet; therefore, this branch is among the main ones in the Ukrainian food industry. Its development depends on the demand and supply of the population of Ukraine with food products made of meat. Paying attention to the current variability of the economy and crisis phenomena directly in the meat industry, it is necessary to analyze the market of meat and meat products and consider the main factors affecting the economic efficiency of meat processing enterprises.

Due to such factors, enterprises can more effectively adapt to various changes and prevent bankruptcy. Exiting the market of every meat processing enterprise or simply reducing production threatens the food security of not only Ukraine, but other countries, because today the domestic production of beef and chicken has a strong export orientation. Accordingly, in order to prevent a food crisis, it is necessary to study the activities of enterprises in the market of meat and meat products as producers of one of the most important food products [12].

Balanced nutrition is characterized by the volume of consumption of livestock products, which is the main source of protein and meets the needs of the human body by 60% [13]. The recommended rational amount of meat consumption per person per year is 80 kg, and the minimum is 45 kg [14; 15]. According to statistics, the volume of meat production in recent years is shown in Table 1.

Table 1. Meat production in Ukraine for 2017-2020

	2017	2018	2019	2020	2020 in % to 2017
Meat in slaughter weight, thousand tons	2318,2	2354,9	2492,4	2477,5	106.9
including per 1 person, kg	54.6	55.7	59.3	59.3	108.6
Beef and veal, thousand tons	363.5	358.9	369.5	345.4	95.0
consumption per capita, kg	8.6	8.5	8.8	8.3	97.0
Pork, thousand tons	735.9	702.6	708.3	697.2	95.0
consumption per capita, kg	17.3	16.6	16.9	16.7	97.0
Poultry meat, thousand tons	1184,7	1258,9	1381,4	1404,7	119.0
consumption per capita, kg	27.9	29.8	32.9	33.6	121.0
Other meat, thousand tons	34.1	34.5	33.2	30.2	89.0
consumption per capita, kg	0.81	0.82	0.79	0.73	91.0

Source: State Statistics Service of Ukraine; authors' calculations

In recent years, the production of all types of meat has declined, except for poultry. The growth of 19% is mainly due to the production of chicken, which provides a quick profit due to the fairly fast production cycle. That is why investors prefer to invest in this industry of poultry. Another key raw material for the meat processing industry is pork, the volume of which has the smallest reductions – by 5%. It is a more traditional food product in the diet of Ukrainians and also has a fairly short production cycle. All this makes it an investment-attractive industry as well.

Recently, the total consumption of meat in Ukraine per capita has slightly increased (by 8.6%), mainly due to poultry meat, as the volume of all other species is declining. However, this indicator, although higher than the minimum need, is insufficient in relation to the recommended norm [15].

One of the biggest problems is the inability to provide enterprises with domestic raw materials, which are reimbursed by imported products of poor quality. Currently, farms have a fairly low level of load due to lack of raw materials and insufficient demand for finished products due to reduced purchasing power of consumers [15]. There is a clear link between affluence and meat consumption. In addition, a negative contribution was made by the increase in the prices of materials, which led to an increase in the cost of finished products. All these factors together have a negative impact on the financial results of most farms [16]. Unfortunately, now there is a situation of decreasing profitability and increasing the number of unprofitable enterprises. However, despite the fact that costs are rising and the overall deficit in market demand is declining, prices are becoming higher.

The level of development of the meat processing industry of the food industry characterizes the degree of food security of Ukraine and affects the health and efficiency of the population [4]. In addition, it can be considered as a basis for strengthening the position of our country in foreign markets.

As mentioned above, the supply of raw materials to enterprises is an acute problem for the meat

processing industry of Ukraine. Although the use of imported products helps keeping the price down and significantly expands the range, the state policy in the field of agriculture is aimed at protecting the domestic market from negligent competition and creating conditions for the development of the livestock industry.

Unfortunately, today the state of the livestock industry is not able to fully meet all the needs of processors. All categories of farms have outdated material and technical base, low degree of concentration and specialization of production, reduction of livestock, etc.

This state of the meat processing industry requires significant innovations and mutually beneficial ties. To improve the efficiency of this industry, first of all, it is necessary to improve the raw material base, expand sales channels, and modernize the technological base, etc.

The intensification of innovation processes is a very important factor in economic development and should affect the manufacturing sector. For most domestic enterprises, the processes of improving financial and economic performance are closely linked with the introduction of new technologies and improved technological processes that would reduce the cost of production. But it should not just be a quality product, but one that is needed by consumers and meets their needs [17].

The trend of healthy eating in recent years has become very popular. Regardless of age and income level, customers want to see organic and healthy products on the shelves to improve and maintain their health. Today, this question is relevant not only for the consumer but also for the manufacturer, how to make the product better by reducing its cost. In the meat processing industry, new types of products with improved recipes are constantly introduced to meet the ever-growing needs of consumers.

The innovative policy of enterprises is aimed at the development, creation and introduction into the production process of sausage products of various types, using new and improved technologies.

Sausages are cooked meat sausages. The shape of the sausage resembles the miniature shape of a cooked sausage. A promising direction is to improve the technology of cooked sausages, because due to the excellent taste, ease of preparation and the ability to combine with any side dish, these products are in great demand in the domestic product market. One way to solve this problem is to improve cooked sausage with the addition of non-traditional raw materials [18].

At the meat processing plant, improvement the recipe of boiled sausage with delicate red caviar and nori seaweed, adding spelled flour and mushrooms as substitutes is suggested. Rejecting red caviar, sugar and nori seaweed, this implementation will allow increasing the content of micro- and macro-elements and dietary fiber in the "Zhyvlnaya sausage" and make its production cheaper.

Scientifically substantiated and experimentally confirmed expediency of using high-quality substitutes of a small percentage of meat raw materials in the recipe of combined cooked sausage products. It is established that raw materials, such as spelled flour, red caviar, mushrooms, have a high content of protein, vitamins, micro- and macronutrients, which will improve the nutritional and energy value of this product [19]. With the right ratio of this input raw material improves organoleptic characteristics, physic-chemical and functional-technological. Therefore, the proposed product can be considered high quality and safe.

Important for economic efficiency is the cost of production, which directly affects the level of

profitability of the enterprise. In addition, the cost is part of the cost of production and is the basis of pricing. The calculation of changes in current costs is carried out in accordance with the "Standard instructions for planning, accounting and calculation of the unit cost of production at the enterprises of the industry of all forms of industry".

The analysis of the cost of the offered recipes of production at comparison of control samples with use of a compounding of the enterprise and experimental in which raw materials are partially replaced or norms of its expenses change, is carried out on the basis of the data given below.

As a result of laboratory studies, it was found that in general the change in the formulation did not significantly affect the production process, having changed the colour of the minced meat from pale yellow to pale grey. The taste of mushrooms is not expressed. There is a slight fresh smell of salt; no other foreign odours are detected.

At the same time, the change in the recipe of sausages had a positive effect on the cost of raw materials, which was reduced by almost three times (by 15,378.49 UAH). This was mostly due to the rejection of expensive ingredients such as caviar and nori. Sugar, sodium nitrite and water were also removed from the recipe. Instead, spelled flour and champignon mushrooms were added to compensate for the missing caviar. However, this replacement forced an increase in the concentration of chicken fillet and sunflower oil by 7% each.

Table 2. Production costs of 100 kg "Zhyvlnaya sausage" under the article "Raw materials and basic materials"

Expense items	Price, UAH/kg	Control		Experiment	
		Norm, kg	Expenses, UAH	Norm, kg	Expenses, UAH
Chicken fillet	94	48.3	4540,2	51.92	4880,48
Sunflower oil	57.6	28.0	1612,8	30.10	1733,76
Red caviar	2700	6.5	17550	–	–
Cow's milk powder	108	5.0	540	3.0	324
Spelled hydrated	65	–	–	10.0	650
Champignon mushrooms	38	–	–	2.6	98.8
Water/ice	6	9,545	57.27	–	–
Sodium nitrite	45	0.005	0.23	–	–
Sea salt	17	1.8	30.6	2.0	34
Sugar	30	0.2	6	–	–
Nutmeg extract	2122,08	0.1	212.21	0.1167	247.65
Pepper extract	450	0.1	45	0.1167	52.52
Allspice extract	318	0.1	31.8	0.1167	37.11
Nori	1210	0.35	423.5	–	–
Total	x	100	23436,81	100	8058,32

Source: authors' calculations

Thus, changing the recipe does not impair the quality and does not affect the volume of production. The colour of the minced meat changed only slightly, from pale yellow to pale grey, and a slight porosity appeared. Foreign odours and taste are absent. The cost of raw materials has almost tripled.

The technological process for the manufacture of both samples is the same, so the calculation of the following cost items is presented for all at once.

In the following Table 3, the calculation of auxiliary materials for the production of 100 kg of product.

Table 3. Costs of auxiliary materials for the production of 100 kg of products

Cost item	Price, UAH/unit	Norm	Expenses, UAH
Shell is artificial, m	12	200	2400
Boxes are standard (60x40x20), pcs	90	6	540
Label, pcs	0.5	334	167
Vacuum packaging, pcs	0,9	334	300.6
Total	x	x	3407,6

Source: authors' calculations

Thus, given the fact that the volume of each type of sausage is the same, respectively, the cost of materials will be the same as well. Namely, for packing, an artificial shell for each sausage separately (200 m per 100 kg), a vacuum package with a label

(334 pieces) and boxes measuring 60 x 40 x 20 cm (6 pieces) are needed. In general, material costs per 100 kg of products amount to 3,407.6 UAH.

Table 4 shows the calculation of energy costs similar to the material.

Table 4. Calculation of the cost of energy costs for the production of 100 kg of product

Cost item	Price, UAH/unit	Norm	Expenses, UAH
Water, m ³	23.6	1.6	37.76
Pair, MJ	36	0.5	18
Cold, J.	4.32	43,6	188.35
Gas, m ³	6.95	1.7	11.82
Electricity, kW	1,68	14.9	25.03
Total	x	x	280.96

Source: authors' calculations

Thus, according to the calculations, the total energy costs for the production of 100 kg of products amounted to 280.96 UAH.

Using the previous data, it is possible to analyze the full production cost of 100 kg of products, which is shown in Table 5.

Table 5. Production costs and cost structure of 100 kg of products, UAH

Cost item	Control	Experiment
Raw	23436,81	8058,32
Materials	3407,6	3407,6
Fuel and energy	280,96	280,96
Salary	34,26	34,26
Deductions for social events	7,54	7,54
Total	26967,17	11788,68

Source: authors' calculations

The largest share in the cost structure is occupied by raw materials. Its highest figure – 23,436.81 UAH – belongs to the control sample “Zhyvilnaya sausage”. The lowest cost of raw materials in the prototype of these products comprises 8058.32 UAH. This has been achieved by replacing some ingredients with cheaper ones. All other costs

remain the same, as the technology for the production of each individual sample has not changed.

In general, it should be noted that the reduction of the cost level makes it possible to increase sales profit, which is extremely important for the enterprise. Therefore, it is possible to conclude that the proposed changes in the recipe are cost-effective and

efficient, and do not significantly affect the quality and taste of these products.

Cost reduction occurs as a result of changes in the organization and development of specialization of production; improving the management staff and reducing costs; improving the use of fixed assets and logistics; reduction of transport costs and other related factors that increase the level of organization of production activities.

Provided that the use of fixed assets is improved, the cost level is reduced by increasing the reliability and durability of the equipment; centralization and use of industrial methods of repair, improvement of the system of planned and preventive repairs; maintenance and operation of fixed assets.

The improvement of material and technical supply and use of material resources is reflected in the reduction of raw material costs, the reduction of their cost price due to replacement with cheaper

ingredients, and the reduction of procurement and storage costs. Transportation costs are reduced due to the reduction of expenses for the supply of raw materials and transportation of finished products.

The economic motivation for the production of meat products is to increase profits and increase profitability, which in turn ensures a stable financial condition and functionality of the enterprise. The efficiency of production is formed by the volume of sales, cost and selling price of the improved product, which is a component of profit. The growth of profitable sales directly affects the proportional growth of profits. Obtaining income and profit is possible by minimizing labour costs and funds in the production of a unit of goods and is determined by the ratio of results to the costs of production means and live labour. An important factor in the efficiency of the production process is the level of profitability (Table 6).

Table 6. Efficiency of production of "Zhyvilnaya sausage"

Indicator	Control	Experiment
The cost of 100 kg, UAH	26967,17	11788,68
Sales price 100 kg, UAH	56040	56040
Profit per 100 kg, UAH	29072,83	44251,32
Profitability level, %	107.81	375.37

Source: authors' calculations

The calculation of economic efficiency shows that the production of sausages according to the classical and proposed technologies is profitable. The profitability of products is especially positively affected by the change in cost in the prototypes, which allowed increasing profitability by more than 3 times.

An important component of any market relationship is competition, which is an effective way to coordinate the actions of market participants. In general, the term "competition" means the ability to achieve the greatest social and economic benefits. It is a means of productive use of the resource potential of the enterprise for the manufacture and sale of its own products cheaper, better and faster than others.

To determine the competitiveness of the product it is necessary to know the specific needs and requirements of potential consumers; dynamics and size of demand for this product; estimated market price for products; product features of competitors; expected level of competition; payback period.

There are four main levels of competitiveness:

- the first level is those who care only about the manufacture of goods, and do not pay attention to customers;

- the second level – they want the products to fully meet the requirements and standards set by competitors;

- the third level – those who ignore the standards of competitors, while themselves become the founders of the criterion in the industry;

- the fourth level – here success is provided thanks to management, instead of production. Thus,

the company fully becomes the founder of the criteria in the industry.

The most commonly used methods of determining competitiveness are:

- based on the theory of the international division of labour. With their help they form comparative advantages of the company, which would provide lower costs than competitors;

- based on the theory of effective competition, on structural and functional approaches;

- methods based on the dependence of competitiveness on product quality or price. It is implied that the better the quality and the lower the price, the greater its competitiveness;

- methods based on A. Marshall's theory of equilibrium. In this case, the criterion of competitiveness is the availability of means of production that can be used with greater than competitors, productivity;

- the method of integrated assessment, which is based on two indicators: the efficiency of production activities and the degree of satisfaction of customer needs.

Entrepreneurs have the right to determine the prices of their goods, which is what led to price competition. Price has always been and will be one of the main levers of competition in the meat market, which provides suitable conditions for its implementation and helps to control the results of production activities.

The pricing process has several features, namely: exceeding the level of supply over demand; high costs due to imperfections and obsolescence of

technologies; lack of state support and measures to stimulate the population; high cost of production; low consumer incomes and more. Under current market conditions, the price competitiveness of industrial enterprises provides an opportunity to maintain and strengthen its position. However, when reducing prices to expand the market, manufacturers must take into account the following factors:

- the reduction in prices should not be too great, because it can provoke the opposite situation, in which consumers will not buy these products;
- reducing the price level is a temporary advantage,

because such a measure can be copied by others. In this way, they reduce the opportunities to increase sales. This situation most often leads to “price wars”, but they occur when the number of producers of the same product is small;

– in terms of price competitiveness, the winners are those producers whose products have a high level of price competitiveness and in which there is a possibility to reduce their price, while ensuring break-even production.

The following table shows the calculation of the price competitiveness of products.

Table 7. Price competitiveness of certain types of products

Indicator	Control	Experiment
Price 100 kg, UAH	56040	56040
Cost of 100 kg, UAH	26967,17	11788,68
Price competitiveness, %	51.88	78.96

Source: authors' calculations

According to the calculations, the experimental sample of sausages has the highest price competitiveness – 78.96%. This means that it is economically more profitable to sell products according to an updated recipe, which has a lower cost.

In general, the highest level of price competitiveness are those companies that have the opportunity to sell their products at prices that are lower than the minimum prices of competitors, while making a profit. The minimum price is determined by the cost of production of a unit of goods.

If the actual selling price is less than the minimum, the company will suffer a loss, and if bigger, it will make a profit. Thus, the lower the cost of goods, the lower its minimum price, respectively, compared to the minimum price of enterprises in which the cost of production will be higher, and vice versa.

To increase the level of price competitiveness, the company should:

- update the recipe, replacing some ingredients with cheaper ones and thus reduce the cost of production;
- change the manufacturing technology, quality control system, packaging, storage, transportation, etc.;
- change the selling price of goods, as well as prices for maintenance and repair of equipment;
- change the system and the volume of supply and costs;
- change the structure and size of investments in production and sales;
- improve imports.

An indicator of price competitiveness, which forms a competitive property, is the ratio of prices set by the company with market and competitors' prices. For a comprehensive assessment of manufacturing enterprises, there is an indicator that characterizes the share of profits in total sales at a price lower than competitors.

Achieving the maximum volume of sales is possible under the conditions of establishing an

equilibrium price. This process requires taking into account the factors of market demand and the corresponding supply.

In general, the formation of price competitiveness should include the following measures of pricing policy: price forecasting; improvement of production technologies; elaboration of price strategies; cooperation with exporters; market research.

► Conclusions

Thus, the development of multifaceted processes is observed in the domestic meat market. The negative side is a decrease in the level of general production, monopolization of various components of the market structure, accumulation of significant amounts of capital in the sphere of circulation, etc.

As a result of destabilizing economic processes, animal husbandry has become unprofitable or completely unprofitable, unattractive for entrepreneurs and producers. The development of animal husbandry in Ukraine is hindered by the lack of stability and state support for agricultural producers, unpredictable price policy, undeveloped export potential and, as a result, the absence of sales markets. The existing level of competitiveness of enterprises of the meat sub-complex in the regions of Ukraine is insufficient, and the volume of domestic production of meat and meat products does not fully satisfy the needs of consumers. The organizational structure of the meat industry is formed mainly by small and medium-sized enterprises according to the subject division of the production of finished products, in particular: meat, sausages, canned goods, medicines, technical products, etc.

It was proven that the priority task of meat industry enterprises was the efficiency of their functioning and development processes. It was investigated that specialists of meat processing enterprises were constantly engaged in the search and development of such recipes of cooked sausage products,

when consuming which the deficit of important functional ingredients was somewhat reduced. At the same time, great attention is paid to the combination of components of the classic recipe and biologically active additives of plant origin. Thus, the proposed ways of reducing the price of meat products by changing the recipe of products by abandoning expensive ingredients indicate the possibility of their application at the micro level. The production of these products will allow expanding the domestic assortment of functional products. Such sausage products meet modern requirements for food products and allow us to characterize them as products with fundamentally new functional properties.

Increasing the production of high-quality, ecologically and sanitary-epidemiologically safe food products are the main prospective direction of the development of the meat industry and the appropriate level of competitiveness of meat processing enterprises. Solving these issues is a complex task that requires consistent, clear, purposeful and effective

cooperation of all subsystems of the enterprise. The sources and reserves of achieving high competitiveness are laid in the internal environment of each enterprise in the improvement of production technologies and recipes of combined types of cooked sausages with a high content of minerals, protein and vitamins and the creation of nutritionally balanced products using vegetable and animal raw materials.

The implementation of environmental factors also allows increasing the efficiency of the enterprise and influencing the level of its competitiveness. According to the results obtained, increasing the competitiveness of meat processing enterprises of Ukraine in today's difficult conditions is possible thanks to the search for new resources of irreplaceable food components, the use of non-traditional types of raw materials, the creation of new progressive technologies to increase the nutritional value of the product, which improves organoleptic indicators, increases the shelf life of finished products and reduces its cost.

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Тенденції розвитку м'ясопереробної промисловості України та практичні підходи до оптимізації рецептури ковбасних виробів

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► **Анотація.** Сьогодні Україна виконує складне геополітичне завдання та повинна вистояти, щоб стати гарантом не лише військової, а й продовольчої безпеки. Особливого значення набуває підвищення ефективності функціонування м'ясопродуктового підкомплексу, як однієї зі складових даного завдання. Метою статті є обґрунтування економічних аспектів підвищення ефективності функціонування м'ясопродуктового підкомплексу України внаслідок удосконалення рецептури ковбасних виробів з метою зниження їхньої собівартості. В статті висвітлюються проблеми сучасного стану м'ясної галузі України, передумови та основні причини виникнення даної ситуації. Наведені статистичні дані про тенденції розвитку м'ясної промисловості та доцільність зменшення витрат виробництва внаслідок удосконалення рецептур. Дослідження проводилось на основі використання загальнонаукових методів і прийомів: логічного та якісного аналізу та синтезу, монографічного методу, системно-структурного аналізу, причинно-наслідкового методу, експериментального методу, економіко-статистичного методу, розрахунково-конструктивного методу й методу логічного узагальнення. Результати дослідження в вигляді практичних рекомендацій щодо зниження собівартості ковбасних виробів унаслідок зміни норм витрат і вдосконалення рецептури продукції дозволяють підвищити економічну ефективність виробництва м'ясної продукції. Наукова новизна одержаних результатів полягає в розробленні практичних підходів до вивчення та аналізу динамічних процесів у м'ясопродуктовому підкомплексі на основі політики стимулювання попиту на конкурентоспроможну продукцію як на внутрішньому, так і на зовнішньому ринках. З метою здешевлення м'ясних виробів рецептура продукції була змінена за рахунок відмови від дорогих інгредієнтів. У статті поглиблені практичні підходи щодо вдосконалення рецептури ковбасних виробів, здійснена оцінка оновленої їхньої рецептури задля зменшення собівартості продукції та підвищення її ефективності, що закладає основу для подальших досліджень щодо інших видів продукції

► **Ключові слова:** виробництво, споживання, рецептура, якість, собівартість, ковбасні вироби



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Current State and Prospects of Grain Logistics Development in Ukraine

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► **Abstract.** Considering the lack of elevator capacities and the imbalance in the distribution of commodity flows due to the occupation and blocking of seaports, other modes of transport are currently unable to provide the required volumes of grain for export, and the safety of the harvest is under threat. Therefore, the issue of logistics development in war conditions is urgent, which determines the relevance of the study. The purpose of the study is to analyse the pre-war and current state of the grain logistics system and to identify efficient ways of its development during the war and after its end. The study is based on the following methods: dialectical, historical, monographic, abstract-logical, systematic and classification, analytical forecasting, statistical, economic, economic-mathematical, and graphical. Investigated the length of roads in Ukraine and forecasted the reduction of roads due to military operations. The analysis of export-import logistics was performed, and the advantages of maritime transport were determined, the share of which in exports was 99.5%, and in imports, the majority of transportation was by rail (44.9%). The state of elevator capacities was explored, the lack of which in 2021 amounted to 18.3 million tons (17.4%), the volume of their losses due to hostilities in 2022 was determined – 12.6 million tons (22.2%), the impact of the war on the growth of prices for grain storage services was analysed. A critical analysis of the infrastructure projects of the National Council for the Restoration of Ukraine from the Consequences of the War is performed and identified their disadvantages. The proposed measures to improve logistics will allow for reducing the lack of elevator capacities, increasing grain exports, accelerating the movement of products across the border and reducing logistics costs. The results of the research can be used by public authorities in the establishment of programs for the development of agrarian logistics, business structures – for the development of infrastructure projects and improvement of logistics systems of enterprises, scientists – for further investigation of grain logistics problems and determining the prospects for its development

► **Keywords:** elevator capacities, tariffs, ports, transport, intermodal system

► Introduction

The purpose of modern logistics in agriculture is to improve the development and efficient management of commodity, information, and financial flows in the supply, production, and marketing of agricultural products. The achievement of the purpose is based on the eight components of the "logistics mix of 8 P", which include the requirement to deliver the right product of the right quality in the right quantity to the right consumer in the right place at the right time at the right cost [1].

