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## STATE SUPPORT FOR AGRICULTURE IN UKRAINE IN THE POST-WAR PERIOD

**Purpose.** The purpose of the study is to assess the level and trends of state support for agriculture in Ukraine, to determine its post-war measures and programmes and to improve the method of allocating funds among state support programmes at the stage of drafting budget declarations and requests by central and regional executive bodies that implement the agricultural policy.

**Methodology / approach.** Analysis and synthesis were used to determine the level of state support for agriculture and its impact on its development. Assessment of the effectiveness of financing individual agricultural support programs was made using regulatory, calculation and constructive methods. Mathematical modelling methods were used to optimise the distribution of budget funds in various areas of state support for rural commodity producers aimed at forming fixed capital. Techniques of the abstract and logical toolkit allowed formulating intermediate and final conclusions.

**Results.** The study focuses on the directions of support for the agricultural sector of Ukraine in wartime and in the post-war period. It was established that in order to resume the operation of agricultural enterprises in the liberated territories, which produce grain and cultivate oil crops, about USD 1.370–1.500 of fixed capital are needed for 1 ha of crops and USD 1.340–1.400 of working capital. It was estimated that in 2023 the lack of working capital in Ukraine for the cultivation of grain and oil crops, with the area of their crops being at the level of 2022, will amount to about UAH 41.5 billion. It is established that support programmes for Ukrainian producers of agricultural products should be developed on the basis of the Roadmap for the Recovery in Ukraine in order to achieve the indicators of the Strategy for Ukraine's Agro-Industrial Complex Development.

**Originality / scientific novelty.** The scientific value of the study is in conducting a comparative assessment of the support of agriculture in Ukraine and the EU in 2019–2021, highlighting measures of state support for the agricultural sector of Ukraine in wartime and in the post-war period. The method of allocation of funds among state support programmes at the stage of drafting budget declarations and requests by central and regional executive bodies that implement the agricultural policy has been improved.

**Practical value / implications.** The practical value of this study is the fact that it can be used as a source and tool in the development of relevant plans and programs aimed at the development of agriculture in Ukraine.

**Key words:** agriculture, recovery, state regulation, financing, agrarian policy.

**Introduction and review of the literature.** The full-scale invasion of Russia into the territory of Ukraine significantly affected the economy of our country, in particular, its agricultural sector. New problems were added to the economic, social

and environmental issues that existed in agriculture in the pre-war period: Reduction of cultivated areas due to the occupation of territories, mined or unusable fields due to the mass bombing and destruction of the material and technical base in the liberated territories, reduction in the number of employees due to mobilisation, deterioration of employment conditions, disruption of logistics chains, destruction of critical infrastructure, blockade of sales markets, etc. Direct losses caused to the agricultural sector of Ukraine as a result of active hostilities amounted to USD 6.6 billion as of September 2022, while indirect losses are estimated at more than USD 23 billion (KSE, 2022).

The food security system in Ukraine has significantly worsened. In 2022, according to the Global Food Security Index (GFSI), Ukraine was rated 71st among 113 countries of the world, as compared to the 58th position in 2021. According to the Availability of Food Indicator, Ukraine was rated 93rd due to a decrease in funding for agricultural research, deterioration of the supply chain infrastructure, and an increase in political and social barriers. According to the Sustainable Development and Adaptation Food Security Indicator, Ukraine was rated 94th due to the deterioration of water supply and natural disaster risk management (Global Food Security Index, 2022).

Ukraine's food security is essentially the responsibility of agribusiness and the state. Currently, the majority of Ukrainian farmers cannot effectively organise the production process without sufficient volumes of equipment, fertilizers, fuel, seeds, and plant protection products due to a lack of financial resources. Therefore, given these circumstances, an effective mechanism of state support for the agriculture development is needed for the recovery and increase in the economic efficiency of agricultural producers, development of agricultural product markets, creation of jobs in rural areas, observance of ecological production standards and representation of national producers on world markets.

Over USD 800 billion in transfers are allocated annually to the farm sector worldwide to support agriculture (Vos et al., 2022). This testifies to the need for the right combination of state and market regulation of agriculture and the development of effective programs to support it for the formation of a sustainable food system. Scientists from different countries should jointly search for effective solutions to the problems of achieving sustainable development in agriculture, ecology and food safety (Veeck et al., 2020; UNTAD, 2022).

The support policy, which is based on subsidies, can have both positive and negative sides. For example, the system of agricultural subsidies in China aimed at granting subsidies for the purchase of grain seeds, direct subsidisation of agricultural producers, and the distribution of general subsidies for the purchase of agricultural goods ensured an increase in the volume of grain production and a rise in farmers' incomes (Dehua et al., 2021).

The European Union's Common Agricultural Policy (CAP), which shaped the EU's agricultural sector until 2020, supported a variety of practices that ensured increased output. However, they caused biodiversity loss, increased greenhouse gas

emissions, soil erosion and land degradation (Pe'er et al., 2020). Often CAP practices during this period were also ineffective in addressing social and economic challenges. Agricultural economists have long warned that EU CAP funds were being spent inefficiently, in particular that there was a large discrepancy between the stated objectives and CAP budgets and that the largest budgets were allocated to the least effective measures (Pe'er & Lakner, 2020; Heyl et al., 2020). Funds allocated to the EU CAP could be spent much more effectively on issues for farmers, climate and biodiversity. To do this, CAP payments need to be reallocated from supporting incomes in regions where farming is already profitable to supporting farmers to adopt ecological and climate-friendly practices. EU Member States should also improve the system of monitoring and evaluation of CAP costs (Scown et al., 2020).

The post-2020 CAP proposed by the European Commission in June 2018 recognises the need to address environmental and sustainable development challenges and presents a new green architecture that offers Member States greater flexibility in how they implement the CAP (Pe'er et al., 2020; Official website of the European Commission, 2022).

The European Green Deal (EGD) program of strategic decisions and actions of the EU aims to make Europe the first climate-neutral continent by 2050. The EGD includes several strategies to achieve its goal, which are based on the Farm to Fork strategy (Official website of the European Commission (2022)). Research findings suggest that the implementation of this strategy will change the EU agricultural supply chain, including a targeted reduction in the use of agricultural resources, which could lead to a 12 % reduction in EU agricultural production, less competitiveness in export markets and a negative impact on public welfare. To reduce these negative consequences, it is necessary to introduce technological improvements (Beckman et al., 2020; Pajewski et al., 2020).

Research results show that neither a subsidy for the quantity of products nor only a subsidy for ecological innovations can solve the conflict between agricultural development and environmental protection. Applying a hybrid subsidy scheme that combines these two unilateral subsidies can reduce pollution emissions, increase output, improve firm profits, and increase consumer surplus, which is a truly effective and viable solution (Ranran et al., 2020).

The adoption of climate smart agricultural practices (CSA) is recognised as a promising and successful alternative to reduce the negative effects of climate change. CSA is a comprehensive approach that aims to achieve three results simultaneously: Increasing productivity and income, increasing resilience (adaptation) and reducing emissions (Arora, 2019). Chinese scientists X. Jin et al. (2021) also argue that to ensure continuous improvement and sustainable development of rural areas, it is necessary to develop a series of guarantee mechanisms that include policy, organisational leadership, capital investment and systematic management of rural infrastructure.

When studying the current state and role of agriculture in the national economy of Ukraine, it was found that the priority vectors for the further development of

agriculture are the introduction of European principles of regulation and organisation of the agricultural sector into the Ukrainian environment, which will contribute to its long-term sustainable development (Lupenko et al., 2022; Tiurina et al., 2021; Kushniruk et al., 2021). At the same time, support programs for Ukrainian producers of agricultural products should be developed on the basis of a systemic approach. State support programs based on the experience of EU member states and best practices of other countries should be long-term, include small agricultural producers in state programs, contribute to the implementation of sustainable farming methods and reduce the negative climate impacts (Official website of the European Commission, 2022; Savytskyi, 2022; Kravchuk et al., 2021).

