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Capacity and saturation of the food market in Ukraine

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▸ **Abstract.** In a market economy, the optimal supply of food to the population depends entirely on the development of the food market. To establish indicators of rational consumption, it is important to determine the capacity and saturation of the food market. The purpose of this study was to highlight the current proportions of supply and demand in the Ukrainian food market, establish the correspondence of the capacity and saturation of the food market to rational consumption parameters. The study used dialectical method of cognition of market processes and a systematic approach, analytical generalizations, statistical comparison, constructive-calculation, tabular, and abstract-logical method. The food market is recognized as aggregative, as it includes several interconnected markets for crop production, livestock production, and industrial processing. The study investigated the specific features of the formation of demand for food with low purchasing power of the population. The market capacity was established – standard with minimum and rational consumption standards and real. The latter was almost 30% lower than the calculated one based on rational norms, which indicates additional opportunities to replenish the income of the agricultural sector. It was found that even with an increase in effective demand of the population, the improvement in consumption is levelled due to rising food prices. A prominent level of self-sufficiency of the country in food products (excluding fish and fish products) was established, and a considerable saturation of the market with essential products – potatoes, vegetables, eggs, butter, and bread. The study results should be used in the formation of a target program for the development of the food market for a long-term period aimed primarily at rational provision of food products to the population of Ukraine

▸ **Keywords:** foods; commodity supply; effective demand; sufficiency of consumption; expenses; needs of the population

▸ Introduction

The socioeconomic development of the state prescribes the direction of food systems toward fully providing the population with food. In recent years, researchers have investigated and examined the development of the Ukrainian and world food market, pricing, insurance, agricultural development based on greening and resource conservation, production on an innovative basis, made a forecast of market conditions considering the requirements of the World Trade Organization, etc. Thus, it was found that the Ukrainian food market cannot yet be recognized as optimal in terms of functioning, structure, and content. Over a prolonged time, it has been caused, on the one hand, by the low purchasing power of the population, and therefore by the non-compliance of the level of consumption of food products with the established rational norms, as well as weak economic positions on the world market.

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T. Lozova (2019) investigates the current trends in the development of the market for fruit and berry products in Ukraine and defines the boundaries of the market, its main subjects, competitive advantages, and issues of supply chain development. Lozova proposed the following key points: the creation of sales or processing cooperatives, the construction of warehouses, the creation of wholesale markets, the establishment of communication between manufacturers and wholesalers, and providing them with a set of marketing services. Furthermore, O. Nikishyna (2019) described the significant role of connections and interactions between link entities in forming the structure of an effective supply chain.

N.V. Roznina *et al.* (2022) determined that the instrument of economic growth of the country is private consumption. On the other hand, there is the underdevelopment and low profitability of many branches of crop production and animal husbandry, the lack of sufficient areas of industrial plantations, livestock, the formation of the supply of certain types of food products mainly by households, its non-compliance with product quality standards, resale through numerous intermediaries, inefficient market infrastructure covered in the study by S. Cheremisina (2022). The article by A. Pedorchenko (2022) examines the impact of a full-scale russian invasion in February 2022 on the territory of Ukraine regarding the production, and export of agricultural products, ways of supplying grain and oil crops and products, their processing of Ukrainian origin to world markets. The purpose of the study by K. Shatnenko (2017) and C. Béné *et al.* (2021) was to figure out the consequences of the decline of industrial production in post-Soviet and developed countries using evidence from Ukraine.

Considering the globalization of the world economy, substantial changes in climatic conditions, and their impact on the volume of production and sale of agricultural products, the main economic parameters of the food market in the country require additional, more profound investigation, precisely from the standpoint of ensuring the rationality of consumption and adaptation to modern economic conditions, which was researched and covered by the authors of the present paper.

Scientific originality. The capacity and saturation of the food market are determined from the standpoint of the need for rational provision of food needs of the population, increasing the purchasing power of the population, and further market development, considering the economic realities of the time.

The purpose of this study was to establish the main economic parameters of the food market from the standpoint of providing the population with food products that undergo the stages of commodity-money relations, including normative, real capacity, and saturation indicators.

▸ Literature review

O. Shpychak *et al.* (2017) investigated the issues of the formation, functioning, and development of the food market, its infrastructure, its capacity, pricing issues, the effectiveness of agricultural product sales channels, and the purchasing power of the population from the very beginning of a market economy in Ukraine. Their research served as a basis for solving the problems of the development of the agrarian industry and the functioning of the market for agricultural products. Given the change in social relations, forms of ownership, the structure of commodity producers, the state system, Ukraine's entry into the international economic level, and the emergence of the latest information sources, they are still quite relevant and necessary. At the same time, the scientific developments of L. Khudolii (1998) are no less important. She paid special attention to the formation and functioning of the main market of crop production – grain. Khudolii thoroughly covered its composition, and structure, and characterized the state of the market situation and methodological aspects of its forecasting and development.

The areas of development of the food market have somewhat changed – apart from increasing the requirements for the formation of supply and trade in products, a need occurred to improve foreign trade relations and enter the world market (Casas-Rosal *et al.*, 2023). Therefore, there was a need for additional and more in-depth scientific investigation of theoretical, methodological, and practical aspects concerning the provision of rational standards of consumption of high-quality foods at affordable prices, the ratio of supply and demand by their types, the efficiency of production and sale by various types of agricultural enterprises, activities of households, pricing, insurance, improvement of market infrastructure and marketing activities, forecasting, prospects for the development and financing of agriculture, increasing export potential, effective national support for market development, etc. Considering this, the studies of S. Ostapenko (2021), O. Senyshyn and N. Dzyubenko (2013) are important and timely. The authors cover the theoretical aspects of the food market from the standpoint of the classical market economy as a component of the socioeconomic system of society and the protectionism of domestic market operators. Yu. Biliavska *et al.* (2023) and I. Kyrylenko *et al.* (2018) covered the specific features of the development of the Ukrainian food market by types of agricultural products and the place of Ukraine in the formation of the world supply of food products, the issue of competition between countries, and export-import transactions. O. Bazaluk (2020) thoroughly investigated the development of the organic food market in Ukraine and the world. O. Darmograi (2015), and S. Seheda *et al.* (2019) investigated the strategic development vectors of the regional agri-food market, its structure, regulation, and factors shaping the market conditions. In addition, in earlier studies, the author of the present paper substantiated and developed a market development strategy aimed at optimal provision of internal needs, import substitution, and expansion of export potential, the main trends of operation and specific features of the development of aggregative markets were determined based on the system of indicators

of food supply, which allowed estimating the competitiveness of Ukrainian products and substantiating market forecast (Salo *et al.*, 2022).

K. Ryabchenko (2018) investigated the world practices in the development of the food market and providing for the population, specifically in the EU countries, and also directs the research to improve the mechanism of market regulation, which contains the relevant stages of the implementation of national policy. N. Pohuda (2023) and I. Fedulo-va (2015) focused on the investigation of influencing factors and their interaction with the food market, namely price policy, market conditions, market infrastructure, demand and supply of food products, institutional support, and budget restrictions of consumers, as well as factors of cyclical and economic growth.

Summarizing the research of scientists, in the future, to expand the general supply of the food market and fully meet the needs of the population for quality food products, according to rational consumption norms, expand export supplies, and reorient the status of the country from a supplier of raw materials to a supplier of finished products, the expansion of the Ukrainian industrial sector is of particular importance production of agricultural products.

▸Materials and methods

During the study, the authors were guided by modern economic theory, methodological approaches to the study of the capacity and saturation of food markets, as well as separate normative indicators for the production and sale of food products. The study used the dialectical method of understanding market processes and a systematic approach (to investigate the issues that arise in the production, formation of the product offer, and sale of food products); analytical generalizations, statistical comparison, the constructive calculation (to generalize, analyse, and evaluate market conditions), tabular (to illustrate research results), abstract-logical method (for conclusions).

The conducted research is based on methodological approaches to determine the capacity of the food market, which is formed under the solvency of the population, the state of development of the agrarian sector, and the development of the foreign economic activity. The normative (potential) capacity of the internal food market is determined under the conditions of consumption of food products at the level of rational or minimum consumption norms. The total (real) capacity of the internal food market depends on the real volumes of consumption and the prices of the consumed products. As a result, the capacity is established proceeding from the real solvent demand of the population, excluding the amount of food that is outside commodity-money relations.

Having determined the quantitative indicator of market capacity, it is necessary to calculate its saturation with foods. The market saturation indicator is defined as a percentage of the share of market capacity and population needs for food.

The food needs of the population are established based on their rational consumption norms per capita.

The step-by-step algorithm for determining the capacity of the food market according to the current methodology can be described as follows (O. Shpychak *et al.* (2017).

1. The normative capacity of the internal food market is defined as the sum of the products of the norm of consumption by the population of a certain type of food and their average consumer price.

$$FMC=\sum_{n=1}^{c}(Rc_n\times CP_n)\times H, \quad (1)$$

where FMC is the food market capacity, UAH; Rc_n – rate of consumption of the n^{th} type of product per capita, kg; CP_n – consumer price of the n^{th} type of product, UAH; H is the average annual number of permanent populations, people; n is the type of food products that form the market capacity; c is the number of types of products that form the market capacity.

2. The aggregate (real) capacity of internal food consumption (commodity and natural part) is determined at market retail prices according to the following formula:

$$ACC=\sum_{i=1}^{a}C_i\times P_i, \quad (2)$$

where C_i is the number of i^{th} products consumed per year (pcs.); P_i is the price of the i^{th} product, which is an aggregate value (UAH); i is the type of product consumed by the population; a is the number of types of products consumed by the population.

3. The volume (capacity) of internal consumption of food, which is outside commodity-monetary relations, is determined according to the following formula:

$$CC_{ps}=\sum_{i=1}^{a}C_i=\times SC_i\times P_i, \quad (3)$$

where SC_i is the share of consumed i^{th} type of food that has passed commodity-money relations.

4. The capacity based on the real paying demand of the population is determined according to the formula:

$$M_i=TCn_i\text{-}CC_{ip}, \quad (4)$$

where M_i is the capacity of the internal consumer market of the i^{th} type of agricultural products, t; Cn_i is the total capacity of internal consumption of the ith type of products in natural measurement, t; CC_{ip} is the consumption capacity of the ith type of production that has passed commodity-money relations, t.

▸ Results and Discussion

The capacity of the food market can be characterized in detail using the balance sheets of individual food products. Notably, the set of food products in the table was approved by the Resolution of the Cabinet of Ministers of Ukraine "On approval of sets of food products, sets of non-food products and sets of services for the main social and demographic groups of the population" No. 780 dated October 11, 2016 (2016) (Table 1).

Table 1. Balances of individual food products in Ukraine in 2020, thous. t

Balance sheet items	2020								
	Potatoes	Fruits berries grapes	Vegetables and melons	Meat and meat products	Milk and dairy products	Eggs	Oil	Sugar confectionery products	Fish and fish products
General offer	**21 163**	**3 455**	**10 440**	**2 708**	**9 955**	**938**	**7 794**	**986**	**542**
Production	20 838	2 305	10 148	2 478	9 264	934	7 549	982	118
Import	325	1 150	292	230	691	4	245	4	424
Total demand	**20 812**	**3 310**	**10 003**	**2 723**	**9 784**	**939**	**7 783**	**1 386**	**537**
Internal demand	20 808	3 038	9 706	2 250	9 344	747	542	1 216	522
Spent on feed (egg incubation)	5 840	681	1 512	6	904	74	-	55	-
Spent on planting (sowing)	5 611	-	110	-	-	-	-	-	-
Losses (expenses for non-food purposes)	3 764	230	1 238	-	10	3	30	-	5
Export	4	272	297	473	440	192	7 241	170	15
Year-end stock change	351	145	437	-15	171	-1	11	-400	5
Consumption fund	**5 593**	**2 357**	**6 846**	**2 244**	**8 430**	**670**	**512**	**1 161**	**517**
Consumption level. kg per capita	134.0	56.5	164.0	53.8	201.9	16.1(278 pcs.)	12.3	27.8	12.4
Rational consumption rates kg per year	**124**	**90**	**161**	**80**	**380**	**290 pcs.**	**13**	**38**	**20**
Deviation of real consumption from the rational norm. kg	10.0	-33.5	3.0	-26.2	-178.1	-12.0	-0.7	-10.2	-7.6

Source: calculated by the author based on data from the State Statistics Service of Ukraine (Resolution of the Cabinet…, 2016)

According to these balance indicators, a prominent level of self-sufficiency is observed for almost all types of foods, i.e., the share of imported supplies, compared to domestic production, is insignificant or significantly lower. However, almost 80% of the population consumes fish and fish products of imported origin. Almost all oil produced in Ukraine is exported – 96% (7,241 thous. t). That is its import of 245 thous. t almost equalled the volume of Ukrainian production remaining for own consumption – 308 thous. t. Fruit and vegetable products are exported mainly at the expense of processing industries. To a certain extent, this indicates a lack of technical equipment of Ukrainian producers for conducting foreign trade in these fresh products and a more profitable sale of value-added goods.

Special attention should be paid to setting indicators of food consumption. In 2020, bread and bread products, potatoes, vegetables, melons, butter, and eggs are close to rational consumption standards, i.e., this suggests sufficiency. Critical indicators should be considered indicators for the consumption of milk and dairy products – this is 59% of the established minimum standards and 53% of the rational ones, with an increase of only 1.5% in 2020 compared to 2000. Poultry meat is cheaper than pork and beef, and it is the reason the positive dynamics of the consumption of meat and meat products are observed. The best situation is observed in the egg market. Their consumption in 2020 was 278 pcs. or 96% of the norm, which is 2.2% more than in 1990. Thus, among the principal factors that led to the expansion of the product offer of poultry products, the increase in investment support for this type of activity, the volume of industrial Ukrainian production of agricultural enterprises, their use of new breeds of poultry, as well as their effective marketing policy should be included.

Ensuring the needs of the population with food products largely depends on its material well-being. The principal issue in expanding the volume and cost of food market capacity is the low purchasing power of the population. Indicators of the sufficiency of consumption are in low positions relative to norms for such food products as meat, milk, fruits, berries, and fish; therewith, there is also a

substantial differentiation in the nutrition of the population, depending on the size of average per capita total incomes. The analysis indicates that in 2021, the difference in food costs between population groups with the lowest and highest levels of income is substantial – 4.43 times (Table 2).

Table 2. The level of public spending on food in 2021, UAH per capita per month

Indicator	Decile (10%) groups of households by the level of average per capita total income		Ratio of higher and lower deciles (4.43)
	First (lowest) decile (5 991.88)	Tenth (highest) decile (26 539.20)	
Bread and bread products	319.0	474.2	1.49
Meat and meat products	357.0	813.4	2.28
Fish and fish products	76.2	201.9	2.65
Milk and dairy products	192.8	417.5	2.17
Eggs	55.8	76.5	1.37
Oil	158.4	241.5	1.52
Fruits	86.9	264.8	3.05
Vegetables and melons	155.3	296.9	1.91
Potatoes	75.5	72.0	0.95
Sugar and confectionery products	120.1	255.6	2.13
Other foods	46.9	65.3	1.39
Soft drinks	73.6	199.1	2.71
Eating out	19.0	190.4	10.01
Total food costs	1736.4	3569.2	2.06

Source: calculated by the author based on data from the State Statistics Service of Ukraine (Resolution of the Cabinet…, 2016)

The population with the lowest level of total income consumes 2.2-2.7 times less meat and meat products, fish and fish products, milk and dairy products, and fruits per month compared to the highest level of income. This indicates a higher level of consumption of energy-expensive food products in high-income groups. To determine the qualitative structure of demand, the energy value of food consumption by the population was estimated (Table 3). Thus, in 2020, the total caloric content of the diet almost corresponded to the rational norm (2,928 kcal), was 2,674 kcal. However, the main consumption is made up of plant-based products (70%). In terms of calories, their actual consumption is 5% higher than the standard one.

Table 3. Energy value of food consumption by the population of Ukraine, kcal per capita per year

Indicator	Rational consumption rate, kcal	Years							2020 in % to 1990
		1990	2010	2016	2017	2018	2019	2020	
Plant and animal-based products, kcal	2 928	3 597	2 933	2 742	2 707	2 706	2 691	2 674	74.3
Plant-based products, kcal	1 786	2 572	2 124	1 952	1 926	1 919	1 891	1 872	72.8
Animal-based products, kcal	1 142	1 025	809	790	781	787	800	802	78.2
Share of food in total expenditures, %	-	32.8	53	49.8	47.9	47.7	46.6	48.1	146.6
Indicator of purchasing power of 1% of budget expenditures, kcal based on 1% of expenditures	-	109.7	55.3	55.1	56.5	56.7	57.7	55.6	50.7
Deviation from 1990, times	-	-	2.0	2.0	1.9	1.9	1.9	2.0	-

Source: calculated by the author based on data from the State Statistics Service of Ukraine (Resolution of the Cabinet…, 2016)

For a more reliable description of the development of the food market, the cost of the total capacity of domestic demand is established, i.e., the cost expression of the part of food products that has reached the consumer in the form of goods (Table 4).