Grain production is the foundation for the development of leading industries in Ukraine's

economy. Therewith, Ukraine has all the necessary conditions for growing grain crops: a favourable climate, fertile soils, rich water resources, extremely favourable geopolitical location, etc. Thus, "the potential capabilities of the domestic agro-industrial complex for the production of high-quality grain are such optimistic that they allow Ukraine to claim a leading position in the world grain market" [2].

At the current stage of development of the agricultural sector of the economy, considering the impact of the war, the key purpose of the development of agricultural logistics, in particular its grain

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sector, in Ukraine is to ensure the most efficient interaction between public authorities, agricultural traders and agricultural producers.

The grain industry of the country occupies a leading position in ensuring food security. In addition, grain exports are one of the main sources of foreign exchange earnings. Thus, in 2021, 50.8 million tons of grain were exported for the amount of 12.3 billion USD, which amounted to 18% of all export earnings.

Transportation, primary processing (cleaning, drying), storage, and loading of vehicles with grain require extensive transport, storage, and information infrastructure: roads, railways, elevators, port grain terminals, and reliable means of communication and information transfer.

Even before the war, the logistics infrastructure had many deficiencies that hurt the conditions of transportation and storage of grain, the information system did not correspond to modern requirements. The roads did not correspond to international standards, resulting in delays in product delivery, and significant losses during transportation, a high degree of physical and moral deterioration of trucks. Rail transport was characterised by a lack of specific wagons for grain transportation, a high degree of wear and tear, and locomotives, insufficient electrification of the railway, high freight tariffs, and long delays in the development of freight trains, etc. In the country, there was a lack of elevator capacities for storage and primary processing of products, a low level of automation of loading and shipment of grain at existing warehouse complexes, and imperfection of access roads caused long queues of vehicles. Insufficient development of inland water transport did not allow increasing the volume of transportation of agricultural products in a cheaper way. The largest river terminals in terms of transshipment volumes are owned by only two companies – “Nubilon” and “Ukrflot” – more than 75%, although smaller companies have recently invested in the development of river transport.

After the outbreak of the war, the problems of grain logistics intensified primarily due to the blockade of seaports, as sea transport is the most efficient in the transportation of grain for export. The blockade has disrupted logistics chains, significantly increased the load on the least efficient road transport for the transportation of large volumes of grain, and increased the load on rail transport. In general, this did not solve the problem, despite the unblocking of some ports from August 1, 2022. In 2021, out of 50.80 million tons of exported grain, 50.56 million tons, or 99.5% were transported by sea.

To assess the scale of problems in grain logistics during the war and identify ways to solve them, it was necessary to analyse the state of modern logistics systems in Ukraine. The purpose of the study is to develop tasks and identify efficient measures to overcome the crisis that arose in grain logistics as a result of the war based on the analysis, to outline the ways of its development in the post-war period.

The result of the research was scientifically based proposals for improving the functioning of

the grain logistics system during martial law and identifying the main tasks for its development in the postwar period.

► Literature Review

The issues of the development of logistics systems in general and in the agricultural sector, in particular, are covered in the works of many Ukrainian and foreign scientists.

Andréa Leda Ramos de Oliveira, Karina Braga Marsola, Ana Paula Milanez, and Sandra Liegê Renner Faretto [3] noted that “the lack of investment in logistics infrastructure limits the growth of its potential”. They identified rail and water transport as the most efficient for long-distance transportation of agricultural products with low added value. They widely used the concept of “intermodal transport” as a combination of at least two modes of transport, where the longest part of the route runs either by rail or by water.

The research of Natalia Wagner [4] is to develop a system of ranking Polish voivodeships by the level of their material and technical potential. Three arrays of variables were used for this purpose. The calculation is based on three areas of research: transport infrastructure (road and rail transport), warehouse capacities, and activities of companies providing the logistics process. The researcher used one of the methods of numerical systematics proposed by Z. Hellwig. The results of the study allow the authorities to determine the logistics potential of the regions by the sustainable transport development strategy of the country.

Lumír Pečený, Pavol Meško, Rudolf Kampfb, & Jozef Gašparík [5] in their research defined modern logistics as “an interdisciplinary science that improves the quality of business processes and allows companies to respond to market and customer requirements faster”. The study proposes methods for optimising logistics processes for more efficient use of vehicles in combination with modern technologies and human resources.

In their studies, A. Vorona, L. Istomin, S. Kalmykov, & M. Lyashenko [6] determined the place of customs logistics in ensuring the movement of grain crops as a factor in the growth of foreign trade. To ensure a competitive advantage in the world grain market, the study proposes to establish a technological scheme of interaction between entities, in particular, government agencies, exporters and carriers participating in the world grain market.

The research of M. Grazia Speranza [7] is devoted to solving the problems of interaction between the subjects of the logistics system, in particular transport, to improve the quality of decision-making through using Operational Research (operations research – the application of scientific methods and approaches (mathematics) to solve decision-making problems, particularly in business management and public administration). Determination of modern trends and the place of the latest technologies, in particular IT, in the development of logistics, were the subject of the author's research.

J. Mehmman, F. Teuteberg [8] investigated the feasibility and efficiency of involving a third-party logistics service provider in the transportation process, defined the functions of the participating parties and the implementation of a modified transportation planning process.

Research results indicate cost savings of up to 38% and a reduction of environmental pollution when using a third-party carrier as a link in the logistics chain. According to the authors, this approach contributes to achieving the purposes of sustainable development of the transport system.

Kamal Lamsal, Philip C. Jones, & Barrett W. Thomas [9] in their research substantiated the optimal logistics system through the establishment of a model that considers two factors: the presence of a specific number of farms and the lack of premises for storing agricultural products.

The objective of the model is to minimise the amount of road transport required to transport harvested crops from the field to storage facilities or processing plants. It is accomplished by reducing vehicle idle time in traffic jams at the destination by optimising the timing of the start of crop harvesting in individual farms. The researchers propose a two-phase approach that divides the problem, first by determining the start of harvesting on farms, and then determining the number of vehicles required to transport the produce.

Elham Mardaneh, Ryan Loxton, Shiv Meka, & Luke Gamble [10] in their study defined a decision-making system designed to support farmers in choosing different approaches in the process of harvesting grain and its distribution. One such approach may be the decision to store products in their warehouses or use the warehouses of third-party enterprises located at a considerable distance from the grain producer. The system, which is based on the application of a mathematical model and considers several factors, such as the number of crops, grain moisture, possible crop losses, loss of quality due to adverse weather conditions, etc., is the foundation for the construction of an integrated logistics scheme (fourth-party logistic), which considers all external and internal factors to achieve maximum efficiency. The variables used in the mathematical models are the yield of each crop, harvest time, transport, and storage costs. According to the results of the study, the conclusion is substantiated that storage at own storage facilities is more efficient due to the reduction of harvesting time and losses, the overall yield increases, and, thus, the profits of agricultural producers increase.

Theoretical and practical aspects of logistics development in agriculture of Ukraine, in particular, the introduction of effective logistics approaches in production, are devoted to the works of I.G. Smirnov, T.V. Kosareva [11, 12], O.V. Pavlenko, T.V. Volkova [13, 14]. The prospects for the development of foreign logistics in general and in the context of the agreement with the EU were studied by O.P. Velichko, & S.I. Hrytsenko [15, 16].

A significant contribution to the development of grain logistics, which is the subject of this study,

was provided by: V.A. Kolodiichuk [17], who proposed a model for the efficient development of logistics of the grain subcomplex of the agro-industrial complex of Ukraine, considering its integration into the world logistics systems; O.I. Gutorov [18], who substantiated the theoretical and methodological foundations of using vehicles in the logistics of agricultural production, where a significant place is occupied by the transportation of grain; L.M. Volynets [19], which considered the issue of improving the logistics system for grain exports, including an assessment of the economic efficiency of container transportation. The area of research of I.V. Yehorashchenko [20] was the system of logistics in the grain market, which he proposes to improve through the adoption of a national development program based on the experience of developed countries, reforming the legal mechanism of the logistics system of agriculture, development, and implementation of state financing for the development of grain logistics, development of investment attractiveness of logistics infrastructure through the introduction of a system of tax and customs benefits.

The studies in the field of agricultural logistics that were analyzed by the authors are thorough and valuable in scientific terms, but all of them were performed in peacetime and do not reflect the specific features of the functioning of agricultural logistics systems in a country at war. Thus, the subject of this research, designed to analyse and improve the grain logistics system of Ukraine during and after the war, is extremely relevant and timely.

► Materials and Methods

The theoretical and methodological foundation of the research in the study was the dialectical method of scientific cognition, a systematic approach to the study of the economic essence of logistics in general and its features in Ukraine, in particular, structural changes during military operations. Scientific works of domestic and foreign scientists on the development and functioning of logistics infrastructure in general and grain logistics in particular, legislative and regulations of Ukraine have become the theoretical foundation of the research.

To substantiate the theoretical provisions of the study and analysis of the evolution of theoretical approaches to the nature of the concept of logistics and agrarian logistics, in particular, the historical method and the method of theoretical knowledge were applied.

The monographic method was used in the process of processing the literary sources on the defined subject of the research.

Abstract-logical and dialectical methods have become the scientific foundation for the determination of the terminology regarding the definition of the general term "logistics" and the narrow terms "agricultural logistics" and "grain logistics" in the process of studying scientific publications and developing conclusions and proposals.

System and classification methods are used in the research to determine the factors of efficiency

of logistics systems in agriculture, and the development of new approaches to the classification of agricultural logistics entities.

System and classification methods are used in the research to determine the factors of efficiency of logistics systems in agriculture, and the development of new approaches to the classification of agricultural logistics entities. Notably, due to military actions, according to the Law of Ukraine “On the Protection of the Interests of the Subjects of Submission of Reports and Other Documents during the Period of Martial Law or State of War” dated 03/03/2022 No. 2115-IX [21], access to current statistical information for 2022 is limited. Thus, data from Internet sources were widely used for the study.

The economic and mathematical method is used to calculate individual indicators of the functioning of the agrarian logistics system and their forecasting – the volume and proportion of deficit or surplus of grain storage capacities in the regions of Ukraine. The calculation was based on the available capacity for grain storage and gross harvest by region.

The visual representation of individual dynamic series is performed using a graphical method, for example, the dynamics of volumes and changes in the structure of export-import of agricultural products by different modes of transport and the operational length of the routes of Ukraine and the dynamics of grain transportation by mode of transport.

The main stages of the research were:

- a) analysis of theoretical studies of Ukrainian and foreign scientists on the development and functioning of logistics systems, in particular in the agricultural sector of the economy;
- b) analysis of the state of logistics in Ukraine in general and the grain sector in particular before the war, for example, the length of transport routes and volumes of domestic grain transportation and export-import operations by type of transport;
- c) determination of the volume of losses of logistics infrastructure during military operations, in particular losses of elevator capacities and transport;
- d) investigation and systematisation of the national policy areas for improvement of grain logistics considering the losses caused by the war and their critical analysis;
- e) defining the main tasks and identifying their recommendations for improving the development of grain logistics during the war and after its end.

The initial sources of information used in the research process were: the regulatory framework of the state economic regulation of logistics systems of Ukraine, statistical and analytical data of the Ministry of Agrarian Policy and Food of Ukraine, State Statistics Service of Ukraine, State Customs Service of Ukraine, publications of domestic and foreign scientists and practitioners, operational and annual reports of international organisations, the results of the author's observations on the functioning of logistics systems in the leading countries of the world, and scientific electronic sources of information on the Internet, personal observations and research.

► Results and Discussion

The term “logistics” appeared in the ancient world and meant “the art of reasoning”. Opinions on the essence of logistics have been transformed over the centuries: from the ancient world to the beginning of the Middle Ages, a “philosophical” essence was developed, which consisted in formalising the implementation of calculations and distribution of products. From the Middle Ages to the 60s of the 20th century, the essence of logistics was developed under the influence of numerous wars and consisted of the spatial and temporal movement of troops and military cargo. From the 60s to the present day – the “civilian period”, during which logistics competencies have been transformed from the physical movement of goods and phase and functional logistics to enterprise logistics and logistics systems, and finally – supply chain logistics [22]. During this period, “logistics” began to develop as a science. In Ukraine, this science began to develop in 1991 after gaining independence.

The development of logistics and the definition of the term “logistics” have been contributed by several Ukrainian scientists. Thus, in the author's opinion, a rather extensive, comprehensive concept of “logistics” was given by V.A. Kolodiichuk: “Logistics is a scientific and practical field of relations between market elements, which involves a functional study of material and related information, financial and service flows on the way from the primary source of raw materials to consumers of final products to optimise the properties of a particular system and implement its target function in obtaining a synergistic effect” [23]. Using the integration approach, N.M. Tyurina, I.V. Goy, I.V. Babii interpret logistics as “the science of integrated management of material and related flows in various (including economic) systems” [24]. Consider that this definition is too general, and one-sided and does not explain the essence of the term, the place of its elements in the process of establishing a logistics chain. I.O. Zharska concisely and informatively defined that “logistics is to ensure maximum consistency of all operations related to the movement of resources between different links of the supply chain [25]”. The most precise definition of logistics, in the author's opinion, was given by E.V. Krykavskyi: “Logistics is the process of planning, controlling and managing the development of material flow, its warehousing, and integrated information from the place of production to the place of consumption to adapt to the consumer's demands” [22]. Admittedly, all these definitions fully correspond to the essence of the concept of “grain logistics”. But grain logistics, in particular, and logistics in agriculture, in general, have their characteristics, two of them, the author notes. First of all, contrary to, for example, industrial logistics, the beginning of the development of logistics chains is connected with the place of production, and with clear time limits, which are determined by the harvest period. Secondly, the conditions of grain storage are specific, namely: temperature and humidity conditions, the necessity of aeration during long-term storage,

ensuring the absence of pests, rodents, and diseases using chemical protection, a high level of mechanisation, special training of workers servicing the process of storage of products. Thus, the definition of grain logistics developed by the author is the process of planning, development, control, and management of grain logistics chains to achieve the maximum economic effect by all entities at all stages of transportation, storage and delivery of products to the consumer, considering the narrow time frame of the process start and specific storage conditions.

The main purpose of the development of modern logistics in the agrarian sector of the Ukrainian economy is to establish the most efficient interaction between public authorities, business organisations (traders), and agricultural enterprises.

The world economy is developing rapidly, currently, economic relations between the subjects of the world market are globalised and establish conditions for the comprehensive integration of

economic sectors. Transport occupies a leading place in the process of sustainable economic development. Transport logistics has a complex multilevel structure, and the established logistics chains are diverse and multifunctional, they involve different types of transport in the process of cargo delivery from the manufacturer to the end consumer. The development of logistics transport systems occurs in a competitive environment in the markets of domestic and international transportation. For domestic transportation of products, an extensive system of roads in Ukraine is used.

By length, the longest routes are highways, the length of which in 2021 was more than 160 thousand km. The second place in terms of the length of routes is occupied by the railway, the length of which was 19.8 thousand km (excluding the occupied territories, the network of which is not currently in operation), of which more than 47.2% is electrified, and the least developed network of river transport routes – only 2 thousand km (Fig. 1).



Figure 1. Operational length of Ukrainian railways and dynamics of grain transportation by types of transport

Source: Based on the data of the State Statistics Service of Ukraine [26]

According to the volumes of cargo transportation, which are indicated in the same figure, railway transport undoubtedly dominates, the domestic freight turnover of which over the past 5 years ranged from 33.6 to 40.0 million tons of grain, and in the structure of all transportation, its share ranged from 62.3% to 73%. During the same period, from 12.7 to 19.3 million tons of grain were transported by road, or from 25.9% to 35.8% in the structure of domestic grain

transportation. River transport accounts for the smallest volume of traffic – 0.3-0.6 million tons or 0.4-1.1%.

Considering the war with Russia, which resulted in the loss of a significant part of Ukrainian territories, it can be predicted by the end of 2022 a reduction in the length of roads by 40.9 thousand km compared to 2021, a reduction in the length of railways by 4.9 thousand kilometres, the length of river routes will be reduced by 0.2 thousand km.

Compared to last year, the level of operation of alternative modes of transport to sea in grain logistics has increased: rail – from 33.6 million tons (62.3%) in 2021 to 38.8 million tons (60%) in 2022, road – from 19.3 million tons (35.8%) to 22.75 million tons (35%), river – from 0.5 million tons (0.9%) to 3.25 million tons (5%), respectively [26]. Considering the loss and blocking of the Black Sea and Azov ports, it is expected that the volumes of grain transportation by rail, road and river transport will increase.

Railway transport in Ukraine is the leading industry in the road transport complex of the country, which provides almost 82% of freight and 36% of passenger traffic carried out by all modes of transport.

In terms of freight traffic, Ukrainian railways rank fourth on the Eurasian continent, behind only the railways of China, Russia and India.

One of the most significant problems, according to L.M. Volynets, particularly during traffic peaks, is the low capacity of the port railway infrastructure. Currently, the maximum capacity of port railway stations is about 2,100 wagons with grain. As one of the ways to overcome this adverse situation, she suggests “increasing the number of stations that can develop routes” [19]. However, in the author's opinion, being in a deep crisis, Ukrzaliznytsia will not be able to invest significant funds in the development of any number of stations to establish the possibility of developing routes. Otherwise, all costs will be covered by the growth of tariffs, which have already become exorbitant for many companies using railway transport services. Consider it quite appropriate for her proposal to establish conditions for increasing the capacity of railway stations, which requires significantly lower costs and is quite an efficient solution to the problem.

Road transport occupies a leading position in transport logistics. Road transport is one of the main instruments of influence on the economic development of the country – more than 100 thousand road carriers serve about 64 per cent of domestic freight turnover.

In grain logistics, it is an indispensable means of delivering products to farm warehouses or elevators, to railway and port terminals or even straight to the customer both inside and outside the country.

In general, the road transport of Ukraine corresponds to the economy's demands for the transportation of goods, although the structure of the truck fleet is unbalanced, a significant number of vehicles by their technical and economic parameters (ergonomics, body type, environmental friendliness, efficiency, carrying capacity) do not fully comply with modern requirements. The renewal of the fleet is slow, as indicated by about 70% of morally and technically outdated rolling stock.

All over the world, including Ukraine, the demand for inland waterway transportation services

is growing significantly. Considering the deep economic crisis in the country, the constant growth of prices for energy resources, frequent interruptions in the work of road and rail transport due to military operations in the eastern and southern regions of the country, cargo owners, in particular grain traders, are trying to reduce transport costs and optimise logistics flows by transporting products by river transport. Thus, this type of transport is becoming rather relevant in Ukraine. Inland water transport is gradually recovering its lost position and is increasingly competing with other modes of transport.

Based on the data of the Ministry of Infrastructure of Ukraine, it allows increasing the annual volume of cargo transportation up to 45 million tons (including 30 million tons of export products, and 15 million tons of import products). The modernisation of existing gateways may become a condition for such growth. [27].

The maritime transport sector of the logistics system of Ukraine is a universal complex that provides the demands of the Ukrainian economy in the transportation of export products.

The domestic port and transport industry have several advantages, particularly significant for grain logistics:

- 1) adaptability for the transshipment of significant volumes of grain products and oilseeds;
- 2) powerful production base, which allows performing cargo handling;
- 3) the favourable location of ports, which allows efficient servicing of the flow of transit cargo;
- 4) a developed regulation framework that facilitates the attraction of both domestic and foreign investments in the development of ports;
- 5) high human resources potential.

Before the war, the seaport system of Ukraine had 18 ports, 5 of which are located in the temporarily occupied Crimea. The total capacity of ports and terminals located on the continental part was 313.3 million tons. In 2021, more than 50 million tons of grain were transhipped through seaports – 4.1% more than in 2020. The largest volumes of grain processing were performed in the following ports: Chornomorsk – 14.55 million tons (an increase of 9.2 % compared to the previous year), Mykolaiv seaport – 12.9 million tons (a decrease of 2.1 %) and “Pivdennyi” – 9.7 million tons (+7.2 %) [27].

The maritime transport complex is a multifunctional structure that satisfies the national economy's requirements for transport support of export transportation (Fig. 2). By 2022, almost 100% of the export cargo was shipped by sea. The developed infrastructure of ports and port elevators allows the shipping of significant volumes of grain by sea. The share of other modes of transport in grain exports is not significant.

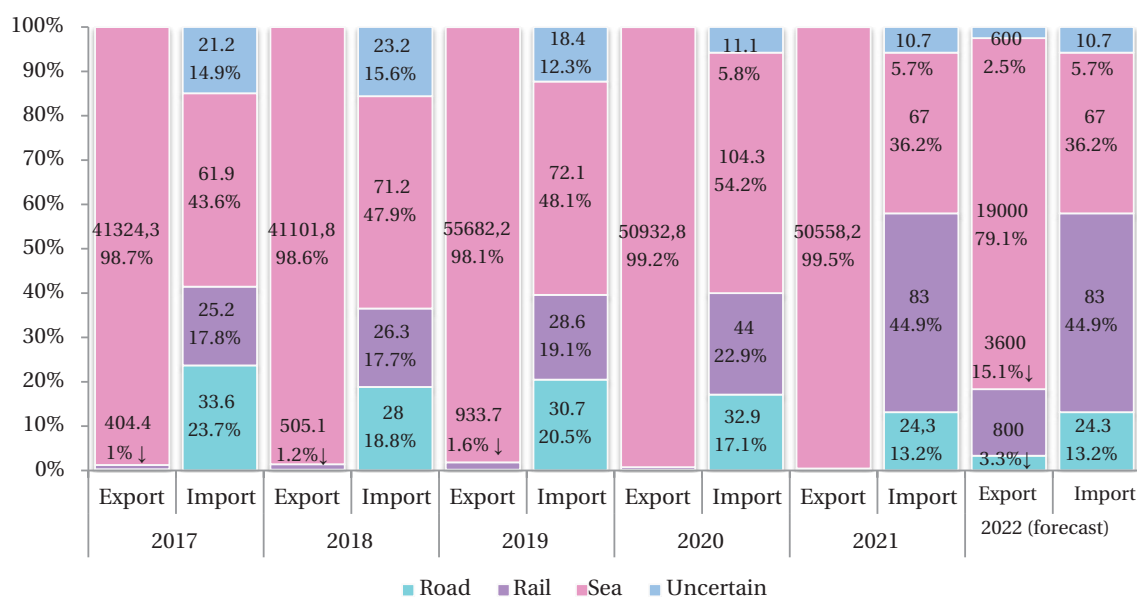


Figure 2. Export-import of grain by different types of transportation

Notes: without air transport and postal transportation due to insignificant volumes

Source: developed by the authors based on the data of the State Customs Service of Ukraine [28]

Considering the imbalance between sea and other modes of transport in the export of grain products until 2022, believe that the logistics system has developed inefficiently and one-sidedly. After all, during the blocking of ports by Russia, the volume of grain exports sharply decreased precisely due to the lack of adaptation of road, rail and river transport to respond quickly to the threats that have arisen and compensate for a load of maritime transport.

