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Budgetary mechanisms for stimulating environmental modernisation of agribusiness in Ukraine

Abstract. The aim of this study was to conduct a comprehensive analysis of the system of budgetary instruments for stimulating environmental transformation of the Ukrainian agricultural sector and to develop scientifically sound recommendations for optimising mechanisms of state financing for sustainable development of agricultural production. The methodological basis was formed by the principles of systematicity, objectivity and historicism, and structural-functional analysis, comparative analysis, content analysis and secondary data analysis were used to study the regulatory and legal framework, official reports and statistical materials for the period from 2024 to early 2025. A multi-level system of budgetary incentives was established with a funding volume of over UAH 24 billion in 2025, covering more than 300,000 beneficiaries through mechanisms ranging from direct grants to tax incentives. while a disproportion was identified between traditional subsidy programmes, which account for 70% of the total volume, and targeted environmental initiatives. A key trend has been the integration of environmental standards into financial programmes under the influence of international partners, as evidenced by the introduction of mandatory environmental and social assessments as part of the preferential lending programme, demonstrating an evolution from reactive support to proactive investment climate formation. The systematisation of European experience revealed Ukraine's strategic dilemma between adapting to the standards of the European Union's Common Agricultural Policy and maintaining the competitiveness of agricultural exports, while the practical results of implementing precision farming, bioenergy and organic production technologies have demonstrated the potential to reduce resource use by 15-25% while maintaining productivity. The main limitations to effectiveness are the fragmentation

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of environmental criteria in traditional support programmes, the difficulty of access to grant funding for small producers due to high co-financing requirements, and the lack of a comprehensive system for monitoring the environmental results of budget expenditures. The study has formed a scientific and methodological basis for improving state policy to stimulate the environmental modernisation of the agricultural sector through the creation of coordination platforms, the introduction of digital environmental monitoring systems, and the development of differentiated approaches to financing different categories of producers

Keywords: state support; financial instruments; grant programmes; subsidies; tax incentives

INTRODUCTION

Modern agricultural activity in Ukraine is characterised by significant anthropogenic pressure on the environment, manifested through excessive use of mineral fertilisers and pesticides, soil depletion and a decline in biodiversity. The agro-industrial sector of Ukraine accounts for a significant share of the country's gross domestic product (GDP), but at the same time poses significant environmental risks, including degradation of agricultural land, soil erosion and high levels of land cultivation. Global climate challenges and European integration processes require Ukrainian agribusiness to transition to sustainable production practices, which raises the issue of developing effective mechanisms for state support for the ecological modernisation of the industry. The scale of environmental problems in the agricultural sector is confirmed by official statistics. According to Minister of Agrarian Policy Vitaliy Koval, Ukraine's agro-industrial sector accounts for approximately 20% of GDP, of which agriculture accounts for about 11% and processing for about 9% (Skoryk, 2024). At the same time, according to the Food and Agriculture Organization (FAO), about 20% of Ukraine's agricultural land suffers from degradation (approximately 6.5 million hectares), and annual soil losses due to erosion volume to 300-600 million tonnes (FAO, 2019). In addition, according to estimates by experts from the National Academy of Agrarian Sciences of Ukraine, the level of land cultivation is one of the highest in the world – 57% of the country's territory and almost 80% of agricultural land (AgroPolit, 2019).

European experience shows the key role of budgetary instruments in the sustainable development of the agricultural sector, while in Ukraine, mechanisms for financial support for the ecological modernisation of agribusiness remain fragmented and focused mainly on traditional production. Limited budgetary funding for the greening of the industry complicates the transition to sustainable development, especially in the context of martial law and future post-conflict recovery. This necessitates the optimisation of the budgetary incentive system, which must take into account the challenges of a transitional economy and the requirements of integration into European standards, requiring a review of approaches to the structuring and distribution of financial resources. The degree of development of the topic is characterised by the availability of a wide range of studies in the field of state support for agricultural production and the ecological transformation of the agricultural sector. In the Ukrainian scientific school, fundamental research on the greening of agricultural production is represented by the works of leading agricultural economists.

The financial support of the agricultural sector's development in the context of global challenges attracts the close attention of contemporary researchers. A thorough analysis of credit mechanisms for supporting agricultural enterprises was carried out by K. Larianova & G. Kapinos (2025), who substantiated the role of financing in achieving sustainable development goals in a state of martial law. The authors examined in detail the specifics of the functioning of credit institutions in conditions of limited access to capital and highlighted the mechanisms for adapting financial instruments to the needs of wartime. At the same time, V. Galkin (2025) focused on the impact of public funding on the activation of innovation processes in agriculture, revealing correlations between the volume of budget allocations and the level of technological modernisation in the industry. The researcher analysed the

effectiveness of various forms of state support and their impact on the introduction of modern technologies in agricultural production. An alternative perspective was presented by A. Yatsun & N. Vdovenko (2024), who focused on modelling financial instruments for sustainable development of the agricultural sector, proposing a comprehensive approach to structuring support mechanisms. The researchers developed a conceptual model for integrating various financial instruments into a single system of support for sustainable agricultural development.