Table 4. Capacity of the internal food market in 2021, billion UAH

Indicator	Standard capacity (minimum standards)	Standard capacity (rational standards)	Total real capacity	The ratio of real indicators to normative ones, %	Deviation of real indicators from the standard ones, billion UAH	The share of food outside the commodity-money relations, %	Internal food market capacity
Bread and bread products	92.5	99.4	89.8	90.3	-9.6	1.4	88.5
Meat and meat products	245.1	377.1	288.5	76.5	-88.6	10.8	257.5
Fish and fish products	41.8	69.6	58.5	84.0	-11.1	2.8	56.8
Milk and dairy products	1 002.2	1 116.8	663.0	59.4	-453.8	13.9	570.9
Eggs	27.7	34.8	27.4	78.6	-7.4	30.2	19.1
Oil	19.5	31.6	37.9	120.0	6.3	3.5	36.6
Fruits	51.6	68.4	35.5	52.0	-32.8	11.4	31.5
Vegetables and melons	39.7	60.9	38.6	63.4	-22.3	41.8	22.5
Potatoes	41.9	54.1	30.4	56.1	-23.7	57.2	13.0
Sugar and confectionery products	34.6	41.1	29.8	72.6	-11.2	17.8	24.5
Total basic food products	1 596.6	1 953.8	1,299.4	66.5	-654.4	x	1 120.9
Other food items, soft drinks, out-of-home meals	175.6	214.9	142.9	x	x	x	142.9
Total	1 772.2	2 168.7	1 442.3	x	x	x	1 263.8

Source: calculated by the author based on data from the State Statistics Service of Ukraine (Resolution of the Cabinet…, 2016; Prokopenko, 2022)

It was determined that the most consumed products were those outside of commodity-monetary relations – potatoes, vegetables, and eggs, and the least consumed – bread and bread products, fish and fish products, oil, and sugar. The capacity of the internal food market is UAH 1,263.8 billion, which is UAH 904.9 billion less than the standard capacity established based on rational norms (the cost share of the food basket is considered). Notably, this difference in cost can be attributed to losses in the budget of the agricultural sector of the country. Apart from capacity, an essential indicator of the assessment of the internal food market is its saturation. Saturation in this case should be interpreted as the real level of satisfaction of consumers' needs with food products through purchases on the market.

In Ukraine in 2021, the highest level of saturation occurred in the markets of oil, bread, and fish within 84.0-120.0% (Fig. 1).

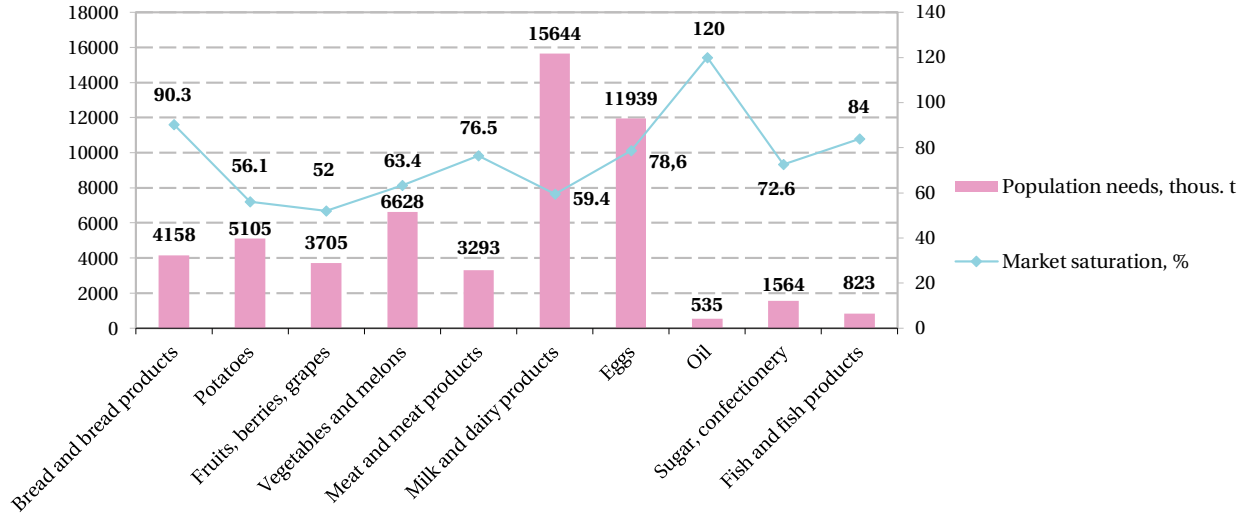

Figure 1. Population needs and food market saturation in 2021

Source: calculated by the author based on data from the State Statistics Service of Ukraine (Resolution of the Cabinet…, 2016; Prokopenko, 2022)

The lowest saturation rate of fruit and vegetable, potato, and milk markets is within 52.0-59.4%. Their supply is insufficient to meet the needs of the population. The level of production by households is 79.2%, 97.7%, and 68.3% (1,770.9 thous. t, 20,861.7, and 5,961.4 thous. t), respectively. In the absence of an organized supply of high-quality and affordable food products from agricultural enterprises to the internal market, the population independently produces them for domestic needs and partially sells them to friends or local markets. Chaotic production and sales cannot ensure uniform and sufficient consumption.

Notably, the food supply problems of any country can be considered both at the global macro- and micro-level, including at the regional level for a truer description of the economic situation, which is also discussed in the studies of foreign researchers (Hinrichs, 2013; Ge *et al.*, 2017; Béné *et al.*, 2021). Therewith, food security is assessed by the main components, namely energy supply, weather conditions, rationality, and quality of consumption (Gebhardt & Thomas, 2002; Sage, 2013; Krolchik & Latawiec, 2015). In their research, the authors focused mainly on macro-level indicators for the country and quantitative and qualitative indicators of food consumption, which allowed figuring out the main indicators of capacity and saturation, considering the solvent demand of the population, which comprehensively characterize the food market.

For a detailed investigation and assessment of the internal food market, referring to the methodical approaches of L. Khudolii (1998), it was recognized as aggregative (unifying, connecting). The authors of the present study believe that it comprises separate markets according to their types, characterized by a set of economic relationships in the system of "production-sale-consumption" of food products at the country level. First of all, the food market is divided into the markets of raw materials of crop production and animal husbandry, then into products of their food and technical processing. Next, for a more realistic definition of consumption, capacity, and saturation indicators, the food market is divided into submarkets of the following hierarchical levels – fresh, frozen, dried, canned products, etc. J.K. Casas-Rosal (2023), H. Wasserbacher, and M. Spindler (2022) also paid attention to the issue of segmentation of the food market based on consumer preferences using multi-criteria approaches and its analysis and forecasting.

T. Lozova (2019) and O. Nikishina (2019) have analogous studies of food markets, but they are conducted mainly at the macro level and are focused on the problems of supply chain management, investment, and innovation policy of nature use. Thus, the researchers developed a theoretical and methodological approach to the interaction of the economic interests of the subjects of supply chains of commodity markets, methodological recommendations for a comprehensive assessment of the dominant investment-innovation policy of nature use of the national economy based on sustainable development with an emphasis on the sectoral, structural, and investment dimension of diagnostics, organizational economic mechanisms of effective supply chain management of commodity markets. The issues of risk assessment regarding a sustainable supply chain in the food industry were addressed by H.I.Y. Tavakoli and A.S. Darestani (2023).

In the research of the authors of the article, the market capacity is perceived as the total paying demand of the population for particular types of products during a certain time (mostly during the year, marketing year) or potential demand for them, which, corresponds to the statement of A. Timonin, O.A. Nebylitsa (1997), M.S. Firouz *et al.* (2021). The indicator was calculated as the product of the production volume and the marketability level,

including the volume of imported products and excluding export deliveries, which corresponds to classical methods O. Shpychak *et al.* (2017).

In general, scientists, when investigating and evaluating the food market, mainly use statistical indicators of the total supply and demand, the Consumption fund (Kyrylenko *et al*, 2018; Riabchenko, 2018). In contrast to these developments, the authors of the study focused on the formation of a product offer, emphasizing that a considerable share of the population's needs is met through natural production. In this regard, it should be noted that the total production of potatoes and fruit crops in Ukraine is concentrated at almost 85-95% of households. Because of this, the level of self-sufficiency is quite high, and the product offer cannot be stable. After all, productivity depends substantially on weather conditions, manual labour prevails in the care of plantations, the sale of products is still problematic due to the underdevelopment of their procurement system and distance from markets, prices are formed depending on demand and prices of competitors, products are competitive on the market in terms of environmental friendliness. According to the authors, for the effective operation of this category of farms, expanding the market capacity, the development of service cooperatives, especially in the sales sphere, with the presence of individual processing shops, is still essential (Jurabaevich & Mullabayev, 2020).

One of the important and promising ways of expanding the capacity of the food market is to increase the organic production of foods, as the demand for them is growing substantially (Krolczyk & Latawiec, 2015). The authors believe that among the main issues of the development of organic production in Ukraine, the following should be highlighted: the imperfection of the regulatory framework, the lack of appropriate material and technical support for agricultural enterprises, the focus exclusively on raw material production, the lack of an effective and reliable distribution system, the proper policy of supporting the organic sector, etc. M.S. Firouz (2021), H.V. Nguyen *et al.* (2019), and A. Sharma (2023) paid attention to relevant studies of market demand for organic food products, the influence of consumer factors on its development, issues of ecological marketing of the food chain, the shelf life of food products, their consumption safety and quality.

In addition, an important and urgent measure of state regulation is the development of the trade structure, specifically wholesale markets, production, and service cooperatives. A.R. Abbas *et al.* (2022), S.N. Jurabaevich, and B.B. Mullabayev (2020) paid attention to the need for state funding of scientific research, specifically regarding climate change, energy, transport, industrial production, as well as areas and specific features of state regulation of the food market.

The authors of the present paper believe that the objective features of the development of the food market necessitate its infrastructural development and legislative regulation of state financial support. The strategic tasks of support from the state should be control of the volume of import deliveries, revision of the legal framework regarding financial support of agriculture and the targeted use of funds, promotion of the creation of transparent sales channels and an optimal price situation for producers and consumers, stimulation of the development of crop insurance, as well as lending to enterprises.

Conclusions

According to the set purpose, the authors of this study established that, despite the prominent level of self-sufficiency of Ukraine in certain food products, the capacity of the market is narrowed, and the level of consumption of most of them is insufficient to meet the physiological needs of the population. Studies of indicators of material support in population groups show that at a low level of purchasing power, energetically expensive food products are mostly consumed under conditions of higher incomes. The determined indicators of market saturation showed that due to insufficient product supply, primarily fruit, potatoes, and milk, the share of providing the population due to natural products is growing substantially. This additionally creates issues of uneven and sufficient consumption of products by the urban and rural populations of the country and does not contribute to the development of market relations.

Among the set of organizational and economic measures aimed at improving the food supply of the population and expanding the market capacity, given its disproportion, primary importance should be given to the problems of selling food products, increasing the level of the population's solvency, promoting a healthy lifestyle and an optimal nutrition structure, as well as the formation of an effective and a wide range of fresh plant and animal products and their processing products, primarily by Ukrainian producers. Therefore, soon, the strategic development vectors of the food market should be as follows: increasing the volume of production of high-quality goods by agricultural enterprises, improvement of relations between producers and intermediaries should underlie the commercial policy of enterprises and this policy should focus on the main profits in the primary chain – direct producers. Pricing on the Ukrainian market should be aimed at ensuring the affordability of product consumption, covering production costs, and the possibility of expanding the supply, mutually coordinated economic relations between farmers and operators of industrial resource markets should be aimed at providing enterprises with material and technical resources (machinery, fuel, pesticides, fertilizers, etc.) based on the principles of equivalence, the use of innovative ecologically safe technologies for growing products to obtain maximum profits at minimum production costs.

To better meet the needs of the population of Ukraine, the authors of this paper consider it expedient to further focus attention on estimating

the purchasing power of the population by region, capacity, and saturation of regional food markets. Furthermore, to make a forecast of these indicators for the formation of a target program to develop the food market for the long term.

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Conflict of Interest
None.

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Місткість та насиченість продовольчого ринку в Україні

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► **Анотація.** За ринкової економіки оптимальне забезпечення населення продуктами харчування цілком залежить від розвитку продовольчого ринку. Для встановлення показників раціональності споживання важливо визначити місткість та насиченість ринку продуктами харчування. Мета статті – висвітлення сучасних пропорцій попиту та пропозиції на вітчизняному продовольчому ринку, визначення відповідності місткості та насиченості ринку продуктами харчування раціональним параметрам споживання. У дослідженнях використовувалися: діалектичний метод пізнання ринкових процесів та системний підхід, аналітичних узагальнень, статистичного порівняння, конструктивно-розрахунковий, табличний, абстрактно-логічний метод. Продовольчий ринок визнано агрегативним, оскільки складається з множини пов'язаних між собою ринків продукції рослинництва, тваринництва та промислової переробки. Досліджено особливості формування попиту на продовольство за низької купівельної спроможності населення. Встановлено місткість ринку – нормативну за мінімальних і раціональних норм споживання та фактичну. Остання практично на 30% виявилася нижчою за розраховану на основі раціональних норм, що свідчить про додаткові можливості поповнення доходів аграрного сектору. Виявлено, що навіть за підвищення платоспроможного попиту населення, поліпшення споживання нівелюється через зростання цін на продукти харчування. Встановлено високий рівень самозабезпеченості країни продуктами харчування (за виключенням риби та рибопродуктів) та значну насиченість ринку продуктами першої необхідності – картоплею, овочами, яйцями, олією та хлібом. Результати досліджень слід використати при формуванні цільової програми розвитку продовольчого ринку на довгостроковий період спрямованої, перш за все, на раціональне забезпечення населення України продуктами харчування

► **Ключові слова:** продукти харчування; товарна пропозиція; платоспроможний попит; достатність споживання; витрати; потреби населення

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Food security in the countries of Central and Eastern Europe: state and strategic directions of provision

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► **Abstract.** The relevance of the study lies in the fact that in modern conditions, the food security of the countries of Central and Eastern Europe is under threat due to the influence of negative factors associated with both global destructive events and the vulnerabilities of food systems at the EU level. The purpose of the article is to study the state and problems of food security in the countries of Central and Eastern Europe, and to identify strategic directions for ensuring food security in the studied countries. Research methods became general scientific and special methods of cognition: comparative analysis, statistical, induction and deduction, abstract-logical, generalization, and abstraction. The peculiarities of the formation of food security in the countries of Central and Eastern Europe are shown. The level of prices for food products was studied, and it was proved that the cost of food in the countries of Central and Eastern Europe is lower compared to other EU member states. It is claimed that the economic availability of food is a problem for the population of the analysed group of countries due to the low level of income and the growing share of food expenses in the structure of household expenses. The main measures adopted at the level of the European Commission, aimed at ensuring food security by transitioning to a sustainable food system based on reducing the energy dependence of the agricultural sector and increasing its innovativeness and environmental friendliness, are considered. The practical significance of the study is that the formulated recommendations will help reduce food insecurity in the countries of Central and Eastern Europe by ensuring the stable functioning of agri-foodmarkets, implementing strategic directions for supporting the agricultural sector and reducing import dependence on production resources, supporting Ukraine as a key global food exporter, forming a sustainable food system in EU countries

► **Keywords:** food; food security; agri-foodmarkets; economic availability of food; population income; food price index

► Introduction

Modern global political and economic challenges create new threats to food security in all countries of the world. According to the definition of the Food and Agriculture Organization of the United Nations, food insecurity occurs when the population does not have sufficient physical, social, or economic access to a sufficient amount of safe and nutritious food that meets nutritional needs and promotes an active and healthy lifestyle (FAO, 2009). Awareness of the need to guarantee food security around the world contributed to the adoption in 2015 by the United Nations of the Sustainable Development Goals for the period up to 2030. In particular, goal No. 2 "Overcoming hunger" emphasizes the need to "end hunger, achieve food security, improve nutrition and promote sustainable agriculture" (Sustainable Development Goals, 2015).