According to the forecasts of the Ministry of Agrarian Policy, in 2022, the harvest of grains, legumes, and oilseeds is expected to be about 65 million tons, including about 48 million tons of grains. About 30 million tons are planned to be exported [29]. According to estimates, about 50% (24 million tons) of the new grain harvest will be exported.

In March 2022, 1.16 million tons of grains were exported, which is 3 times less than in March 2021 (3.48 million tons), of which only 370 tons were exported by road, which is 26.6 times less than in March 2021 (9,874 tons), and 1.07 million tons by sea, which is 3.2 times less than in March 2021 (3.46 million tons). Export transportation by rail in March 2022 increased 12.1 times and amounted to 90.9 thousand tons (in March 2021 – only 7.5 thousand tons). In March 2021, only 2 tons of grain were exported by air [28]. The structure of grain exports by modes of transport in March 2022 changed radically compared to the same period of 2021 and became as follows: road transport – 0.03%, rail transport – 7.8%, sea transport – 92.1%. Considering the unblocking of some of the Black Sea ports from August 1, 2022, it allows calculating the approximate volumes and structure of exports and imports by mode of transport. Road transport will account for 3.3% of exports, rail transport – 15.1%, maritime transport will

remain the key for exports, with a share of 79.1%, and the share of uncertain transport will be 2.5% (Fig. 2).

Considering the insignificant volumes of grain imports and the relatively small share of maritime transport in the transportation of imported products, it is believed that the structure of transportation will not undergo significant changes neither will the volumes.

The structural difference between the volumes of imported and exported grain transportation is influenced by the following factors:

1) insignificant volumes of grain imports compared to exports allow more efficient use of land transport (road and rail);

2) the reduction in the volume of grain transportation by road in 2020-2021 is caused by stricter quarantine restrictions for this particular type of transport.

In general, summarising the analysis of export-import operations by modes of transport, it can be concluded that the increase in railway tariffs, fuel, and quarantine restrictions at customs due to the COVID-19 epidemic have restricted the use of land transport, and sea transport is the most efficient in the transportation of large volumes of products.

The crop storage system is one of the most crucial links in logistics. Currently, the largest agro-industrial companies by elevator capacities in 2021 were placed on the Black Sea coast in Odesa, Chornomorsk, Mykolaiv, and other cities.

The State Food Grain Corporation (SFGCU) has one of the largest elevator capacities of 3.5 million tons (Fig. 3). Elevator capacities of over 2 million tons are owned by some of the largest agricultural holdings in Ukraine: Kernel, UkrLandFarming, and Nibulon.

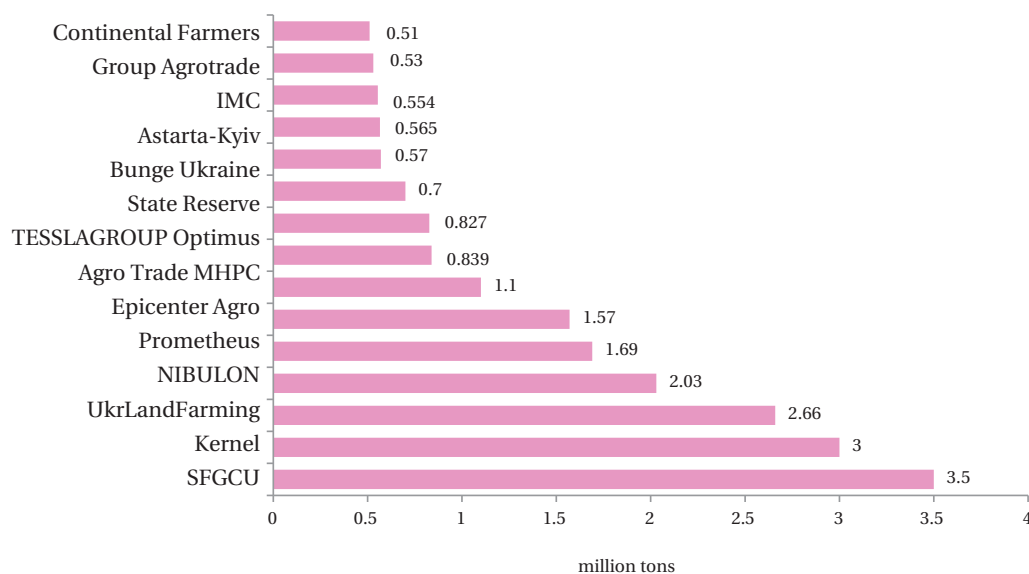


Figure 3. Top 15 companies by elevator capacities in 2021

Source: calculated based on the data of the main elevator site of Ukraine [30]

The smallest elevator capacities from this list are owned by Continental Farmers Group in the Western region of the country.

The cost of grain storage services provided by certified elevators is quite an influential factor in the

development of the cost of this product. The leading operator in the grain storage services market is currently JSC “SFGCU”. The cost of services of JSC “SFGCU” branches for the 2021/2022 marketing year is presented in Table 1.

Table 1. Cost of services of JSC “SFGCU” branches for 2021/2022 MY, UAH (including VAT)

Region	Reception		Drying, UAH/t-%	Purification, UAH/t-%	Storage. UAH/t-day	Shipment	
	Car, UAH/t	Railway, UAH/t				Car, UAH/t	Railway, UAH/t
Grains (wheat, barley, millet, rye, buckwheat, oats, rice, sorghum)							
Northern	18-25	20-25	55-77	18-33	1.7-2.4	110-156	110-156
Southern	15-27	27	57-80	16-28	1.8-2.7	108-176*	130-154*
Eastern	11-20	21-40	60-126	12-23	1.8-2.3	126-170	133-174
Central	10-17	10	60-76	15-24	1.7-2.5	142-168	144-207
Western	17-44	34-60	60-140	18-35	1.8-2.8	75-195	93-202
Grains (corn)							
Northern	18-24	–	85-170	18-33	2-2.3	110-156	110-156
Southern	18-27	–	77-117	18-24	2-2.3	109-160	124-154*
Eastern	15-25	–	75-168	18-25	1.8-2.3	126-166	132-166
Central	10-21	–	75-170	18-25	1.9-2.5	141-175	141-190
Western	19-43	–	80-165	18-34	1.8-2.8	75-150	93-157
Oilseeds (sunflower)							
Northern	19-27	–	95-127	21-40	2.1-2.7	132-150	132-155
Southern	18-30	–	77-139	24-33	2-2.7	130-182*	135-182*
Eastern	25-42	–	84-150	17-30	1.8-2.5	125-170	133-174
Central	13-32	–	89-225	21-33	2.1-3.0	150-200	157-210
Western	20-39	–	92-227	28-39	2-2.8	90-160	93-160
Oilseeds (rape, flax, mustard)							
Northern	18-23	–	67-78	22-32	2.1-2.4	140-150	139-155
Southern	21-28	–	74-114	24-31	2-2.5	124-184	124-182

Table 1, Continued

Region	Reception		Drying, UAH/t-%	Purification, UAH/t-%	Storage, UAH/t-day	Shipment	
	Car, UAH/t	Railway, UAH/t				Car, UAH/t	Railway, UAH/t
Eastern	19-26	–	65-82	20-21	1.8-2.3	150-166	133-166
Central	6-30	–	60-104	21-30	2-3	150-200	150-214
Western	20-45	–	74-167	18-34	2-2.8	75-160	93-160
Legumes (peas, soybeans)							
Northern	17-29	–	82-99	21-33	2-2.5	132-156	132-156
Southern	18-27	–	52-140	19-33	1.8-2.3	124-170	124-170*
Eastern	18-26	39	84-212	20-25	1.8-2.5	150-166	133-166
Central	12-27	–	58-120	21-30	1.9-2.7	142-190	142-190
Western	20-43	–	140-203	18-34	1.8-2.8	75-150	93-156

Note: with the possibility of shipment on water

Source: Based on the data of the State Food and Grain Corporation of Ukraine [31]

Services as of today have increased by 2-3 times for agricultural enterprises from different regions of Ukraine due to the rise in the price of gasoline and diesel fuel and other factors.

Due to the blockade of the Azov and Black Sea ports by Russia, grain sellers are forced to use land and river transport to export grain and oilseeds to European countries to reload the products on ships in the Baltic and Black Sea ports. Before the war, Ukrainian seaports could provide monthly transshipment of grain for export in the amount of 6-7 million tons. Currently, due to the limited capacity of land and river cargo crossings, only 1.5 million tons were exported by rail, road, and river in May 2022 [32].

Currently, Ukraine can export agricultural products only by water through the Danube ports. Due to the insufficient number of barges, grain terminals and berths, their throughput capacity is very limited. In the past, these ports were hardly used for the export of Ukrainian products, which is why the investment attractiveness for their development

was low. Prolonged downtime of port infrastructure led to tens of billions of losses. Ukraine's loss of export revenues amounted to one and a half billion US dollars in the first month of the war alone. Thus, it is planned to increase the annual throughput capacity of the Danube ports to 25 million tons or 1.7 times [33].

In 2021, farmers harvested 85 million tons of grain. Because domestic consumption in Ukraine is less than 20 million tons, about 55-60 million tons of the harvest could be exported, which would provide foreign exchange earnings. During the 2021-2022 marketing year, about 40.0 million tons of grain were exported.

The availability of granaries in the regions of Ukraine is presented in Table 2. The provision of elevator capacities at the end of 2021 amounted to 56.6 million tons, in addition to the storage facilities of agricultural enterprises (about 30.0 million tons). Last year, the deficit of warehouses was 17.4%. Only 3 regions had a surplus of warehouses, these are Mykolaiv (9.6%), Odesa (15.9%) and Poltava (2.9%).

Table 2. Provision of granaries in the regions of Ukraine

No.	Region	Quantity, units.	Simultaneous storage volumes, million tons	Gross harvest in 2021, million tons	Deficit/surplus of elevator capacities, +/- million tons	Deficit/surplus of elevator capacities, +/- %
1	Vinnitsia	85	6.4	7.7	-1.3	-16.9
2	Volyn	24	1.4	1.8	-0.4	-22.2
3	Dnipropetrovsk	78	5.1	6.5	-1.4	-21.5
4	Donetsk	30	2.0	3	-1.0	-33.3
5	Zhytomyr	38	2.4	3.8	-1.4	-36.8
6	Zakarpattia	10	0.2	0.4	-0.2	-50.0
7	Zaporizhzhia	52	3.7	5.1	-1.4	-27.5
8	Ivano-Frankivsk	18	0.9	1.2	-0.3	-25.0
9	Kyiv	52	4.2	5.3	-1.1	-20.8
10	Kirovohrad	57	5.5	6.6	-1.1	-16.7
11	Luhansk	25	1.5	2.2	-0.7	-31.8
12	Lviv	30	1.7	2.1	-0.4	-19.0
13	Mikolaivska	56	5.7	5.2	0.5	9.6

Table 2, Continued

No.	Region	Quantity, units.	Simultaneous storage volumes, million tons	Gross harvest in 2021, million tons	Deficit/surplus of elevator capacities, +/- million tons	Deficit/surplus of elevator capacities, +/- %
14	Odesa	81	7.3	6.3	1.0	15.9
15	Poltava	72	7.2	7	0.2	2.9
16	Rivne	22	1.5	1.9	-0.4	-21.1
17	Sumy	53	4.4	5.1	-0.7	-13.7
18	Ternopil	50	2.9	3.8	-0.9	-23.7
19	Kharkiv	75	4.8	6.4	-1.6	-25.0
20	Kherson	57	3.1	4.4	-1.3	-29.5
21	Khmelnysky	65	4.7	5.6	-0.9	-16.1
22	Cherkasy	55	4.6	6	-1.4	-23.3
23	Chernivtsi	16	0.4	0.8	-0.4	-50.0
24	Chernihiv	63	5.1	6.8	-1.7	-25.0
Total		1164	86.7	105.0	-18.3	-17.4

Source: developed by the authors based on the data of the State Statistics Service of Ukraine [26]

The lowest provision with granaries (50% and more of the deficit) is observed in the Western region – Transcarpathian (50%), and Chernivtsi (50.0%) regions.

The smallest deficit of grain storage capacities (less than 20%) was observed in Vinnytsia (16.9%), Kirovograd (16.7%), Lviv (19.0%), Sumy (13.7%) and Khmelnytsky (16.1%) regions. In general, the deficit of elevator capacities in Ukraine amounted to 18.3 million tons or 17.4%. The decisive role in the deficit or surplus of storage capacities is played by the volume of harvesting, which constantly fluctuates under the influence of both objective factors, such as the level of technological and logistical support of production, and subjective factors, such as weather and climatic conditions.

The author of the study can agree with V.A. Kolodiyuk, who argues that “ambitious strategic programs

to increase annual grain production in Ukraine to 90-100 million tons, and in some strategies – up to 120 million tons will remain a populist call if we do not systematically approach the development of the grain subcomplex of the agro-industrial complex” [23]. It was the systematic approach and favourable weather conditions that allowed obtaining the largest ever gross harvest of grains and oilseeds in the amount of 105 mln tonnes in 2021, while the problem of grain storage deficit remained, which amounted to 17.4% with significant differentiation by regions.

Since the beginning of the war, some of the elevator capacities have been damaged or destroyed, some remained in the occupied territories. In general, today, the national economy has lost more than 12.5 million tons of elevator capacity out of 56.6 million tons available as of January 1, 2022 (Table 3).

Table 3. Availability and losses of elevator capacities as a result of military operations by regions

No. n/a	Region	Elevator capacity by 02/24/2022 (thousand tons)	Elevator capacity after 02/24/2022 (thousand tons)	Destroyed, occupied, blocked sea and river vessels (thousand tons)	Proportion of destroyed, occupied, blocked sea and river vessels, %
1	Vinnytsia	4212.5	4150.0	62.5	1.5
2	Volyn	927.0	927.0	0.0	0.0
3	Dnipropetrovsk	3190.0	3100.0	90.0	2.8
4	Donetsk	1127.2	0.0	1127.2	100.0
5	Zhytomyr	1303.0	1205.0	98.0	7.5
6	Zakarpattia	111.5	111.5	0.0	0.0
7	Zaporizhzhia	2170.0	264.0	1906.0	87.8
8	Ivano-Frankivsk	552.0	552.0	0.0	0.0
9	Kyiv	2688.0	2688.0	0.0	0.0
10	Kirovohrad	3565.0	3565.0	0.0	0.0
11	Luhansk	880.0	0.0	880.0	100.0
12	Lviv	1095.0	1095.0	0.0	0.0
13	Mikolaivska	4221.0	2080.0	2141.0	50.7

Table 3, Continued

No. n/a	Region	Elevator capacity by 02/24/2022 (thousand tons)	Elevator capacity after 02/24/2022 (thousand tons)	Destroyed, occupied, blocked sea and river vessels (thousand tons)	Proportion of destroyed, occupied, blocked sea and river vessels, %
14	Odesa	5500.0	2400.0	3100.0	56.4
15	Poltava	5150.0	5150.0	0.0	0.0
16	Rivne	1010.0	1010.0	0.0	0.0
17	Sumy	2901.0	2877.0	24.0	0.8
18	Ternopil	1800.0	1800.0	0.0	0.0
19	Kharkiv	3007.0	1670.0	1337.0	44.5
20	Kherson	1817.0	0.0	1817.0	100.0
21	Khmelnysky	3060.0	3060.0	0.0	0.0
22	Cherkasy	2850.0	2850.0	0.0	0.0
23	Chernivtsi	234.0	234.0	0.0	0.0
24	Chernihiv	3185.0	3185.0	0.0	0.0
Total		56556.2	43973.5	12582.7	22.2

Source: Developed by the authors based on [34]

After the beginning of the war with Russia, Ukraine completely lost grain storage capacities in Donetsk (1127.2 thousand tons), Luhansk (880.0 thousand tons), and Kherson (1817.0 thousand tons) regions. Elevators in Zaporizhzhya (1906.0 thousand tons or 87.8%), Odesa (3100.0 thousand tons, 56.4%), Mykolaiv (2141.0 thousand tons, 50.7%), and Kharkiv (1337.0 thousand tons or 44.5%) regions were largely destroyed, occupied and blocked in sea and river ports. Insignificant losses are observed in Zhytomyr (98.0 thousand tons, 7.5%), Dnipropetrovsk (90.0 thousand tons or 2.8%), Vinnytsia (62.5 thousand tons, 1.5%), and the smallest – in Sumy region (24.0 thousand tons or 0.8%) of the available capacities in the region. In total, 12582.7 thousand tons (22.2%) of grain storage capacities were lost in Ukraine.

As of the beginning of 2022, the total capacity of grain storage facilities was 85-87 million tons, including 28-30 million tons of warehouses located on the farms of agricultural producers. Considering the elevator capacities in the regions where the hostilities are occurring, only 70.0 million tons of grain storage capacity is available. Thus, about 23% of the available grain storage capacities are required to preserve the last season's carryover stocks (20.0 mln tonnes).

Considering that this year it is planned to harvest at least 50 million tons of grain and 15 million tons of oilseeds, considering the transitional stocks, the shortage of storage capacities is expected in the range of 15-20 million tons. It can result in significant, 5-7%, losses due to the lack of appropriate conditions for crop preservation. The lack of elevator capacities

during peak periods in early and late autumn will be particularly painful for the agricultural market.

Diversification of logistics infrastructure is one of the most significant areas of development of the agricultural sector of Ukraine, the problems of which are dealt with by the government. Currently, UAH 4.0 billion is required only to provide farmers with temporary storage facilities. An alternative to stationary elevators can be using polymer sleeves for grain storage.

The adverse consequence of Russia's war against Ukraine was the fall in prices of agricultural producers for grain and oilseeds. The blockade of ports has resulted in significant surpluses in the domestic market of these products and an almost fivefold increase in the cost of export logistics. Therefore, domestic prices for major crops intended for export lost more than 30%, for example, the price of grains fell to 4.0-5.0 thousand UAH per ton. Indirect losses of agricultural enterprises from the decline in prices for major export crops, such as corn, wheat, barley, and sunflower, increased to 11.9 billion USD.

The most acute problem for agriculture nowadays is the high tariffs for transporting crops and the cost of storage. In 2022, railway tariffs increased twice: in January-February – by 15-20% compared to January-February 2021 and from June 29, 2022 – by 70%. As a result, the additional annual expenses of agricultural producers amounted to 120 million USD [35].

The cost of international road transportation of grains and oilseeds in July 2022 almost doubled, for domestic transportation, it averaged UAH 3.33 per ton-kilometer (Table 4).

Table 4. Cost of domestic transportation of grains and oilseeds in July 2022

Cargo	Transport	Distance (km)	UAH/t	UAH t/km
Wheat in bulk	dump truck	797	2300	2.89
Wheat	dump truck	310	1450	4.68
Sunflower	dump truck	750	2500	3.33
Wheat	dump truck	310	1280	4.13

Table 4, Continued

Cargo	Transport	Distance (km)	UAH/t	UAH t/km
Sunflower	container ship	620	1900	3.06
Sunflower	dump truck	620	2100	3.39
Grain in bulk	grain carrier	721	2500	3.47
Corn	dump truck	360	1150	3.19
Corn	dump truck	754	1950	2.59
Corn	dump truck	799	1950	2.44
Rape	grain carrier	585	2300	3.93
Soybeans in bulk	dump truck	882	2400	2.72
Rape	grain carrier	511	2000	3.91
Rape	grain carrier	944	3200	3.39
Sunflower in bulk	dump truck	942	3100	3.29
Corn	grain carrier	596	2100	3.52
Soybeans in bulk	dump truck	710	2300	3.24
Sunflower	grain carrier	620	2200	3.55
Soybean	grain carrier	556	2500	4.50
Soybean	grain carrier	994	2700	2.72
Soybean	grain carrier	500	2900	5.80
Corn	grain carrier	840	1850	2.20
Corn in bulk	grain carrier	1100	2200	2.00
Soybean	grain carrier	841	2900	3.45
Corn	grain carrier	930	2050	2.20
Corn	grain carrier	596	2100	3.52
Corn in bulk	grain carrier	744	2100	2.82
Average cost, t/km				3.33

Source: developed by the authors based on the data of DELLA™ transport company [36]

The cost of transportation depends on many factors: type of body, cargo, distance, region of delivery, etc. One of the key factors is the distance of transportation, in Table 4, the author can observe an inversely proportional relationship between the distance and the cost

of transportation (ton-kilometre). The author notes a similar trend in international road transportation of grains and oilseeds. The cost of grain transportation for export increased and, in July 2022, averaged EUR 0.17 or UAH 6.33 per tonne/km in hryvnia equivalent (Table 5).

Table 5. Cost of international transportation of grains and oilseeds, July 2022

Country	Cargo	Transport	Distance, km	EUR/t	UAH t/km
Romania	grain	grain carrier	313	65	0.21
Romania	sunflower in bulk	grain carrier	1450	170	0.12
Romania	grain	grain carrier	1182	150	0.13
Romania	corn in bulk	grain carrier	508	100	0.20
Romania	rape in bulk	grain carrier	847	159	0.19
Poland	soybeans in bulk	grain carrier	509	83.3	0.16
Poland	rape in bulk	grain carrier	1134	96	0.08
Greece	grain in bulk	grain carrier	2104	172	0.08
Bulgaria	sunflower	grain carrier	1413	166	0.12
Average cost t/km		x	x	X	0.17

Source: developed by the authors based on the data of DELLA™ transport company [36]

Due to the blockade of ports, logistics costs in the structure of export costs increased 5-7 times and amounted to 180 USD per ton of grain. Considering this situation, grain producers have to sell products well below cost, on average about 90 USD per ton of

grain in the field, in Europe, its production cost is not lower than 160 USD per ton.

In most regions, there is a deficit of own elevator capacities. Prices for their services have increased significantly. Unloading a ton of grain costs 70 UAH,

storing a ton – 70 UAH per month, and loading one ton – 70 UAH. Storage during the year increases the actual cost of grain by almost 1 thousand UAH. Thus, it is unprofitable to store the harvest currently.