N. Avramenko et al. (2022), M. Nehrei & O. Trofimtseva (2022) and V. Shulha (2022) studied the analysed the impact of measures and programmes of state support for agriculture introduced by the government under martial law on its functioning and further development. According to L. Udova & A. Haievyi (2022), despite the active state support for small businesses in the agricultural sector of the Ukrainian economy in wartime, the introduction of relocation programmes, tax and customs benefits, the effectiveness of these measures in general remains inadequate. According to O. Sobkevych et al. (2023), the important directions of ensuring sustainability in the agricultural sector of the economy include the improvement of agricultural policy to build the agricultural capacity, strengthen food security and increase the export of agro-industrial products. A. Bilochenko (2023) proposes to solve the issue of the growing need for financing the operational activities of agriproducers in the conditions of war by implementing a number of measures aimed at the state guarantee of cheaper loans for the agricultural sector. N. Pryshliak et al. (2023) substantiated the need for the implementation of state support measures for the agricultural sector in order to preserve the capacity to meet the food needs of Ukraine and the countries that import agricultural products from Ukraine in the conditions of active hostilities.

Despite the great focus of researchers and experts on the above, there are still unresolved questions regarding the determination of measures and programmes of state support for the agriculture of Ukraine in different periods of its operation (the period of hostilities, the stage of recovery, growth) and the improvement of the methodology for determining priorities of these measures and programmes, the allocation of funds among them at the stage of drafting of budget declarations and requests by central and regional executive bodies that implement the agricultural policy. These are the issues that are addressed in the article.

**The purpose of the article.** The purpose of the study is to assess the level and trends of state support for agriculture in Ukraine, to determine its post-war measures and programmes and to improve the method of allocating funds among state support programmes at the stage of drafting budget declarations and requests by central and regional executive bodies that implement the agricultural policy.

**Results and discussion.** One of the main economic aspects of guaranteeing state independence is food security. Agriculture plays a leading role in its achievement and



support, which is one of the most important sectors of the Ukrainian economy, determining the macroeconomic situation in the country.

The goal of agriculture is to ensure national food security and unlock export agricultural and food potential based on sustainable and innovative development. At the same time, the volume of exported agricultural and food products cannot be an end in itself of agricultural production, but should be considered as surpluses when the domestic food market is saturated with high-quality and affordable products, provided that this is sufficiently justified from the economic point of view. First of all, this applies to products with a high degree of processing, innovative and organic ones, which can be available on a certain market segment for a long period of time, have lower price volatility and special competitive advantages. The main prerequisite for maintaining high levels of national food security and export positions is the mutual consistency of the interests of rural producers and communities, which is manifested in the balanced economic, social and ecological development of rural areas (Table 1).

*Table 1*

**Share of agriculture in the economy of Ukraine, %**

Indicator	2015	2016	2017	2018	2019	2020	2021
Number of economic entities	3.56	3.56	3.83	3.76	3.51	3.38	3.30
Number of employees*	7.72	7.19	6.81	6.42	6.04	5.94	5.70
Number of hired people*	7.72	7.91	7.45	6.94	6.53	6.25	6.31
Non-current assets	4.25	5.11	6.24	7.08	7.93	7.80	8.15
Capital investments	13.58	17.57	17.61	13.92	11.31	12.58	12.68
Volume of produced products	11.65	10.85	9.44	9.52	8.79	8.99	11.17
Volume of sold products	6.44	5.93	5.38	5.18	5.22	5.43	7.22
Added value based on costs	12.8	10.1	8.4	7.8	6.7	8.3	9.9
Export of agricultural and food products	38.19	42.02	41.05	39.32	44.24	45.09	40.71

*Note.* \*Employees of large, medium, small and micro enterprises.

*Source:* based on data from State Statistics Service of Ukraine (2022).

The data in Table 1 show a decrease in the share of the number of economic entities, employed and hired workers in the agricultural sector during 2015–2021. The share of agricultural and food exports during this period varied between 38–45 % of its total volume.

The increase in the shares of the production volume, sale and export of agricultural products in 2020–2021 testifies to the strengthening of the negative trend of the raw material development of the Ukrainian economy.

During 2015–2021, the development of agriculture entrepreneurship was unstable. If in 2015 70,286 business entities operated in this sector, then in 2021 their number decreased by 5,746 units. In 2021, 45,661 agricultural enterprises operated in the agriculture sector (State Statistics Service of Ukraine, 2022).

Business entities of the agricultural sector of Ukraine are focused on producing

grain for oilseeds. In recent years, in the structure of their revenues, the share of funds from the sale of grain was more than 45 %, oilseeds (sunflower, soybean, rapeseed, flax) accounted for more than 30 %, animal and poultry products amounted to about 8.0 %, milk was estimated at 5.0 %, eggs accounted for 3.5 %.

Agricultural products in Ukraine are produced in farms of two categories – agricultural enterprises and households. In 2021, 32 % of products from their total volume were made in households, including 28.8 % of crops and 46.3 % of livestock. During 2000–2021, gross harvests increased for almost all major types of agricultural crops. At the same time, in 2021, agricultural enterprises produced: 81.0 % of grains, 95.4 % of sugar beets, 86.7 % of sunflower seeds, 2.3 % of potatoes, 14.1 % of vegetables and 20.8 % of fruits and berries.

If the increase in grain production during 2000–2021 was caused mainly by an increase in the yield of grain crops (2.8 fold) with a slight increase in the area of crops, then the increase in the production of oil crops was caused by both an increase in the yield (2.0 fold) and a significant increase in the area of these crops. Consequently, during this period, the area for sunflower crops increased by 2.2 times, the area for soybeans increased by 15.5 times, and by 6.1 times for rapeseed. At the same time, it should be noted that the rate of increase in the yield of agricultural crops in agricultural enterprises was significantly higher compared to households. The main reason for this is insufficient material and technical support, limited access to advanced technologies, lack of working capital, which would enable producers to purchase new breeding varieties of plants, and appropriate means to protect them and increase yields (fertilizers, growth stimulants, etc.). This especially applies to households and small farms, where the grain yield is about 80 % of the average level in Ukraine.

Furthermore, large companies (agricultural holdings) that have the opportunity to raise capital for their activities on external financial markets achieve average and higher levels of grain crop yield in EU countries.

During 2000–2021, the volume of meat production (based on slaughter weight) in farms of all categories increased by 46.6 %, and in agricultural enterprises by 3.9 times. The volume of produced milk in farms of all categories decreased by 31.2 % with a 3.2-fold decrease in the number of cows and a 2.2-fold increase in animal productivity, including a 4.3-fold increase in agricultural enterprises. The volume of egg production in farms of all categories increased by 59.7 %, while agricultural enterprises saw a 2.4-fold increase.

During 2014–2021, there was a decrease in the volume of domestic grain consumption in Ukraine, mainly due to its use for feed, which was caused by a decrease in the number of animals. In this period, the volume of domestic grain consumption (including losses) ranged from 21.3 to 27.3 million t, and the rest (55.2–67.0 %) of the produced grain was exported. For example, in 2021, 51.2 million t of grain were exported, including almost 20.4 million t of wheat and 24.7 million t of corn (State Statistics Service of Ukraine, 2022).

The profitability of the production of certain types of products in agrarian

institutions tends to significant fluctuations, both by year and based on product type. The most profitable products made in Ukraine in 2020 were flax seeds (74.8 %), buckwheat grains (44.9 %), sunflower seeds (37.3 %), soybeans (33.5 %), corn grains (29.1 %), rye (27.1 %), milk (22.5 %). The production of sugar beets, beef, pork, lamb, and wool was less profitable and in some years unprofitable (State Statistics Service of Ukraine, 2022).