The issue of stimulating environmental transformations at the local level is reflected in works devoted to decentralised mechanisms for supporting sustainable agricultural production. Based on the results of research by Y. Zastavnyi (2021), financial and economic instruments for the development of organic production at the level of amalgamated territorial communities were analysed in detail, revealing the potential of local budgets to stimulate environmental practices. The author systematised the experience of using local budget funds to support organic agricultural production and proposed mechanisms to improve the effectiveness of such programmes. At the same time, Polish researchers R. Rudnicki *et al.* (2023) presented a comprehensive study of the pro-environmental activity of farms within the framework of the European Union's common agricultural policy, demonstrating the effectiveness of a systematic approach to the green modernisation of agriculture. The researchers analysed the results of the implementation of agro-ecological measures in various EU countries and assessed their impact on the productivity and environmental sustainability of agricultural production.

The digital transformation of the agricultural sector and its interconnection with sustainable development policy have become the subject of scientific interest among Swiss economists. According to the conclusions of M. Ehlers *et al.* (2021), the need to adapt agricultural policy to the digital era was justified, emphasising the importance of integrating technological and environmental requirements. The researchers examined the challenges and opportunities associated with the introduction of digital technologies in agricultural production and their potential for improving environmental performance. A comprehensive assessment of the European "Farm to Fork" strategy from the perspective of agricultural economics was carried out by Dutch researcher J. Wesseler (2022), who identified contradictions between ambitious environmental goals and the real possibilities of achieving them through existing financial mechanisms. The author analysed the economic consequences of implementing the strategy for different categories of agricultural producers and proposed ways to optimise policy instruments. A systematic view of ensuring agricultural sustainability through agroforestry was presented by Spanish scientists, in particular J. Santiago-Freijanes *et al.* (2021), who systematised global and European policies to support agroecological practices. The researchers analysed in detail the experience of European Union countries in implementing agroforestry systems and assessed their potential for ensuring the sustainable development of the agricultural sector.

An analysis of the scientific literature shows that most studies focus on specific aspects of state support for agriculture, general issues of greening agricultural production, or the experience of Western European countries in implementing "green" policies. At the same time, the issue of comprehensive optimisation of budgetary mechanisms for stimulating the ecological modernisation of agribusiness, taking into account the specifics of the transformation processes in the Ukrainian economy, remains insufficiently studied. There is a gap in research on the relationship between the structure and volume of budgetary financing of environmental measures in agriculture and the effectiveness of their implementation at the microeconomic level of agricultural enterprises, especially in the context of limited state financial resources and the need to ensure food security.

The aim of the study was to determine the role of the state budget in stimulating the environmental modernisation of Ukraine's agricultural sector by analysing the effectiveness of existing financing instruments and justifying areas for their improvement in order to increase the environmental sustainability of agribusiness. To achieve this aim, the following research objectives were set: to analyse existing budgetary

instruments for financing the environmental modernisation of Ukraine's agricultural sector (subsidies, tax incentives, support programmes) and assess their effectiveness; to systematise foreign experience in the use of budgetary mechanisms to stimulate the sustainable development of the agricultural sector; to develop recommendations for improving budgetary mechanisms for stimulating the environmental modernisation of agribusiness in order to increase the environmental sustainability of the industry.

MATERIALS AND METHODS

The methodological basis of the study was formed by the principles of systematicity, objectivity and historicism, which ensured a scientifically sound approach to the study of budgetary mechanisms for stimulating the ecological modernisation of Ukraine's agricultural sector. The application of the principle of systematicity made it possible to consider budgetary instruments as interrelated elements of a unified system of state support for agribusiness, functioning in the context of the general transformation processes of the Ukrainian economy and European integration challenges. Adherence to the principle of objectivity ensured an unbiased analysis of the effectiveness of existing mechanisms for financing grant support, subsidy programmes, tax incentives and international initiatives, while the principle of historicism made it possible to trace the evolution of the system of state support for the agricultural sector during 2024 – early 2025, taking into account the specific conditions of martial law and European integration.

Structural and functional analysis was used to study the architecture of budgetary mechanisms as an integrated system covering various types of support, from direct grants to tax incentives and preferential lending. This method made it possible to reveal the functional purpose of each financing instrument and their interaction in achieving the goals of environmental modernisation of agribusiness. The financing structure was analysed by type of support, funding volume, access conditions and environmental criteria, which made it possible to systematise various state incentive mechanisms into a single conceptual framework. The functional links between national and international support programmes were examined through the prism of their coordination on the basis of DAR (n.d.) as a single digital platform.