According to the Decree of the President of Ukraine “Issues of the National Council for the Recovery of Ukraine from the Consequences of War” of 04/21/2022 No. 266/2022, the National Council for the Recovery of Ukraine from the Consequences of War was established [37]. The working group “New Agrarian Policy” of this Council has developed several projects [38] to restore Ukraine from the consequences of the war, including several logistics projects.

The calculations performed by the group and our calculations demonstrate that this year the agricultural sector of Ukraine may lose USD 7.5-8.0 billion only due to the blocking of seaports and changes in the logistics of export transportation. The cost of

unsold last year’s grain is USD 0.5 billion, and the cost of destroyed or occupied elevator warehouses is USD 1.3 billion. In total, this will amount to USD 9.3-9.8 billion, or almost two years of profits received by agricultural enterprises in 2020 and 2021 (Fig. 4).

The author considers that in the future the main risks that will adversely affect the development of infrastructure and the efficient functioning of logistics chains will be:

- the spread of the military conflict to new territories and its aggravation;
- the destruction of logistics chains;
- curtailment of lending to infrastructure and logistics projects;
- sharp deterioration of the investment climate, imperfect legal protection of investors’ interests;
- insufficient state support for infrastructure and logistics development.

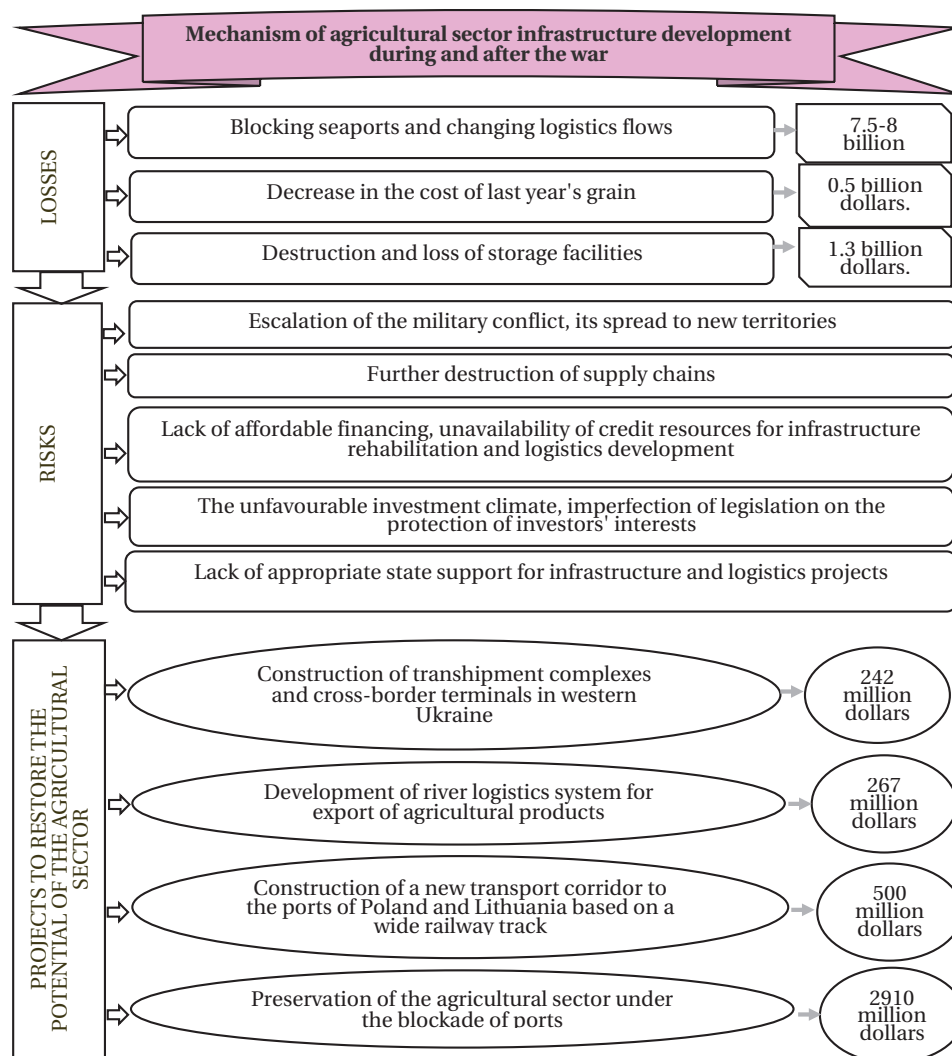


Figure 4. Economic mechanism of infrastructure development during and after the war

Source: developed by the authors based on data from [38]

Critically assessing the proposed projects, consider it necessary to provide several remarks. The project of construction of a new transport corridor

to the ports of Poland and Lithuania based on a wide railway track raises doubts about the feasibility and efficiency of its implementation. Since the

implementation of this project is planned for the period 2023-2025, as a result of the potential end of the war, the unblocking of the Black Sea ports (from August 1, 2022, they have already been unblocked for 120 days with the possibility of extending this period), the need for a wide-gauge transport corridor will disappear. In the case of implementation of this project, there is an additional necessity to pay for the transit of goods through the territory of Ukraine's partners Poland and Lithuania. When unblocking their ports, their terminals will be unloaded, which will result in job losses and loss of customs payments. In addition, there is a risk of increasing the cost of the project due to the necessity to pay compensation to the owners of the land through which the track will run. Such significant investments are designed for a long-term payback period, and in the case of forwarding cargoes to domestic ports shortly, the significance of the transport corridor will be offset, which will require foreign currency to be used for its maintenance.

The project of construction of transshipment complexes and cross-border terminals in western Ukraine raises questions about the efficiency of its implementation. Based on the fact that domestic ports are already gradually resuming their work (as of August 20, 2022, 25 vessels with 630 thousand tons of agricultural products were shipped to three ports of Greater Odesa [39]), the importance of powerful grain transshipment terminals will significantly decrease, which will result in idle storage facilities in the western regions of Ukraine and additional costs for their maintenance and conservation.

The project of development of the river logistics system for the export of agricultural products

has a long-term perspective and is highly efficient for the export of agricultural products both during the war and after its end. After all, currently, almost a third of Ukrainian exports are exported through the Danube ports. From them, the products are delivered by the river to the port of Constanta in Romania and then go by sea to other countries of the world. The turnover of river transport is gradually growing. During April 2022, it increased 4 times to 850 thousand tons, which is 15% of the pre-war trade turnover. According to experts, the volume of traffic may increase to 1 million tons per month [40]. Thus, in the author's opinion, the investment of USD 242 million in the project is fully justified.

The project of preserving the agricultural sector under the blockade of ports assists agricultural enterprises in providing their production with the necessary resources for sowing and harvesting. In addition, the project provides for the purchase and/or construction of temporary facilities for crop storage. Evidently, the implementation of the project is necessary for the country's economy, but, in the author's opinion, its high cost (2910 million USD) requires more detail, in addition, the project objectives somewhat overlap with the objectives of the project for the construction of transshipment complexes in western Ukraine.

It can be agreed with the scientists A.L.R. de Oliveira, C.B. Marsola, A.P. Milanese and S.L.R. Fatorretto [3], who determined the most efficient sea and rail transport. The concept of "intermodal transport" used by them was completely appropriate to apply to grain transport logistics in Ukraine. The scheme of intermodal transport in grain logistics is presented in Figure 5.

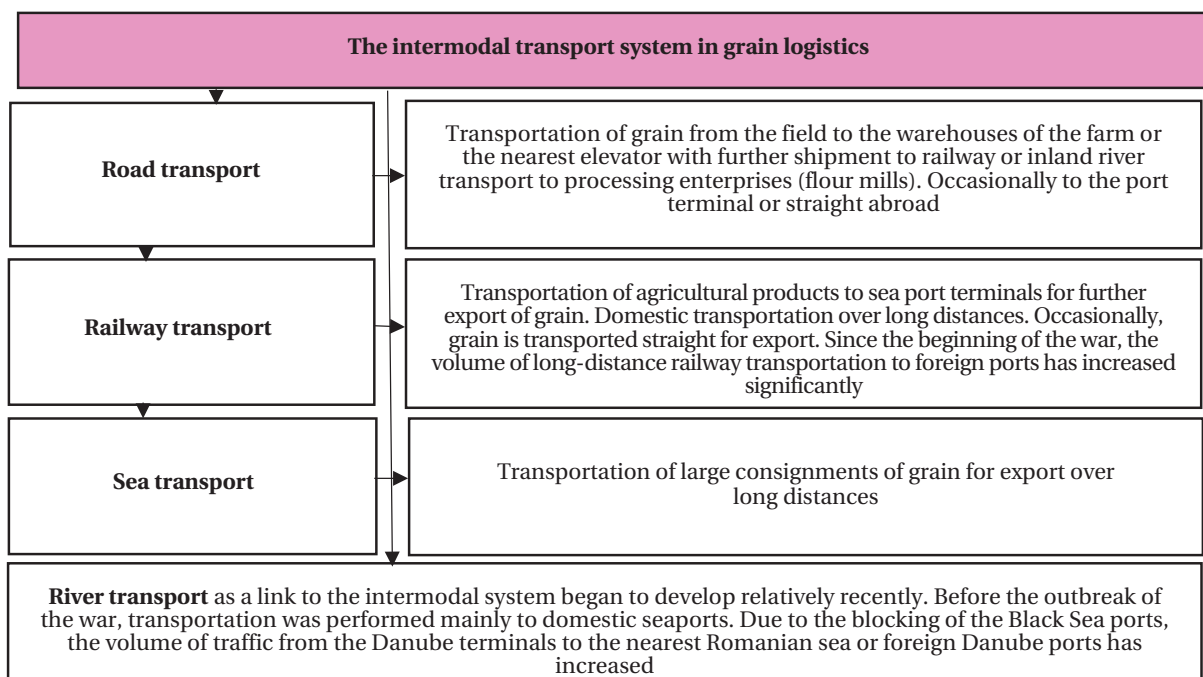


Figure 5. Scheme of the intermodal transport system in grain logistics

Source: developed by the authors based on data from [3]

Currently, the intermodal system is frequently violated. Though some Black Sea ports have been unblocked since August 1, the volume of maritime traffic is much lower than before the war. Thus, this type of transport, which was the most efficient in the system, often began to disappear from the system. More and more often, despite the high price of fuel, grain is transported by road over long distances, in particular for export. In addition, the volume of transportation outside the state by rail has increased. But in this situation, there are several problems with grain exports:

- 1) insufficient number of border crossings, narrow access roads, lack of modern scanners at customs crossings, which does not allow trucks to quickly pass customs control, resulting in long queues;
- 2) different gauges in Ukraine and European countries, insufficient number of European railcars. The low capacity of the railway at the border does not allow a significant increase in the volume of grain transportation;
- 3) the small number of vessels adapted to work in the Danube ports restrains the increase of cargo turnover through them;
- 4) an imperfect system of logistics flow management results in the slowdown of freight traffic;
- 5) high tariffs for domestic rail transportation and transit, and rising fuel prices significantly reduce the efficiency of road and rail transport.

In the author's opinion, it is expedient to implement cheaper and more efficient projects to develop infrastructure:

- 1) construction of modular grain storage facilities that can be easily assembled and dismantled, the introduction of grain storage technologies in polymer sleeves, rather than the construction of large grain terminals on the western border, the economic significance of which will fall after the unblocking and return of the Azov and Black Sea ports;
- 2) construction of new and reconstruction of existing customs crossings together with European partners in the field of expanding access roads to them, equipping them with powerful X-ray scanners and establishing domestic infrastructure;
- 3) establishment of own production, purchase and lease of vessels for transportation of cargoes, in particular grain products, from the Danube ports;
- 4) repair and reconstruction of the only European railway track in Ukraine from Kovel to Poland, construction of a grain terminal in Kovel, reconstruction of wagons based on the Kovel depot to European standards;
- 5) re-profiling of facilities for the production of wheelsets of freight car bogies for the European gauge;
- 6) improvement of the information flow management system, establishment of conditions for efficient coordination of cargo movement with European partners, and training of management personnel in the field of logistics.

These measures will largely offset the adverse

effects of the loss and blocking of seaports and increase the volume of grain exports with minimal costs and will contribute to the preservation of jobs and the establishment of new ones.

► Conclusions

As a result of the research, the author proposed a definition of the term "grain logistics", which includes the specific features of the beginning of the establishment of the logistics chain and the features of grain storage, attention is devoted to the conditions for obtaining the effect for all subjects of the logistics process.

A forecast was made regarding changes in the structure of domestic grain transportation by type of transport due to the blocking of seaports and the development of river transport infrastructure as more economically profitable. The volume of transportation by river transport compared to 2021 will increase by 2.75 million tons or from 0.9% to 5% in 2022, the volume of transportation by road will increase by 3.45 million tons, but the structure of transportation volumes will decrease by 0.8%, the volume of transportation by rail will increase by 5.2 million tons, in the structure of transportation there will be a drop of 62.3% to 60%.

Considering the forecast of harvest volumes and the partial unblocking of seaports, the author has made an indicative forecast of the structure of exports by mode of transport in 2022. The largest share of transportation will remain for maritime transport – 79.1%, 15.1% of grain will be exported by rail, 3.3% by road and only 2.5% of transportation will be indeterminate.

The restriction of using railway and road transport was caused by the increase in railway tariffs and fuel prices, and anti-epidemic quarantine measures at border crossings, particularly for road transport. Sea transport remains the most efficient in the transportation of large volumes of grain.

As a result of hostilities, Ukraine lost a significant part of elevator capacities – 12.6 million tons or 22.2%. Comparing the forecasted harvest and the available elevator capacities in 2022, there may be significant losses of harvested grain due to the shortage of storage facilities for its storage – 5-7%.

Considering several problems that have arisen in grain logistics, some proposals have been developed to overcome them. First of all, it is the introduction of relatively inexpensive technologies for storing grain products, increasing the number and reconstruction of road freight customs crossings to increase the efficiency of road transport for the transportation of grain for export, increasing the export cargo flow through the Danube ports, construction of a grain terminal and repair of the European railway track in Kovel, clear coordination of cargo flows with European partners. The implementation of these proposals will overcome the crisis in grain logistics and significantly increase domestic and export-import cargo turnover.

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Сучасний стан та перспективи розвитку зернової логістики в Україні

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► **Анотація.** Враховуючи нестачу елеваторних потужностей та диспропорцію у розподілі товарних потоків через захоплення та блокування морських портів, інші види транспорту сьогодні не в змозі забезпечити перевезення необхідних обсягів зерна на експорт, а збереження врожаю знаходиться під загрозою. Тому нагальним є питання розвитку логістики в умовах війни, що визначає актуальність дослідження. Метою статті є аналіз довоєнного та сучасного стану зернової логістичної системи і визначення ефективних шляхів її розвитку під час війни та після її закінчення. Дослідження ґрунтується на наступних методах: діалектичному, історичному, монографічному, абстрактно-логічному, системному та класифікаційному, методі аналітичного прогнозування, статистико-економічному, економіко-математичному, графічному. Досліджено протяжність доріг в Україні та здійснено прогноз щодо скорочення шляхів через військові дії. Проведено аналіз експортно-імпоротної логістики, визначено переваги морського транспорту, питома вага якого при експорті складала 99,5 %, а при імпорті більшість перевезень припадала на залізничний транспорт (44,9 %). Досліджено стан елеваторних потужностей, дефіцит яких у 2021 році складав 18,3 млн тонн (17,4 %), визначено обсяги їх втрат через військові дії у 2022 році – 12,6 млн тонн (22,2 %), проаналізовано вплив війни на зростання цін на послуги зберігання зерна. Здійснено критичний аналіз інфраструктурних проектів Національної ради з відновлення України від наслідків війни та вказано їх недоліки. Запропоновані заходи щодо удосконалення логістики допоможуть частково знівелювати дефіцит елеваторних потужностей, наростити обсяги експорту зернових, сприятимуть пришвидшенню переміщення продукції через кордон та зменшенню логістичних витрат. Результати досліджень можуть бути використані органами державної влади при створенні програм розвитку аграрної логістики, бізнес структурами – для розробки інфраструктурних проектів та удосконалення логістичних систем підприємств, науковцями – для подальшого вивчення проблем зернової логістики та визначення перспектив її розвитку

► **Ключові слова:** елеваторні потужності, тарифи, порти, транспорт, інтермодальна система



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Energy Independence and Financial Stability of Economic Entities in the Conditions of War

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► **Abstract.** Russia's invasion of Ukraine has caused many social, economic, environmental and energy problems. Most business entities faced problems at the national level that affected their financial and economic activities. The mass departure of workers abroad, rising natural gas prices, internal relocation, and constant shelling force business entities to search for new approaches to the management and development of their enterprises. The purpose of the study – substantiate and test the scientific and methodological approach to achieving energy independence of economic entities as a way to avoid their insolvency in times of war. In the course of the study, a critical analysis of the thematic literature was performed, and a set of general scientific and special research methods was used: expert assessments, observation, analogy, grouping, obtaining a consensus, deductive, inductive reasoning, systematisation, system-functional, measurement, analysis, comparison, logical generalisation, systematisation, hypothesis, a repeated combination of independent scenarios, extrapolation, elasticity estimation and graphical. The study identified the consequences of the military invasion of Ukraine and developed an algorithm for actions during the war. Four scenarios have been identified, under which the investigated business entity can solve the urgent problems. It is substantiated that the best scenario is the one in which it is required to increase its production capacity by setting up a "full cycle" production using a continuous pyrolysis system for the recycling of worn-out tires. The rationality of its use is proved. The scientific and methodological tools for interaction between business entities and the state during the war have been improved based on a systematic approach, which, unlike the existing ones, deepens the significance of shifting the centre of gravity from the macro to the micro level and is based on the proposed algorithm of actions (identifying the problem, developing possible scenarios for its immediate solution, compliance of the chosen scenario with the national interests of the state, finding a source of funding for the implementation of one of the scenarios), which determines the most optimistic scenario of the balance of interests between the state and business entities. The practical value of the proposed lies in the identification of economic, social, environmental and energy efficiency of the developed algorithm of actions in practice, on the example of financial and economic activities of the entity. Such an approach, on the one hand, allows for achieving energy independence soon and is a way to avoid the insolvency of economic entities in the conditions of war. On the other hand, it should become a reliable base for the national economy in the period of post-war reconstruction

► **Keywords:** insolvency, financial condition, environmental disposal, financial and economic activity, production capacity, alternative energy sources, natural gas

► Introduction

The activities of business entities are crucial for the economic development of the country. They provide jobs, fill budgets of different levels with funds, and stimulate the development of innovations, thereby accelerating structural changes in the domestic economy. The activity of business entities is a catalyst for economic growth in the country.

However, in recent years, business entities in Ukraine have encountered many challenges and

threats that have adversely affected their activities. The outbreak of the COVID-19 pandemic and its spread has resulted in a decrease in staff employment, production cuts and the closure of some of them. Another major shock was the full-scale Russian invasion of Ukraine, which caused both a humanitarian crisis and significant economic consequences. Due to the destruction or overloading of supply chains that supported the business sector,

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the domestic economy is in a chaotic state. During the first months of the military invasion, more than 40% of business entities in the business sector of the economy ceased their activities, and thousands of people were left without a source of income. In general, Ukraine lost from 5 to 7 million jobs due to the invasion. In the first quarter of 2022, the industry reduced production by 34%, construction – by 47%, and mining and metallurgical complex – by 53% [1].

To support business entities in a difficult situation, the Government implements state support for them to restart the economy in wartime. However, not every business entity has the opportunity to use it or resume its activities in full in other regions of Ukraine. The rise in the cost of energy (natural gas – January 2021 – UAH 7.9 per cubic meter; January 2022 – UAH 43.6 per cubic meter) [2], the forced emigration of the population (from February 24 to June 3, 2022 – more than 5.2 million people) [3], mobilization (08.07.2022 – more than 1000000 people) [4], constant rocket attacks force business entities to look at their financial and economic activities in a new way. The old approach to the functioning of economic entities in modern conditions does not work and does not contribute to the avoidance of phenomena that adversely affect their financial solvency.

In the production sector of the Ukrainian economy, natural gas is the most significant energy resource [5] for economic entities. Ukraine has the most powerful network of underground gas storage facilities in Europe (30 billion cubic meters), the capacity of which is equal to a quarter of the EU storage facilities [6]. Therewith, for about two decades, Ukraine has been importing most of its gas from Russia, while retaining its promising fields. Such national policy mainly enriched individual politicians and oligarchs of both countries but did not contribute to the socio-economic development of economic entities and the country in general. Currently, in the conditions of war, when the issue of natural gas supply as the main cost-scarce source of energy in the production sphere has become of global importance, business entities have become key figures in achieving energy independence, and hence Ukraine's ability to efficiently resist the aggressor.

Considering the national interests of Ukraine during the war, business entities face a question that requires an immediate solution: "What measures to take to reduce energy dependence without reducing production and with the possibility of establishing new jobs?". Based on the above, economic entities must search for alternative energy sources that would enable them to achieve energy independence as the foundation of their solvency in times of war.

After reviewing and analysing the literature, it can be stated that currently there are many publications devoted to energy resources, which disclose their essence and types (fuel, renewable resources, nuclear resources) [7-9]. Many works are addressed to renewable energy sources, where approaches to their content are given [10-12], the main forms [13] and economic conditions of use [14] are determined, and

scenarios of renewable energy until 2040 are demonstrated [15]. There is a study devoted to the search for alternatives to renewable energy sources from an environmental standpoint. Thus, J. Pilusa, E. Muzenda cite statistical data (the temperature in the Arctic is 30 degrees higher than the historical level, and in Antarctica – by 40 degrees) and quote the opinion of the UN Secretary-General Antonio Guterres ("dependence on fossil fuels is a mutual guaranteed destruction") propose to use only environmentally friendly renewable energy sources (biogas, biodiesel), which can be obtained as a result of waste conversion [16]. Another group of researchers, against the backdrop of the military invasion of Ukraine, provide ways to achieve energy independence at the national level. Thus, M. Flanagan, A. Kammer, A. Pescatori, M. Stuermer consider that energy dependence can be overcome in two ways: 1) by finding alternative energy sources; 2) by encouraging energy saving by economic entities while protecting the most vulnerable. In their opinion, Italy should be included in the countries that already encourage enterprises to save energy [17]. In turn, C. Halser, F. Paraschiv, to reduce energy dependence, propose an accelerated deployment of renewable energy capacities, which is of the greatest national interest to provide the economic power necessary for the energy transition [18]. And according to J. Bowman, it is essential to stop buying and move away from fuel that depends on the aggressor state. The worst thing that can be done now is to make future generations decades more dependent on this dangerous fuel – and those who would use it as a weapon. In his work, the author proposes to use clean energy sources that will not cause endless cycles of chaos, suffering and war. It is the way to establish true energy independence, strengthen the Ukrainian economy and improve the security of Ukraine [19]. A similar opinion is expressed by J. Bowman, President of the European Commission Ursula von der Leyen, who stated the necessity of an immediate transition to renewable energy sources [20]. K. Bekhrad, A. Aslani, T. Mazzuca-Sobczuk in their research demonstrate the importance of the transition to alternative energy sources for achieving energy independence of the country and identify the problems of its achievement (growth of energy consumption, high volatility of fuel prices, interruptions in energy imports and exports, climate change and environmental pollution) [21]. Another group of researchers, A. Juaidi, F. Montoya, I. Ibrik, F. Manzano-Agugliaro, and J. Gázquez [22; 23], prove the importance of the transition to alternative energy sources and bioenergy for both the economic and environmental sectors, and the social sector. In turn, A. Antonenko, R. Nitsovych, O. Pavlenko, K. Takac substantiate the role of alternative energy sources in the coming years from the standpoint of compliance with EU directives [24].