Despite the relatively significant average annual growth rates of agricultural production and export volumes during 2015–2021, the industry has faced a number of issues, which, if not addressed in a timely manner, may lead to the degradation of production and the loss of its position in the ranking of countries with a relatively high value of the Global Food Security Index. The agricultural and food system of Ukraine, which covers agriculture and rural areas, does not develop on the basis of the coherence of interests of the agricultural industry, rural communities or rural areas.

The increase in the volume of production in Ukraine during 2000–2021 was mainly reached by intensive farming methods with non-compliance with scientifically based crop rotations and soil protection technologies, violation of the scientifically based ratio between the introduction of organic and mineral fertilizers, the dominance of land lease as a type of use that does not contribute to the implementation of measures to improve the quality of land. All this led to an increase in the share of agriculture in energy use (up to 3.7 %) and greenhouse gas emissions (up to 12.8 %). At the same time, the average nitrogen balance decreased as compared to 2000, and the national balance of phosphorus during the last decade became negative (2.2 kg/ha), which may cause problems for sustainable development in the long term (OECD, 2022). According to expert estimates, Ukraine loses 300–500 million t of soil annually. Each year, erosion leads to the loss of soil fertility, which is estimated at about USD 5 billion (Bernoux, 2014). In 2001–2019, an average of 19 villages disappeared from the map of Ukraine every year (State Statistics Service of Ukraine, 2022). Other challenges of agricultural development in Ukraine include: Structural imbalance of production, formation of predominantly raw materials, export-oriented agrarian economy, significant dependence on the import of material and technical resources (fertilizers, plant protection products, fuel and lubricants, agricultural machinery, etc.), underdevelopment of the agricultural market infrastructure, insufficient level of innovativeness of production and skilled workers, a decrease in the number of the working population in rural areas, incompleteness of the land reform, etc.

Due to the military invasion of the Russian Federation into the territory of Ukraine on February 24, 2022, the following were damaged, destroyed or stolen: Agricultural machinery worth USD 2.9 billion, granaries estimated at USD 1.1 billion, finished products worth USD 1.9 billion, animals worth USD 0.3 billion, perennial crops worth USD 0.3 billion (KSE, 2022). Military actions on the territory of Ukraine caused a threat to the development of both rural and national levels, which was formed under the influence of inflationary and devaluation processes. During



March–June 2022, Ukraine's grain export market remained inactive due to the blockade of the Black Sea ports used to export about 90 % of agricultural and food products. The export of grain via alternative routes through Poland and Romania remained rather limited and was complicated by the seasonal increase in the burden on all supply chains. The throughput capacity of “alternative” logistics routes reached the level of 3 million t per month, with the need to export over 70.0 million t of agricultural and food products in the 2021–2022 marketing year. Moreover, the cost of logistics saw a significant 5–6 fold increase. If before the war, logistics costs per 1 t of grain from the central region to the Black Sea ports amounted to about USD 30–40, then the cost to the ports of neighboring countries reaches USD 170–180. Together with transshipment of grain and the cost of logistics outside Ukraine, the logistics component in the price of grain can reach USD 180–200. The cost of transporting a ton of crops by vehicles to Europe varies between USD 150–200. The reduction in grain exports from Ukraine has led to a rise in world grain prices and created inflationary pressure. Grain prices in the domestic market, in contrast to the global market, tended to decrease due to the pressure of large grain stocks in warehouses and the expectation of the 2022 harvest. Even after the organisation of the “grain corridor”, which provided for the unblocking of three Ukrainian ports (Odesa, Chornomorsk and Pivdenny) to export Ukrainian agricultural products, the price of buying wheat grain on the domestic market increased by mere 10–15 %. World prices for wheat were USD 350–370/t, while the prices on the domestic market of Ukraine were only USD 140–165/t (Peshko & Zaverbnyi, 2022).

The National Council for the Recovery of Ukraine from the War was established by the President to coordinate the development of the Roadmap for Recovery of Ukraine. One of the working groups of the National Recovery Council, which included representatives of the Ministry of Agrarian Policy and Food, the Ministry of Economy, the State Service of Ukraine on Food Safety and Consumer Protection, industry associations, unions, non-governmental organisations, experts of international technical assistance projects and other stakeholders, developed a draft Roadmap for Recovery of Ukraine in the direction of the New Agrarian Policy (Recovery of Ukraine, 2023). Based on this Roadmap, the Strategy for Ukraine's Agro-Industrial Complex Development was developed to make Ukraine a global food supplier for more than 600 million people across the globe by 2032, ensure full vertical integration and localisation and import substitution, provide for the processing of at least 50 % of the harvest, replace imported food products on the domestic market, facilitate Ukraine becoming the largest food supplier in the EU network, guarantee the production of 10 billion cubic meters of biomethane from agricultural by-products (Ministry of Agrarian Policy and Food of Ukraine, 2023). The Roadmap for Ukraine's Agro-Industrial Complex Recovery provides for the achievement of two strategic goals: 1) economic transformation of the agro-industrial complex; 2) development of agricultural infrastructure. The Roadmap for Ukraine's Agro-Industrial Complex Recovery will be implemented in three stages. The first stage lasted from June 2022 to the end of 2022, the second stage will be implemented

during 2023–2025, and the third stage will cover 2026 to 2032. The recovery of the agro-industrial complex is to be facilitated through the implementation of 16 consolidated projects (programmes) that will require USD 57.0 billion of funding. At the same time, the recovery projects are expected to be localised by region and supported by individual international partners (Recovery of Ukraine, 2023).

The concept of the post-war agro-industrial complex of Ukraine in its Development Strategy can become the basis for developing a set of measures and programmes of state support for agriculture. However, state support for agriculture must be coordinated with the Ukrainian path of integration into the EU and implemented through cooperation between the Ukrainian state, the business community and international partners. In 2022, under martial law, the main task of agrarian policy was to preserve the economic potential of the industry.

To maintain and ensure further development of agricultural producers, the state has taken a number of necessary measures: 1) Conditions for the relocation of enterprises from the war zone were simplified; 2) Tax benefits were set; 3) VAT reimbursement was renewed and the VAT on fuel reduced; 4) The effectiveness of an effective lending mechanism was ensured; 5) A system of state guarantees was created for borrowers (agricultural producers); 6) Certain regulatory procedures were simplified (simplification of the import of seed material, permission to operate tractors, self-propelled chassis, etc. without their registration, introduced ban on the export of mineral fertilizers, reservation of workers by agricultural enterprises during the mobilisation period, etc.); 7) Separate state programs to support agricultural producers, etc. were introduced (Ministry of Agrarian Policy and Food of Ukraine, 2023; Shulha, 2022; Tyshchenko, 2022).

For instance, as part of the Available Loans 5-7-9 % Programme, UAH 36.9 billion of loans were issued to agricultural enterprises in 2022. In particular, UAH 25.7 billion was raised for sowing, of which UAH 24 billion was under state portfolio guarantees. In addition, UAH 1.65 billion of support was provided for 30,000 small farmers. Thanks to this, the volume of production in Ukraine amounted to more than 53 million t of grain and about 17.5 million t of oilseeds in 2022. In 2022, the volume of grain and oilseeds production in Ukraine amounted to more than 53 million t and about 17.5 million, respectively. During 2022, more than 16 million t of agricultural products along were exported to 40 countries of the world through the “grain corridor” (Ministry of Agrarian Policy and Food of Ukraine, 2023).

Due to the Russia's delay of ships in the Bosphorus, Ukraine lost the opportunity to export more than 3 million t of grain every month. Large stocks of unsold grain of the 2022 and 2023 harvests, with the absence of processing capacities, caused the prices of grain on the domestic market to remain at a low level, and due to the small volume of sales, the majority of agricultural enterprises faced a problem regarding their further activities. Grain production in Ukraine as a whole has become unprofitable.