The countries of Central and Eastern Europe, like other EU member states, generally have a single system of legislative regulation of food quality and safety, as well as the supply of food products, which meets the goals of the EU Common Agricultural Policy to provide EU consumers with high-quality, nutritious, safe and affordable food products (Keane,

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& O'Connor, 2016). The physical availability of food is not a threat to the food security of EU countries. However, the countries of Central and Eastern Europe are more vulnerable to threats to food security due to the lower level of income of the population compared to the EU average (Dudek, 2014).

The majority of scientific research in the field of food security of the EU countries, in particular the countries of Central and Eastern Europe, is based on the analysis of the peculiarities of their agri-food sectors (Burkitbayeva *et al.*, 2021), assessment of food security of households with an emphasis on household income and economic availability of food (Dudek, 2014), implementation of the potential of small farms in the formation of food security (Van Herck & Swinnen, 2015; Hernández *et al.*, 2021). During 2020–2022, there is a significant increase in threats to food security in the countries of Central and Eastern Europe. Thus, global and European food markets have been negatively affected by the global COVID-19 pandemic (Béné *et al.*, 2021). In 2022, due to the russian invasion of Ukraine, there was a disruption of supply chains in the EU agri-food markets, and experts recorded a significant increase in food prices due to the increase in energy prices.

Scientists have published some scientific works in the field of food security, both at the global level and at the level of groups of individual countries. Certain aspects of the development of the agricultural sector and the sphere of food security in the countries of Central and Eastern Europe are highlighted in the publications of S. Burkitbayeva *et al.* (2021). Scientists studied the dynamics of the formation of the potential of the agricultural sector and its role in guaranteeing the food security of the states in retrospect and analysed the factors and causes of crisis phenomena in agriculture, which caused the deterioration of the food supply of the population.

At the beginning of 2020, the pandemic of the coronavirus disease COVID-19 began in the world. One of the negative socio-economic consequences of this pandemic was the deterioration of the level of food security in most countries of the world, especially those with a low and medium level of economic development. The destructive impact of the pandemic was manifested in the fact that part of the population lost their jobs and source of income due to quarantine restrictions. The governments of the states directed funds to support the population during the conditions of the pandemic, which smoothed out the negative effect on the food supply. However, some studies confirm the deterioration of food security at the global level (Béné *et al.*, 2021).

An important factor in the emergence of threats to world food security is the war in Ukraine. The russian invasion of Ukraine and its impact on global food security is explored in the article by M. Muhammedov *et al.* (2023). A thorough study was carried out in the work of authors N. Kryvenko (2022). and showed the impact of the war in Ukraine on the food security of Eastern European countries.

The study of food security and the impact of the Common Agricultural Policy of the EU on the minimization of threats to food security both in Europe and in the world was conducted by the authors J.J.L. Candel *et al.* (2014). Scientists M.B. Morales *et al.* (2022) suggested directions for softening the environmental obligations of the EU's Common Agricultural Policy to compensate for the shortage of grain imports and strengthen food security in the context of the russian invasion of Ukraine.

A general review of the literature on the researched problem showed that most of the works are devoted to general aspects of food security of the member states of the European Union, analysis of the influence of individual macro-indicators or global challenges on the state of food security, the transformation of the foundations of the Common Agricultural Policy of the EU. At the same time, scientists focus their attention either on the European Union as a whole or on the threats to the food security of individual states, leaving out of consideration complex studies of the geo-economic group of countries of Central and Eastern Europe, which form the core of the agricultural potential of the EU. This issue is especially relevant against the background of Ukraine's European integration priorities and strategic challenges caused by the post-pandemic recovery of the EU and the military conflict in Ukraine.

Therefore, taking into account the emergence of new global threats, there is a need for an in-depth study of the food security of the countries of Central-Eastern Europe in the conditions of modern geopolitical and geo-economic challenges.

The scientific value of the research lies in deepening the theoretical and methodological basis of food security strategy in the countries of Central and Eastern Europe.

The purpose of the article is to study the current trends and problems of food security in the countries of Central and Eastern Europe, as well as to justify the strategic directions of ensuring food security in the studied countries based on the food initiatives and programs in the field of food security adopted by the European Union.

The objectives of the research are as follows:

- to analyse food prices in the countries of Central and Eastern Europe as the main factor of threats to food security;
- to reveal the global factors of food security and their impact on the state of food supply in the countries of Central and Eastern Europe;
- to determine strategic directions for improving food security in the EU countries in the context of the Common Agricultural Policy and strengthening regional support.

Materials and methods

The research methods were general scientific and special methods of cognition, in particular:

- comparative analysis (study of the main macro-indicators of socio-economic development of the countries of Central and Eastern Europe, indicators of food security, identification of differences in the level of food insecurity of the countries according to the considered indicators);
- statistical (study of the state and trends of food security in the countries of Central and Eastern Europe based on statistical data);
- inductions and deductions (justification of threats to food security in the countries of Central and Eastern Europe in modern crisis conditions);
- abstract (systematization of factors causing food insecurity in the analysed group of countries and formulation of conclusions);
- abstracting (research of strategic directions for ensuring food security in EU countries in conditions of global threats).

The study was conducted based on statistical data from Eurostat (2022), which made it possible to formulate conclusions regarding food insecurity in the countries of Central and Eastern Europe. To identify the deviation of food prices in the countries of Central and Eastern Europe from prices in the EU, the Eurostat methodology for calculating price level indices was used (price level indices, PLIs), which reflect a comparison of price levels in countries with the average price level in the EU. To determine the rate of growth of food prices in the analysed countries, the Harmonized Index of Consumer Prices (Harmonized Index of Consumer Prices, HICP), is calculated by Eurostat for EU countries.

The article uses scientific publications of the world and European scientists on the topic of research, as well as normative legal acts of EU supranational regulatory bodies (European Commission, European Parliament, Council of the EU), which approved the initiated initiatives, support programs, strategies in the field of food safety in the EU.

Results and Discussion

In the countries of Central and Eastern Europe, the role of agriculture in ensuring food security and availability of food is particularly significant, in particular, in conditions of growing demand for food. The real GDP per capita of the countries of Central and Eastern Europe is lower compared to the more developed countries of Western Europe and the EU average. Annual average wages in certain countries of Central and Eastern Europe were also significantly lower, compared to the average wage in the EU, which is 2021 amounted to 14,225 euros per year (Eurostat, 2022) (Table 1).

Table 1. The main macro-indicators of the socio-economic development of the countries of Central and Eastern Europe in 2021

Country	Real GDP per capita, euros	Average annual salary, net, euros	Global Food Security Index (ranking position in brackets)
Czech Republic	18020	7461	77.7 (16)
Hungary	13690	5037	71.4 (34)
Poland	13760	5504	75.5 (21)
Slovakia	15920	5921	71.1 (36)
Estonia	16490	8477	is not calculated
Latvia	12970	6113	is not calculated
Lithuania	14820	6517	is not calculated
Slovenia	21310	8337	is not calculated
Bulgaria	6950	3636	73.0 (29)
Romania	9550	4300	68.8 (45)

Source: compiled by the authors given the Eurostat (2022) and The Economist Newspaper (2022)

Given the data, a pronounced negative impact on the purchasing power of the population and sensitivity to rising prices for basic necessities, primarily food products, is shown. The share of expenditure on food products in EU countries was on average about 17% of household incomes in 2021 (Eurostat, 2022). Thus, in 2021, food prices in Central and Eastern Europe were lower than the average level of food prices in the EU. In particular, prices in Romania were 31% lower than the EU average, in Bulgaria – by 22%, and in Poland – by 29% (Table 2). A study of the price level of basic food products, in particular, bread, cereals, meat, fish, and dairy products, showed that prices in the countries of Central and Eastern Europe were lower compared to other EU countries. The share of household expenses in the EU countries for bread and cereals was 17 %, for meat – 23%, for fish – 5%, and for dairy products – 16% of the total sum of food expenses. Among the considered countries, the lowest level of prices for dairy products (milk, cheese, and eggs) is observed in Poland. The lowest prices for bread and cereals were in Romania, for fish in Bulgaria, and for meat and dairy products in Poland. The level of price deviation between the considered food groups is quite significant.

Table 2. Indices of food price levels in the countries of Central and Eastern Europe in 2021 compared to the EU average (EU=100 %)

Country	Price level index, %							
	in general for food products	bread and cereals	meat	fish	dairy products	oils and fats	fruits, vegetables, and potatoes	other products
Czech Republic	88.5	84.5	81.8	98.9	97.4	103.5	85.5	99.0
Hungary	84.6	79.7	69.6	85.1	94.1	123.9	90.3	100.0
Poland	70.7	70.3	61.2	83.5	74.4	87.1	82.6	78.3
Slovakia	93.6	91.3	80.2	100.4	102.5	121.5	96.3	107.0
Estonia	96.6	98.4	87.4	93.4	100.9	115.8	97.8	108.8
Latvia	94.5	92.1	76.8	87.8	113.4	129.5	89.8	119.0
Lithuania	85.9	88.4	71.4	81.7	99.0	116.1	82.0	104.8
Slovenia	100	108.6	101.5	93.8	107.3	111.4	86.7	107.8
Bulgaria	77.4	66.4	63.5	69.4	110.7	131.5	70.8	90.3
Romania	68.2	59.4	61.7	76.0	97.8	109.4	58.6	80.0

Source: compiled by the authors given the data of Eurostat (Eurostat, 2022)

As for food product groups such as oil and fats, fruit, vegetables and potatoes, and other food products, the share of household expenditure in the EU was respectively 3%, 22%, and 13% in the structure of household expenditure on food. Among the considered countries, the highest prices for oil and fats compared to the EU were observed in Latvia, Bulgaria, and Hungary. The price level for fruits, vegetables, and potatoes was lower in all countries, in particular, Romania and Bulgaria have the lowest price level for these food products. Poland and Romania have the lowest price level for other food products. The deviation of prices for fruits, vegetables, and potatoes in EU countries is the largest among the considered food groups.

Consumers in Central and Eastern European countries have felt the brunt of the recent sharp rise in food prices in the European Union. According to Eurostat, food inflation in the EU in October 2022 was 17.3%, compared to October 2021 (Eurostat, 2022).

According to operational Eurostat data on the harmonized index of consumer prices, which is calculated for EU countries, in October 2022, food prices in Lithuania increased by 32% year-on-year, in Bulgaria – by 26.4%, in Latvia – by 29.6%, in Hungary – by 43\%, in Estonia, Romania, and Slovakia – by more than 21% (Eurostat, 2022). The average level of food price growth in the EU countries in October 2022 was 17.3% (for comparison, the food price index in the EU was 4.8% in January 2022) (Table 3).

Table 3. Price indices and the share of expenditure on food products in the countries of Central and Eastern Europe (October 2022)

Country	Harmonized index of consumer prices, % until October 2021.	Harmonized index of consumer prices for food products, % until October 2021.	The share of household expenditure on food, % until April 2021.
Czech Republic	15.5	25.7	18.6
Hungary	21.9	43	19.3
Poland	16.4	21	16.7
Slovakia	14.5	26.1	21
Estonia	22.5	27.9	19.2
Latvia	21.7	29.6	23.4
Lithuania	22.1	32.6	19.2
Slovenia	10.3	17.3	15.8
Bulgaria	14.8	26.4	20.6
Romania	13.5	21.4	28.3
EU-27	11.5	17.3	15.9

Source: compiled by the authors given the Eurostat data (Eurostat, 2022)

The analysis of the factors that led to the deterioration of the economic availability of food for the population requires special attention. Firstly, the war in Ukraine has global negative consequences for global food security and trade in agricultural products. The uncertainty caused by hostilities disrupts the stable functioning of agri-food markets and threatens food supplies, affecting food prices and the basic inputs needed to produce food.

Food security of EU countries in the context of the physical availability of food is not a significant problem today. The countries of the EU, and especially of the Central-Eastern region, are quite self-sufficient in terms of key agricultural products. The EU is an exporter of wheat and barley and is also able to cover domestic consumption of staple food crops such as maize or sugar. It also has food independence in products of animal origin, including dairy products and meat, excluding seafood. At the same time, the EU is a net importer of certain agri-food products, such as feed protein, sunflower oil, or seafood. However, the invasion of the russian federation in Ukraine and the global increase in raw material prices lead to higher prices on agri-food markets and reveal the vulnerabilities of the food system: dependence on imports of energy, fertilizers, and animal feed. This increases the costs of producers and affects the prices of food products, reducing the purchasing power of consumers (Food security implications…, 2022; The Global Food..., 2022).

According to the report of the European Commission, the total volume of trade in EU agri-food products in 2021 reached a record 328.1 billion euros, which is 7% more than in 2020. The trade balance was positive and amounted to 67.9 billion euros, which is 8% more than in 2020 (Monitoring EU agri-food…, 2021). Trade in high-value-added food products increased, while trade in goods produced by farmers and agribusinesses, such as pork, dairy products, and wheat, declined in monetary terms.

In 2021, Ukraine exported agri-food products to the EU worth almost 7 billion euros, which made it the fourth largest agri-food trading partner of the EU (Monitoring EU agri-food…, 2021). The share of Ukraine in EU imports of cereals was 36%, and oils and fats – were 16%.

The invasion of the russian federation into Ukraine caused a sharp rise in food prices and created the risk of food shortages. The increase in food prices is especially noticeable in EU countries, where the share of food costs makes up a significant part of household expenses. Most of these countries belong to the analysed group of Central-Eastern European countries. In addition, some of them depend on imported food products.

At the same time, sanctions against the energy sector of the russian federation led to an increase in energy prices, which increased the cost of food production in EU countries. Rising food prices combined with rising energy prices have worsened inflationary expectations in Central and Eastern European countries, which were high even before the hostilities in Ukraine, and caused by the consequences of the global COVID-19 pandemic.

The increase in food costs against the background of high inflation will lead to a deterioration in the standard of living of the population and an increase in inequality in society.

To counter threats to food security, the EU has developed a plan for its provision and started its implementation (Communication from the Commission…, 2021). The priority directions for ensuring food security are:

- support for Ukrainian producers, providing preferential conditions to exporters when supplying agricultural products to the EU, which will help Ukraine maintain economic activity and produce agricultural products (financial assistance should compensate for the costs of seeds, fuel and lubricants, fertilizers, and plant protection products);
- connecting Ukraine to the European electricity grid, as well as reconstruction of civil infrastructure;
- the provision by EU farming organizations of targeted aid for the recovery and development of Ukrainian farmers affected by the war.

International cooperation in the field of implementation of the World Food Program is aimed at supporting the multilateral food system and agri-food markets. In response to the growing risks and threats to food security, a food and agriculture sustainability mechanism was proposed (Food and Agriculture Resilience Mechanism), which provides:

- reducing tension in the markets of agricultural products, guaranteeing full transparency of commodity flows and stocks, countering unjustified trade barriers;
- supporting the agricultural potential of Ukraine, providing access to agricultural products at reasonable prices in the neediest countries (Food security: implementation…, 2022).

In addition to it, the European Commission developed and implemented in March 2022 the European Food Security Crisis Preparedness and Response Mechanism (European Food Security Crisis preparedness and response Mechanism), aimed at improving the coordination of efforts of European and national administrations, as well as relevant non-EU countries and private stakeholders to ensure food security in crises. The mechanism will contribute to an in-depth analysis of the risks and vulnerabilities of the food supply chain in the EU, based on which recommendations and appropriate mitigation measures will be provided (Communication from the Commission…, 2022).

In the conditions of rising food prices, social policy measures are important both to protect the most vulnerable segments of the population (families with children, the elderly, and the poor) from food insecurity and to ensure the economic availability of food for them. These measures should be aimed at eliminating the causes of poverty and social isolation. In addition, the EU program "European guarantee for children" (European Child Guarantee) contains guidelines for member states

to guarantee access to sufficient and healthy food for children in need, including at least one free meal during each school day (Communication from the Commission…, 2022). Fund for European aid to the most disadvantaged (Fund for European Aid that the Most Deprived) supports EU member states in providing food and/or material aid to the most deprived persons, which provides food aid to more than 15 million people who have experienced food deprivation of various kinds (Communication from the Commission…, 2022).

To minimize the rise in food prices, member states can introduce reduced VAT rates and thus encourage businesses to lower prices for consumers. In particular, in December 2021, the Council of the EU agreed on a reform of VAT rates at the EU level, which allows member states to reduce rates to 0% on certain goods, including basic foodstuffs (New rules on VAT…, 2021). In addition, it is possible to implement one-time food assistance programs for households.