The purpose of the study is to determine the specific features of the functioning of economic entities during the war and to develop based on these theoretical provisions and practical recommendations

for achieving energy independence by economic entities as a way to avoid their insolvency. By the defined purpose, the following tasks were solved: to propose an algorithm of energy independence as a way to avoid insolvency of economic entities in times of war; to identify possible scenarios for the implementation of the proposed algorithm; to perform an economic justification of the most optimistic scenario on the example of LLC “Megatex Industrial”.

► Materials and Methods

The study was performed in several stages. In the first stage, a problem of a general and individual nature was identified, which affects the further successful financial and economic activities of business entities and the performance of the state's powers during the war. In the second stage, it is proposed to shift the centre of gravity from the macro to the micro level, which is based on the economic life of the country. Accordingly, an algorithm for achieving a balance of interests between business entities and the state in war as a single system was proposed and developed. In the third stage, the economic justification of the proposed algorithm of actions was performed. The fourth stage involved finding a possible source of funding for the implementation of one of the proposed scenarios and justifying the rationality of its practical use.

In the course of the study, a critical analysis of the thematic literature was performed, and a set of general scientific and special research methods was used. When identifying problems of general and individual nature, the following methods were used: expert assessments, observation, and analogies. The method of grouping and the method of obtaining an agreed opinion allowed a large number of observations on achieving energy independence and finding a possible alternative energy source to be reduced to a fairly small number, in which observations are grouped by more striking features. Deductive, inductive reasoning, systematisation and system-functional methods were used in the development of an algorithm for achieving a balance of interests between business entities and the state during the war as a single system. When considering the current state of financial and economic activities of the entity, calculation and analytical methods of research, measurement, analysis and comparison were applied. Heuristic methods and logical generalisation are used to find an alternative energy source to natural gas. Using the methods of systematisation, hypothesis, and repeated combination of independent scenarios allowed the development of possible scenarios that reflect the probability of making decisions that will affect the further financial and economic activities of the entity with the probability of

receiving benefits or expected losses. The application of extrapolation methods, a clear sequence of actions and elasticity estimation allowed for exploring the selected fourth scenario from a practical standpoint. Graphical and visualisation methods were used mainly not as independent methods but as methods that accompany, illustrate, and explain the conclusions from other methods.

The research has a theoretical and applied nature and contains an analytical part. The practical principles of achieving energy independence as a way to avoid insolvency are demonstrated in the example of LLC “Megatex Industrial”. The financial statements of LLC “Megatex Industrial” for 2017-2021 are used as the initial data.

► Results and Discussion

Since Russia's invasion of Ukraine, the issue of the danger of warming the country and the search for alternative energy sources has gradually faded into the background. Ukraine is actively trying to reduce its dependence by reducing gas demand, increasing domestic gas production and expanding reverse import capacity from more competitive European markets. According to forecasts, natural gas production in 2025 will range from 27 to 30 billion cubic meters [25]. The rapid growth of energy prices has already pushed to increase the volume of fuel production, which contributes to global warming [26]. According to the authors, this approach is ineffective in the conditions of war, as the lack of energy independence and environmental problems are interconnected and one of the main ones. The same opinion is expressed by Professor of Globalisation and Development at Oxford University Goldin Ian, who notes that high energy prices can result in governments narrowing the list of priorities for renewable and sustainable energy sources, which is highly adverse [27]. A similar reasoning is held by P. Cohen, who notes that “concerns about the climate are receding into the background as fuel prices soar, and the crisis in Russia deepens. Energy security has gained relevance, while the conflict in Ukraine raises concerns about possible disruption of natural gas supplies” [28].

Energy is at the heart of the economic welfare of every business entity [29]. Energy independence can be reached only with stable and permanent access to diverse energy sources. In war, these components are completely offset. Thus, the centre of gravity should be shifted from the macro to the micro level, which is the foundation of the country's economic life. By clearly identifying the problems of business entities faced during the war and taking appropriate measures, it allows for achieving a balance between the interests of business entities and the state as a single system in the short and long term (Fig. 1).

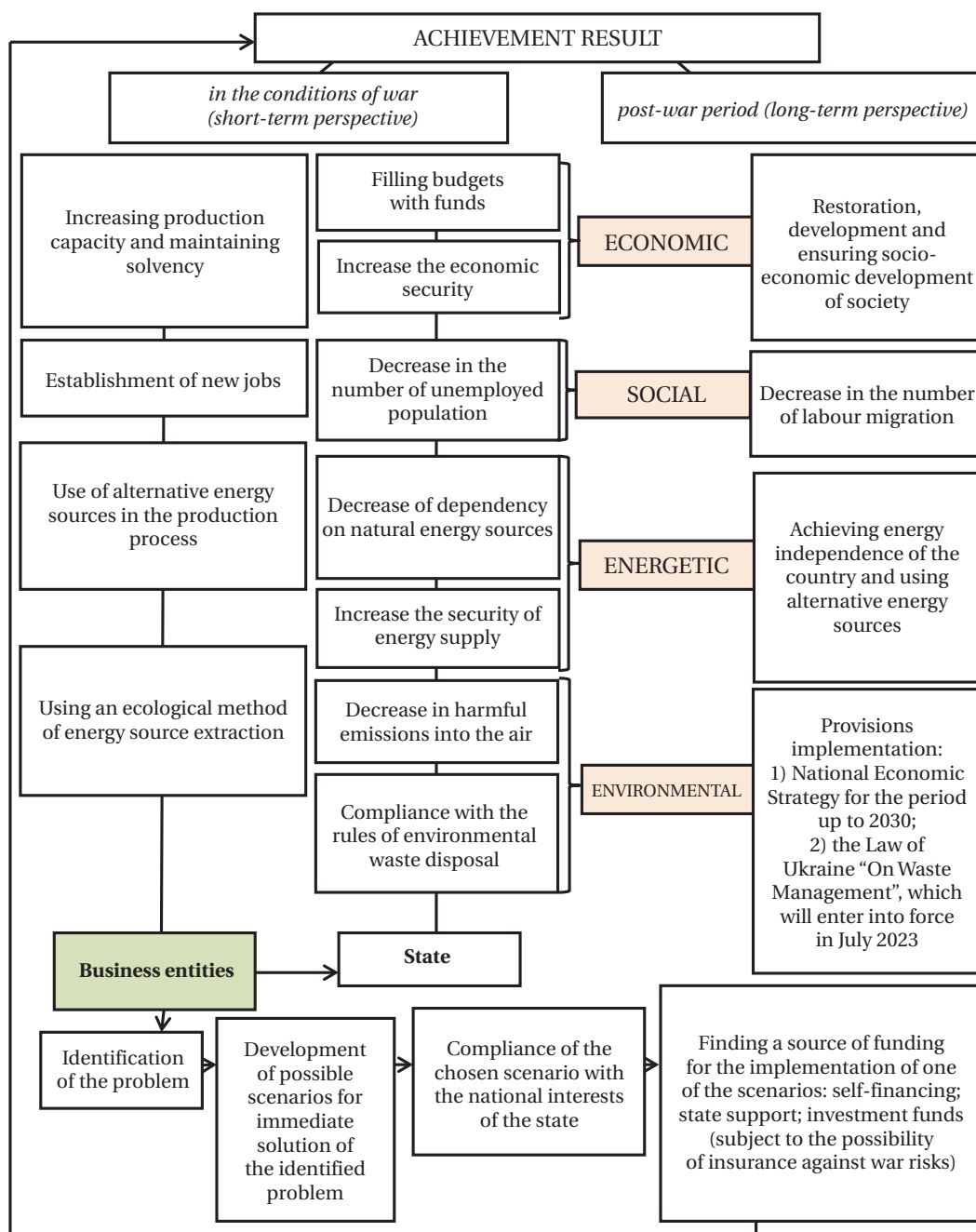


Figure 1. Block diagram of the algorithm for achieving a balance of interests between business entities and the state in war as a single system

Source: proposed and developed by the authors

In the short term, the most critical tasks are achieved, the implementation of which is vital for the further functioning of business entities and the performance of the state's powers and duties. In the long term, fundamental changes can be applied that will contribute to the recovery of Ukraine in the post-war period.

Energy independence covers four areas: economic, social, energy and environmental. By developing measures to solve a particular problem, business entities simultaneously promote the interaction of all four spheres. It allows not abandoning the development priorities of each of them but

applying the practice of mutual solution and development. Considering the above, the proposed scientific and methodological approach to achieving a balance of interests between business entities and the state during the war as a single system in the short and long term is extremely relevant in modern conditions. It provides an opportunity to simultaneously solve vital problems for business entities and the state in the field of implementation of its national interests, namely the achievement of energy independence shortly. Following the proposed algorithm, it is suggested to apply it to the example of LLC "Megatex Industrial".

Currently, during the war, LLC “Megatex Industrial” has faced an extremely serious problem that threatens its successful financial and economic activities. Having close relations with LLC “Megatex” (Kostiantynivka, Donetsk region), the company performed the production of products using

state-of-the-art technology on the principle of “full cycle” (Fig. 2), that is, from the simplest raw materials (lead, plastic, acid) to fully finished, charged starter lead-acid batteries [30]. LLC “Megatex” was a key supplier company.

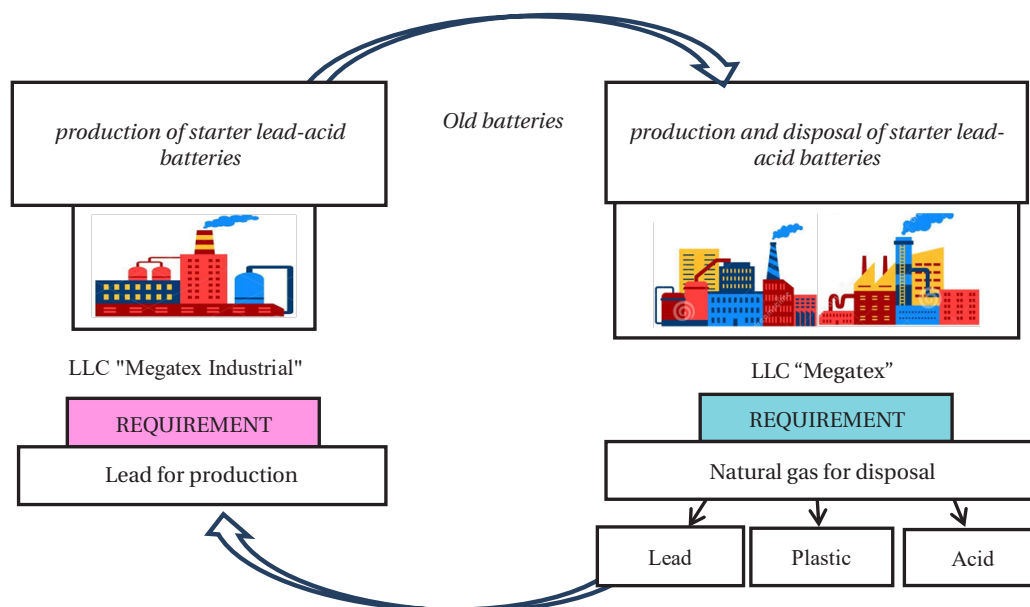


Figure 2. Graphical visualisation of the full production cycle of starter lead-acid batteries before the war

Source: developed by the authors

It allowed not collecting and not throwing of old starter lead-acid batteries to the landfill, but to reuse them and get a pure lead, which is the main source of energy for the production of new ones. The main supplier of lead was LLC “Megatex”. Due to the intensified shelling of the eastern regions of Ukraine, the supplier company participated in the “Program for the temporary relocation of enterprises from the war-affected regions”, and was able to perform only partial relocation of its production facilities to Starokonstantinov (Khmelnysky region). Thus, the supplier company is currently unable to fully restore its production capacity.

Thus, in the first stage of “Identification of the problem,” it was established that LLC “Megatex Industrial” was left without a supplier, which provided it with the main source of production. It threatens the LLC “Megatex Industrial”, in particular: loss of leading positions in the market and its insolvency shortly; 154 people may lose their jobs. For LLC “Megatex”, it is: the risk of inability to restore its production capacity; more than 500 people may be left without work.

In the second stage “Development of possible scenarios for immediate solution of the identified problem” several scenarios were distinguished:

1) LLC “Megatex Industrial” is increasing its production capacity by purchasing equipment for the recycling of starter lead-acid batteries. However, this scenario has both positive and adverse sides. Positive – establishment of new jobs for unemployed workers

and expansion of their production capacities. Adverse – an increase in the price of natural gas may result in significant financial costs, which will cause a corresponding increase in the price of manufactured products for customers;

2) LLC “Megatex Industrial” finds another supplier of lead. But this scenario has both positive and adverse sides. Positive: rapid recovery of its production capacities, which will reduce the risk of insolvency. Adverse: the prices of other suppliers for lead are much higher than those offered by LLC “Megatex”, which is not profitable for the company; the increase in the price of natural gas can lead to significant financial costs, which will cause corresponding increase in the price of manufactured products for customers;

3) LLC “Megatex Industrial” is increasing its production capacity by purchasing equipment for the recycling of starter lead-acid batteries and finds a supplier of an alternative energy source. The positive aspects of such a scenario are: the establishment of new jobs for unemployed workers; the expansion of their production capacities; participation in an environmentally friendly way of extracting energy sources. Adverse: overpriced prices from suppliers for alternative energy sources;

4) LLC “Megatex Industrial” is increasing its production capacity by launching a “full cycle” production using alternative energy sources. In such a scenario, the positive aspects are: the establishment of new jobs for unemployed workers; expansion

of production capacities; application of an environmentally friendly method of energy source extraction; reduction of harmful emissions into the air; compliance with the rules of ecological waste disposal; reduction of dependence on natural energy sources. The adverse side of such a scenario is significant financial costs and time constraints.

In the third stage "Compliance of the selected scenario with the national interests of the state", it was established that the fourth scenario corresponds to the national interests of the state, namely strategic purpose 4 "Improving the energy efficiency of the economy and ensuring the environmental friendliness of the energy sector" of the National Economic Strategy for the period up to 2030 [31]. In addition, this scenario will allow implementation of the provisions of the Law of Ukraine "On Waste Management" from July 2023 [32].

The fourth stage "Finding a source of financing for the implementation of one of the scenarios" is designed to determine at the expense of which LLC "Megatex Industrial" can finance the fourth scenario. There are three forms of financing: self-financing, state support, and investment funds. It is not profitable for LLC "Megatex Industrial" to use only self-financing, as it already has significant financial costs. It is practically impossible to find an investor who would agree to invest in the scenario during the war. Moreover, since February 24, 2022, no insurance company in the world can insure property in Ukraine against war risks. As for state support, attention should be paid to the state program "eRobota", which includes six grant programmes designed to stimulate entrepreneurship. The main purpose of the state program is to intensify entrepreneurship and increase employment among the population of Ukraine by establishing new jobs.

The problem of developing economic and financial solutions for obtaining fuel that will become an alternative to natural gas remains. Disposal of non-biodegradable solid waste is a necessary alternative for LLC "Megatex Industrial" during the war. The process of waste-to-energy is a very simple concept, which involves obtaining maximum energy from waste with minimal damage to the environment through various thermal processes, such as pyrolysis technology [33; 34]. Pyrolysis is the decomposition of organic compounds at high temperatures (from 200 to 600 degrees) without oxygen, and the emitted gases condense into pyrolysis fuel [35]. According to the International Energy Agency, it is planned to produce 27% of fuel in the automotive industry from waste by 2050 [36].

Worn-out car tires can become the secondary raw material that can be processed to produce pyrolysis fuel. This approach allows both finding an alternative to natural gas and reducing emissions of toxic gases into the air. As an example, due to: 1) storage – if a worn-out car tire is not disposed of, then under the influence of atmospheric precipitation and groundwater, toxic substances are removed from car tires, which cause great harm to

the environment [37]; 2) disposal of worn-out car tires by burning in the open – according to the State Statistics Service [38], 150 thousand tons are subject to disposal annually. Nothing has been growing on the site of burning worn-out car tires for ten years. Out of 1000 kg of burnt tires, 450 kg of various toxic gases, and 250-270 kg of soot [39]. It results in a high mortality rate from diseases caused by air pollution (cardiovascular and lung diseases), where according to WHO Ukraine ranks fifth. Therefore, it can be agreed that the automotive industry is a "black pollution" [40] that threatens the environment and human life.

Having analysed and performed the relevant calculations, the following advantages of using a continuous pyrolysis system for the disposal of worn-out tires for LLC "Megatex Industrial" were identified:

- availability of a market – the received fuel can be used by the entity in its production, sold to LLC "Megatex" or other customers in different regions of Ukraine;

- availability of technology – different types of such equipment is known today. LLC "Megatex Industrial" in its activities should use a continuous pyrolysis system. As an example, can be used equipment model UPP-10, offered by LLC "Research and Production Enterprise "Electric Welding Technologies of Paton" (cost – 2770397 UAH (the price includes: development of working documentation considering the basic model, considering the terms of reference; development of technological modes by the technical task; training of maintenance personnel; a package of operational documentation; warranty service – 1 year; delivery, installation and commissioning – 90-120 days); productivity – 10 tons. The equipment is modular and completely energy independent from external networks;

- ease of use – a powerful continuous pyrolysis system ensures uniform heating of the material with the subsequent production of three products: carbon black, purified metal cord, and pyrolysis fuel. The main characteristics of such equipment are automatic feeding and removal of slag, automation of production processes, high productivity, high safety, the presence of a screw conveyor, which allows mixing materials in the reactor at different temperatures;

- availability of raw materials – pyrolysis technology allows using raw materials of any degree of deterioration. The main channels for obtaining it can be: a collection of tires from landfills and in cities (after the war), removal of worn-out tires from the territory of economic entities, purchase of tires in service centres and car repair shops, organisation of points of collection of worn-out tires for the population. It will allow LLC "Megatex" to both provide itself with raw materials and draw the attention of the population to the current environmental situation;

- environmental friendliness – the continuous pyrolysis system implements an environmentally friendly waste disposal technology and is completely safe for the environment;

- state support – the state supports business entities in their activities by providing benefits for doing

business in the form of subsidies, low-interest loans, and grants for the establishment or development of the enterprise. To implement the proposed fourth scenario, LLC “Megatex Industrial” can use one of the grant programs offered by the government. As an example, the Resolution of the Cabinet of Ministers of Ukraine dated 06/24/2022 No. 739 “Some Issues of Granting Grants for Processing Enterprises”, which

approved the Procedure for granting grants for the establishment or development of processing enterprises [41];

– profitability – having estimated the costs in the amount of 8197069 UAH (Table 1), having identified the sources of funding (70% state funds – 5737948 UAH, 30% own funds – 2459121 UAH. The profitability is calculated considering the prices for the products received.

Table 1. Brief estimate of monthly expenses of LLC “Megatex Industrial” according to 4 scenarios

Indicators	Amount of financing, UAH	Amounts of financing, %
Expenses of equipment, software, materials and inventory	5540794	67.6
Labour expenses of employees of the technical department (4 persons)	150000	1.8
Expenses associated with the purchase of raw materials (based on the 50:50 principle)	15460	0.2
Expenses associated with the new jobs establishment	167430	2.0
Expenses related to training of new employees	1273385	15.5
Expenses of remuneration of new employees (40 persons)	1000000	12.2
Other expenses	50000	0.6
Total expenses	8197069	100.0

According to the data presented in Table 1. It can be estimated the profitability of the implementation of the 4th scenario, given that pyrolysis fuel is sold for 24 UAH per litre. Based on the technical characteristics of the continuous pyrolysis system of the UPP-10 model, the calculation of profitability can be performed only conditionally, since the output depends on the internal characteristics of solid waste. But, if considering the lowest figures, from 1 ton of worn tires you can get: technical carbon – 0.275 tons, pyrolysis fuel – 0.3 tons, and purified metal cord – 0.425 tons. After the calculation, it was determined that LLC “Megatex Industrial” will receive pyrolysis fuel for 2160000 UAH, purified metal cord – 1290000 UAH (provided that its cost is 10 UAH per kg). Thus, the company can receive UAH 3450000 already in the first month of operation, using a continuous pyrolysis system. The authors did not estimate the cost of carbon black, as the company can use it for its use – heating the reactor, drying the charge, and autonomous power supply.

Thus, the pyrolysis of worn-out tires is a suitable solution for LLC “Megatex Industrial” as a cheap way to obtain alternative liquid fuel in an environmentally friendly way. For the state, it is a driving force, the growing interest which can ensure the energy security of the country [42] and contribute to the achievement of energy independence in an environment free from threats and risks [43]. Pyrolysis of used car tyres will allow the safe reuse of used car tyres, and contribute to economic, social, energy and environmental welfare by converting waste tyres into fuel [44].

► Conclusions

The war in Ukraine has had adverse long-term consequences for business entities and caused serious damage to the environment. Gas is the main energy-consuming source for the production activities of economic entities, which requires reformatting the market by national interests – to eliminate dependence on russian energy carriers. In conditions of shortage of own energy resources, using alternative energy sources is especially important for business entities. For this purpose, products obtained during the disposal of worn-out car tires can be used. Pyrolysis technology offers a practical solution for converting car tires into liquid fuel. It can be considered a renewable product that has a high marketing value and establishes economic, social, environmental and energy benefits at the same time.