The results of the estimates (based on the average prices of the domestic market

in early January 2023 and the average yield level of 2022 in Ukraine) show that the revenues received by commodity producers from the sale of wheat grain from 1 ha of the 2022 harvest is sufficient only for sowing 0.8 ha of the crop in 2023 (Table 2).

*Table 2*

**Revenues from the sale of the 2022 harvest and costs for grain production  
per 1 ha of the sown area in 2023**

Indicator	Winter wheat	Corn	Spring barley	Buckwheat
Productivity, t/ha	4.5	8.0	3.6	1.3
Price per 1 t (including VAT), UAH	5300.0	5790.0	5250.0	21000.0
Revenue from 1 ha, UAH	23850.0	46320.0	18900.0	27300.0
Variable costs per 1 ha, UAH:				
salary with accruals	1122.8	1118.3	886.8	859.5
seeds	1637.4	5050.4	1610.2	1652.0
mineral fertilizers	7505.0	15642.3	7183.0	3606.5
plants protecting tools	1524.4	1770.1	1643.3	1055.9
fuel and lubricants	4342.7	5477.1	3474.0	3058.1
costs of grain drying and storage	1035.0	11360.0	1116.0	560.3
insurance payments	905.8	1504.6	828.1	614.0
other variable costs	3312.3	4820.2	2775.5	1659.0
Total variable costs	21385.2	46743.0	19516.9	13065.3
Total fixed costs, UAH	6406.4	8571.9	5766.5	5180.3
Total costs, UAH	27791.6	55314.9	25283.4	18245.6
Cost per 1 t of grain, UAH	6175.9	6914.4	7023.2	14035.1
Required working capital per 1 ha of the 2023 crop, UAH	29612.5	61305.2	27291.0	19263.1
Payment (+), refund (-) of VAT based on 1 ha, UAH	-1721.0	-4149.8	-1984.3	352.0

*Source:* developed by the authors on the basis of technological maps of growing agricultural crops (Mazorenko & Maznev, 2006).

A similar situation is observed in the cultivation of other export-oriented crops, such as corn and barley. Even with the involvement of financial resources represented by loans, the production of these crops will be unprofitable if the prices on the domestic market are maintained. Therefore, in 2023, we can expect a decrease in crops, primarily corn, due to the high costs of its cultivation and logistics.

Only some large agricultural enterprises that have introduced new technologies for growing agricultural crops will be able to achieve a low unit cost of production. Such technologies involve the use of digital technologies and artificial intelligence, the introduction of highly productive seed hybrids, the use of drugs that minimise the negative impact of high temperatures and improve the yield of field crops.

A somewhat different situation is observed in the cultivation of cereal grain crops (buckwheat, millet), which are in great demand on the domestic market. The production of these crops in 2023 may be profitable, but in the volume of demand on the domestic market, while maintaining the price situation.

The cultivation of oilseed crops for the 2022 harvest was generally profitable, as

the price situation on the market for the products of these crops was favourable. Therefore, in 2023, we can expect an increase in sunflower, soybean and rapeseed crops (Table 3).

*Table 3*

**Revenues from the sale of the 2022 harvest and costs for oilseeds production per 1 ha of the sown area in 2023**

Indicator	Sunflower	Soybeans	Winter rapeseed	Rapeseed
Productivity, t/ha	2.7	2.8	3.2	2.5
Price per 1 t (including VAT), UAH	14520.0	15081.0	14620.0	14620.0
Revenue from 1 ha, UAH	39204.0	42226.8	46784.0	36550.0
Variable costs per 1 ha, UAH:				
salary with accruals	1021.6	1039.3	1237.0	1136.7
seeds	3964.8	4672.8	5074.0	4720.0
mineral fertilizers	7862.4	6504.4	11090.0	7533.6
plants protecting tools	1870.9	3035.8	2800.2	2800.2
fuel and lubricants	4987.5	5274.3	4621.7	4425.8
costs of grain drying and storage	864.0	896.0	1024.0	800.0
insurance payments	1070.5	1111.6	1296.4	1102.8
other variable costs	2799.5	2936.5	2936.7	2642.3
Total variable costs	24441.3	25470.7	30080.0	25161.5
Total fixed costs, UAH	7445.4	7697.0	7190.3	6767.6
Total costs, UAH	31886.7	33167.8	37270.2	31929.1
Cost per 1 t of grain, UAH	11809.9	11845.6	11646.9	12771.6
Required working capital per 1 ha of the 2023 crop, UAH	29289.7	35166.1	40541.1	34400.8
Payment (+), refund (-) of VAT based on 1 ha, UAH	262.9	-356.7	-670.4	-937.9

*Source:* developed by the authors on the basis of technological maps of growing agricultural crops (Mazorenko & Maznev, 2006).

Based on the results of 2022, a significant part of agricultural enterprises do not have sufficient working capital to cultivate crops for the 2023 harvest. Our estimates show that in 2023 the lack of working capital in Ukraine for the cultivation of grain and oil crops, with the area of their crops being at the level of 2022, will amount to about UAH 41.5 billion. This issue is particularly acute for enterprises in the liberated territories that have completely or partially lost their material or technical base. The conducted estimates proved that in order to resume the operation of agricultural enterprises in the liberated territories, which produce grain and cultivate oil crops, about UAH 50,000-55,000 of fixed capital (USD 1.370–1.500) are needed for 1 ha of crops, and UAH 45.0–50.0 thousand of working capital (USD 1.340–1.400) (without taking into account the costs of demining and land development). Therefore, the need for the agriculture sector state support in Ukraine has increased significantly.

In 2023–2025, according to the Roadmap for Ukraine's Agro-Industrial Complex Recovery, the main task of agrarian policy is to restore its economic potential to the pre-war levels. Therefore, the main measures of state support for



agriculture in this period should include the development of an effective mechanism for lending to agricultural enterprises and insurance of agricultural products; providing of incentives for the restoration and establishment of new gardens and berry orchards, construction of modern greenhouse facilities; attraction of investments in the reconstruction and construction of new land reclamation systems, production of agricultural machinery, construction of new factories for the production of hybrid seeds, industrial production of biogas, development of livestock breeding and processing of agricultural products, construction of “dry” ports and cross-border terminals in the western regions of Ukraine. At the national level, a number of measures should be introduced to return all land resources damaged and lost for agriculture to economic use. In order to reduce shadow agricultural production, all producers of agricultural products should be registered as market operators, and the model of taxation of agricultural cooperatives used in the EU and the US should be introduced to ensure further development of cooperation. At the second stage of the implementation of the Roadmap for Ukraine’s Agro-Industrial Complex Recovery, efforts will also be continued to establish an indefinite regime of non-application of quotas and duties on Ukrainian products with strategic partners (EU, US, Canada, Japan), and measures will also be taken to promote the export of seeds of Ukrainian origin. The main part of the state support funds will be directed to finance lending and insurance programmes. The rest of the projects will be financed primarily at the expense of international loans and EU donor aid (Recovery of Ukraine, 2023).

In the Law “On the State Budget of Ukraine for 2023”, the program of direct support for rural producers contains only two points: 1) “Financial support of agricultural producers” that UAH 200.0 million is allocated for; 2) “Formation of the authorised capital of the Agricultural Partial Credit Guarantee Scheme Fund, with UAH 360.0 million being allocated (Law of Ukraine, 2022). The distribution of funds under the first program between predetermined directions is established by the order of the chief administrator of budget funds and may change during the budget year depending on the real amount of their use. The Agricultural Partial Credit Guarantee Scheme Fund was formed to provide credit guarantees to small and medium-sized farms, agricultural enterprises that cultivate up to 500 hectares of crops. However, these funds are clearly not enough to effectively support the development of agriculture in 2023. In addition to the allocated funds from the state budget, the Government agreed with international partners on assistance to agricultural producers for almost USD 1.5 billion. Agricultural producers can also take advantage of these state and international business support programmes, information about which is available on the portal of the State Agrarian Registry. Agricultural producers can also take advantage of other state and international business support programs detailed on the portal of the State Agrarian Register. Agricultural producers can participate in all state and international support programs exclusively through the State Agrarian Register or Diia online platform (Ministry of Agrarian Policy and Food of Ukraine, 2023; Shulha, 2022; Tyshchenko, 2022). Since the beginning of 2023, as of July 5, agribusinesses have attracted more than UAH 40.0 billion in bank loans, including



UAH 24 billion under the Affordable Loans 5-7-9 % Programme. According to the Affordable 5-7-9 % Loans government program, since the outbreak of the war, Ukrainian businesses were granted 19,200 loans totalling UAH 79.34 billion, with UAH 25.83 billion being loans for agricultural producers.