The common agricultural policy of the EU envisages effective measures to ensure food security, including a system of price security and the possibility of taking exceptional measures aimed at stabilizing agri-food markets in crisis conditions. At the same time, to eliminate the consequences of the crisis in the economy and food security of the EU member states, in March 2022 the European Commission adopted the Temporary Anti-Crisis Program Crisis Framework). This document allows providing financial support to farmers affected by the crisis and rising gas and electricity costs. As a result, producers of fodder and fertilizers, as well as energy-intensive enterprises, in particular, in the processing industry, can receive support (State aid: Commission…, 2022).

In general, the basis of food security in the EU is the stability of the food supply. Currently, in crisis conditions, the dependence of the EU food system on imported resources, such as fuel, fertilizers, fodder, and some types of raw materials, is obvious. Therefore, in 2022, the "From farm to table" strategy was adopted (Farm to Fork Strategy), which should contribute to the formation of a fair, healthy, and ecologically clean food system (Farm to Fork Strategy…, 2020). The main goal of the strategy is the reorientation of EU agriculture and food systems to the concept of sustainable development, which involves reducing the use of resources (plant protection products, fertilizers), transitioning to organic farming and ecologically clean food production while maintaining the productivity of the agricultural sector, ensuring food security following the Green Agreements (Green Deal) and reforms of the EU Common Agrarian Policy regarding the strategic development of rural areas (A European Green Deal, 2022).

According to one of the work programs "Horizon. Europe" for 2023-2024, funding is provided for the development of the circular economy and bioeconomy sectors (European Commission Decision…, 2022). In addition, the partnership "Circular Bio-based Europe" (2022) contributes to increasing the sustainable use of biomass, recovery of valuable nutrients, and production of alternatives based on biological products.

However, during the pandemic, mechanisms for ensuring close coordination between the European External Action Service, the European Commission, aid agencies of member states, and European financial institutions remain an urgent problem in the field of food security. Special attention should be paid to the most vulnerable sections of the population and temporarily displaced persons, in particular in the countries of Central and Eastern Europe, which have been affected by the increase in food prices due to high purchase prices of energy carriers and continue to suffer from the consequences of the COVID-19 pandemic.

At the level of EU member states, it is necessary to provide financial support to small and medium-sized farms to increase their resistance to threats and risks caused by market instability; use funds for the development of rural areas; support the creation of short supply chains to minimize the rise in retail food prices. Plans and programs should be developed to facilitate farmers' access to loans for the implementation of sustainable production methods and technologies, including the production and use of renewable energy.

The more developed countries of Western Europe are already reducing energy consumption in agriculture and food production through energy efficiency measures. More efficient use of nitrogen, valorization of biomass, and reduction of food waste are necessary for the future. Scientific research and innovation should be aimed at further improving the efficiency of fertilizer application on farms, in particular, through the introduction of precision farming methods. In addition, research funding for sustainable food production systems should be focused on mixed farming, agroecology, and organics.

It should be noted that even today, scientists focus their attention on the study of modern challenges to global food security, in particular, the consequences of the COVID-19 pandemic (Béné *et al.*, 2021) and the russian invasion of Ukraine (Mottaleb *et al.*, 2022; Lin *et al.*, 2023). At the same time, the issue of food supply in the countries of Central and Eastern Europe remains mostly out of the authors' attention. Thus, the work of H. Dudek *et al.* (2021) is devoted to the study of the economic and socio-demographic factors of food security in certain countries of Central and Eastern Europe in the context of achieving the Sustainable Development Goals. Scientist H. Dudek (2014) systematically analysed the impact of food costs on the food security of EU households. In continuation of these studies, N. Sotvoldiev and B. Mullabayev (2021) emphasize that in the system of food security mechanisms of states in the conditions of globalization, the price level and price parity are decisive. At the same time, priority in state policy should be given to stabilization measures to support consumer

demand, and not to obtain excess profits at the expense of export-import activities.

Scientists F. Galli *et al.* (2020) substantiated the directions of food policy development in the EU countries based on the formation of sustainable food systems as the basis of the Common Agricultural Policy of the EU, ensuring food security and social justice in society, as well as the preservation of natural resources.

In general, the countries of Central and Eastern Europe are vulnerable to threats to food security because small farms, which are the basis of food security in the region, have difficulties with integration into the Common Agricultural Policy of the EU. The integration of small farms into regional food systems in EU countries is an important factor in ensuring regional food security. They need support measures adapted to the specifics of their economic conditions, which is emphasized in the work of I. Toma *et al.* (2021), M. Rivera *et al.* (2020), and A.P. Hernández *et al.* (2021).

The development of food quality assurance systems in Eastern Europe remains a separate area of scientists' research. Thus, the basis of food safety in the food safety system is the certification of goods at all levels of the value creation system. At the same time, the primary link of certification should be agricultural production, which forms the basis for the health of the nation (Gawron & Theuvsen, 2009). Modern research by M. Gurinovic *et al.* (2020) showed that nowadays management decisions in the field of population nutrition should be based on food product databases, which enable the dynamic assessment and plan rations at the country level. In addition, in most countries of Eastern Europe, during the pandemic period, the so-called non-traditional methods of food self-sufficiency of the population, which are associated with changes in the philosophy of lifestyles and nutrition, became widespread (Jehlička *et al.*, 2020).

A comparison of the obtained results with the already existing works of scientists showed that the conducted research, in addition to the existing scientific development, t akes into account c ritically important factors of food security in the countries of Central and Eastern Europe. It is these countries that are in the greatest food danger due to the deterioration of the economic availability of food products, connected with the higher rates of growth of their price indices. Therefore, the population of these countries is more vulnerable to rising food prices due to lower household incomes. In addition, the authors deepened the scientific basis for the study of threats to the stability of the EU agri-food markets due to the disruption of supply links, as well as the increase in food prices as a result of energy sanctions against the russian federation due to the invasion of Ukraine, initiated by European and American colleagues (Kryvenko, 2022). At the same time, it should also be emphasized that the scientific community is fully aware of the long-term consequences of the military conflict on the territory of Ukraine. Scientists T. Ben Hassen and H. El Bilali (2022) noted that as a result of military operations, not only logistical chains are disrupted, but also the threat of a decrease in the volume of food supplies in the future due to the loss of human and agricultural potential of Ukraine, mined land massifs, as well as the deterioration of the quality of exported products due to soil contamination with heavy metals and chemical compounds of military origin.

The proposed measures will contribute to the strategic development of the agricultural sector of the EU and the formation of sustainable food systems in the conditions of global threats and challenges to the food security of the countries of Central and Eastern Europe.

Conclusions

In the countries of Central and Eastern Europe, the role of the agrarian sector in guaranteeing food security and availability of food, in particular in conditions of growing demand for food products, is significant. Food insecurity is mainly caused by rising food prices. Even though the price levels of basic food products in the countries of Central and Eastern Europe were lower compared to other EU countries, the increase in food prices during the crisis led to the deterioration of the food supply of the population due to the lower level of their incomes and a high share of food costs in the structure of household expenses.

Among the main factors that led to the deterioration of the economic availability of food for the population of the EU countries in general, and the countries of Central and Eastern Europe in particular, the war in Ukraine should be mentioned: the russian invasion disrupted the stable functioning of agri-food markets and endangered the supply of food, led to an increase in prices on the basic resources necessary for food production, and therefore on food products for the final consumer.

To counter threats to food security in the EU, it is necessary, firstly, to implement a set of actions to support Ukraine as a key player in global agricultural markets, as well as to create a sustainable food system that can withstand challenges and risks in agricultural production and the food sector. Several initiatives have already been adopted at the level of the European Commission in 2022 to achieve the set goals. However, ensuring food security through the formation of a sustainable food system will require the implementation of strategic measures provided for by the Common Agricultural Policy of the EU.

Guaranteeing food security in the countries of Central and Eastern Europe needs more attention given the lower level of income of the population. It is necessary to implement financial support measures for commodity producers to compensate for the increase in resource prices and to develop and implement social support programs for the population. The transition to the concept of sustainable development will contribute to the reduction of import dependence on the resources of the agricultural sector and food production.

Further scientific research should be devoted to the development of a methodological toolkit for evaluating the effectiveness of implemented measures in the area of ensuring food security in the countries of Central and Eastern Europe.

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Conflict of Interest
None.

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Продовольча безпека в країнах Центрально-Східної Європи: стан і стратегічні напрями забезпечення

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► **Анотація.** Актуальність дослідження полягає у тому, що в сучасних умовах продовольча безпека країн Центрально-Східної Європи знаходиться під загрозою через вплив негативних чинників, пов'язаних як із глобальними деструктивними подіями, так і з вразливостями продовольчих систем на рівні ЄС. Метою статті є дослідження стану та проблем продовольчої безпеки у країнах Центрально-Східної Європи, та виявлення стратегічних напрямів забезпечення продовольчої безпеки у досліджуваних країнах. Методами дослідження стали загальнонаукові та спеціальні методи пізнання, зокрема: порівняльного аналізу, статистичний, індукції та дедукції, абстрактно-логічний, узагальнення й абстрагування. Показано особливості формування продовольчої безпеки у країнах Центрально-Східної Європи. Досліджено рівень цін на продукти харчування та доведено, що вартість продовольства у країнах Центрально-Східної Європи є нижчою, порівняно з іншими країнами-членами ЄС. Стверджено, що економічна доступність продуктів харчування є проблемою для населення аналізованої групи країн через низький рівень доходів та зростання частки витрат на продовольство у структурі витрат домогосподарств. Розглянуто основні заходи, прийняті на рівні Європейської Комісії, спрямовані на забезпечення продовольчої безпеки шляхом переходу на стійку продовольчу систему на основі зменшення енергозалежності аграрного сектора та підвищення його інноваційності й екологічності. Практичне значення дослідження полягає у тому, що сформульовані рекомендації сприятимуть зниженню продовольчої небезпеки країн Центрально-Східної Європи за рахунок забезпечення стабільного функціонування агропродовольчих ринків, впровадження стратегічних напрямів підтримки аграрного сектора та зменшення імпортозалежності від виробничих ресурсів, підтримки України як ключового світового експортера продовольства, формування стійкої продовольчої системи у країнах ЄС

► **Ключові слова:** продовольство; продовольча безпека; агропродовольчі ринки; економічна доступність продовольства; доходи населення; індекс продовольчих цін

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Evaluation of the efficiency of agrarian institutions of higher education of Ukraine using the DEA method

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► **Abstract.** The relevance of the study is determined by the need to perfect the evaluation of the efficiency of scientific and educational activities of the country's higher education institutions and determine the causes of inefficiency. The purpose of this study was to improve the evaluation of the efficiency of scientific publication activities of agrarian higher education institutions of Ukraine using the Data Envelopment Analysis method. The study was conducted according to the general heuristic method, the authors also employed mathematical and statistical methods of processing and analysis of input and output data, computer methods for the implementation of research tasks and abstract-logical methods for determining the degree of relevance, formulation of conclusions. The study substantiated the feasibility of using the non-parametric method of Data Envelopment Analysis to evaluate the efficiency of the scientific and educational activities of higher education institutions, as well as the feasibility of using Voluntary Retirement Services and Compulsory Retirement Service models, which are input-oriented, to evaluate the technical, purely technical, large-scale efficiency of scientific publication activity. Based on statistical information for 2020-2021, the technical, purely technical, large-scale efficiency of the scientific publication activity of 38 agricultural institutions of higher education of Ukraine were evaluated using the Data Envelopment Analysis method. According to the results of calculations, 18% of the educational institutions under study have the maximum value of technical and large-scale efficiency. The average technical efficiency is 0.6, the average pure technical efficiency – 0.7, and the average scale efficiency – 0.85. The analysis of the estimated values of relative efficiency allowed identifying the reasons for the inefficiency of each higher education institution under study, including suboptimal use of educational resources and an unbalanced scale of activity. Based on the study results, a rating of agrarian institutions of higher education in Ukraine in terms of the efficiency of scientific publication activities was compiled, which can be used as an addition to conventional ratings for analysing scientific and educational activities. The results of this study can be used to rank higher educational institutions by efficiency, to find the reasons for their ineffective activities

► **Keywords:** agrarian institutions of higher education; Data Envelopment Analysis method; technical efficiency; pure technical efficiency; large-scale efficiency; rating

► Introduction

An objective assessment of the efficiency of the scientific and educational activities of higher education institutions (HEI) in Ukraine is necessary for all participants in the market of educational services: stakeholders of educational services, managers of higher education institutions, and supervisory bodies for ensuring the quality of higher education. It is important to use efficiency assessment methods that allow considering the influence of multiple factors on multiple activity results, are based on open objective statistical information and do not depend on the opinions and judgments of experts, and also allow determining the causes of inefficiency. The relevance of this study is conditioned upon the need to perfect the evaluation of the efficiency of scientific and educational activities of the HEI of Ukraine, considering the conditions that affect the objectivity of the evaluation and determining the causes of inefficiency. There is a wide variety of performance evaluation methods. Choosing a method for evaluating efficiency is an important research task. M. Dubinina *et al.* (2023) provided an analysis of the current methods of eval-uating efficiency, including non-parametric meth-ods that allow evaluating efficiency based on the impact analysis of a set of input factors (resources) on a set of output factors (results of activity). The DEA method is a non-parametric method of as-sessing the relative efficiency of any complex socio-

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economic economic objects. Charnes *et al.* (1978) used the term "Decision-making unit" (DMU) to emphasize the fact that the DEA method evaluates the efficiency of any decision-making organization. The advantages of using the DEA method are described by Ya. Dolgikh (2020), the key to which are the ability to comprehensively evaluate efficiency, as well as the ability to identify the causes of inefficient activity and provide reasonable recommendations for increasing efficiency to the maximum level. The DEA method allows for obtaining a remote performance assessment based on open statistical information.

The DEA method is widely used in the foreign practice of evaluating the performance of various business entities. There are special professional websites that contain software developed for DEA models. For instance, the site "Data Envelopment Analysis Online Software" (2023). Many statistical programs offer DEA calculations. For example, the software environment for processing data arrays R includes the "deaR" program package for solving practical problems with a wide range of DEA models (Coll-Serrano *et al.*, 2018; Lotfi *et al.*, 2020).

Many studies by foreign authors cover the theoretical and practical aspects of the application of the DEA method for evaluating the efficiency of various business entities. A. Emrouznejad *et al.* (2008) provides an extended analysis of works on the application of the DEA method from 1978-2007. The article of A. Charnes *et al.* (1978) are one of the most famous scientific studies, which became the basis of many scientific papers. According to data for 1987-2020, 301 papers covering the application of the DEA method in education were published (Data Envelopment Analysis…, 2023). Scientific studies on the application of the DEA method in education are divided into such areas as the application of the DEA method to evaluate the efficiency of schools and universities. These areas of research determine the variety of models used, which is primarily conditioned upon various combinations of input and output data. One of the first scientific studies on the application of the DEA method in education is the article by A. Bessent *et al.* (1982), which evaluated the efficiency of educational activities of schools.

Among the latest foreign studies covering the application of the DEA method for evaluating the efficiency of HEIs, one can note the studies of D. Mirasol-Cavero and L. Ocampo (2023), who were engaged in programming fuzzy preferences in data analysis for the evaluation of university departments. Unfortunately, in Ukraine, modern modelling methods are rarely used to analyse the efficiency of scientific and educational activities.

The scientific originality of this study is to determine the specific features of using the DEA method to assess the efficiency of scientific publication activities of agricultural universities in Ukraine.

The purpose of the study was to evaluate and analyse the efficiency of the scientific publication activities of agrarian educational HEIs, to identify the causes of inefficiency.

▸ Literature review

A. Bessent *et al.* (1982) evaluated the efficiency of the educational activities of schools. The paper identified such advantages of the DEA method as evaluating efficiency ba sed on mu ltiple pe rformance results, the absence of the need to set a functional form for a production function, and the ability to identify sources of inefficiency. The studies of T. Stal *et al.* (2023), A. Athanassopoulos & E. Shale (1997), and G. Madden *et al.* (1997) can be noted among the first scientific papers using the DEA method to evaluate the efficiency of the educa-tional and scientific activities of universities. Among the scientific articles published recently, the paper by D. Mirasol-Cavero and L. Ocampo (2023) can be noted, which proposes the application of the FPP-DEA model that allows the processing of missing and imprecise initial data. The FPP-DEA model has been tested in a higher education institution in the Philippines. The study by T. Tran *et al.* (2023) examines the efficiency of 172 Vi etnamese HEIs during 2012-2016 using the DEA method.