The research proposes an algorithm that reflects the gradual order of actions that are necessary to be implemented to achieve a balance of interests between business entities and the state in war. It is justified that its application will contribute to the solution of immediate problems that arise in business entities as a result of the adverse impact of hostilities and the achievement by the state of its national interests related to energy independence. Such an approach allowed identifying four scenarios of achieving energy independence as a way for economic entities to avoid insolvency. The most optimistic was the fourth scenario, in which the entity increases its production capacity by launching a “full cycle” production based on pyrolysis fuel. The expenses associated with the implementation of the

selected scenario are financed in the form of co-financing: 30% – own funds of the studied business entity; 70% – funds that the enterprise can receive as financial support from the state in the form of a grant. The implementation of the proposed scenario allows short-term business entities to establish new jobs, increase their production capacity, maintain solvency at the proper level, use alternative energy sources, and apply environmentally friendly methods of energy extraction. For the state, it means providing the necessary funds to the budget; increasing economic security; reducing the number of unemployed people, reducing dependence on natural energy sources, and

harmful emissions into the air; improving the security of energy supply; compliance with the rules of environmental waste disposal. Therewith, the highlighted scenario has long-term development prospects.

The conclusions, proposals and practical recommendations can serve as a foundation for achieving energy independence by the business entity while avoiding insolvency in times of war.

Further research in this area consists of the economic substantiation of the areas of increasing the profitability of economic entities using the pyrolysis method of solid waste disposal.

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Енергетична незалежність та фінансова стійкість суб'єктів господарювання в умовах війни

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► **Анотація.** Вторгнення Росії на територію України спричинило багато проблем соціального, економічного, екологічного та енергетичного характеру. Більшість суб'єктів господарювання зіштовхнулись з проблемами національного рівня, що вплинули на їх фінансово-господарську діяльність. Масовий виїзд працівників за кордон, зростання цін на природний газ, внутрішня релокація, постійні обстріли змушують суб'єктів господарювання шукати нові підходи до управління та розвитку своїх підприємств. Мета статті – обґрунтувати та апробувати науково-методичний підхід досягнення енергетичної незалежності суб'єктів господарювання як способу уникнення їх неплатоспроможності в умовах війни. Під час дослідження здійснено критичний

аналіз тематичної літератури, використано комплекс загальнонаукових і спеціальних методів дослідження: експертних оцінок, спостереження, аналогії, групування, отримання узгодженої думки, дедуктивний, індуктивного міркування, систематизації, системно-функціональний, вимірювання, аналізу, порівняння, логічного узагальнення, систематизації, гіпотези, повторюваного об'єднання незалежних сценаріїв, екстраполяції, оцінки еластичності та графічний. В дослідженні виявлено наслідки військового вторгнення на територію України, розроблено алгоритм дій під час війни. Виокремлено чотири сценарії, за яких досліджуваний суб'єкт господарювання може розв'язати назрілі проблеми. Обґрунтовано, що найкращим сценарієм є той, за якого необхідно нарощувати свої виробничі потужності, налаштовуючи виробництво «повного циклу» з використанням безперервної системи піролізу утилізації зношених автомобільних шин. Доведено раціональність її використання. Удосконалено науково-методичний інструментарій взаємодії суб'єктів господарювання та держави під час війни на основі системного підходу, який, на відміну від наявних, поглиблює важливість зміщення центру ваги з макро- на мікрорівень та базується на запропонованому алгоритмі дій (виявлення проблеми, розробка можливих сценаріїв її негайного вирішення, відповідність обраного сценарію національним інтересам держави, знаходження джерела фінансування реалізації одного із сценаріїв), що визначає найбільш оптимістичний сценарій балансу інтересів між суб'єктами господарювання та державою в умовах, що склались. Практична цінність запропонованого полягає у виявленні економічної, соціальної, екологічної та енергетичної ефективності розробленого алгоритму дій на практиці, на прикладі фінансово-господарської діяльності суб'єкта господарювання. Такий підхід, з одного боку, дозволяє досягти енергетичної незалежності найближчим часом та є способом уникнення неплатоспроможності суб'єктів господарювання в умовах війни. А з іншого – має стати надійною базою для вітчизняної економіки в період післявоєнної відбудови

► **Ключові слова:** неплатоспроможність, фінансовий стан, екологічна утилізація, фінансово-господарська діяльність, виробнича потужність, альтернативні джерела енергії, природний газ



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Impact of Martial Law on Development Financial Mechanism of the Agricultural Sector of Ukraine

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► **Abstract.** Martial law and hostilities on the territory of Ukraine have an unprecedented devastating impact on the national economy. There is a restructuring of management and financial regulation to preserve statehood and security. The purpose of the article is to summarize the state of the financial mechanism in the agrarian sector of Ukraine, primarily on the example of its budgetary instruments, in a war economy. A monographic method was used to review scientific publications and the regulatory framework, system analysis and synthesis to display the dynamics of indicators for the object of study. The methodological foundations of the functioning of the financial mechanism of the agricultural sector are summarized through its structural levels, strategy and tactics, methods, levers and tools. The definition of the categories of the financial mechanism, financial instruments of the financial and agricultural markets has been clarified, their connection with agricultural policy has been highlighted. The structure of the regulatory field, according to which the financial mechanism of agrarian policy is regulated under martial law, is determined. The state of the financial market of Ukraine, the structure and volume of its resources for the period of conducting the hybrid military aggression of the Russian Federation are analyzed. The state of the financial mechanism of the agricultural sector in 2013-2022 is highlighted. for financial instruments and components of budget support, lending, fiscal and price regulation, capital consumption, capital investment; connection of the volumes of financial resources of industry corporations with the results of activities in terms of profitability. The financial instruments of international assistance for the economy and the agricultural sector of Ukraine are summarized. The novelty of the study is the systematization of the features of the financial mechanism and its constituent instruments for the agricultural sector of Ukraine under martial law and the forecast of the volume of financial potential for 2022 by individual components. The directions of transformation of the financial mechanism for post-war reconstruction are outlined. It is shown that a significant criterion for the impact of agricultural policy on financial processes is the growth of qualitative characteristics of the mechanism for their implementation, primarily the expansion of the regulatory field for the formation of financial resources and attraction of investments, the simplification of agricultural business, the expansion of logistics and ways of marketing products, the formation of food balances, export-import operations. Separate results of the study in terms of determining the structure and volume of the financial potential of the directions for further transformation of the financial mechanism can be used in the formation of the financial component of the Strategy for the post-war recovery of the economy of Ukraine

► **Keywords:** agrarian policy, agricultural sector, budget support, lending, financial mechanism, financial market, financial instruments, post-war reconstruction strategy

► Introduction

Under martial law, the role of state financial regulation is significantly strengthened. The current models are transformed by adapting the financial mechanism and its instruments exclusively to ensure national security. It provides for the redistribution of state and public funds for priority measures, primarily financial, foreign economic, energy and food

security through appropriate models of their implementation.

Economic entities of Ukraine are experiencing a lack of resources, which is a consequence of the destruction, termination or decline of business activity of enterprises, forced relocation, loss of human, physical and financial capital, reduction of market

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institutions, deterioration of the investment climate, destruction of communications, logistics. The agricultural sector continues to work even in the conditions of war, but its financial mechanism faces great challenges, as the domestic market is weak and the state does not have significant resources that can be used to restore and support the activities of corporations. Thus, it is essential to explore the financial mechanism of guaranteeing food security under martial law, which includes a wide range of issues and interconnected links.

The purpose of the study is to summarise the specific features of the financial mechanism for the agricultural sector of Ukraine and to analyse the impact of the introduction of the legal regime of martial law on its structure. The objectives are: clarification of the essence of the category "financial mechanism", determination of its structure through financial instruments; establishment of links between the financial mechanism and agricultural policy, in particular on the example of budget, credit, and price support (2013-2022); analysis of the structure of the financial mechanism by components of the financial potential of the industry; determination of areas for post-war development of the financial mechanism.

The state and development of the financial mechanism under martial law are explored by scientists, analytical centres, and public platforms and are reflected in the adoption of legislative acts and the preparation of new ones, which together affect the development of financial policy. Ukrainian scientists A. Bilochenko, I. Gushcha [1], O. Halytskyi [2], M. Latynin, T. Kharchenko [3], O. Kvasnytsia, T. Nekliudova [4] covered the organisational aspects of financial support and the mechanism of state regulation of the agro-industrial complex; I. Hryshchenko, T. Kovtun [5] – state support for business; V. Demianyshyn and Z. Lobodina [6] – development of the financial mechanism in the context of reforming the financial system of Ukraine; Ya. Dropa [7], A. Mykhailov [8] – financial instruments for the development of resources in the context of globalisation; N. Tanklevska, O. Synenko [9] – possibilities of adapting the foreign experience to improve the financial mechanism of functioning of agricultural enterprises; N. Trusova et al. [10] – financial mechanism as a tool for ensuring sustainable development of agricultural enterprises. L. Tulush et al. [11; 12] – analysis of fiscal instruments for the agricultural sector; S. Petrukha et al. [13] – sustainable development purposes and triggers for the

modernisation of public finance; V. Shaleny et al. [14], L. Tytarenko, V. Yatsenko [15] – issues of financial support for business during the war, etc.

Researches of M. Behnassi, M. Haiba [16], T. Benton et al. [17] T. Glauben et al. [18] focus on the consequences of the Russian-Ukrainian war for global food security; M. Buti, M. Messori [19] – on the role of the central fiscal potential in combining the EU's domestic and global agenda, etc. However, researchers have not sufficiently covered the aspects of the financial mechanism and its instruments in the agricultural sector under martial law, as hostilities continue, deepening losses and worsening forecasts of recovery resources, which is the object of this study.

► Materials and Methods

The monographic method was used for the review of scientific publications and systematisation of the regulatory framework for agricultural policy and the corresponding financial instruments, system analysis and synthesis for the classification of financial instruments of the agricultural sector, a graphical method for displaying the dynamics of the studied indicators, a statistical method for identifying the efficiency of financial instruments and their integration into the structure of the financial market, abstract-logical method for theoretical generalisations and conclusions.

The study is based on the definition of the essence of the financial mechanism, generalised by researchers [4, p. 150; 7, p. 682;] with the development of the hypothesis that the financial mechanism is a set of forms, methods, and levers of regulatory and information support for the establishment and management of financial resources for the needs of stakeholders in the financial market and the national economy.

For the study, the methods and levers of the financial mechanism are designated as financial instruments. Then, the schematic diagram of the financial mechanism as a link to financial policy (Fig. 1) will act as a practical implementation of financial strategy and tactics, which has its structure. The financial mechanism is essentially institutional, it connects economic, social, political, ethical, legal, and other problems and has various manifestations at the level of the state, the financial market, sectors of the economy and corporations, and the population.

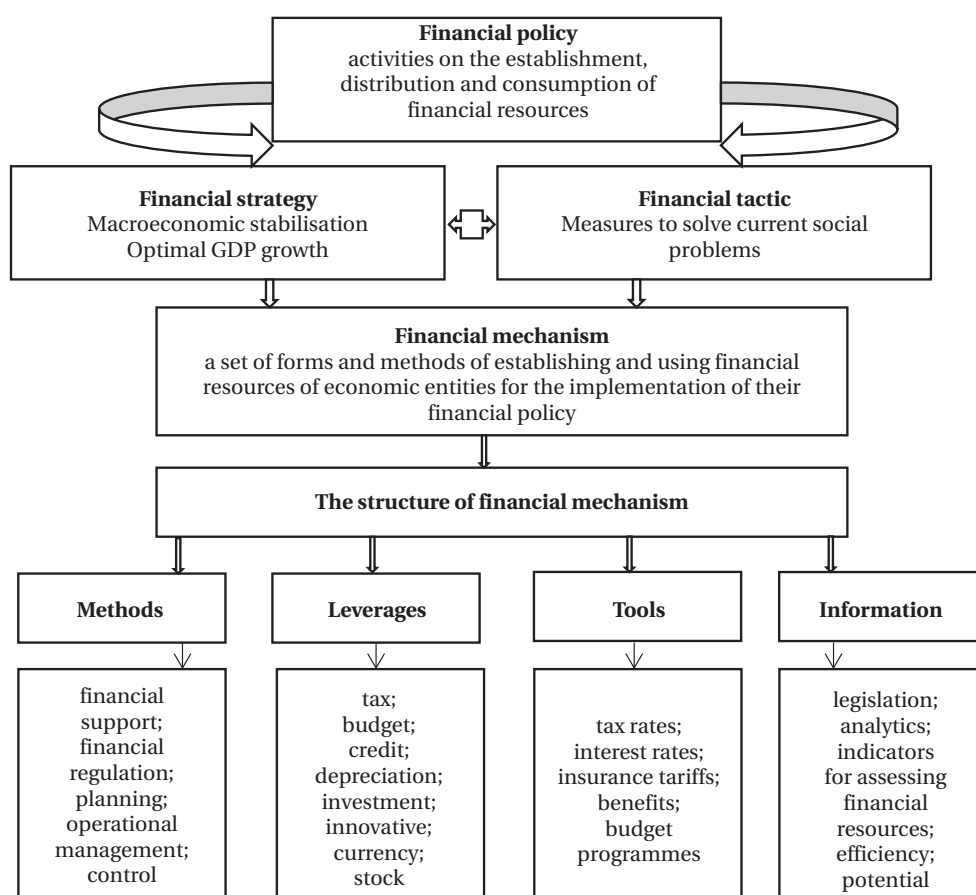


Figure 1. Structural links between financial mechanism and financial policy

Source: developed by the authors based on the research of O. Kvasnytsia, T. Neklyudova [4]

The financial mechanism of the agricultural sector is defined as a set of organisational, regulatory, and managerial measures to maintain the balance of financial resources of corporations and the industry to optimise financial flows (redistribution of financial resources). It is implemented in the financial market and has appropriate methods and levers.

Financial instruments are specific products, in the form of a contract/agreement that is used to attract financial resources and allow the state and business entities of the agricultural sector to expand sources of investment.

The research of the financial mechanism involves its qualitative and quantitative assessment. Such an assessment in the pre-war practice of Ukraine was implemented through financial stability management indicators by the Strategy for the Development of the Financial Sector of Ukraine until

2025. It is based on the mutually agreed application of instruments of the monetary, budgetary, and tax sectors, debt, currency, and exchange rate policies. With the beginning of the implementation of martial law, the NBU adopted the Basic Principles of Monetary Policy for the period of martial law, which summarises the strategic course of regulators that correspond to economic realities.

The government of the country pursues a policy of promoting the development of the domestic financial market, which restrains the economic decline, and activates investment processes. The study is based on the legislative framework, calculations, and forecasts of the Government of Ukraine and international organisations regarding the state of the research object. In particular, several key legislative initiatives for organisational and financial support of the agrarian sector and food security are presented in Table 1.

Table 1. Legislative initiatives to support the agricultural sector during the period of martial law

Document	Contents on support for the agricultural sector
Decree of the President of Ukraine No. 64/2022 "On the Introduction of Martial Law in Ukraine" (2022, February)	Development of financial powers and other measures related to the introduction of martial law
Law of Ukraine No. 7137-d "On Amendments to the Tax Code of Ukraine and Other Legislative Acts of Ukraine Regarding the Validity of Provisions for the Period of Martial Law" (2022, March)	The amendments provide for: establishing the specific features of single taxation; setting the rate of excise tax on fuel; abolition of land tax

Table 1, Continued

Document	Contents on support for the agricultural sector
Law of Ukraine No. 2145-IX "On Amendments to Certain Legislative Acts of Ukraine on Establishing Conditions for Ensuring Food Security under Martial Law" (2022, March)	The priority of public (state) interests in the conditions of war is established. It defines the conditions of land use for agricultural production, and infrastructure placement
Resolution of the Cabinet of Ministers of Ukraine No. 274 "On Amendments to Certain Acts of the Cabinet of Ministers of Ukraine on Providing Credit Support to Agricultural Producers" (2022, March)	The financial mechanism for providing soft loans to small and medium-sized agricultural producers has been improved
Resolution of the Cabinet of Ministers of Ukraine No. 312 "On Amendments to the State Program "Affordable Loans "5-7-9%" (2022, March)	Financial instruments of credit support for agricultural producers for sowing and other necessities have been introduced
Resolution of the Cabinet of Ministers of Ukraine No. 438 "Some Issues of Financial Support for Entrepreneurship, in Particular Agricultural Producers, under Martial Law" (2022, April)	The decision to allocate the remaining funds of the special fund to the programs: "Governance and management in the agricultural sector", "Land inventory", and "Measures to improve access of agricultural SMEs to export markets"
Resolution of the Cabinet of Ministers of Ukraine No. 918 "On Approval of the Procedure for the Use of Funds Provided in the State Budget for the Provision of Support to Farms and Other Agricultural Producers" (2022, August)	The State Agrarian Register has opened registration for farmers (1-120 hectares) to receive support for 1 hectare (not more than UAH 372 thousand); and for 1 cow (UAH 5.3 thousand)
Resolution of the Cabinet of Ministers of Ukraine No. 7465 / No. 7465-1 "On Amendments to Certain Legislative Acts of Ukraine on Peculiarities of the Financial Sector Activities in Connection with the Introduction of Martial Law in Ukraine"	Supporting the stable operation of the financial sector during the war. Loans restructuring. Abolition of the requirement to guarantee monetary claims by first-class banks for foreign investment
Decision of the Council of the National Bank of Ukraine "Basic Principles of Monetary Policy for the Period of Martial Law" (2022, April)	The National Bank determined the basic principles of functioning of the banking and financial system of the country to provide for the economy and defence requirements

Source: summarised by the authors according to the above regulations [20]

The financial crisis in the agricultural sector of Ukraine caused by the war requires the development of sufficient financial resources and efficient management of financial flows. The development of the financial mechanism of the agrarian sector in terms of regulatory support is focused on lending under state guarantees, establishing logistics routes for the sale of agricultural products, and simplifying the issuance of permits. The Government has adopted several regulations to support farmers through partial guaranteeing of loans from commercial banks for sowing campaigns; cancellation of additional procedures for certification of seed material; permission to operate agricultural machinery without their registration for the period of martial law; reduction of VAT on fuel; expansion of the list of critical imports; provision of humanitarian assistance in terms of fixed and circulating assets; expansion of logistics capabilities, etc. During martial law, an agricultural platform was launched to collect the actual requirements of farmers, and an online platform was established to improve logistics routes. The financial mechanism for supporting the agricultural sector, presented by the relevant ministry [21], includes levers: budget process, taxation, financing from the state budget, lending, agricultural insurance, and price support. Currently, developments and search for options to expand financial and material support for agricultural producers continue.

Analysis of the legislative field demonstrates that the financial mechanism for supporting the agricultural sector under martial law can be conditionally

divided into blocks: straight financial support through budget financing, lending, insurance, and organisational (implicit, regulatory) support to preserve the structure of the industry and its horizontal-vertical relations through taxation, tariffs, price regulation; investments, regulation of capital consumption, etc. These blocks have specific sets of levers and financial instruments. According to the disclosed methodological approach, the study analyses mainly financial instruments of the first block, in particular, budgetary ones.

► Results and Discussion

The International Monetary Fund [22] forecasts a 35% drop in Ukraine's economy in 2022. As for the agricultural sector, the risks are even greater, in particular, the level of food security according to the analysis of the food availability index has already decreased by almost 50% [23]. According to [24], the number of industry losses for six months amounted to \$ 4.29 billion, or almost 7.8% of the financial resources of the period 2021. According to scientists of the NSC IAE, direct losses of the agricultural sector exceed \$ 6 billion, additional economic losses – up to \$ 22 billion, and from the decline in revenues in the agro-industrial chain – up to \$ 30 billion, the volumes of which are increasing with the conduct of hostilities [25]. In total, the losses amount to USD 58 billion, or UAH 2300 billion. For comparison, the total output of agriculture according to the balance of production and income generation accounts (in actual prices) in 2021 amounted to UAH 1366 billion, or

59% of the industry's losses, and the average annual output for 2014-2020 was 70%. The volume of financial resources of agrarian corporations (according to the financial balance sheet) in 2020 amounted to 1130 billion UAH, or 49% of losses, and the average annual level of financial resources for 2013-2020 – 38% of losses incurred from military aggression. To reduce the decline in production indicators, the level of income of agricultural corporations, the alignment

of food security in terms of availability and accessibility of food, and appropriate compensation mechanisms, primarily financial instruments, are required.

The financial mechanism of the agricultural sector is a component of the national economy. Its condition is determined by the total volume and availability of resources of the financial market of Ukraine, the structural components and dynamics of which for the period 2018-2022 are presented in Fig. 2.

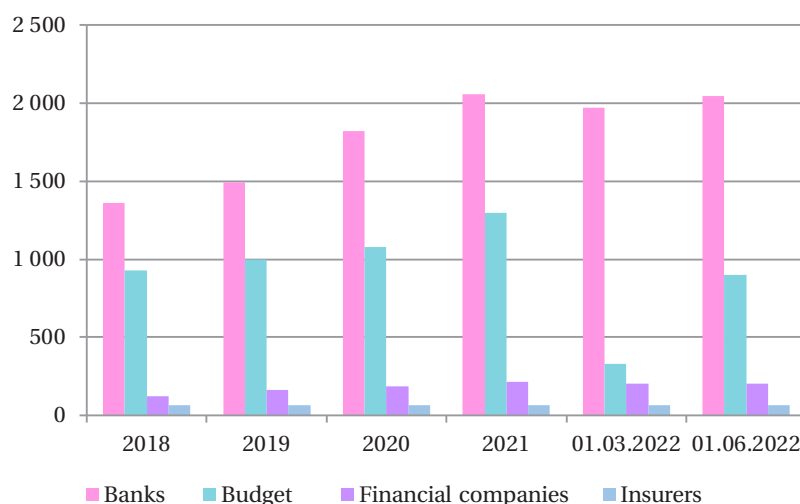


Figure 2. Dynamics of financial market resources in Ukraine for 2018-2022, UAH billion

Source: developed by the authors based on the NBU data [26]

According to these data, in 2018 the volume of financial resources of the market (including state budget resources) amounted to UAH 2476 billion, in 2021 – UAH 3629 billion, or 47% more. In the first quarter of 2022, resources decreased almost to the level of 2018, but already in the 2nd quarter of 2022, they increased by almost 30% compared to the level of 2018, and compared to the level of 2021 they are only 12% lower, not 29%, as it was in the 1st quarter of 2022. Thus, the relevant measures implemented by the Government and the NBU allowed partial stabilising of the financial system and state budget revenues, which is the greatest achievement of state regulation under martial law.

According to the State Tax Service [27], for 2 quarters of 2022, the State Budget revenues amounted to UAH 418.1 billion, which is 23.3% more than the corresponding period of the previous year. The state budget was executed with a deficit of UAH 412.0 billion against the planned UAH 743.4 billion for this period. The state borrowings for this period amounted to UAH 613.8 billion, 66% of which are domestic government bonds. Before the war, the state budget was more or less balanced, but now tax revenues cover only about 40% of public spending. Therewith, military expenditures account for more than 60% of the budget [12], and their financing through external borrowing is limited. Therewith, the monthly financial demands of the government are estimated at USD 5 billion.