In June 2022, the Cabinet of Ministers of Ukraine approved a program for providing grants aimed at creating greenhouses and gardens, with the total budget amounting to UAH 7 billion (Resolution of the Cabinet of Ministers of Ukraine dated June 21, 2022 No. 738, 2022). Since the start of the Programme, as of July 2023, more than UAH 356.8 million have already been paid to 95 entities. As part of the eRobota government project, non-refundable grants are also provided for the creation and development of processing enterprises, including those involved in the agricultural products processing (Ministry of Agrarian Policy and Food of Ukraine, 2023).

Given the martial law being in effect, the mechanisms of financing agricultural producers, for example, agricultural receipts, which make it possible to grant a loan for equipment, fertilizers or other resources necessary for farmers, remained. The future harvest serves as a mandatory pledge during registration.

The European Union finances the program of assistance to small agricultural producers estimated at over UAH 1.5 billion (EUR 50 million). Farms and other agricultural producers, which are registered in the State Agrarian Register and meet the criteria of the program, will be able to receive non-refundable assistance estimated at UAH 3,100 per hectare of cultivated agricultural land (but not more than UAH 372,000) and UAH 5,300 for each cow owned by the recipient (but no more than UAH 530,000) (Ministry of Agrarian Policy and Food of Ukraine, 2023).

The United States Agency for International Development offers the USAID Program for Agrarian and Rural Development (AGRO), the Credit Resources for Agricultural Producers project and the Agricultural Sustainability Initiative in Ukraine (AGRI) worth USD 100 million, which should improve the export mechanisms of Ukrainian agricultural products. The USAID program for agricultural and rural development (AGRO) is designed for five years (until 2024) and has a total cost of UAH 35 million. Within its framework, agronomic support is provided to about 3,000 commodity producers from 13 regions of Ukraine. As part of the Credit Resources for Agricultural Producers project, credit unions that are USAID partners provide loans to small agricultural enterprises (Shulha, 2022).

For 2026–2032, the Roadmap for Ukraine's Agro-Industrial Complex Recovery provides that the agrarian policy will be primarily focused on the rapid growth of the economic indicators of the agro-industrial complex. By 2030, the volume of production of grain and oilseeds is expected to increase to 150 million t; pork products by 480,000 t compared to 2021; beef by 160,000 t; poultry by 500,000 t; eggs by 7 billion; milk by 1.8 million t. The volume of raw material processing will be increased by 85 %, from 20.1 million t in 2021 to 38.8 million t in 2030. However, the share of raw material processing will be 50 % of the export potential (Ministry of Agrarian Policy and Food of Ukraine, 2023).

The main measures of state support for agriculture in this period should include attraction of investments in the building human capacity, deep processing of grain and oilseeds, construction of seed factories, redirection of grain and oil raw materials to the livestock industry, development of organic production, localisation and production of agricultural machinery, development of river logistics along the Danube; facilitating the implementation of key reforms under the EU-Ukraine Association Agreement and the Deep and Comprehensive Free Trade Area in terms of plant health and improving phytosanitary control to ensure compliance with the EU regulations. Significant efforts will be directed at opening new sales markets for fruit, livestock and processed products. The main part of the state support funds will be directed to finance lending and insurance programmes. Due to the lack of adequate state support, the vast majority of these measures will be financed by international loans and EU donor aid.

Currently, in global practice, two methodological approaches are used to determine the level of domestic support for the country's agriculture. One of them is used by the OECD when evaluating and comparing national policies in the area of agri-food, the other is used by the World Trade Organization (WTO) when monitoring the obligations of WTO member countries to reduce the level of support that "distorts" trade. When evaluating the effectiveness of state support, the OESD estimates the volume of support with regard to its recipients: Producer Support Estimate (PSE), Consumer Support Estimate (CSE), General Services Support Estimate (GSSE), Nominal Protection Coefficient (NPC), Total Support Estimate (TSE) (OESD, 2022).

Support for agricultural producers in Ukraine, as estimated by the Producer Support Estimate (PSE), is low compared to European Union countries and has been volatile over the years 2000–2021, mainly due to fluctuations in market price support. During 2019–2021, the PSE indicator in Ukraine averaged 1.7 % of the gross revenues of agricultural enterprises compared to 18.8 % in the EU countries, and based on estimates per 1 ha of agricultural land, this indicator averaged USD 16.9 in Ukraine, and USD 561.9 in EU countries (Table 4).

During most of the last two decades, support for market prices in Ukraine was mainly negative, as the average producer price for most products was lower than the world price. With tariff protection, domestic prices for meat products and sugar were higher than international reference levels, while prices for most cereals and technical crops and milk were generally lower than world prices. State intervention in price formation takes place for wheat, corn, rye, barley, oats, sunflower, sugar, potatoes, milk, beef and veal, pork, poultry and eggs.

In recent years, the overall impact of government intervention on prices has been limited, and during 2019–2021, the magnitude of positive support exceeded negative price support.

Producers of sugar, rye, potatoes and pork have the highest support, while oats and, to a lesser extent, milk and sunflower seeds are implicitly taxed.

Support for producers from the State Budget of Ukraine is provided mainly by

tax benefits, cheaper bank loans and insurance premiums, subsidies for 1 ha of cultivated land for newly formed farms, assistance represented by fixed capital (partial compensation for the cost of purchased agricultural machinery and domestically produced equipment, partial reimbursement of the cost of purchased breeding animals and livestock facilities, grain storage and processing facilities, partial reimbursement of the cost of planting gardens, vineyards and berry orchards, construction and reconstruction of refrigerators for storing fruits and berries, etc.).

*Table 4*

**Comparative assessment of agricultural support of Ukraine and the EU  
in 2019–2021**

Indicator	Ukraine			EU		
	2019	2020	2021	2019	2020	2021
Producer Support Estimate (PSE), million USD	1018	490	590	105117	103988	97980
Including positive support of market prices	891	359	551	20268	16601	13369
negative support of market prices	-207	-175	-289	-403	0	-642
subsidies, partial reimbursement of the fixed assets cost, etc	120	135	150	14606	15180	16182
payments for areas with crops and animal husbandry, benefits from preferential taxation, support for small and medium-sized producers, etc.	214	172	178	27699	29387	28106
Payments that are not related to production	0	0	0	41224	41006	38884
Producer Support Estimate per 1 ha of agricultural land, USD	24.5	11.9	14.3	578.7	570.0	537.0
Percentage of PSE in the amount of revenues, %	2.85	1.41	1.14	19.54	19.25	17.57
Nominal Protection Coefficient (NPC)	1.02	1.01	1.01	1.05	1.04	1.03
Nominal Assistance Coefficient (NAC)	1.03	1.01	1.01	1.24	1.24	1.21
General Service Support Estimate (GSSE), million USD	222	224	268	12783	14676	14511
Consumer Support Estimate (CSE), million USD	-694	-192	-214	-18524	-14677	-12100
Total Support Estimate (TSE), million USD	1240	714	858	118186	119152	112919
Including per 1 hectare of land, USD	29.9	17.3	20.8	650.6	653.1	618.9
TSE percentage (% of GDP)	0.81	0.46	0.49	0.64	0.66	0.67

*Note.* EU28 for 2019, EU27 plus UK for 2020 and EU27 for 2021.