The authors compare the efficiency of pu blic and private, mono- and multidisciplinary, non-autonomous, and autonomous HEIs that carry out international activities and those that do not have such activities. It is concluded that public universities tend to be less efficient than their counterparts in the private sector. Universities with international programs have higher performance indicators than those that do not have international programs.

Zh. Ma *et al.* (2021) proposed a DEA model for evaluating the performance of mixed-type DMUs. The model was tested to evaluate the efficiency of interdisciplinary scientific research by teachers at the University of Inner Mongolia. R.S. Tavares *et al.* (2021) suggest the use of the DEA method for evaluating the efficiency of the ed ucational, sc ientific, and financial activities of universities. The proposed model was tested in 45 Brazilian federal universities. The paper by R. Mammadov and Ah. Aypay (2020) identifies factors that influence the effi ciency of research universities in Turkey. G. Zhang *et al.* (2020) proposed the application of the DEA method to evaluate the efficiency of resource use by HEIs in the provinces of China. Changes in efficiency were evaluated, and suggestions for improving the current higher education system were provided.

Among the latest works of Ukrainian authors, which describe the use of the DEA method for evaluating the efficiency of educational activities, one can note the study by I. Lesik *et al.* (2022). The paper analyses some factors that affect t he efficiency of the education system in Ukraine using the DEA method. The study was conducted in 24 regions of Ukraine. The input indicator was the number of students who entered the university for the first time, the output indicators were the following: the number of people who received a certificate of complete general secondary education, the number of people who completed the External Independent Evaluation, the average cost of studying at the university

per year, UAH, the number of students studying with budget funds. The next study that deserves attention is the paper by O. Omelianenko (2022), which provides a methodological approach to the application of the DEA method to evaluate the efficiency of spending budget funds on various social programs, including secondary education. In the paper by A. Shender (2013), the efficiency of the use of educational resources in different regions of Ukraine was established using the DEA method.

Based on the analysis of the obtained results, problematic issues that need to be solved were identified, and measures of the regional policy of the market of educational services were recommended. The analysis of publications covering the application of the DEA method in education shows that the issue of the application of the DEA method for evaluating the efficiency of HEIs in Ukraine and analysing the causes of ineffective activity has been understudied.

▸Materials and methods

The following methods were used during the study: 1) generalized heuristic method; 2) statistical research (for collection, processing, and analysis of input and output data); 3) economic-mathematical modelling (application of the Voluntary Retirement Services (VRS) and Compulsory Retirement Service (CRS) models of the DEA method to evaluate the technical, purely technical, large-scale efficiency of scientific publication activities); 4) special (non-parametric DEA method, according to which the relative efficiency of each researched DMU (Decision-Making Units) is evaluated by solving linear programming problems; a benchmarking method for comparing the performance of researched DMUs with reference ones that have maximum efficiency); 5) computer (development of a program in the Visual Basic for Applications language for Microsoft Excel to perform calculations according to DEA models); 6) abstract-logical (to assess the degree of relevance of the study, to formulate conclusions).

The DEA method evaluates the relative efficiency of each business entity of the same type (DMU) o_k, $k=\overline{1,K}$ any complex socio-economic system, the activity of which is characterized by vectors of input $X_k=(x_{k1}, x_{k2}, \ldots, x_{km})$ and output $Yk=(y_{k1}, y_{k2}, \ldots, y_{kn})$ variables. Input variables can be resources used in economic activity, output resources – results of economic activity (amount of produced goods, services). Entities that produce the maximum number of goods or render the maximum number of services for a certain number of resources have the maximum relative efficiency and form the so-called efficiency limit in the space of input-output variables. The relative efficiency of entities that do not belong to the efficiency boundary is evaluated by the degree of distance from it – the further, the smaller the value of relative efficiency.

The DEA method is used to calculate technical efficiency (*TE*), pure technical efficiency (*PTE*) and scale efficiency (*SE*). Pure technical efficiency is calculated according to the VRS model, which considers the variable effect of the scale of economic activity. Technical efficiency is calculated using the CRS model, which considers the constant effect of the scale of activity. Large-scale efficiency is calculated as the ratio of technical efficiency to pure technical efficiency. Determining the values of the specified types of efficiency allows for a complete analysis of economic activity. There is also a distinction between DEA models that are input-oriented and output-oriented. Input-oriented models minimize the vector of input variables with a fixed vector of output variables, while output-oriented models maximize the vector of output variables with a fixed vector of input variables.

Estimation of technical efficiency according to the input-oriented CRS model is carried out by solving the following linear programming problem (Charnes *et al.*, 1978):

$$\min_{E, \lambda_1, \lambda_2, \ldots, \lambda_k} E \quad (1)$$

$$EX_0 \geq \sum_{k=1}^{K} \lambda_k X_k, \; Y_0 \leq \sum_{k=1}^{K} \lambda_k Y_k \quad (2)$$

$$\lambda_k \geq 0 \; (k=\overline{1,K}) \quad (3)$$

where E is the input technical efficiency; λ_k is the unknown coefficients to be determined; K is the number of DMUs that are compared in efficiency; X_0 is the vector of input variables of the DMU being analysed; Y_0 is the vector of the output variables of the DMU being analysed; X_k is the vector of input variables of the k^{th} DMU; Y_k is the vector of output variables of the k^{th} DMU.

Estimation of pure technical efficiency according to the input-oriented VRS model is carried out by solving problems (1)-(3) with the addition of the following constraint to the system of constraints (2), (3) (Banker *et al.*, 1984):

$$\sum_{k=1}^{K} \lambda_k = 1 \quad (4)$$

Correct solution of problem (1)-(4) is possible if the following non-degeneracy condition is met (Cooper *et al.*, 2006):

$$K \geq max\{m \times n; 3(n+m)\}, \quad (5)$$

where n is the number of output variables; m is the number of input variables.

The application of the DEA method to assess the effectiveness of the scientific publication activities of the agricultural higher education institutions of Ukraine was carried out in the following stages: 1) identification of the subjects of economic activity, the effectiveness of which is subject to evaluation (agrarian HEIs), as well as the object of the study (scientific publication activity); 2) selection of a modelling apparatus (non-parametric efficiency assessment methods, DEA method), DEA method models for relative efficiency assessment (VRS-, CRS-, input-oriented); 3) determination of input and output data for the construction of DEA models, which

consider the specific features of the object under study, satisfy the specific features of the application of the DEA method, the condition of non-degeneracy. The statistical database of the values of the input data, namely the number of scientific and pedagogical workers (SPWs) of the HEIs under study, the amount of funding of the HEIs under study in 2020, the amount of income to the special fund per SWP of the HEIs under study in 2020 was formed according to the information on the official website of the Ministry of Education and Science of Ukraine (Ministry of Education and Science..., 2023). The statistical base of the values of the initial data, namely the number of Scopus publications by the SWPs of the HEIs under study in 2021, the number of citations of the SWPs of the HEIs in 2021, the Hirsch index of the SWPs of the HEIs in 2021, the difference in the Hirsch index (2021-2020) formed based on the information of the ranking of universities by Scopus indicators of 2021, published on the website "Education in Ukraine and abroad" (Education in Ukraine..., 2023); 4) the implementation of the research task, namely the determination of the values of technical, pure technical, large-scale efficiency, the nature of the return on the scale of activity, the analysis, and evaluation of the solutions found, the provision of recommendations to increase the effectiveness of the scientific and educational activities of the agrarian HEIs under study, the determination of areas for further scientific research.

Results

Determination of the subjects, the object of the study, the effectiveness of which is subject to evaluation. HEIs of Ukraine, namely universities, academies, institutes with an agrarian orientation of scientific and educational activities, were chosen as entities of economic activity to be evaluated according to the DEA method. Among these HEIs, 38 were selected, which carry out educational and scientific activities in the following fields: "Agrarian sciences and food", "Production and technologies", "Natural sciences". Table 1 shows a sample of DMUs – agrarian HEIs of Ukraine selected for the study.

Table 1. Agrarian HEIs of Ukraine under study

No. DMU	HEI	No. DMU	HEI
1	Bila Tserkva National Agrarian University	20	Odesa State Agrarian University
2	Vinnytsia National Agrarian University	21	Odesa State Ecological University
3	Uzhhorod National University	22	I. I. Mechnykov Odesa National University
4	Luhansk Taras Shevchenko National University	23	Podillia State University
5	Dnipro State Agrarian and Economic University	24	Polissia National University
6	Oles Honchar Dnipro National University	25	Poltava State Agrarian University
7	Zaporizhzhia National University	26	Vasyl Stefanyk Precarpathian National University
8	West Ukrainian National University	27	Sumy National Agrarian University
9	Lutsk National Technical University	28	Lesya Ukrainka Volyn National University
10	Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv	29	Volodymyr Dahl East Ukrainian National University
11	Lviv National Environmental University (Lviv National Agrarian University)	30	Dmytro Motornyi Tavria State Agrotechnological University
12	Bogdan Khmelnytsky Melitopol State Pedagogical University	31	Ternopil Ivan Puluj National Technical University
13	Mykolaiv National Agrarian University	32	Uman National University of Horticulture
14	Ukrainian National Forestry University	33	O. M. Beketov National University of Urban Economy in Kharkiv
15	National Technical University "Kharkiv Polytechnic Institute"	34	Kherson State Agrarian and Economic University
16	Chernihiv Polytechnic National University	35	Khmelnytskyi National University
17	National University of Life and Environmental Sciences of Ukraine	36	Central Ukrainian National Technical University
18	National University of Water and Environmental Engineering	37	Cherkasy State Technological University
19	National University of Food Technologies	38	Yuriy Fedkovych Chernivtsi National University

Source: Ministry of Education and Science of Ukraine (2023)

Definition of the simulation apparatus, models of the DEA method for efficiency assessment. The non-parametric DEA method was chosen to evaluate the effectiveness of the scientific and journalistic activity of agrarian HEIs of Ukraine. The subject of economic activity is efficient if, according to the solution of problems (1)-(3) or (1)-(4), the input technical efficiency is equal to 1 and the binary

values are equal to zero. For efficient economic entities, the T.C. Koopmans (1951) optimum is achieved, at which the existing level of resource consumption ensures the maximum possible results of activity. This suggests that the combination of resources is optimal. Non-zero values of dual estimates indicate that the subject of economic activity is inefficient.

An economic entity that is efficient according to the CRS model is also efficient according to the VRS model and operates in the most productive scale, the CRS (Constant Return to Scale) zone (Bogetoft & Otto, 2013). The scale efficiency value of such an entity is SE=1. If SE<1, then the scale of activity of such an economic entity is inefficient due to too large or too small scale of activity. The following zones of scale inefficiency are distinguished: with decreasing return to scale (DRS) and with increasing return to scale (IRS). If the subject works in the DRS zone, then the scale of its activity is too large, and if in the IRS zone, it is too small from the optimal one. It is possible to determine the nature of returns to scale (RTS) when solving problems (1)-(3). If according to the received solution $\sum_{k=1}^{K}\lambda_k^*<1$, then the subject works in the IRS zone, if $\sum_{k=1}^{K}\lambda_k^*>1$, then in the DRS zone (Bogetoft & Otto, 2011).

At the stage of clarification and detailing of the research task, input-oriented VRS and CRS models of relative efficiency assessment were chosen. Determining the relative efficiency according to the VRS and CRS models will allow a full analysis of efficiency to identify the causes of inefficient activity. The reasons for inefficient work can include the irrational use of resources and the wrong scale of activity. The chosen orientation of input-oriented models allows providing recommendations for achieving the maximum efficiency of the scientific and journalistic activity of the HEIs under study through the optimization of the resources used. This approach to optimization is appropriate if the indicators of the results of scientific publication activities are sufficient, are limited by the contracts of SWPs, and it is necessary to save the resources spent. Input-oriented DEA models are more convenient for educational process managers, as management has more opportunities to control input resources and adjust them.

▸ **Determination of input and output values for performance evaluation.** The specified stage of the study included the determination of input and output variable models, namely, the formation of the composition of factors considering the specific features of the object under study, the verification of the condition of non-degeneracy. Statistical data of input factors were obtained from the official website of the Ministry of Education and Science of Ukraine (2023), output factors – from the website "Education in Ukraine and abroad" (2023). The values of the input and output variables are presented in Table 2.

Table 2. Input and output data for building DEA models

No. DMU	Input data			Output data			
	SWPs. people	Financing of HEIs in 2020[1]. UAH	Income to the special fund per one SWP of the HEIs in 2020[2]. UAH	Number of Scopus publications by SWPs of the HEIs in 2021. pcs.	Number of citations of SWPs of the HEIs in 2021. pcs.	Hirsch Index of SWPs of the HEIs in 2021	Hirsch index difference (2021-2020)
1	376	89 194 277	5 004	173	590	13	2
2	327	69 255 597.38	13 456	206	515	10	2
3	1 285	206 950 420.3	1 485	2 673	14 444	43	3
4	401	80 868 766	271	193	852	14	1
5	327	68 290 648.29	9 906	280	765	11	1
6	826	244 447 860.6	2 112	4 262	18 456	46	1
7	665	131 734 756	1 043	972	2 374	21	1
8	686	113 593 894.1	2 211	961	2 765	21	4
9	413	107 988 364.3	6 356	561	1 058	13	1
10	412	86 775 294	518	286	1 970	22	2
11	338	82 024 309.75	2 194	233	722	9	2
12	278	63 836 469	5 831	174	536	11	5
13	352	83 015 800	15 337	205	517	12	4
14	314	81 628 951	11 321	363	3 292	26	5
15	1 387	370 456 684	4 206	4 890	19 915	48	3
16	260	102 850 837	12 579	467	1 825	19	19
17	1 210	460 500 086.1	8 055	1 730	6 645	32	4
18	549	137 998 203.1	4 003	722	2 402	19	4
19	577	171 116 283.3	1 432	717	3 243	25	3
20	141	28 348 087.48	963	34	64	6	6

Table 2, Continued

No. DMU	Input data			Output data			
	SWPs. people	Financing of HEIs in 2020[1]. UAH	Income to the special fund per one SWP of the HEIs in 2020[2]. UAH	Number of Scopus publications by SWPs of the HEIs in 2021. pcs.	Number of citations of SWPs of the HEIs in 2021. pcs.	Hirsch Index of SWPs of the HEIs in 2021	Hirsch index difference (2021-2020)
21	168	48 057 414	2 096	296	1 631	17	1
22	759	116 341 560.4	7 170	3 916	25 987	67	5
23	199	56 214 057	17 623	101	143	6	6
24	356	70 454 941	1 909	244	546	11	3
25	325	70 359 641	4 467	243	418	9	3
26	876	127 778 537	10 042	1 152	11 944	47	5
27	385	118 660 074.1	7 355	463	1 932	20	3
28	772	151 417 840	6 683	975	7 082	32	2
29	435	125 405 236	996	943	3 498	21	5
30	318	83 029 307	3 174	281	668	12	5
31	416	85 079 178	2 108	910	2 832	17	2
32	295	76 091 055.5	1 407	211	306	9	4
33	499	109 467 191.9	11.081	597	1 440	17	3
34	216	47 324 793	2 072	123	349	10	4
35	544	104 312 584.6	2 234	684	2 812	19	0
36	311	74 986 147.68	341	261	606	10	2
37	345	72 738 483	193	294	1 093	20	14
38	1 035	178 450 009.4	539	3 995	20 227	64	3

Note: [1]except for 1) funding to ensure social benefits and other expenses according to the legislation; 2) a reserve, except for added expenses related to the increase in the official salary (rate) of an employee of the first tariff category, which was not prescribed as of January 1 of the previous year;
[2]according to the results of scientific and scientific and technical works under international cooperation projects, according to the results of scientific and scientific and technical works under economic contracts and according to the results of the provision of scientific services per one SWP according to the principal place of employment
Source: Ministry of Education and Science of Ukraine (2023), Education in Ukraine and abroad (2023)

The selected variables reflect the relationship between the resources of HEIs and the results of scientific publication activities created on their basis. When forming the composition of input and output variables, the time factor is considered – the specified results of scientific publication activity are possible at least one year after the impact of the specified input factors. The performance of the condition (5) is verified as follows:

$38 \geq max\{3\times4;3(3+4)\}$; $38 \geq max\{12;21\}$; $38 \geq 21$.

Thus, condition (5) is being performed.

▸ **Efficiency evaluation results.** At the last stage of the study, the implementation of the research task, analysis, and evaluation of the found solutions were carried out.