Thus, since the beginning of the large-scale aggression of Russia against Ukraine, the support of the government by the National Bank has become the main one, but in the future, it is planned to increase alternative financing of the budget deficit from other sources, such as attracting international and market financing. The NBU summarises that the current model of managing the financial system of the state is based on the following principles: financing the budget deficit by issuing; maintaining low yields of hryvnia government bonds; fixing the exchange rate and strengthening currency restrictions [28]. In general, the Government's forecasts for the implementation of the budget for 2022 are moderately pessimistic. The presentation of information on existing fiscal risks in public finance increases the degree of validity of financial policy decisions in the agricultural sector.

The dynamics of resources of agricultural enterprises according to their financial balance sheet (Fig. 3) demonstrates a steady increase in the volume of financial resources, in particular at the end of 2021 to 1306 billion UAH, which is 4.2 times higher than in 2013. An increase in profitability is noted – from 30% in 2015-2017 to 40.3% in 2021, but a decrease is expected in 2022 [29]. Producers predict that without the establishment of logistics, none of the crops will be profitable, and taking into account the prices of fertilizers, PPE, fuel, collection services, etc., breaking even is optimistic [30].

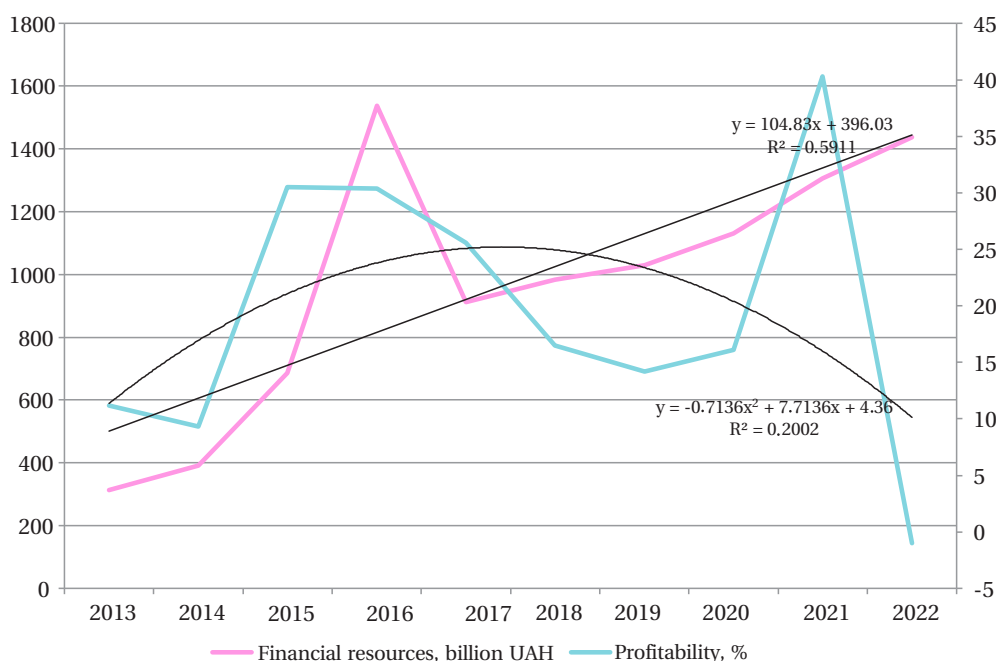


Figure 3. Dynamics of financial resources and profitability of activities of agricultural enterprises of Ukraine for 2013-2022, UAH billion, %

Source: developed by the authors based on the data of the State Statistics Service [31]

Note: *2022 – forecast

The reason for the low efficiency of the financial mechanism of the agricultural sector is primarily due to the fact that the state support of the industry during this time was unstable (Fig. 4). For the period 2014-2022,

support from tax privileges prevails, which in 2020 harmoniously aligned with price support but later again outstripped it. In forecasts [30] for 2022, state support by species was expected at the level of 2021.

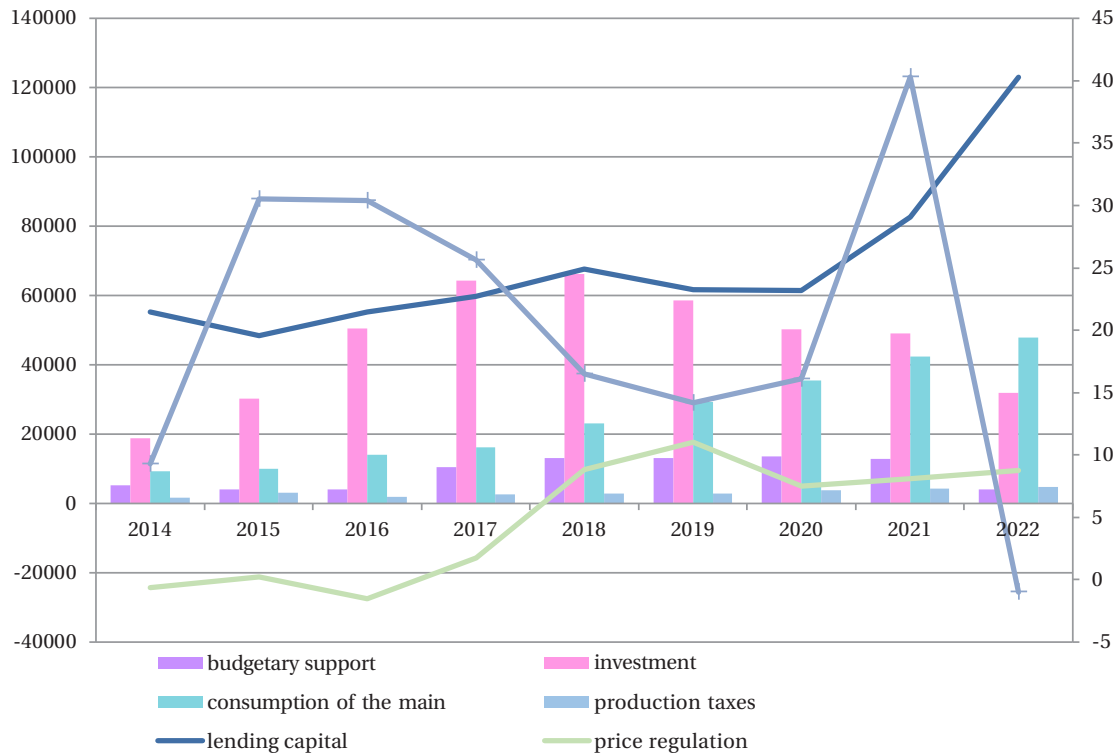


Figure 4. Dynamics and structure of individual instruments of the financial mechanism of the agricultural sector of Ukraine for 2014-2021, UAH million

Source: developed by the authors based on [21; 28; 29]. The level of budget support is given according to the functional expenditures of the state budget for the industry, production taxes – according to the macroeconomic accounts of the industry [31], and price support – according to the OECD [32]

Note: *2022 – forecast

A specific share in the structure of the financial mechanism of the agricultural sector is budget financing, but now its volumes mainly rely on the capabilities of the State Budget, which are very limited. Since 2017, funding has almost steadily reached UAH 12 billion per year. However, these funds, even if allocated in full in 2022, are not significant for the industry, compared to the losses already incurred as a result of hostilities. For 2022, the agricultural budget was adjusted downward from UAH 6.78 billion to UAH 1.95 billion, or by 71.4%. Over the two quarters, the sector was financed by UAH 685 million, which is 35.2% of the adjusted annual financing plan. Therewith, additional amendments have been introduced to the provisions of the Law of Ukraine "On the State Budget of Ukraine for 2022", in particular regarding the support of farms and other agricultural producers. The new program of assistance to small agricultural producers provides UAH 1.5 billion, which is financed with the support of the EU. Thus, the volume of agricultural expenditures in the state budget has been increased to UAH 2.118 billion.

As for financial lending instruments, the volume of loans granted in 2 quarters of 2022 reached UAH 123 billion, while for the entire 2021, it amounted to UAH 61.5 billion, an increase of 2 times. The Government pays particular attention to microcrediting of small and medium-sized enterprises, in particular through the program "Affordable Loans 5-7-9%", which has been amended, and the lending objectives are focused on investment loans for the purchase of agricultural machinery, loans to replenish working capital for the purchase of seeds, fertilisers and fuel, and lubricants. According to the Ministry of Agrarian Policy, for the 2 quarters of this year, 28.5 thousand corporations attracted 50.752 billion UAH of loans, the largest volumes of which are in Kyiv (4.21%), Vinnytsia (3.34%), Khmelnytsky (2.19%) regions [21].

The impact of martial law on the structure of the financial mechanism of the agricultural sector of the Ukrainian economy is manifested in the redistribution of its components. The structure of agrarian financial resources in 2017 in terms of financial potential for 1024 billion UAH (37 billion USD), 90% consisted of own resources of corporations [33]. During the introduction of martial law in 2022, the financial potential of the industry is projected at UAH 1645 billion (\$ 41.1 billion), where the share of own resources of corporations has decreased to 82-87%, which is close to the level of the crisis of 2012-20214. In the forecasts for 2022 (Figs. 3; Fig. 4), the volume of own resources of agricultural corporations, price, investment, and tax components of financial potential are determined according to the actual state at the end of 2021, with the adjustment of budget support from 13.4 billion UAH to 4 billion UAH, price support from 4.6 billion UAH to 9.6 billion UAH, and actual lending for 2 quarters.

Own and attracted financial resources in 2022 are critically insufficient to compensate for losses and level the development of the agricultural sector under martial law. Thus, the Government is

negotiating and hoping for international donor support. In particular, a probable scenario for Ukraine is the experience of supporting the economies of new EU member states. Programs – financing instruments were provided for Poland and Hungary: PHARE (economic restructuring), SAPARD (support for rural development), and ISPA (infrastructure development) [32]. As a country that received the status of a candidate for EU membership on 06/23/2022, Ukraine gains the opportunity to receive financial assistance under the Instruments of Pre-Accession, IPA through grants, investments, technical assistance, and participation in EU programs and initiatives [34].

When developing the budget for 2023, the Government stated that Ukraine requires \$38 billion to cover the budget deficit, which it hopes to attract from international partners – the US, the EU, and the IMF. In addition, based on the assessment of losses, a budgetary Fund for the elimination of the consequences of armed aggression can be established, the sources of which will be confiscated funds of the Russian Federation [35]. Currently, new cooperation areas with Ukraine are offered by the European Investment Bank; the well-known investment company BlackRock, the International Finance Corporation (IFC) from the World Bank group, etc.

Therefore, it is natural that the vector of influence of agrarian policy on financial processes under martial law is to increase the share of market resources and international loans, the second block of the financial mechanism. State regulation of the financial mechanism of the agrarian sector contributes to the growth of qualitative organisational features of the financial potential, without which agrarian entrepreneurship is impossible: expansion of the regulatory field for the development of financial resources in terms of customs, tax, budget, investment regulation, simplification of agricultural business, expansion of logistics and marketing routes, development of food balances, export-import operations, mitigation of inflation and currency pressure, etc. [36].

Further development of the financial mechanism of the agricultural sector involves its integration and interaction with the Post-War Recovery Strategy of Ukraine. To implement the strategic purposes and objectives set before the agricultural sector by the wartime challenges, its financial mechanism requires a transformation of methods, tools, and levers. They have to solve the problems of stabilisation of financial capital, sufficient financial resources for reproduction of production and food security, growth of agricultural investments in the war and post-war periods, and entry into the EU financial system through financial market components and special programmes of state and international support. For the effective implementation of financial policy on the development of the financial mechanism, it is necessary to coordinate the work of agrarian corporations, the branches of government involved, and proper regulatory support in terms of guaranteeing investment, taxation, lending, insurance, income support, sales, export, logistics, etc.

Thus, the financial mechanism of the agricultural sector of Ukraine during the period of martial law is described by the fact that the Government, in response to the threats, expanded the existing and introduced new financial instruments to support farmers through regulation of prices for components of production costs; simplification of taxation; guaranteeing budget support; attracting international public and private donor assistance and borrowing; partial guarantee of compensation for loans from commercial banks; projects of organisational and permissive nature; stimulating the preservation and maintenance of human, material and financial capital. In addition, indirect organisational instruments of support are the provision of humanitarian assistance in terms of fixed and circulating assets; targeted support to individual industries, farms, value chains, development of logistics, etc.

► Conclusions

The financial mechanism of the agricultural sector of the Ukrainian economy during martial law solves the problems of stabilisation primarily through financial levers and instruments of state support. Its transformations are mainly related to the requirements: compliance of financial instruments of the industry with the main trends of the financial market; focus on achieving the strategic purpose of agrarian development; focus on the development of balanced sources and necessary volumes of financial resources for the industry.

The originality of the study is the generalisation of the features of the financial mechanism and its constituent instruments for the agricultural sector of Ukraine under martial law and the forecast of the financial potential for 2022 by individual components. If in the pre-war period 90% of the financial resources of the agricultural sector were accounted for by producers' resources, in 2022, it is expected that their share may be at most 82-87%, as in the financial crisis of 2014.

The practical value of the study is that the limited budget resources pose great challenges to agricultural policy, which are systematised by vectors of direct and indirect financial regulation. Since the agricultural budget of the current year has been

reduced by more than 70%, the regulatory mechanisms of indirect influence on financial resources are becoming more critical. All the efforts of the government are designed to facilitate access to financial market resources, primarily lending, attracting international assistance, expanding exports through the development of logistics, new markets, new niche products, stimulating the development of livestock on its feed base, etc.

It is demonstrated that an essential criterion for the impact of agrarian policy on financial processes is the growth of qualitative characteristics of the mechanism of their implementation, primarily the expansion of the regulatory field for the development of financial resources and investment attraction, simplification of agricultural business, expansion of logistics and marketing routes, development of food balances, export-import operations with a tendency to a commodity rather than a raw material assortment.

The post-war strategy of agrarian development of Ukraine will require the involvement of all mechanisms of the financial market. The reconstruction should involve both Ukrainian and international financial instruments, using the experience of European and other countries where the agrarian sector and its logistics structure were destroyed by military conflicts. Such experience can be useful for the domestic agricultural sector in terms of attracting international assistance for recovery, capital investment under state guarantees, structural organisational restructuring of the industry, horizontal and vertical linkages, balancing the development of crop and livestock production, shifting the emphasis on commodity rather than raw material production, expanding markets, etc. Thus, the specific features of the process of developing new instruments and sources of financing in the agricultural sector are areas for further research on this subject.

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Вплив воєнного стану на розвиток фінансового механізму аграрного сектору України

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► **Анотація.** Воєнний стан та бойові дії на території України чинять безпрецедентний руйнівний вплив на національну економіку. Відбувається перебудова управління та фінансового регулювання задля збереження державності та національної безпеки. Мета статті – узагальнити стан фінансового механізму в аграрному секторі України, насамперед на прикладі його бюджетних інструментів, в умовах воєнної економіки. Використано монографічний метод для огляду наукових публікацій та нормативної бази, системний аналіз та синтез для відображення динаміки показників щодо об'єкту дослідження. Узагальнено методичні засади функціонування фінансового механізму аграрного сектору через його структурні рівні, стратегію та тактику, методи, важелі й інструменти. Уточнено визначення категорій «фінансовий механізм», «фінансові інструменти» фінансового та аграрного ринків, висвітлено їх зв'язок з аграрною політикою. Визначено структуру нормативного поля, за якими здійснюється регулювання фінансового механізму аграрної політики в умовах воєнного стану. Проаналізовано стан фінансового ринку України, структуру та обсяг його ресурсів за період ведення гібридної військової агресії РФ. Висвітлено стан фінансового механізму аграрного сектору в 2013–2022 рр. за фінансовими інструментами та складовими бюджетної підтримки, кредитування, фіскального та цінового регулювання, споживання капіталу, капітальних інвестицій; зв'язок обсягів фінансових ресурсів галузевих корпорацій з результатами діяльності за рівнем рентабельності. Узагальнено фінансові інструменти міжнародної допомоги для економіки та аграрного сектору України. Новизною дослідження є систематизація особливостей фінансового механізму та його складових інструментів для аграрного сектору України в умовах воєнного стану та прогноз обсягів фінансового потенціалу на 2022 рік за окремими складовими. Окреслено напрями трансформації фінансового механізму для поствоєнного відновлення. Показано, що вагомим критерієм впливу аграрної політики на фінансові процеси є зростання якісних характеристик механізму їх реалізації, насамперед розширення нормативного поля щодо формування фінансових ресурсів та залучення інвестицій, спрощення ведення аграрного бізнесу, розширення логістики та шляхів збуту продукції, формування продовольчих балансів, експортно-імпортних операцій. Окремі результати дослідження, в частині визначення структури та обсягів фінансового потенціалу, напрямів подальшої трансформації фінансового механізму можуть бути використані при формуванні фінансової складової Стратегії повоєнного відновлення економіки України

► **Ключові слова:** аграрна політика, бюджетна підтримка, кредитування, фінансовий ринок, фінансові інструменти, стратегія повоєнного відновлення



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Instruments and Resources for Sustainable Development Acceleration of Agribusiness in Ukraine

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► **Abstract.** Agribusiness in Ukraine takes one of the most important places in the national economy, but not all subjects conduct it sustainably, because of the lack of resources to finance such transformations. Therefore, it is necessary to investigate the instruments of resource attracting for Sustainable Development Acceleration of Agribusiness in Ukraine. The aim of the article is to determine the current state of basic tools which are used to obtain resources for accelerating the sustainable development of agribusiness in Ukraine, namely agriculture insurance, green bonds and impact investment. The article uses a situational analysis, a monographic method, tabular and graphical methods, scientific generalization to analyze the experience of the use of agriculture insurance, green bonds and impact investment as tools to accelerate the sustainable development of agribusiness. The information sources for this research were the reports of the International Finance Corporation, the sustainability reports of the European Bank for Reconstruction and Development and the reports of the United Nations Development Program in Ukraine. The study of the practice of using agriculture insurance, green bonds and impact investment as tools to accelerate the sustainable development of agribusiness in Ukraine made it possible to determine the embryonic level of their use. This is indicated by the modeling of the development of the agriculture insurance in Ukraine, which showed that this type of insurance is formal and does not perform a real protective function. As for projects, the resources of which are attracted through green bonds and impact investment programs, they are fragmentary and need to be more systemic. This work is one of the first which looks into the practice of applying tools to accelerate the sustainable development of agribusiness in Ukraine, in the context of three dimensions and achieving sustainable development goals. For the further development of both agriculture insurance and green bonds, it is necessary to stimulate the emission of such debt securities by insurance companies and to develop not only insurance of primary agricultural products, but also processed ones, exporting of which brings more foreign exchange earnings to Ukraine. This study aims to highlight current practices in the application of tools to accelerate the sustainable development of agribusiness in Ukraine, including agriculture insurance, green bonds and impact investment, which represent the basis for their promotion and prevalence in the scientific community and among agribusiness professionals

► **Keywords:** agriculture insurance, green bonds, impact-investment, sustainability, Sustainable Development Goals, agricultural, food security

► Introduction

Ensuring the sustainable development of agribusiness is directly implemented within the framework of Sustainable Development Goal 2 "Eradication of hunger, ensuring food security and improving nutrition, promoting sound agriculture". However, any goal of sustainable development from the economic, social or environmental dimension can be implemented in the field of agribusiness. For example, Goal 3 "Good Health and Well-Being", Goal 4

"Quality Education" correspond to the social dimension of sustainable agribusiness development in the context of providing affordable and quality medical and educational services to the rural population, which is mostly engaged in agribusiness. Regarding the ecological dimension of sustainable agribusiness development, the goals such as 6 "Clean water and good sanitation", 15 "Protection and restoration of terrestrial ecosystems" are aimed at wastewater

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treatment and prevention of water pollution, restoration of degraded lands and soils, including lands affected by desertification, drought and floods. Regarding the economic dimension of sustainable agribusiness development, the following Goals 8 “Decent Work and Economic Growth”, 9 “Industry, Innovation and Infrastructure”, 12 “Responsible Consumption and Production” are aimed at creating jobs in rural areas, developing road and transport infrastructure in rural areas, reducing plowing of agricultural lands and their contamination with chemical fertilizers, observing crop rotations to prevent depletion of agricultural lands, etc. In order to achieve any goal, it is necessary to attract resources. Various tools are used for this: loans and debt securities, which are not always available due to terms and price for agribusiness entities. That is why at the initiative of international financial organizations in the late 2000s, the first green bonds appeared to finance green projects aimed at mitigating and adapting to the effects of climate change, in particular due to greenhouse gases, as well as preventing environmental pollution. In general, any type of economic activity can potentially lead to adverse environmental, social effects or some other unpredictable negative consequences. Thus, it is necessary to pay attention to investment, the main motive of which in terms of the traditional approach is to make a profit. However, in today's reality, new approaches that focus not only on financial performance, but also on ensuring positive social and environmental effects are emerging. Such investments are classified as impact investments.

Insurance is a unique tool used to finance the recovery of the situation in case of various types of risks that cause insured events. Thereby, due to the variety of insurance services, insurance is a tool to achieve sustainable development of agribusiness in the context of all dimensions. However, this tool is also not completely affordable for the price and compliance of insurance products with the needs of agribusiness entities in Ukraine.

Without reference to a specific activity, i.e., more generally, when considering ways to transition to a green economy and sustainable development, scientists suggest using FinTech [1]. FinTech is an industry that uses technology to provide financial services that can bring closer and expand access to financial resources to achieve goals, including sustainable development ones. One of the important financial services for the smooth operation of agribusiness is agriculture insurance [2], which can also be carried out on the basis of FinTech. This is noted by R. Hinson, R. Lensink, A. Mueller, who consider the transformation of agribusiness in developing countries in the context of achieving interconnected SDG groups through the integration of FinTech with other technologies, including green technologies. The authors emphasize that “FinTech can help increase the adoption of available index insurance by integrating innovations in the data infrastructure to improve the correlation of index insurance payouts

with actual damage” [3]. This is a logical recommendation, as the main obstacle to the mass use of index agriculture insurance is the risk of the base, i.e., when the farm has an insured event, but the average data for the area does not show a serious decline, so the farm does not receive insurance compensation. Innovative tools for long-term financing of sustainable development projects, in particular in the field of agribusiness, but without FinTech elements, include green bonds. The first green bonds were issued by international financial institutions, including the European Investment Bank in 2007, the World Bank (WB) in 2008, and the European Bank for Reconstruction and Development (EBRD) in 2010. However, today “green bonds have become a popular financial instrument to be used by various development banks, state and municipal entities, as well as private companies for issuing capital for green investments in order to... accelerate the global transformation towards resource-efficient and low-carbon sustainable economies” [4]. This financial instrument is issued in accordance with the Green Bond Principles (GBP), which have been revised several times, and according to their latest version, green bonds are understood as “any type of bond instrument where the proceeds or an equivalent amount will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects and which are aligned with the four core components of the GBP” [5].