*Source:* estimated by the authors according to the Official website of the European Commission (2022).

Consequently, agricultural producers of Ukraine are entitled to a single tax, which is determined as a percentage of the normative value of agricultural land. Currently, this tax replaces three taxes – income tax, land tax (for land used in agricultural production) and a special fee for water use. The single tax regime for agricultural enterprises generates implicit tax benefits estimated at approximately

UAH 4.3 billion (USD 150 million) annually.

The budgetary support for commodity producers during 2018–2021 was on average less than 1 % of gross revenues of agricultural enterprises, but it exceeded the volume of support in 2010–2017. Since 2020, additional support has been provided in response to the COVID-19 pandemic, but it has remained small, accounting for 0.4 % of budget support for producers in 2020 and 1.8 % in 2021.

The volume of general service support expenditures (GSSE) in Ukraine remains insignificant as compared to other countries and during 2019–2021 they averaged 0.6 % of the agricultural products value as compared to 3.0 % in the EU countries. A significant part of these costs in Ukraine goes to the organisation and regulation of the institutions' activities in the system of the agro-industrial complex, upgrading the expertise of specialists, performing work under state target programs and state orders in the agro-industrial complex development area, training scientific personnel, scientific developments in the area of standardisation and certification, etc. The general service support in Ukraine was unstable during 2000–2021 and since 2015 had an upward trend, yet it was 2–3 times smaller as compared to 2005–2013.

The increase in the volume of state support for agriculture in 2021 as compared to 2019–2020 was caused by an increase in its directions: Support for niche and organic production, beekeeping, partial compensation of the costs of operating irrigation sprinklers and drip irrigation, lowered prices of insurance payments (premiums) under crop insurance contracts against the risk of failure.

During 2019–2021, total agricultural support in percentage terms (TSE) in Ukraine averaged 0.35% of GDP as compared to 0.56 % in EU countries, while in Ukraine per 1 ha of agricultural land, this indicator in monetary terms averaged USD 22.7, and USD 640.9 in EU countries (OESD, 2022).

The data in Table 4 show that payments not related to production account for up to 40 % of the cost structure for producer support in EU countries. This is associated with the fact that despite the small share of agriculture in the economy of developed countries, including the economy of the European Union, there is an active state intervention in its development through the CAP development and implementation. The CAP program provides for supporting not only the function of food production, but also its sustainable development, combating climate change, spatial and landscape planning, diversification and viability of the rural economy, population health, product quality, energy and biomaterials production. Accordingly, in developed countries, unlike Ukraine, agricultural production is not only a business, but also an area where vital public goods not rewarded by the market are created.

Expenditures on agriculture and development of rural areas in EU countries are financed by two funds that are part of its general budget: The European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD) (OESD, 2022).

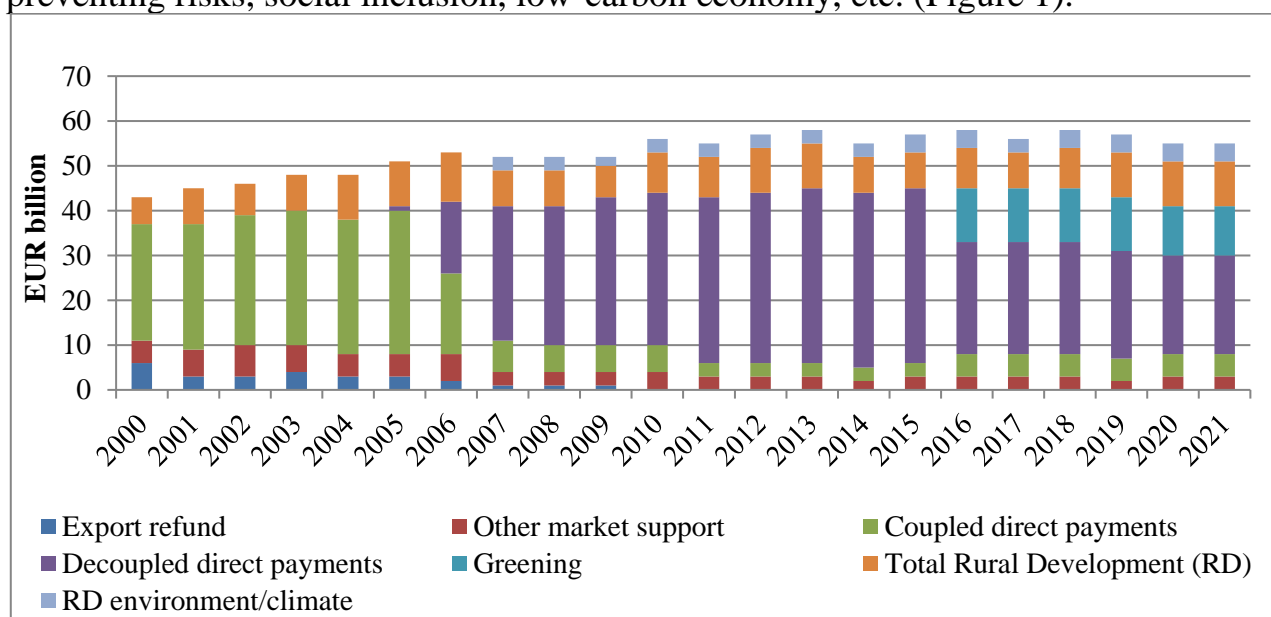
The EAGF primarily finances direct payments to farmers and market measures that regulate or support agricultural markets. Direct payments to EU farmers are made through different payment schemes, including the basic payment scheme,

payment for sustainable farming methods (greening), payment for the size of the farm in hectares and other schemes designed to help small and medium-sized farms, young farmers, farmers who work in areas of natural limitation (mountain areas) or industries that are declining. Receiving these payments is often conditional on compliance with EU rules on food safety, environmental protection and animal welfare. Farmers who do not comply with these rules may not receive support payments or receive smaller amounts. Direct payments to farmers help stabilise farm incomes in the face of volatile market prices, unpredictable weather conditions and variable input costs (OECD, 2022).

Hence, income support for farmers in the European Union is aimed at: Promoting sustainable agriculture and increasing the profitability of agricultural production; ensuring food security in Europe; helping farmers to produce safe, high-quality and affordable agricultural products; remunerating farmers for the delivery of public goods (favourable living environment, biodiversity, attractive agro-landscapes, etc.) that are not usually paid for in the market.

The EAGF also partially reimburses the costs of wine marketing programs, fruit and vegetable producer organisations, school fruit and milk schemes, advertising, beekeeping product development programs and other market support measures.

The EAFRD finances member countries' rural development programs that strengthen market interventions and support farmers' incomes and are aimed at strengthening the EU's agricultural and forestry sectors, environmental sustainability and the well-being of rural areas as a whole. The main areas where the EAFRD's funds aimed at the development of rural areas of the EU countries and national budgets are used are as follows: Increasing the competitiveness of SMEs, protecting the environment and improving resource efficiency, adapting to climate change and preventing risks, social inclusion, low-carbon economy, etc. (Figure 1).



**Figure 1. EU CAP funding, EUR billion**

Source: developed by the authors according to the Official website of the European Commission (2022).



Data in Figure 1 reflect the trend of costs for the implementation of CAP measures in accordance with its changes. The Agenda–2000 program continued the reform process that was adopted in 1992. Market price support was reduced and replaced by producer support as direct income support for farmers. Spending on measures for the development of rural areas also increased, with a separate fund being created for their implementation. The 2003 reform decoupled the vast majority of direct income support payments to farmers from current production, meaning that these funds were paid to the farmer regardless of the results of their production activities. Spending on the development of rural areas continued to grow until 2013.