Table 3 shows the results of the calculations of technical efficiency (*TE*), pure technical efficiency (*PTE*), scale efficiency (*SE*) and returns to scale (*RTS*).

Table 4 shows the summary efficiency evaluation indicators.

Table 3. Calculation results

No. DMU	*TE*	*PTE*	*SE*	*RTS*	No. DMU	*TE*	*PTE*	*SE*	*RTS*
1	0.3806	0.4524	0.8414	Increasing	20	1.0000	1.0000	1.0000	Constant
2	0.3493	0.5058	0.6906	Increasing	21	1.0000	1.0000	1.0000	Constant
3	0.5919	0.6332	0.9347	Increasing	22	1.0000	1.0000	1.0000	Constant
4	0.5614	0.8691	0.6459	Increasing	23	0.5468	0.7625	0.7172	Increasing
5	0.3637	0.5411	0.6722	Increasing	24	0.4117	0.5667	0.7264	Increasing
6	1.0000	1.0000	1.0000	Constant	25	0.3515	0.5238	0.6711	Increasing
7	0.4837	0.6001	0.8060	Increasing	26	0.6742	0.6847	0.9847	Increasing
8	0.4673	0.5565	0.8397	Increasing	27	0.5414	0.5460	0.9915	Decreasing
9	0.3406	0.5115	0.6658	Increasing	28	0.4759	0.4792	0.9930	Increasing

Table 3, Continued

No. DMU	*TE*	*PTE*	*SE*	*RTS*	No. DMU	*TE*	*PTE*	*SE*	*RTS*
10	0.8347	0.8736	0.9555	Increasing	29	0.7317	0.8349	0.8764	Increasing
11	0.3337	0.5130	0.6505	Increasing	30	0.5068	0.5641	0.8984	Increasing
12	0.5324	0.6027	0.8834	Increasing	31	0.5446	0.7172	0.7593	Increasing
13	0.4066	0.4718	0.8618	Increasing	32	0.4388	0.6413	0.6842	Increasing
14	0.9001	0.9138	0.9849	Decreasing	33	0.3816	0.4457	0.8562	Increasing
15	0.7167	1.0000	0.7167	Decreasing	34	0.6282	0.7415	0.8473	Increasing
16	1.0000	1.0000	1.0000	Constant	35	0.4770	0.5611	0.8501	Increasing
17	0.3322	0.3532	0.9403	Increasing	36	0.5126	0.9953	0.5150	Increasing
18	0.4249	0.4720	0.9001	Increasing	37	1.0000	1.0000	1.0000	Constant
19	0.6392	0.6519	0.9805	Increasing	38	1.0000	1.0000	1.0000	Constant

Source: according to authors' calculations

Table 4. Evaluation indicators

Indicators	Calculated values		
	TE	*PTE*	*SE*
Number of effective ones	7	8	7
Percentage of effective ones	18.42	21.05	18.42
Average efficiency	0.6022	0.6996	0.8511
CRS	7		
IRS	28		
DRS	3		

Source: according to authors' calculations

The calculated values of relative efficiency allow making a rating of agrarian HEIs according to scientific publication activity. Table 5 shows the rating of the HEIs under study by technical, pure technical efficiency of scientific publication activity.

Table 5. Evaluation indicators

Rating of agrarian HEIs according to the CRS-input model			Rating of agrarian HEIs according to the VRS-input model		
No. DMU	*TE* (CRS)	Rank	No. DMU	*PTE* (VRS)	Rank
6	1	1	6	1	1
16	1	1	15	1	1
20	1	1	16	1	1
21	1	1	20	1	1
22	1	1	21	1	1
37	1	1	22	1	1
38	1	1	37	1	1
14	0.9000	2	38	1	1
10	0.8347	3	36	0.9953	2
29	0.7317	4	14	0.9138	3
15	0.7167	5	10	0.8736	4
26	0.6742	6	4	0.8691	5
19	0.6392	7	29	0.8349	6
34	0.6282	8	23	0.7625	7
3	0.5919	9	34	0.7415	8
4	0.5614	10	31	0.7172	9
23	0.5468	11	26	0.6847	10
31	0.5446	12	19	0.6519	11
27	0.5414	13	32	0.6413	12
12	0.5324	14	3	0.6332	13
36	0.5126	15	12	0.6027	14

Table 5, Continued

Rating of agrarian HEIs according to the CRS-input model			Rating of agrarian HEIs according to the VRS-input model		
No. DMU	***TE* (CRS)**	**Rank**	**No. DMU**	***PTE* (VRS)**	**Rank**
30	0.5068	16	7	0.6001	15
7	0.4837	17	24	0.5667	16
35	0.4770	18	30	0.5641	17
28	0.4759	19	35	0.5611	18
8	0.4673	20	8	0.5565	19
32	0.4388	21	27	0.5460	20
18	0.4249	22	5	0.5411	21
24	0.4117	23	25	0.5238	22
13	0.4066	24	11	0.5130	23
33	0.3816	25	9	0.5115	24
1	0.3806	26	2	0.5058	25
5	0.3637	27	28	0.4792	26
25	0.3515	28	18	0.4720	27
2	0.3493	29	13	0.4718	28
9	0.3406	30	1	0.4524	29
11	0.3337	31	33	0.4457	30
17	0.3322	32	17	0.3532	31

Source: according to authors' calculations

Analysis of the calculated technical efficiency (*TE*) values in Table 3 allow concluding on the efficiency of resource use. The following HEIs had the highest technical efficiency (*TE*): Oles Honchar Dnipro National University, Chernihiv Polytechnic National University, Odesa State Agrarian University, Odesa State Ecological University, I.I. Mechnykov Odesa National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University. The minimum value of technical efficiency (*TE*) corresponded to the National University of Life and Environmental Sciences of Ukraine. The estimated value of *TE*=0.33 means that the use of involved resources can be reduced by 67% and at the same time the indicators of scientific publication activity will not decrease. Conclusions about relative efficiency are better made by calculations of pure technical efficiency (*PTE*) because both the efficiency of the use of resources and the efficiency of the scale of activity are considered. The following HEIs had the highest value of pure technical efficiency (*PTE*): Oles Honchar Dnipro National University, National Technical University "Kharkiv Polytechnic Institute", Chernihiv Polytechnic National University, Odesa State Agrarian University, Odesa State Ecological University, I.I. Mechnykov Odesa National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University. The minimum value of pure technical efficiency (*PTE*) corresponded to the National University of Life and Environmental Sciences of Ukraine and was *PTE*=0.35. The reasons for the inefficient operation of the mentioned HEIs are the irrational use of resources and the small scale of activity, it works in the zone of Increasing Return to Scale (*IRS*).

The maximum technical efficiency (*TE*) of scientific publication activity was achieved by the seven HEIs under study, based on the data presented in Table 4. The percentage of efficient ones was 18%. Thus, 82% of HEIs use resources irrationally. The maximum pure technical efficiency (*PTE*) of scientific publication activity was achieved by eight HEIs under study. The percentage of efficient ones was 21%, i.e., 79% of HEIs use resources irrationally and have an unbalanced scale of activity. Only seven HEIs operate in the zone of the most productive scale (*CRS*). The percentage of efficient activities in terms of scale is 18%. In other words, 82% of HEIs can increase efficiency by changing the scale of their activities. The average scale efficiency is *SE*=0.85. In the zone with an increasing return to scale (*IRS*) there are twenty-eight HEIs. The size of the activity of these HEIs is too small from the optimal one. The scale of activity is too large for three HEIs. These HEIs operate in a zone with a decreasing return to scale (*DRS*).

According to the results of the calculations presented in Table 5, the first place in the rating of technical efficiency was shared by the following HEIs: Oles Honchar Dnipro National University, Chernihiv Polytechnic National University, Odesa State Agrarian University, Odesa State Ecological University, I.I. Mechnykov Odesa National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University. These universities efficiently use educational resources. The first place in the rating of pure technical efficiency was shared by the following HEIs: Oles Honchar Dnipro National University, National Technical University "Kharkiv Polytechnic Institute", Chernihiv Polytechnic National University, Odesa State Agrarian University,

Odesa State Ecological University, I.I. Mechnykov Odesa National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University. These HEIs are efficient in terms of the use of educational resources and the scale of their activities. The rating values displayed in Table 5 can be used as a benchmarking tool, by which reference objects are determined, and comparative analysis is carried out to improve the efficiency of activities.

Conclusions

Different authors use different specifications of DEA models to measure the effectiveness of educational and scientific activities. The variety of models used is primarily determined by different combinations of input and output data. In the conducted study, the models of the DEA method were selected, input and output data were presented for the evaluation and analysis of the efficiency of the scientific publication activity of agrarian higher education institutions of Ukraine, and the identification of the cause of inefficiency.

According to the study results, eight agrarian HEIs in Ukraine have the maximum pure technical efficiency of scientific publication activities. These HEIs are efficient in terms of the use of the educational resources, and the scale of their activities. 18% of the HEIs under study efficiently use the educational resources and 18% have an optimal scale of activity. The average technical efficiency is 0.6, the average pure technical efficiency is 0.7, and the average scale efficiency is 0.85, which is quite high. Investigated HEIs that are inefficient according to the DEA method can improve efficiency indicators by optimizing resource indicators and changing the scale of operations. One of the advantages of using the non-parametric DEA method is the ability to determine the optimal values of input and output variables, which allow the business entity to achieve maximum efficiency. The task of further research is to determine, using the DEA method, the main resource indicators of agrarian HEIs, which will allow inefficient HEIs to become as efficient as possible. Notably, relative efficiency is calculated using the DEA method. Therefore, HEIs that rank first in the compiled rating can also increase efficiency. For this, both the best universities in the world and countries can be selected as reference objects, but with modified indicators. The choice of reference HEIs should be made by experts. Improving the efficiency of agrarian HEIs, which have maximum efficiency, is also the task of further research.

The results of the ranking of agrarian HEIs of Ukraine according to the effectiveness of scientific publication activities reflect the results of the activity of a certain HEI, are a tool for decision-making by stakeholders, are the HEI's tool for marketing, external audit, self-analysis, and benchmarking.

The study results can be used to rank agrarian HEIs according to the efficiency of scientific publication activities, to determine the reasons for their inefficient work, and to provide reasonable recommendations for increasing efficiency to the maximum level.

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Conflict of Interest

None.

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Оцінка ефективності аграрних закладів вищої освіти України методом DEA

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► **Анотація.** Актуальність дослідження зумовлена необхідністю удосконалення процесу оцінки ефективності наукової і освітньої діяльності закладів вищої освіти країни та визначення причин неефективності. Мета статті – вдосконалити процес оцінки ефективності науково-публіцистичної діяльності аграрних закладів вищої освіти України методом Data Envelopment Analysis. Дослідження здійснювалось за загальним евристичним методом, застосовувались математико-статистичні методи обробки та аналізу вхідних та вихідних даних, комп'ютерні методи для реалізації задач дослідження та абстрактно-логічні для визначення ступеню актуальності, формулювання висновків. У дослідженні обґрунтовано доцільність застосування непараметричного методу Data Envelopment Analysis для оцінки ефективності наукової і освітньої діяльності закладів вищої освіти, а також доцільність використання Voluntary Retirement Services та Compulsory Retirement Service моделей, що орієнтовані на вхід для оцінки технічної, чистої технічної, масштабної ефективності науково-публіцистичної діяльності. На основі статистичної інформації за 2020-2021 роки методом Data Envelopment Analysis здійснено оцінку технічної, чистої технічної, масштабної ефективності науково-публіцистичної діяльності 38 аграрних закладів вищої освіти України. За результатами розрахунків 18% досліджуваних закладів освіти мають максимальне значення технічної та масштабної ефективності. Середня технічна ефективність складає 0,6, середня чиста технічна ефективність – 0,7, середня масштабна ефективність – 0,85. Аналіз оцінених значень відносної ефективності дозволив виявити причини неефективності кожного досліджуваного закладу вищої освіти, серед яких неоптимальне використання освітніх ресурсів та незбалансований масштаб діяльності. За результатами дослідження складено рейтинг аграрних закладів вищої освіти України за ефективністю науково-публіцистичної діяльності, який може бути використаний як доповнення до традиційних рейтингів аналізу наукової та освітньої діяльності. Результати досліджень можуть бути використані для ранжування закладів вищої освіти за ефективністю, визначення причин їх неефективної діяльності

► **Ключові слова:** аграрні заклади вищої освіти; метод Data Envelopment Analysis; технічна ефективність; чиста технічна ефективність; масштабна ефективність; рейтинг

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Development of farms in wartime conditions

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► **Abstract.** Farms form an integral element of territorial entities and local culture: they use a variety of agricultural systems, promoting a balanced diet and preserving the environment. In wartime conditions, farms have a unique potential for creating productive and sustainable food systems. All these features indicate that the study of the system of farm development is relevant and has both theoretical and practical significance. The purpose of this study was to substantiate the theoretical and methodological principles, socio-economic and legal issues of the activities of farms in the conditions of martial law. The methodological framework of the present study included the provisions of system analysis and economic theory. To generalize results, monographic, normative, graphic, abstract-logical methods and approaches were used. It was found that the conditions for staying on the single tax of group 4 are the most beneficial for farms, since the tax is fixed and depends solely on the volume of land plots. It was established that personal farms have the opportunity to implement their activities in the form of entrepreneurship for individuals-entrepreneurs who have organized a family farm. The study characterized individual family farms in Lviv, Zakarpattia, and Chernihiv regions. It was established that during martial law, the state allocates funds under special grants and subsidies to support the development of farms. It was found that the most adapted to the crisis conditions associated with military actions are farms and household plots. The results of the study can be considered in the development of regional programs for the development of agricultural business entities; the development of regulations for the formation and development of cooperation and integration in the agricultural sector of the economy

► **Keywords:** business entity; adaptation to martial law; farming; household plots; agricultural cooperative; integration and cooperative structures; integration associations

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Introduction

Farms are an essential component of the agricultural sector of the economy and an effective mechanism that contributes to expanding employment and increasing the incomes of the population in rural areas. The organization and activity of family farms were established by the Law of Ukraine No. 1788-IX "On Amendments to Certain Legislative Acts of Ukraine on Stimulating the Activities of Farms" dated 24.09.2021 (The Supreme Council…, 2022). The need for legal consolidation of such an economic structure is caused by the fact that household plots factually operate as family farms.

Family farms are the most motivationally oriented (the owner is the head of the family, the farm is owned by the family, and the family holds shares in its capital). The effective development of entrepreneurship as the main driving force in the development of the country's agrarian economy depends on the state of the business and market environment.

Considering the functioning of farms in extreme conditions, most researchers paid attention to the expediency of their creation; the formation of social capital of farms and private farms, and the military and economic significance of business entities. Economists' attention is focused on the problems of infrastructure support for rural areas and the assessment of target parameters of the anti-crisis stability of enterprises.

In the published studies on the problems of the development of farms, the main attention was paid to the essence of the concepts, the need for state support, the assessment of the impact of the external environment, and the criteria for assessing the investment status of subjects. But the issues of the development of farms in the conditions of martial law have been neglected. In addition, the issues of methodological foundations of estimation – indicators that identify the effectiveness parameters of social development processes, which concerns family farms, have not been further developed. These issues are discussed in this paper, with particular examples of the effective functioning of family farms.

Yu. Lupenko *et al.* (2021) state that the use of modern production technologies is one of the main areas of development of the farmer's activity. M. Odnorog *et al.* (2019) established that entrepreneurs are most adapted to extreme operating conditions, and the activities of inefficient institutions in the state reduce the guarantees of property rights and the level of life of the villager.

T. Ivanyuk *et al.* (2020), argued that during the cooperation of farmers' associations, the start-specialization mechanism should be implemented as an opportunity for additional financing of development, considering the features of innovative resources, the territorial, or local socio-economic system of functioning. I. Yatsiv and Yu. Solovei (2019) found that the imperfection of forms of social capital hinders the involvement of small agricultural entrepreneurs in integration processes.

H. Molnar (2021) substantiated models of strengthening, commercialization, and differentiation of farm activities. H. Sanikidze (2021) covered methodological provisions regarding the creation and functioning of farmer organizations and agricultural cooperatives. N. Gafarov *et al.* (2023) substantiated that the cooperation of private farms can improve the socio-economic living conditions of the rural population.

D. Shyian *et al.* (2021) analysed the situation in households from the standpoint of income, expenses, food quality, and consumption of individual products, and assessed potential opportunities for the development of the organic products market. Notably, S. Strapchuk & O. Mykolenko (2022) analysed house-hold expenses as a component of estimating their financial condition. J. Junaidi *et al.* (2022) found that household food security is related to survival strategies and the socio-economic characteristics of the family.