A tool such as impact investment is also associated with the project approach to attract resources for the sustainable development of agribusiness. The American non-profit organization Global Impact Investing Network (GIIN) defines impact investments as investments that are made to achieve positive, measurable social and environmental impact together with financial returns [6]. The Rockefeller Brothers Fund (RBF) aims to allocate 20% of its portfolio to impact investments, as impact investments have a significant and measurable impact on the Foundation's mission to promote social change for a fairer, more sustainable and peaceful world [7]. At the same time, the Fund characterizes impact investments as investments that bring a market level of income. T. Bush, R. Bauer and M. Orlitzky define impact investments as investments that include environmental, social, and managerial aspects in investment decisions [8]. J. Simon and J. Barmeler note that impact investments are focused on sectors that have a significant positive impact on the recipients' quality of life [9]. However, unlike non-governmental organizations that provide development assistance, impact investments are for-profit and do not largely depend on external subsidies to support their activities. Impact investors operate on the plane of two opposing goals, applying market-based, profitable models that provide both social benefit and positive financial return. In economic theory and practice, approaches to the interpretation of the essence of impact investment are not fundamentally different. Emphasizing their social and environmental orientation, it is

important to note that these are still different areas of market investment, which are aimed at obtaining the appropriate financial result.

The purpose of the article is to find out the real situation as for instruments that are vital in the context of resources attracting for accelerating the sustainable development of agribusiness in Ukraine, namely agricultural insurance, green bonds and impact investment.

For achieving this goal, the next tasks are necessary to perform:

- describe documents of SDGs implementation in Ukraine;
- create the model of the development of the agriculture insurance in Ukraine, as an instrument of financing losses;
- determine the level of using green bonds of the EBRD for financing green projects in Agribusiness of Ukraine;
- find out the state of prevalence of the impact investment for achieving sustainable development of agribusiness.

► Materials and Methods

Regarding the terminological apparatus in the context of distinguishing between instruments and resources, the research was guided by the fact that for obtaining any resources (financial or non-financial) it is necessary to use certain tools, including impact investment, risk-based instruments (insurance), debt instruments (loans, bonds), etc. In this article, the focus was concentrated on the period of adopting and achieving the Sustainable Development Goals (SDGs) on the example of agribusiness. Regarding

data sampling, information was used since the adoption of the SDG for an analysis of the sustainable development achievement of agribusiness in Ukraine, except agricultural insurance development modeling, where available data from 2005 to 2018 was used. Due to the fact that different types of insurance do not provide data sampling by type of activity, the analysis of the use of this tool in agribusiness used data from the International Finance Corporation only on agriculture insurance as a tool to ensure the food security and economic dimension of sustainable development of agribusiness. Among the debt instruments, only the green bonds of the EBRD were analyzed as a tool for financing long-term green projects to ensure the environmental dimension of sustainable development of agribusiness with a certain economic effect. And impact investment is dedicated to the social and environmental dimensions of sustainable development of agribusiness with a certain economic effect on the basis of the United Nations (the UN) Development Program in Ukraine.

► Results and Discussion

The implementation of the concept of sustainable development in the world has gone through several stages: from the concept development to the Millennium Development Goals [10] and from the Millennium Development Goals to 17 SDGs [11]. Ukraine has joined the achievement of the SDGs, adapting them to the current situation regarding the dimensions of sustainable development – economic, environmental and social, as indicated in a number of documents (Table 1).

Table 1. Features of SDGs implementation in Ukraine

Stage	Characteristic
2017	National Report “Sustainable Development Goals: Ukraine” (identified 86 objectives and 172 national development indicators, set target values for 2030 (and intermediate values for 2020 and 2025)
2018	Regional Reports “Sustainable Development Goals: Volyn”, “Sustainable Development Goals: Dnipro-2030”
2019	Nationwide Monitoring “Sustainable Development Goals: Ukraine 2019”, Monitoring Report on Assessing the Progress of SDG 8 “Decent Work and Economic Growth” in Ukraine and National Thematic Report “Sustainable Development Goals for Children of Ukraine”
2019, February	Law of Ukraine No. 2697-VIII “On Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the Period up to 2030”
2019, August	Order of the Cabinet of Ministers of Ukraine No. 686-o “Issues of Data Collection for Monitoring the Implementation of Sustainable Development Goals”
2019, September	Decree of the President of Ukraine No. 722/2019 “On the Sustainable Development Goals of Ukraine until 2030”

Sources: [12-14]

However, in order to achieve any goal, it is necessary to use available tools to obtain adequate resources for the implementation of the SDGs, in particular in the field of agribusiness. Among such instruments, agriculture insurance, green bonds and impact investments are considered in more detail.

Agriculture insurance

Agriculture insurance in Ukraine is not developed. There are a number of reasons for this: imperfect insurance legislation, lack of quality insurance products for agribusiness entities, problematic financial condition of agribusiness entities, etc. And even the

introduction in 2005-2008 of partial compensation for insurance payments made by agricultural producers did not radically change the situation. In view of this, the Law of Ukraine "On Peculiarities of Insurance of Agricultural Products with State Support" was adopted in 2012, declaring state support in the form of partial compensation of insurance payments for insurance of agricultural products [15], but in

fact such support was not significant. The modeling of the development of the agriculture insurance in Ukraine showed that this type of insurance is formal, as insurance premiums has the trend to increasing, but insurance payments has the opposite trend, whereas the agribusiness is quite risky and the average level of payments in developed countries is over 60% (Fig. 1).

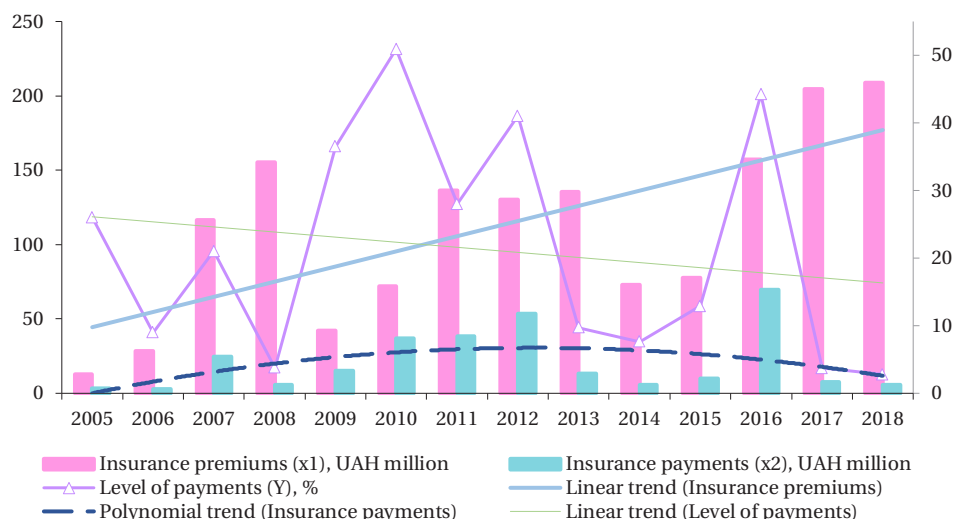


Figure 1. The modeling of the development of the agriculture insurance in Ukraine

Source: built on the basis [16]

Note: * Data for 2005-2008 are presented for calendar years based on the information from the Ministry of Agrarian Policy of Ukraine on the implementation of the program to reduce the cost of insurance premiums, and since 2009 – for underwriting years based on surveys of insurance companies within the projects of the International Finance Corporation

In accordance to the correlation-regression model for the forecasting of the agricultural insurance development in Ukraine the multiple regression equation was obtained: $Y = 0.2097 + 0.00708X_1 - 0.0013X_2$. The obtained model is significant due to the coefficient of determination and Fisher's test. In the studied

situation 83.92% of the total variability of level of payments (Y) is explained by the change of both factors (insurance premiums, X_1 and insurance payments, X_2). The parameters of the model are also statistically significant (Table 2).

Table 2. Statistical significance of the model of the development of the agriculture insurance in Ukraine

	Multiple R	R Square	Adjusted R Square	Standard Error	Observations			
Regression Statistics	0.9160565	0.83915941	0.809915669	0.072493579	14			
ANOVA	df	SS	MS	F	Significance F			
Regression	2	0.30160642	0.15080321	28,69534872	4,31694E-05			
Residual	11	0.057808509	0.005255319					
Total	13	0.359414929						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	0.2097028	0.042828333	4,896356052	0.000474363	0.115438242	0.30396729	0.11543824	0.303967293
X1	0.0070803	0.000983797	7,196926254	1,75948E-05	0.004914994	0.00924564	0.00491499	0.009245641
X2	-0.001304	0.000334717	-3,89581607	0.002494478	-0.002040702	-0.00056728	-0.00204070	-0.000567288

Source: calculations of the authors

As long as that the potential of agriculture insurance as a tool to ensure the food security and economic dimension of sustainable development of agribusiness is not implemented in Ukraine completely, in July 2021 the following amendments were made to the above Law:

- insurers can be agricultural producers, regardless of their organizational and legal form;
- insurers do not need to become members of the agriculture insurance pool, which is currently undergoing liquidation, but they need to have a license to insure agricultural products and meet the requirements of the Law of Ukraine “On Insurance” and additional requirements established by regulations of the National Bank of Ukraine;
- the provisions on the organization of catastrophic agricultural risks coverage were abolished;
- state support for insurance of agricultural products is to provide agricultural producers from the state budget with funds in the form of compensation not up to 50 but up to 60% of the cost of insurance

payment (insurance premium) accrued under insurance contracts.

These changes have a positive impact on the legal field of agriculture insurance with state support in Ukraine, but it may be necessary to stimulate not only insurance of primary agricultural products, but also processed ones, exporting of which brings more foreign exchange earnings to Ukraine.

Green bonds

In 2020, the share of EBRD-financed projects in Ukraine increased from 3% in 2016 to 6.2 in 2020, while as for the World Bank, this figure for the same period did not exceed 3% [17]. In addition, since 2015, the EBRD has introduced the Green Economy Transition (GET) approach “that comprises three “pillars”: climate mitigation, climate adaptation and other environmental benefits” [18], which means that the projects financed by green bonds should be in line with this strategy of transition to a green economy (Table 3).

Table 3. EBRD's investments in green economy projects in 2016-2020

Year	Agribusiness, bln €	Total, bln €	Agribusiness, %	Number of projects
2016	n/a	2.942	n/a	187
2017	n/a	4.054	n/a	186
2018	n/a	3.344	n/a	187
2019	0.138	4.618	3	260
2020	n/a	3.192	31%*	197

Source: compiled based on the EBRD Sustainability Report (2016-2020) [19]

Note: * Industry, commerce and agribusiness

According to Table 3, the transition to the GET approach in 2019 alone indicated the volume of financing of agribusiness projects at the level of € 0.138 bln, which is 3% of the total financing of the transition of countries (where the EBRD operates) to the green economy. The total share of project funding for industry, commerce, and agribusiness under the GET approach for 2016-2020 was 22%. Detailed data on funding by sector and country are not provided in the EBRD's sustainability reports, but according to the EBRD Sustainability Reports, there are some characteristics of individual agribusiness projects in Ukraine during the period under review. The EBRD has financed a variety of projects in the field of agribusiness in Ukraine, both to improve crop and livestock production processes, and to establish the processing of industrial waste into bio-fuels and promote more environmentally friendly transportation of products.

For the further development of both agriculture insurance and green bonds, it would be necessary to stimulate the emission of such debt securities by insurance companies to promote the sustainable development of agribusiness in Ukraine.

Impact investment

In economic theory and practice, approaches to the

interpretation of the essence of impact investment are not fundamentally different. Emphasizing their social and environmental orientation, it is possible to note that these are still different areas of market investment, which are aimed at obtaining the appropriate financial result.

In fact, impact investment is a new paradigm of economic development. The results of the impact investment include the achievement of sustainable development indicators, including 17 United Nations Sustainable Development Goals.

Despite the fact that impact investment is a relatively new phenomenon, this paradigm is becoming an important trend in today's economy. Until recently, environmental and social programs and projects were financed mainly through government allocations and charitable foundations, but now impact investment is growing at a high rate. According to GIIN, the impact investment market is estimated at US \$175 billion, and the growth rate is 29% per year. In the long run, the positive dynamics of impact investments is expected to continue.

Impact investments are aimed at mitigating the effects of environmental degradation and solving social problems. These include investments in sustainable agriculture, renewable energy sources, nature and environmental protection, small and

medium-sized business financing, and the development of education and health.

The practice of impact investment involves effective investment in enterprises that produce social or environmental goods and services. The fundamental difference between impact investments is that these investments have environmental and social goals along with financial ones.

Based on the general investment philosophy and motivation, impact investments combine different aspects of investment activity. From an economic point of view, impact investments involve making a profit based on long-term production and investment strategies. The environmental component of

impact investments focuses on improving resource efficiency or recycling and reusing materials and substances. At the same time, profit must be consistent with the development of human, social and cultural capital.

The United Nations Development Program (UNDP) in Ukraine provides for the implementation of impact investment projects aimed at achieving the Sustainable Development Goals. Impact investment projects in agribusiness involve finding accelerators to ensure the sustainable development of agriculture and rural communities, contribute to the preservation of ecosystems and the expansion of the green economy (Table 4).

Table 4. Impact investment projects in UN Development Programs in Ukraine

Project name	Support for green recovery in Ukraine	Strengthening business associations of small and medium-sized enterprises (Phase 1)	Strengthening business associations of micro, small and medium-sized enterprises (Phase 2)
Project goals	Accelerating structural transformations, providing important incentives for the transition to a green economy and a more sustainable financial system – support for implementing new business models, creating new green jobs, improving social integration of citizens	Accelerating the development of small and medium enterprises in Ukraine by strengthening the potential of professional business associations	Spreading positive results of the first phase of the project and ensuring their sustainability by expanding partner organizations to 27 business associations of various types from all over Ukraine, strengthening their customer orientation and ability to productive public-private dialogue to improve regulatory framework and general business environment for micro, small and medium enterprises
Expected results, achievements	Improving the legal framework at the national level to stimulate the transformation of economic and financial relations. Reducing the cost of transactions in the green finance market. Improving climate risk assessment and management in the corporate sector	Improving local capacity by promoting and supporting the development of entrepreneurship and small and medium-sized businesses in the Chernobyl-affected areas by transferring best practices and world experience in using smart tools for business development	Expanding the representation of business associations throughout Ukraine, which will positively affect their ability to attract new members, promote constructive cooperation with government agencies, which will improve the sector of micro, small and medium enterprises and increase their competitiveness due to the benefits of membership in business associations. Inclusive development of micro, small and medium-sized enterprises in terms of ensuring gender equality and promoting the green economy
Project implementation period	November 2020 – May 2022	October 2014 – September 2018	November 2019 – October 2023
Sustainable development goals	Goal 13. Combating climate change; Goal 15. Conservation of terrestrial ecosystems; Goal 17. Partnership for sustainable development	Goal 1. Overcoming poverty; Goal 8. Decent work and economic growth	Goal 8. Decent work and economic growth
Funding amount	US \$ 0.87 mln. The project budget is US \$ 13.33 mln.	The project budget is US \$ 1.6 mln. United Nations Development Program (UNDP) is US \$ 0.1 mln. The Government of Poland is US \$ 0.1 mln. SECO State Secretariat for Economic Affairs is US \$ 1.4 mln.	US \$ 1.3 mln.
Project donor	United Nations Development Program (UNDP) Government of France	United Nations Development Program (UNDP) Government of Poland SECO State Secretariat for Economic Affairs	United Nations Development Program (UNDP) State SECO Secretariat for Economic Affairs

Source: formed on the basis of the United Nations Development Program in Ukraine (2021) [20]

These projects create real opportunities for businesses and communities to solve certain social and environmental problems, which at the same time bring financial benefits. Here are some examples of UNDP projects that reflect the experience of impact investment in agribusiness in Ukraine.

As part of the Project “Community-Based Local Development”, funded by the European Union and the United Nations Development Program in Ukraine, 33 residents of Putyla and neighboring villages of Chernivetska region established the Agricultural Cooperative “Dary Hutsulshchyny” to harvest, process and store wild mushrooms and berries. With the assistance of the UNDP project to start its ecological agribusiness, the cooperative purchased a freezer, dryer, mushroom slicer, scales, containers for collecting and storing mushrooms and berries, and a freezer for storing them. UNDP has allocated US \$ 25,000 for this. Another US \$ 5,000 was allocated by the community. The first harvest of mushrooms was sold online. Subsequently, orders began to arrive from various cities. During the season the company processes up to 20 tons of mushrooms. Mushrooms are sold through a network of supermarkets and also exported to Israel, Poland, the United States and Moldova. In addition to mushrooms and berries, the production of Carpathian herbal teas has been established.

The United Nations Development Program in Ukraine is actively cooperating with public and private organizations in finding effective tools and incentives for the transition to an environmentally oriented economy and the implementation of world best practices in national agriculture.

As part of the Project “Support for Green Recovery in Ukraine”, UNDP signed a memorandum with “Arnica” Agro-Industrial Group to develop a solution and related software to improve corporate climate risk management and access to green finance in the future.

“Arnica” Agro-Industrial Group was founded in 2000 as an agricultural company with traditional technology of growing crops. The main specialization was soybean cultivation and seed production. In 2004, the company built the first soybean processing plant in Ukraine. Since 2012, the “Arnica” Group has been implementing sustainable management systems and moving into the organic business. Today, it is the second largest organic company in Europe with a certified land bank of 14,979 hectares, which provides almost 53% of all organic soybean exports from Ukraine to the EU and is the largest producer and exporter of organic corn from Ukraine.

According to the memorandum, the parties will cooperate in developing the necessary methodology for assessing non-financial risks (environmental, social and managerial) (ESM) for use in organic agriculture. According to the chosen methodology, the ESM-system will be implemented on the basis of the “Arnica” Agro-Industrial Group. It is also planned to develop a program for ESM risk management based on carbon emissions data and other non-financial data. At the same time, the memorandum provides for cooperation in the organization of an independent

audit of the selected for the implementation ESM system by leading experts in the field. Creating and expending environmentally friendly practices based on the positive experience of the “Arnica” Agro-Industrial Group will allow attracting as many companies as possible to an ethical and sustainable way of conducting agribusiness.

► Conclusions

The current state of basic tools which are used to obtain resources for accelerating the sustainable development of agribusiness in Ukraine was determined. Among such instruments, agriculture insurance and new instruments such as green bonds and impact investments were considered.

Agriculture insurance is seen as a tool to achieve the economic dimension of sustainable development of agribusiness, as it provides an opportunity to resume operations to the level that existed before the insured event. Due to the significant limitations of agribusiness entities in their own resources, agriculture insurance is often saved on, because the modeling of the development of the agriculture insurance in Ukraine showed that such type of insurance was formal and did not perform a real protective function. Although Ukraine is actively improving the legislation on the introduction of partial compensation for insurance payments (up to 60%) in agricultural production, it would be necessary to stimulate not only insurance of primary agricultural products, but also processed ones, exporting of which brings more foreign exchange earnings to Ukraine.

Green bonds, first issued by international financial organizations, began to be used in the late 2000s to stimulate the environmental dimension of sustainable agribusiness development. Agribusiness in Ukraine is involved in attracting resources for the transition to green management principles, as indicated by the practice of financing green projects in agribusiness in Ukraine by the European Bank for Reconstruction and Development. At the same time, in order to make the use of this tool more active, it is necessary to stimulate the emission of green bonds by domestic financial institutions, in particular insurance companies.

Impact investment is a socially oriented type of investment that involves solving environmental and social problems and making a profit. The effectiveness of impact investment is determined by the private and public effect. The results of impact investments provide for the achievement of sustainable development goals. Impact investments are aimed at mitigating the effects of environmental degradation and solving social problems.

The purpose of the implementation of impact investment projects under the UN Development Program in Ukraine is to achieve the Sustainable Development Goals. In the agricultural business, these projects create conditions for sustainable development of agriculture and rural communities; contribute to the preservation of ecosystems and the expansion of the green economy. Creating appropriate

conditions and stimulating impact investments in Ukraine will allow attracting private capital to solve environmental and social problems. This will help build a socially oriented model of Ukraine's economic development.

The prospect for further research is the formation of a systematic approach at the state level for a more active combination of traditional and innovative instruments for sustainable development acceleration of agribusiness in Ukraine.

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Інструменти та ресурси для прискорення сталого розвитку агробізнесу в Україні

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► **Анотація.** Агробізнес в Україні займає одне з найважливіших місць у національній економіці, але не всі суб'єкти ведуть його стабільно через брак ресурсів для фінансування таких перетворень. Тому необхідно дослідити інструменти залучення ресурсів для прискорення сталого розвитку агробізнесу в Україні. Метою статті є визначення сучасного стану основних інструментів, які використовуються для отримання ресурсів для прискорення сталого розвитку агробізнесу в Україні, а саме страхування сільського господарства, зелених облігацій та вплив інвестицій. У статті за допомогою ситуаційного аналізу, монографічного методу, табличного та графічного методів, наукового узагальнення проаналізовано досвід використання страхування сільського господарства, зелених облігацій та вплив інвестування як інструментів прискорення сталого розвитку агробізнесу. Джерелами інформації для цього дослідження були звіти Міжнародної фінансової корпорації, звіти про сталий розвиток Європейського банку реконструкції та розвитку та звіти Програми розвитку ООН в Україні. Дослідження практики використання страхування сільського господарства, зелених облігацій та вплив інвестицій як інструментів прискорення сталого розвитку агробізнесу в Україні дозволило визначити зародковий рівень їх використання. Про це свідчить моделювання розвитку сільськогосподарського страхування в Україні, яке показало, що цей вид страхування є формальним і не виконує реальної захисної функції. Що стосується проектів, ресурси яких залучаються через зелені облігації та програми вплив інвестицій, то вони є фрагментарними і потребують більшої системності. Ця робота є однією з перших, яка розглядає практику застосування інструментів для прискорення сталого розвитку агробізнесу в Україні в контексті трьох вимірів та досягнення цілей сталого розвитку. Для подальшого розвитку як страхування сільського господарства, так і зелених облігацій необхідно стимулювати емісію таких боргових паперів страховими компаніями та розвивати страхування не лише первинної сільськогосподарської продукції, а й переробленої, експорт якої приносить більше валютних надходжень на Україну. Це дослідження має на меті висвітлити поточні практики застосування інструментів для прискорення сталого розвитку агробізнесу в Україні, зокрема страхування сільського господарства, зелених облігацій та вплив інвестування, які є основою для їх популяризації та поширеності в науковому середовищі та серед професіоналів агробізнесу

► **Ключові слова:** страхування сільського господарства, зелені облігації, вплив інвестування, стійкість, Цілі сталого розвитку, сільське господарство, продовольча безпека

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