At the same time, market support costs decreased. The 2013 reform continued the market path of reforms while simultaneously strengthening the links between environmental protection and climate measures with the help of a new greening scheme, based on which around 30 % of direct assistance to farmers is allocated on the implementation of sustainable agricultural methods (greening) and the reduction of negative climate impacts, while another 30 % of the rural development package should be reserved for environmental or climate action.

In Ukraine, following the example of EU member states, there should be support for rural development in the system of state support for the agricultural sector, along with support for agriculture.

Every year, the number of state assistance programs for the development of agriculture increases and there is a problem in the optimal distribution of allocated funds between them to obtain the greatest economic, social and environmental effects.

State support, which complements protection measures, can be aimed at ensuring the necessary regional effect. As a tool for supporting national production, monetary assistance should be fully controlled by state and regional regulatory entities. They can be distributed centrally, for example, in proportion to a certain base (at the initial stage of regulation – the actual or planned share of regions in the total volume of production).

To achieve this goal, we have developed an economic and mathematical model aimed at optimising the distribution of state support funds to form fixed capital estimated at UAH 3.1 billion (funds provided for by the 2022 state Budget).

For this purpose, we will present the directions of state support for commodity producers aimed to form fixed capital, listing five projects:

- 1) The Partial Compensation for the Cost of Domestically Produced Agricultural Machinery project.
- 2) The State Livestock Program project.
- 3) The Financial Support for Development, Horticulture, Viticulture and Hops Cultivation project.
- 4) The Partial Compensation for the Construction and Reconstruction of Livestock Farms project.
- 5) The Partial Reimbursement of Premises For Storage and Processing of Agricultural Products project.

In this case, the economic and mathematical model of the state support distribution funds for rural commodity producers aimed at forming their fixed capital may be presented as follows.

Finding the state support funds distribution scheme for rural commodity producers to form fixed capital between projects that would allow reaching the maximum  $C$  value – the value of the net reduced income from the implementation of these projects during the implementation period:

$$C_{max} = \sum_{j \in J} d_j y_j, \quad (1)$$

where:  $y_j$  means the intensity of use of the  $j$  state support project aimed at forming the fixed capital of commodity producers;

$d_j$  means possible net reduced income from the implementation of the  $j$  state support project aimed at forming the fixed capital of commodity producers per unit of project size;

$j$  means variant (index) of the project;

$J$  means a number of state support projects aimed at forming the fixed capital of commodity producers.

The maximum value of the function must be reached when the following conditions are met.

1. Restrictions on the use of state support funds aimed at forming the fixed capital of commodity producers:

$$\sum_{j \in J} k_j y_j \leq K, \quad (2)$$

where:  $k_j$  means the amount of state support funds, which is necessary to implement a unit of intensity (size) of the  $j$  project. In the numerical model, it was assumed that UAH 1,000 million is needed per unit of implementation intensity of each project, i.e.  $k_j = 1000$ ;

$K$  means the amount of state support funds allocated to form the fixed capital of commodity producers.

2. Restrictions on the guaranteed achievement of the minimum value of the economic, social, environmental indicator, which must be reached from the implementation of projects in a certain estimated period:

$$\sum_{j \in J} m_{ij} y_j \geq M_i, \quad (i \in I_1) \quad (3)$$

where:  $m_{ij}$  means the possible value of the economic, social, ecological indicator, which can be reached from the implementation of the  $j$  state support project per unit of its size in the  $i$  estimated period (year);

$M_i$  means the minimum value of the economic, social, environmental indicator, which must be reached from the implementation of projects in the  $i$  estimated period (year);

$I_1$  means a set of estimated periods (years).

3. Terms of relations between projects:

$$\sum_{j \in J} q'_{ij} y_j \leq \sum_{j \in J} q''_{ij} y_j \quad (i \in I_2) \quad (4)$$

where:  $q''_{ij}$  means correlation coefficients between projects;

$I_2$  means a set of correlations between projects.

4. Variables non-negativity conditions:

$$y_j \geq 0. \quad (5)$$

At the initial stage of developing a numerical economic and mathematical model for the distribution of the state support funds for rural commodity producers to form fixed capital between program areas, appropriate projects were developed, with UAH 1,000.0 million to be allocated for the implementation of each project (Table 5).

*Table 5*

**Numerical economic and mathematical model and results of optimised allocation of funds between projects (fragment)**

Investment options	Project 1	Project 2	Project 3	Project 4	Project 5			
Marking	U1	U2	U3	U4	U5			
Solution	1.20	0.15	0.448	0.600	0.702	NPV		
Net reduced income, UAH million	293.6	464.0	3240.2	358.6	567.4	2487.7		
Limitation	Technical and economic coefficients for variables					Total use	Type of restrictions	Scope of restrictions
1. Limitation on funds for 2022, UAH million	1000	1000	1000	1000	1000	3100.0	$\leq$	3100
2. Cash flow in 2022, UAH million	325.5	377.2	-300.0	128.0	228.8	550.0	$\geq$	550
3. Cash flow in 2023, UAH million	317.0	420.8	-150.0	256.0	286.0	730.5	$\geq$	700
4. Cash flow in 2024, UAH million	311.3	444.6	300.0	256.0	286.0	929.0	$\geq$	850
5. Cash flow in 2025, UAH million	297.2	420.8	750.0	256.0	286.0	1110.2	$\geq$	1050
6. Cash flow in 2026, UAH million	283.0	385.1	1050.0	256.0	286.0	1222.3	$\geq$	1150
7. Cash flow in 2027, UAH million	271.7	377.2	1425.0	256.0	286.0	1375.6	$\geq$	1250
8. Cash flow in 2028, UAH million	263.2	464.0	1500.0	256.0	286.0	1412.1	$\geq$	1260
9. Cash flow in 2029, UAH million	254.7	0	1575.0	256.0	286.0	1365.9	$\geq$	1280
10. Number of jobs, people	437	823	17857	63	806	9255.3	$\geq$	9250
11. Ratio between 2 and 4 projects	0	-4	0	1	0	0	$\geq$	0

Source: developed by the authors.

The results of the estimates proved that the smallest amount of net reduced income can be obtained by investing in compensation for the cost of domestically produced agricultural machinery due to the short period of its operation. However, during the implementation of this project, over the first years, the largest annual revenues are generated, as well as the number of jobs in other industries increases significantly, and the innovativeness of the national economy development is ensured. Investments in the implementation of the project on financial support for the development of horticulture, viticulture and hops cultivation generate the largest net

reduced income, result in the increase of jobs and reduction of greenhouse gas emissions. However, over the first years of its implementation, the annual revenues may have negative values due to the low productivity of perennial plantations. Significant annual revenues (except for the first year) are also generated during the implementation of the project aimed at supporting the development of animal husbandry (purchase of breeding animals). In addition, it is accompanied by an increase in soil fertility as a result of the organic fertilizers use. Investing in compensation for the cost of construction and reconstruction of livestock farms and premises used for storage and processing of agricultural products generates relatively small annual revenues. However, because of the long period of their use, the net reduced income from the implementation of these projects may exceed the net reduced income from the implementation of projects aimed at partial compensation for the cost of domestically produced agricultural machinery.

The implementation of a numerical economic and mathematical model aimed at distributing UAH 3.1 billion of state support to rural commodity producers to form fixed capital according to the criterion of the maximum net reduced income optimality with restrictions on the consecutive increase of annual revenues, jobs and increasing soil fertility within 8 years allowed establishing that it is necessary to allocate the following funds based on program areas: UAH 1.2 billion for the Partial Compensation for the Cost of Domestically Produced Agricultural Machinery project, UAH 150.0 million for the State Livestock Program, UAH 448.0 million for the Financial Support for Development, Horticulture, Viticulture and Hops Cultivation project, UAH 600.0 million for the Partial Reimbursement of the Cost of Construction and Reconstruction of Livestock Farms project, and UAH 702.0 million for the Partial Reimbursement of the Cost of Premises for Storage and Processing of Agricultural Products. The net reduced income at a 15.0 % discount rate amounted to UAH 2,487.7 million.