S. Ierokhin *et al.* (2022) found that small and medium-sized entrepreneurship in agriculture is a basic economic tool for the development of civil society. S. Kalnyi (2022) claimed that cooperation, vertical integration, and association reflect areas of organizational transformation of farms. D. Nemish and M. Humenyuk (2022) established that work experience and high flexibility of management reflect the strengths of the development of small business entities.

The present study substantiated the essence of the transformation of household plots into family farms in the conditions of martial law, which proved their effectiveness. Small farms have advantages over large enterprises that have suffered large losses as a result of military operations. Working under conditions of limited access to credit, farms need to address market gaps to have a form of guaranteed co-financing.

The purpose of this study was, from the standpoint of a systemic approach, to evaluate and substantiate the theoretical, methodical, and practical principles of entrepreneurial activity of farms in the agrarian sector of the economy of Ukraine in wartime conditions.

Results

Family-type economic entities. In Ukraine, several distinct entities belong to family-type farms. These are farms – legal entities; family farms (FF) – individuals-entrepreneurs; and other entrepreneurs working on small plots of land, but not registered as farms. There is a certain informal gradation of economic entities according to the amount of land under cultivation: small farmers-entrepreneurs – up to 100-200 ha; medium – 200-10,000 ha; large farms – over 10,000 ha. According to Article 55 of the Economic Code of Ukraine (State property fund…, 2022), the qualification of business entities is determined by two criteria: the amount of income from any activity and the number of employees.

Micro-enterprises include enterprises with an annual income of up to 2 million EUR. Small enterprises, respectively, include those with income from 2 to 10 million EUR. Therewith, considering the specifics of agricultural production (specialization), large

enterprises can also have separate thresholds from 500 thousand EUR to 2 million EUR. For instance, in a grain farm, up to 600-700 ha of land are in use.

Family farms that do not use hired labour and cultivate plots of up to 20 hectares are in the IV group of the unified tax. For these farms in 2023, the minimum tax liability will be set at half the standard amount – 2% of the standard land valuation, and later it will be increased to 2.5%. The share of agricultural production should be 75%. In the conditions of martial law, when the share of production becomes less than 75%, to confirm the status of a unified taxpayer, a copy of the decision of the regional council on unfavourable economic conditions that led to a change in the structure of production should be submitted to the tax authorities (State property fund…, 2022).

▸ **Development of entrepreneurs in agriculture.** For a long time, small farms developed in conditions of limited opportunities, as Ukraine's agricultural policy was focused on supporting large business structures. Furthermore, legislative initiative No. 3131 ("On amendments to the Tax Code of Ukraine and other legislative acts of Ukraine regarding the de-shadowing of agricultural production") (Economic Expert Platform…, 2022) may limit the development of small farms. The purpose of the strategy for the development of entrepreneurship and integration processes in the countryside in the post-war period is the development of an environment capable of ensuring employment and income growth of the able-bodied rural population, rural households, and communities, the development of rural areas based on entrepreneurial initiative, and household plots.

The draft order of the Cabinet of Ministers of Ukraine "On approval of the Concept of stimulating the development of entrepreneurship in rural areas until 2030" for the successful development of family farms proposes to focus on the development of the agricultural advisory system. Furthermore, attention is focused on long-term support for the development of small agrarian business entities and the activation of the creation of family farms (Order of the Cabinet..., 2021).

▸ **Number and main indicators of the functioning of small entrepreneurs.** Considering the positions of local self-government, it is important to form a balanced socio-economic activity of rural communities, which is ensured by the presence of an optimal number of business entities in the forms of management in agriculture of various scales with priority support for farms, various forms of cooperation as integration structures for the organization of joint activities (Tables 1-2).

Table 1. Dynamics of the number of entrepreneurs by forms of management in agriculture for 2027, thousand units

Entrepreneurs	2016	2017	2018	2019	2020	2021	2027 forecast	deviation 2021 in % to 2016
Number of agricultural enterprises. as of 01.11 of the corresponding year. including:	47 697	45 558	49 208	48 504	47 523	45 661	**44 513**	**–4.27**
Farms	33 682	34 137	33 164	32 452	31 851	31 257	**30 123**	**–7.20**
Family farms	-	-	-	64	48	151	**247**	
Production cooperatives	998	997	996	1 005	1 009	1 001	**992**	**+0.30**
Service cooperatives	949	1 017	1 073	1 207	1 270	1 274	**1 265**	**+34.24**
Household plots	4 075.2	4 031.7	3 996.5	3 975.1	3 954.8	3 921 5	**3 782.8**	**–3.77**
Individuals-entrepreneurs	23 458	21 201	20 922	20 337	19 354	18 876	**16 341**	**–19.53**
Horticultural companies	-	-	-	-	-	4 128	**4 135**	

Note: 1) the data are presented without considering the temporarily occupied territories; 2) household plot – a household, the members of which, according to the current legislation, are provided with a plot of land with the intended purpose "for keeping a household plot"

Source: research based on data (Economic statistics, 2023)

Table 2. Principal indicators of functioning of small entrepreneurs in agriculture

Indicators	2016	2017	2018	2019	2020	2021	deviation 2021 in % to 2016
Number of operating small entities. units	40 788	45 815	46 225	45 898	45 480	43 824	**+7.44**
– including individuals-entrepreneurs	23 458	21 201	20 922	20 337	19 354	18 876	**–19.53**
Equity at the end of the year. mln UAH	161 380.2	167 296.7	185 365.6	240 283.4	310 046.9	130 737.1	**–18.99**
Current financial investments (current financial assets) at the end of the year. mln UAH	1 241.6	800.9	858.4	907.7	721.7	1 383.9	**+11.46**
Long-term financial investments (non-current financial assets) at the end of the year. mln UAH	7 870.5	8 905.5	8 323.0	8 790.9	9 654.4	5 276.1	**–32.96**
Capital investments total. mln UAH	21 913.4	27 155.3	24 624.1	19 264.6	15 922.6	22 190 9	**+1.27**
Capital investments in tangible assets. mln UAH. incl.:	21 897.8	27 023.9	24 417.3	19 078.1	15 765.7	21 984.9	**+0.40**
– in the land. mln UAH	44.4	49.2	71.5	75.2	49.6	28.2	**–36.49**
– in available buildings and structures. mln UAH	176.9	181.5	292.6	300.1	138.9	331.6	**+87.45**
– in the construction and reconstruction of buildings. mln UAH	1 690.3	2 343.4	2 636.4	2 593.9	1927.9	2 523.0	**+49.26**
– in machinery and equipment. mln UAH	19 628.3	23 677.0	20 742.7	15 121.2	13 135.0	18 597.6	**–5.25**
Capital investments in intangible assets. mln UAH. incl.:	15.6	131.4	206.8	186.5	156.9	206.0	**+1320.5**
– in concessions. patents. licences. trademarks. mln UAH	0.4	9.2	1.4	0.9	0.4	0.6	**+50.0**
– in the purchase of software. mln UAH	5.3	9.8	12.7	8.4	5.4	14.8	**+179.24**
Volume of products sold. mln UAH	142 400.4	175 406.6	195 893.5	203 805.5	235 869.3	325 714.9	**+128.73**
Share in the total volume of products sold in the industry. %	36.64	40.10	38.82	37.91	40.13	36.55	

Source: research based on data (Economic statistics, 2023)

▸ **Support from the Food and Agriculture Organization of the United Nations (FAO).** As a result of the military operations, 1.5 million citizens need aid in resuming their activities in agriculture. The Food and Agricultural Organization of the United Nations (FAO) in 2023, to resume work in agriculture, plans to help restore activities and directs 205 million dollars for this. In 2022, 40,000 households in rural areas have already received this aid, and 100 million USD are still planned to be directed in 2023 to aid households (Landlord, 2022).

Implementation of the State Program "Affordable Loans 5-7-9%"

As of January 2023, the Entrepreneurship Development Fund has already concluded cooperation agreements with banks regarding the implementation of the State Program "Affordable Loans 5-7-9%". (LandLord, 2023). Farmers can receive a loan for the restoration of production facilities (destroyed or stolen partially or completely due to extreme operating conditions) in the amount of up to UAH 60 million (at 9%) for a period of up to five years; state subsidy; technical support loan from state donors; targeted credit.

In 2022, according to the State Program "5-7-9% Affordable Loans", by Resolution of the Cabinet of Ministers of Ukraine No. 916 dated July 29, loans for seed companies (at 0%) in the amount of UAH 95.5 billion were extended to 12 months, and 24,722 billion UAH were received under state guarantees (80%). There are no funds to support the development of entrepreneurs in agriculture in the country's budget for 2023. However, the state can provide compensation, grants, or loans if necessary. For instance, Switzerland August 2022 allocated almost UAH 100 million for the affected 296 milk production farms in Kharkiv, Sumy, Chernihiv, and Kyiv regions (LandLord, 2023).

▸ **Implementation of the "e-Robota" grant program.** Within the framework of the "e-Robota" grant program, it is planned to create new jobs (632 permanent, 9,000 seasonal) in the development of greenhouses and gardens in 2023. This provides an opportunity for the operation of 80 new farms. 72 applications for gardens have already been approved (for UAH 327 million; 1,090.31 ha); for greenhouses – 8 applications (55 million UAH; 13.97 ha). UAH 383 million is the total amount of grants in two areas (Lupenko & Shpykuliak, 2019).

In 2022, grants in the amount of UAH 53.8 million have already been received by 33 farms and 6 business entities: LLC "Yahidnyi Dar", LLC "Mi-Agro", LLC "Svoi Vitaminy", FE "Rosy Bukovyny", FE "Gold", PE "Lada Agro" (Ministry of Agrarian Policy…, 2022). The decision on the procedure for providing grants for the creation or development of viticulture, horticulture, and berry growing and the procedure for providing grants for the creation (development) of greenhouse farming is stipulated in the Resolution of the Cabinet of Ministers of Ukraine No. 39 of January 17, 2023 (On Amendments to the Procedure for Providing Microgrants for the Creation or Development of Own Business, Procedure for Providing Grants for the Creation or Development of Horticulture, Berry Growing and Viticulture and Procedure for Providing Grants for the Creation or Development of Greenhouses) (Cabinet of Ministers of…, 2023). The issue regarding the transfer of funds to recipients from the general fund of the state budget has been resolved.

In 2022, to provide additional financial support to family farms, the Ministry of Agrarian Policy and Food of Ukraine allocated UAH 1,420.44177 thousand to an off-budget account, paying its share as a single social contribution (Ministry of Agrarian Policy…, 2022). In addition, in 2023, within the framework of the USAID AGRI-Ukraine program, the Bayer company will invest more than 35 million USD in expanding the capacity of the seed processing enterprise (Agroportal, 2022).

▸ **Program for the development of agriculture in the Lviv region.** During 2022, 70 new farms were created in the Ivano-Frankivsk region, but the Comprehensive Agricultural Development Program, fully adapted to the conditions of martial law, was approved only in the territory of the Lviv region. This program covers and substantiates four areas of support and functioning of small and retail producers with funding of more than UAH 22 million. Today, the Lviv region is the leader in the number of family farms.

Subsidy payments for cows from the state budget for two years in a row allowed for slowing the pace of herd reduction. In 2022 alone, 16 new family farms were registered in the Lviv region. As of 01.01.2023, the total number of family farms in the region was 78. Of these, 48 family farms operated in the dairy cattle industry in 2020-2022. The dynamics of cattle population growth are quite positive (+798 heads or +33% compared to 2021). Farmers received a double subsidy per cow (5.3 thousand UAH per head – from the State Agrarian Register; 2.5 thousand UAH – from the regional budget). 109 business entities (77 – legal entities; 32 – individuals-entrepreneurs) received support in the amount of UAH 7.5 million for keeping 3,000 cows.

Farms were also provided with grant support for projects to increase processing capacity under the "e-Robota" program in the amount of up to UAH 8 million (70% – grant funds; 30% – recipient funds) (Agroportal, 2022).

▸ **Indicators of family farming identification.** During the study, it was substantiated that the basis of the methodological principles of estimating the development of family farms are indicators that ensure the identification of parameters with the corresponding assessment of the most general and tangential indicators, namely the effectiveness of business processes; social development considering the specific features of the organizational and legal form; economic interactions, etc. The list of indicators of statistical reporting establishes the content of the corresponding methodical constructions. One of the indicators of identification of a family farm is the volume of land ownership. The second is the work of the owner and their family members.

It was also established that the value of the indicative indicator of the structure and size of land ownership or land use is one of the main institutional and formalization features of family farming. Rating identification of family farms as a legal form is the basis for implementing the priority of state support; development of forecast indicators; improvement of strategic guidelines for development; improvement of national agrarian policy (The concept of development…, 2021).State registration of family farms

54 family farms are registered in the Unified State Register of Legal Entities and Individuals-Entrepreneurs (the name contains family farm or family farming). 7 have an invalid certificate and 6 are registered in the Autonomous Republic of Crimea (FF "Tair", FF "Guliai-Pole", FF "Pryrichne", FF "Khutor Luzhky", FF "Khaziain"). 6 farms ceased their activities, but are still present in the Register.

The distribution of family farms registered as a legal entity by regions (except the Autonomous Republic of Crimea), by type of activity, is as follows:

▸ breeding of dairy cattle: FE "FF "Lyska", FE "FF "Yunikasol", Rivne region;

▸ breeding of other animals: FF "Ravlyk Bukovyny", Chernivtsi region;

▸ mixed agriculture: FE "FF "Riverseil", FE "FF "Koptar", Zakarpattia region;

▸ cultivation of seed and stone fruits: FG "SFG "Agrofruit Zakarpattia", Zakarpattia region;

▸ growing of berries, nuts, other fruit trees: FF "Medova yahoda", Lviv region; FF "Fazenda SS", FF "Krasyvyi Sad", Kyiv region; FE "FF "Dolyna zdorovia", FE "FF "Tertychny", Kherson region; FE "FF "Babychivske", FF "Horikhovyi Rai", Poltava region; FE "M and M Family Farm", FE "FF "Sribna Zemlia", FE "FF "Arnika", Zakarpattia region;

▸ cultivation of grain crops, leguminous crops and oilseeds: FF "Vidrodzhennia 2019", Khmelnytskyi region; FE "FF "Pryshchepa", Chernihiv region; FE "Pronchuk Agro", Rivne region; FE "FF "Kolos", Zaporizhzhia region; FE FF "Raf-agro", Mykolaiv region; FF "Berezka", Zhytomyr region; FE "FF "Zakagrotrans", Zakarpattia region; FE "Simeina Ferma", Vinnytsia region; FF "Kovalovy", Donetsk region; FF "Zelena Dibrova", FF "Dibrova", Sumy region; FE "FF "Mitselia", FF "Soliana", FF "Nerta", FF "Lesia", FF "Agro-Ivanys", FF "Agrikole", Poltava region (Unified State Register…, 2022).

▸ **Animal husbandry and financial support for farms.** A considerable part of farms does not have a livestock sub-sector, or livestock comprises a small share in the structure of agricultural production. For instance, FF "Kub", FF "Medova Yagoda" – Lviv region; FF "Zakagrotrans" – Transcarpathian region (Agroportal, 2022; Nomis, 2022); FE "M and M Family farm", FE "Sribna Zemlia", FE "Arnika", FE "Agrofruit Zakarpattia", FE "Family farming "Koptar", FE "Riverseil" – Zakarpattia region (Unified State Register…, 2022; You Control, 2022).

In 2022, over 3,100 producers of agricultural products in the Volyn region received special budgetary financial support (31.8 million UAH – subsidy for keeping cattle (cows) in the amount of 5,300 UAH per cow for 845 owners; 57.7 million UAH – subsidy per unit of cultivated agricultural land (1 ha) in the amount of 3,100 UAH per 1 ha for 2,282 owners) (Agroportal, 2022).

▸ **Implementation of the "Family Dairy Farms" project.** The "Family Dairy Farms" project is being actively implemented in the territory of four regions (Rivne, Volyn, Khmelnytskyi, Ternopil). The leaders in terms of the number of active family dairy farms are the Khmelnytskyi region (37 farms), Volyn region (26 farms), and Rivne region (23 farms). Dairy farms operate in the Poltava region (9), Mykolaiv region (6), and Sumy region (4). In 2021 alone, the number of new participants increased by 92 farms (Family dairy farms, 2023). In extreme operating conditions in 2022, the number of family dairy farms was 172 (+22% increase in cattle; +20 farms in the Poltava, Volyn, and Khmelnytskyi regions). Therewith, the average milk yield for 2022 in the network of farms of the Family Dairy Farms project amounted to 4,800 litres.