The calculations confirmed the importance of the implementation of these programmes for the development of agriculture, as they are components of the Roadmap for Ukraine's Agro-Industrial Complex Recovery until 2032.

A significant drawback is annual changes to the extent of state support for agriproducers in the State Budget of Ukraine. UAH 6.3 billion was allocated for these purposes in 2018, UAH 5.9 billion in 2019, UAH 4.0 billion in 2020, UAH 4.5 billion in 2021, UAH 6.15 billion in 2022. In 2020, in order to form fixed capital, the Financial Support of Agricultural Producers Programme was to allocate funds in the following directions: State Support for the Development of Animal Husbandry and Processing of Agricultural Products (UAH 1 billion), Financial Support for the Development of Horticulture, Viticulture and Hop-Growing (UAH 400 million), Partial Compensation of the Cost of Agricultural Machinery and Equipment of Domestic Production (UAH 437 million). However, support funds are often allocated to producers with delays or are not allocated at all. For instance, in 2020, out of the planned UAH 4.0 billion, as of October, producers received only UAH 854.0 million of support (AgroPolit.com, 2020).

According to our calculations, the ratio of allocation of funds among programmes is close to the ratio of allocation of funds among these programs in the State Budgets for 2020 and 2021. This indicates the adequacy of the calculation made using economic and mathematical methods, and the calculation can be used when drafting budget requests by central and regional bodies of executive power.

The Ministry of Agrarian Policy and Food of Ukraine is the main administrator of budget funds allocated for financial support of agriculture. When making budget proposals for the drafting of the Budget Declaration, experts of the Department of Budget Planning and Financing of this Ministry distribute the estimated funds between budget programs, directions and subordinate managers of budget funds (structural units of regional state administrations ensuring the performance of functions in agro-industrial development), taking into account the priorities of agrarian policy, reports on the implementation of budget programs passports, results of budget programs effectiveness evaluation. In the process of budget funds allocation, experts of the Department of Budget Planning and Financing of the Ministry of Agrarian Policy and Food consult responsible executors of budget programs and involve independent experts. And despite this, their distribution of funds is usually subjective with respect to the promotion of individual corporate interests, which does not ensure the best effect from the use of these funds.

A similar situation is observed during the preparation of budget requests for the State Budget drafting. Therefore, in order to optimise the allocation of funds, we suggest that at these stages the Department of Budget Planning and Financing of the Ministry of Agrarian Policy and Food use an economic and mathematical model, the implementation of which allows determining the priority of budget programs and making a decision on obtaining the greatest effect from the use of funds allocated for financial support of agriculture. Limitations in the presentation of the economic and mathematical model are a number of conditions (factors) that must be considered when allocating estimated funds between budget programs and directions. It means that Table 5 presents only a fragment of the economic and mathematical model for the distribution of state support funds allocated to rural commodity producers for the formation of fixed capital.

The development of an effective mechanism of state support for agriculture in Ukraine in the post-war period is possible only with a clear vision of the prospects for the agro-industrial complex development. Therefore, we recommend that the Ministry of Agrarian Policy and Food, together with the interested central executive bodies, develop and submit a draft of the State Target Program for the agrarian sector development until 2032 to the Cabinet of Ministers of Ukraine.

*Discussion.* Based on the Agro-industrial Complex Recovery Plan, the production of grain and oil crops is supposed to increase up to 150 million t by 2030, as compared to 108.9 million t in 2021. In our opinion, a significant increase in the production of grain and oil crops is impractical, as it will strengthen the agriculture monopolization, worsen the structure of cultivated areas, and increase the level of soil degradation, which is currently about 20 %.



According to scientific recommendations, the area of grain and oil crops in the structure of sown areas should not exceed 65 %, while in 2021 it was 87.3 % (Shubravska, 2023).

According to the scientifically based structure of the cultivated areas, the area of grain and oil crops (even with the liberation of the occupied territories) in 2030 should be 25 % less compared to 2021. And the yield of these crops cannot be increased by 63 % by 2030, considering the requirements of the European Green Deal for crop farming technologies. In addition, the yield of grain crops in 2022 compared to 2021 decreased by 15.4 %, and the production of export-oriented grain became unprofitable. According to our estimates, with the observance of scientifically based crop rotations and application of sustainable crop farming technologies, the volume of production of grain and oil crops in Ukraine will reach about 100–110 million t by 2030. To sum up, the development and implementation of measures to trigger the increase in the production of grain and oil crops is impractical. Instead, there is a need to develop and implement measures to improve soil fertility and promote the use of sustainable agricultural methods (Ilchuk, 2023). To do this, it is necessary to make changes to the mechanism of environmental taxation, which is defined in the Tax Code of Ukraine, and set forth the provisions on the targeted use of a certain share of revenues from the environmental tax for agricultural enterprises that violate scientifically based crop rotation, exclusively for the support of commodity producers who use sustainable methods of farming and take measures to improve soil fertility in the Budget Code.

**Conclusions.** The agriculture of Ukraine in the pre-war period demonstrated quite high rates of economic growth for a long time, despite the low level of state support. Support for agricultural producers in Ukraine, as estimated by the Producer Support Estimate (PSE), is low compared to European Union countries and has been volatile over the years 2000–2021, mainly due to fluctuations in market price support. During 2019–2021, the PSE indicator in Ukraine averaged 1.7 % of the gross revenues of agricultural enterprises compared to 18.8 % in the EU countries, and based on estimates per 1 ha of agricultural land, this indicator averaged USD 16.9 in Ukraine, and USD 561.9 in EU countries. During most of the last two decades, support for market prices in Ukraine was mainly negative, as the average producer price for most products was lower than the world price. During 2019–2021, total agricultural support in percentage terms (TSE) in Ukraine averaged 0.35 % of GDP as compared to 0.56 % in EU countries, while in Ukraine per 1 ha of agricultural land, this indicator in monetary terms averaged USD 22.7, and USD 640.9 in EU countries.

The results of the study proved that the model of global specialisation formed in the pre-war period in Ukrainian agriculture was raw material oriented and worsened the state of ecological and social environment. The destruction caused by the war in the area of production and sale of agricultural products can create prerequisites for the further development of the country's agrarian sector on the basis of sustainability and structural balance of production and export. As a result of the implementation of

the Agro-Industrial Complex Recovery Plan during 2023–2032, there should be a transition from a highly specialised structure of production and export to a more effective structure that ensures compliance with national economic interests and is in line with modern world trends.

At the first stage of the agro-industrial complex recovery process, which is related to the elimination of the consequences of military activities, the main part of the financial support should be aimed at the formation of the fixed (including the restoration of damaged agricultural land resources) and working capital of agricultural commodity producers, implementation of lending and insurance programs.

The second stage of the agro-industrial complex recovery is connected with the rapid growth of the economic indicators of the agro-industrial complex. At this stage, the main part of financial support should be aimed at the formation of new global value chains, the opening of new markets, and the development of human potential.

The limitation of this study is to see the prospective state of agricultural development based on the indicators of the Agro-Industrial Complex Recovery Plan and the Strategy for the Agro-Industrial Development in Ukraine, which contain separate state investment projects that are not mutually agreed upon the terms of their implementation, funds and executors. The development of an effective state support system for agriculture is possible by working out the State Target Program for the agrarian sector development for the period until 2032, during which the implementation of individual state investment projects is coordinated. When developing the State Target Program, the economic and mathematical model we propose can be applied to determine the priority and optimise the distribution of limited funds between state investment projects.

Further study will be aimed at optimising the sectoral structure of agriculture in Ukraine, which is the basis for the development of the State Target Program for the agrarian sector development, as well as at improving standards and tools to manage the sustainability of agriculture and ensure their compatibility with the EU CAP.

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