Furthermore, compost production was introduced on farms and the network of cheese factories was expanded (The number of..., 2020; Agroportal, 2022). Implementation of the "Family Dairy Farms" project provides opportunities to create family dairy farms and support them (Poltava region); help with transporting cows and equipment (Sumy region); provide seeds for sowing corn (Vinnytsia region) or compound feed (Ternopil region) (Kurkul, 2022).

To revitalize dairy farming, the implementation of the "Family Dairy Farms" project for particular 167 family farms is controlled by UkrMilkInvest LLC. It offers financial support for the construction of premises, the purchase of livestock, and the purchase of equipment; provides consulting and veterinary services. Sources of financing for the activities of family dairy farms are bank loans, grants from foreign governments, and funds from private investors. FF "Molochne Dyvo" (Rachyn village, Lutsk district, Volyn region) keeps 74 heads of cattle; FF "Yunikasol" (Rivne region) – 29 heads of cattle (own craft cheese factory sells about 300-400 kg of cheeses every month); "Molochnyi Shliakh" (Rivne region) – 21 heads of cattle with calves; "Papyki" (Derno village) – 21 heads of cattle; "Markivchanka" – 40 heads of cattle (ITC, 2022).

▸ **Areas of state support for family farming.** To increase the potential of family farming, state support is vital. The areas of state support include starting one's own business, ensuring the protection of property rights, employment, and the formation of the middle class in the countryside (Order of Cabinet..., 2023).

The state should also contribute to the socio-economic development of the village, national identity, and reproductive management in the countryside. It is important to activate the mechanism of stimulating "green" production and the production of niche and sparsely distributed products, fiscal stimulation of the general entrepreneurial activity of the population (The UN announces..., 2019; LandLord, 2022).

▸ **Development of rural households and private household plots.** The mechanism of functioning of farmers and private household plots (PHP) not only preserves but also develops the potential of supply chains and the volumes of local market niches, increases the system of ensuring the adaptation of the agrarian structure of Ukraine to the EU (National Academy…, 2022). The development of private household plots contributes to the formation and stabilization of rural society (Concept of development…, 2021; Expert assessment of..., 2023).

In 2020, there were 3,954.8 thousand PHPs in Ukraine, using 6,125.7 thousand ha of land, producing a share of gross agricultural products (36.6%). The largest share in the production of certain types of products is the production of potatoes (98.1%), vegetables (84.6%), fruit (83.2%), milk (70.2%), livestock breeding (64.9%), poultry farming (45.3%) (Table 3).

Table 3. General characteristics of rural households and private household plots

Indicators	2017	2018	2019	2020	2021	deviation 2021 in % to 2016
Number of households in rural areas. thous. units	4 900.1	4 873.6	4 844.2	4 782.1	**4 734.1**	**–3.39**
Number of PHPs. thous. units	4 031.7	3 996.5	3 975.1	3 954.8	**3 921.5**	**–2.73**
Land area owned by PHPs. thous. ha. incl.:	6 175.6	6 132.2	6 133.6	6 125.7	**6 120.0**	**–0.90**

Table 3, Continued

Indicators	2017	2018	2019	2020	2021	deviation 2021 in % to 2016
for construction and maintenance of residential buildings. outbuildings and structures. thous. ha	793.3	791.0	788.3	787.0	**777.1**	**–2.04**
for private household farming. thous. ha	2 551.3	2 513.4	2 512.6	2 517.7	**2 544.2**	**–0.28**
for commercial agricultural production. thous. ha. of which:	2 799.3	2 777.1	2 781.8	2 772.6	**2 735.3**	**–2.29**
leased. thous. ha	338.5	345.0	348.2	350.9	**367.1**	**+8.45**
Households with land area. %: under 0.50 ha	51.6	51.3	51.6	52.7	**51.3**	
0.51-1.00 ha	26.4	28.0	27.6	27.0	**26.9**	
over 1.01 ha	22.0	20.7	20.8	20.3	**21.8**	
The average area of land used by one household that owns a plot of land. ha	2 868	2 921	2 858	2 822	**2 667**	**–7.01**
The average size of the land area of the household. ha	1.23	1.20	1.19	1.18	**1.24**	**+0.81**
The average land area of the PHP. ha	1 532	1 534	1 543	1 549	**1 561**	**+0.03**
Gross agricultural production. billion UAH	279 393	314 904	311 302	326 604	**437 539**	**+56.60**
Produced by the household per person. UAH	5 347	5 519	5 500	5 184	**5 521**	**+3.25**
The share of households in gross agricultural production. %	39.5	37.2	36.9	36.6	**32.0**	
The share in the production of certain types of products. % of the total volume. incl.:						
potatoes	97.8	98.1	98.2	98.1	**97.7**	
vegetable crops	86.1	85.6	85.3	84.6	**85.9**	
fruit and berry crops	80.9	78.4	83.4	83.2	**79.2**	
milk	74.9	72.6	71.8	70.2	**68.2**	
raising livestock	37.0	34.9	31.9	31.2	**29.4**	
Industrial output index. % to the previous year	95.8	101.7	99.1	93.6	**105.6**	
crop production	95.5	103.3	100.2	92.8	**111.4**	
livestock products	96.3	98.1	96.7	95.6	**92.4**	

Source: research based on data (Economic statistics, 2023)

The negative trend is a decrease in livestock production (about 4% per year). There is a physical reduction of agricultural enterprises in the war zone. A potential loss of up to 30% of the animal population is expected.

▸ **The principal factor of economic development in the period of post-war reconstruction.** During the post-war reconstruction period, the main factor in the development of the economy will be the unification of villagers into cooperatives and simplified companies. In their activities, the villagers understood that their existence can be ensured only based on mutual support. The programs already implemented in Ukraine by the FAO (Food and Agriculture Organization) and other donors implement a farmer-centric model in agriculture. The trend for self-sufficiency, the practice of gardening, homesteads for personal needs is being updated (Economic foresight, 2022).

▸ **Land relations and development of entrepreneurship.** Multi-industry production is a priority for medium and large economic structures, and micro- and small ones, which include family farms with a size of 2-20 hectares, are more effective when focusing on an optimally selected product niche. Reforming land relations is inseparable from the development of entrepreneurship, especially small and medium-sized business structures. During the war, 10,341 agreements were concluded, covering an area of 18,153 ha. In terms of the number of transactions and the area of land for which transactions were registered, the most active land market during the war was as follows: Vinnytsia region (2.2 thous. ha), Dnipro region (1.3 thous. ha), Poltava region (2.2 thous. ha), Kirovohrad region (2.4 thous. ha), Khmelnytskyi region (1.8 thous. ha). In the last week of July 2022, 1,317 transactions were concluded within the land market covering an area of 2,256 ha (Agroportal, 2022).

In terms of efficiency and creativity, it is necessary to single out niches of exclusive products, or innovative ones, which, according to the final balance of costs and benefits, can be considered high-margin, etc. A small farm cannot rely on the effect of scale. It is expedient for such an enterprise to choose the optimal specialization, market segment, and produce high-quality food products to support the demand for it from a certain category of consumers.

▸ **Plans to implement the concept of stimulating the development of entrepreneurship in rural areas until 2030.** In implementing the Concept of stimulating the development of entrepreneurship in rural areas until 2030 (The concept of stimulating the development…, 2021), it is planned to increase the number of cooperatives (based on farms or PHPs) by 40-50 units and the employment of the rural population; advisers and expert advisers up to 70 people, small enterprises in rural areas at the level of 1.5-2 thous. units. The changes also apply to facilities for primary processing of products; the share of production of farms in the total amount of gross agricultural products up to 15% and the income of local budgets; coverage of advisory services to 90% of commodity producers and the rural population (Decree of the President..., 2019).

▸ **Study of the specific features of the processes of functioning and development of farms.** The principal role in the preservation and development of local markets and food supply chains is played by farmers and PHPs. Farmers and PHPs function for the existence of the producer itself, and not just for profit and rent. The development of farms and private farms, as well as their cooperatives, will contribute to ensuring the adaptation of the agricultural structure of Ukraine to the EU (National Academy of Sciences…, 2022; The twilight of..., 2022). The study of the specific features of the functioning and development of family farms in extreme conditions is focused on the essence of concepts, factors, assessment methods, management tools, the influence of external and internal factors, and allows formulating key aspects of using their potential in the field of ensuring food security. These questions have been considered in various interpretations by some economists (Ukraine 2022..., 2022; Expert assessment..., 2023).

M. Malik and V. Mamchur (2020) argued that "family farming" means an organization of agricultural production managed by a family; depends on family work. A family farm can be organized in the form of an individual or legal entity. It was also established that family farms combine two purposes of functioning (consumer (increasing the well-being of all household members) and production (maximizing income)). Emphasis is placed on models of family corporation, labour farming and farming based on the use of hired labour. It was noted that the features of a family farm are as follows: norms of behaviour (social orientation, cultural heritage, predictability of actions of household members, innovativeness); duality of development goals (income maximization, land management); a combination of cultural, economic, technological conditions of functioning and multi-vector processes.

O.H. Shpykuliak and O.V. Alekseeva (2021) conducted empirical assessments of trends in the development of farms. The results confirmed the special socio-economic importance of farms in ensuring labour productivity, rural employment, efficiency of family farms; features of personification of labour results from employment in their own economy and labour motivation. The authors of this paper support the position that the development of family farming in rural areas is a priority model for improving the well-being of the population (Law of Ukraine 755-IV..., 2015).

The implementation of the marketing strategy of small businesses is the most essential element of the management system for the survival of the population and providing citizens with high-quality food. This is also confirmed by the results of modelling the parameters of the stability of the anti-crisis development potential of agricultural business entities. The analysis of the impact of the armed conflict on the development of small business entities in agriculture allows establishing the correlation between the change in the sale price of products and financial costs for defence needs and substantiating the trends of changes in the average sale prices of agricultural products (Semenenko *et al.*, 2021).

The development of cooperation is one of the areas of restoring farm production after the war and increasing employment and well-being of the rural population. The processes of survival and cooperation of small business entities, increasing the complexity of management from the standpoint of Agile Business Process Management (Agile BPM) belong to the processes of the mechanism of realization of the socio-ecological benefits of functioning, expansion of competitive advantages, prompt response to changes in the market and in the business environment (Lopes & Gomes, 2022; Bitkowska *et al.*, 2022).

The authors of this study agree with the opinion of V. Rudenko *et al.* (2022) and S. Kravchenko *et al.* (2022b), who determined that the imperfection of the fiscal mechanism is reflected in the manifestations of the investment activity of households. It is advisable to optimize the taxation of small-scale entrepreneurs and to create innovative integrated structures by involving the employees of the advisory services in the accounting and analytical work of small-scale agricultural producers. This should also be reflected in the priority areas of development of small entrepreneurs in agriculture and in the mechanism of increasing the investment potential of Ukraine.

Small entrepreneurs in agriculture are quite sensitive to extreme conditions and transformational shocks. The model of behaviour and survival in the functioning environment chosen by a small entrepreneur entity is critical. The problem of survival for small entrepreneurs is reflected primarily in the loss of their market niche capacity. Therefore, the management of the business entity should be ready for operational appropriate actions, namely for developing and applying strategies to reflect the effects of the consequences of wars by the entrepreneur and its structures (Kravchenko *et al.*, 2022a).

Some researchers insist that the primary tasks that will arise after the war will be a review of the issue of granting benefits for the development of livestock, as well as repurposing the program of available loans to stimulate the technical re-equipment of production and the development of enterprises for the production of agricultural products in farms

and small farms (in the field of animal husbandry). An essential task will be to prepare entrepreneurs producing the animal husbandry products for adaptation to the sanitary standards of the European Union and the standards of technical regulation (Ukrainian Institute of the Future…, 2022).

The study of the specific features of the functioning of family farms allows concluding on their further development and defining conceptual approaches to the proper performance of their functions to ensure food security, reduce poverty, create more jobs and improve the environment. Considering the state's capabilities under martial law, the focus should be on supporting public goods – ensuring the spread of financial literacy and creating prerequisites for developing investment proposals to increase the potential of the agricultural sector. Added support for small-scale farming is needed, especially for the development of livestock industries and niche organic crops. It is also important to promote the transition of small farms to "green" growth and the transition to climate-neutral technologies.

Conclusions

The conducted empirical assessments of trends in the development of farms confirmed their special socio-economic importance as quickly responding to changes in the business environment under martial law.

According to the "Decade of Family Farming 2019-2028" announced by the UN, 54 family-type farms were registered in Ukraine at the beginning of 2023. The purpose of the strategy for the development of family farms in the post-war period is the formation of an entrepreneurial environment capable of ensuring the growth of the incomes of the rural population.

The study results indicate that the activity of farms in wartime conditions ensures the performance of their functions. Family farms are more adapted to wartime activities due to their mobile management system and compact production. The development of rural social capital is becoming a priority. The prospects for the institution of self-sufficiency and the provision of food support to other citizens are increasing.

The successful development of farming is based on activities that operate in individual regions. Thus, in the Lviv region, a comprehensive program for the development of agriculture, adapted to wartime conditions, was developed and approved, which makes provision for support with appropriate financing of small (including family) producers. This provided a positive trend in the growth of the cattle population in 2022 by 33% compared to 2021.

It was substantiated that there is a need to fulfil the purpose of accelerated development of family farms in the most promising areas that will be capable of providing a substantial increase in added value (processing of agricultural raw materials, innovative renewal of production, and infrastructure). In further studies, there is a need to clarify the strategic areas and principles of small entrepreneurship development, accelerate the post-war development of the Ukrainian economy and activate the involvement of local self-government bodies in supporting the family farms. For this, it is necessary to develop state and regional programs for the development of family farms for the period until 2030 according to the UN action plan "Decade of family farms 2019-2028" and to determine the priority areas of their development in Ukraine.

The reasons that hold back the development of family farming are as follows: the absence of a coherent and consistent policy aimed at the comprehensive development of rural areas, which is based on the needs of the territorial communities of villages and settlements, and on the support of family farms that own and use land plots with a total area of no more than 100 ha, and agricultural cooperatives; low level of technical and technological support; insufficient awareness of the population about the possibilities and advantages of creating family farms.

In the further development of family farms, a crucial factor is state support for starting one's own business, protecting property rights, and employment, spreading financial literacy, and increasing export potential.

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Conflict of Interest

None.

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Розвиток фермерських господарств в умовах воєнного часу

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▸ **Анотація.** Фермерські господарства є невід'ємним елементом територіальних утворень і місцевої культури: застосовують різноманітні сільськогосподарські системи, сприяючі збалансованості раціону харчування, зберігають навколишнє середовище. В умовах воєнного часу фермерські господарства мають унікальний потенціал для формування продуктивних і стійких продовольчих систем. Всі ці особливості свідчать, що дослідження системи розвитку фермерських господарств є актуальним і має як теоретичне, так і практичне значення. Мета статті – обґрунтувати теоретико-методологічні засади, соціально-економічні та правові проблеми діяльності фермерських господарств в умовах воєнного стану. За методологічну основу дослідження слугували положення системного аналізу та економічної теорії. Використано монографічний, нормативний, графічний, абстрактно-логічні методи та підходи узагальнення результатів. Визначено що умови перебування на єдиному податку 4 групи є найбільш вигідними для фермерських господарств, так як податок фіксований і залежить лише від обсягів земельних ділянок. Встановлено, що особисті селянські господарства мають можливість реалізувати свою діяльність у формі підприємництва для фізичних осіб–підприємців, які організували СФГ. Дана характеристика окремих сімейних фермерських господарств Львівської, Закарпатської та Чернігівської областей. Встановлено, що під час воєнного стану держава виділяє кошти за спец дотаціями та субсидіями для підтримки розвитку фермерських господарств. Виявлено, що найбільш адаптованими до кризових умов, пов'язаними з воєнними діями, є фермерські і особисті селянські господарства. Результати дослідження можуть бути враховані при розробленні регіональних програм розвитку суб'єктів аграрного підприємництва; розробці нормативно–правових актів для формування і розвитку кооперації і інтеграції в аграрній сфері економіки

▸ **Ключові слова:** суб'єкт підприємницької діяльності; адаптація до умов воєнного стану; фермерське господарство; особисте селянське господарство; сільськогосподарський кооператив; інтеграційно-кооперативні структури; інтеграційні об'єднання

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