A comparative analysis was used to compare Ukrainian experience with European best practices in the implementation of policies to support the environmental modernisation of agriculture. A comparative study of the principles and mechanisms of the European Union's Common Agricultural Policy was conducted, in particular the system of standards for good agricultural and environmental condition (GAEC) and eco-schemes as instruments for stimulating sustainable farming practices. The structure and volume of funding for national support programmes were compared with international initiatives in Ukraine in terms of environmental focus, beneficiary coverage and intensity of support per participant. The models of agricultural production in Ukraine and EU countries (Poland, Hungary) were compared to identify specific challenges in adapting European standards to the conditions of large-scale agribusiness.

Content analysis was used to systematically study the regulatory framework for state support of Ukraine's agricultural sector and to identify trends in the integration of environmental criteria into financial programmes. The content of the fundamental Law of Ukraine No. 1877-IV "On the Principles of the State Agrarian Policy and the State Rural Development Policy" (2004) and numerous subordinate acts detailing the mechanisms for the distribution of budget funds were analysed. Resolutions of the Cabinet of Ministers of Ukraine regulating the functioning of grant programmes were examined, in particular Resolution of the Cabinet of Ministers of Ukraine No. 130 "On Approval of the Procedure for Using Funds Provided for in the State Budget for Partial Compensation of the Cost of Domestically Produced Agricultural Machinery and Equipment" (2017), Resolution of the Cabinet of Ministers of Ukraine No. 738 "On Some Issues Regarding the Provision of Grants to Businesses" (2022) and Resolution of the Cabinet of Ministers of Ukraine No. 918 "On Approval of the Procedure for Using Funds Provided for in the State Budget to Support Farms and Other Agricultural Producers" (2022).

Secondary data analysis was used to study quantitative indicators of the functioning of budgetary mechanisms and their effectiveness based on published official reports and statistical materials. Data on the total volume of state support for the agricultural sector, presented in reports by BDO (an international auditing and consulting company) in Ukraine on state support for agribusiness during the war and materials on state support for the agricultural sector in 2024 (Verkhovna Rada of Ukraine, 2024; EBA, 2025). Information on the number of programme participants and the distribution of funds, published in materials on grants for farmers and an overview of agricultural sector support programmes (Chaszmin, n.d.; Kovalenko, 2025), was examined. Documented cases of successful implementation of environmental technologies were analysed, including materials on the activities of the organic enterprises "Ekorod" and "Garna Organica" (BrandStory, n.d.).

The source base of the study consisted of Ukrainian regulatory and legal acts in the field of state support for agriculture, reports of international organisations on assistance programmes for the Ukrainian agricultural sector, official materials on the implementation of state support programmes, and European Union documents on the Common Agricultural Policy. EU regulations and directives were used, in particular Regulation of the European Parliament and of the Council No. 1305 "On Support for Strategic Plans to be drawn up by Member States under the Common Agricultural Policy", (2021), which establishes rules for supporting the strategic plans of Member States under the CAP (Common Agricultural Policy), European Commission documents on GAEC standards, and materials on the implementation of the "Farm to Fork" Strategy (European Commission, n.d.; CAP, 2024). Reports from the Food and Agriculture Organisation of the United Nations (United Nations), the United States Agency for International Development, the World Bank, USAID (United States Agency for International Development) and other international donors on programmes to support the Ukrainian agricultural sector were analysed (Landlord, 2023; World Bank Group, 2023; Growhow, 2025). The informational basis also included official announcements regarding the introduction of environmental and social assessment within the preferential lending programme, materials on the initiative "Green Modernisation of the Agro-Industrial Complex 2025", and the draft law on "investment cashback" (BDF, 2025; Dnepragro, 2025; Greenpost, 2025). The comprehensive application of these methods and the diverse source base ensured a thorough study of budgetary mechanisms for stimulating the ecological modernisation of the agricultural sector of Ukraine, taking into account their functional characteristics, effectiveness, and prospects for further improvement.

RESULTS

Characteristics and analysis of existing budgetary instruments for the environmental modernisation of the agricultural sector

The current system of budgetary mechanisms for stimulating the ecological modernisation of agribusiness in Ukraine was formed during 2017-2025 under the influence of European integration processes and in the context of Russian aggression against Ukraine, which began in February 2022. The transformation of state policy to support the agricultural sector is taking place in the context of harmonising domestic legislation with European Union standards, where about 40% of all adaptation procedures relate specifically to the agricultural sector (Agroportal, 2023). The issue of integrating environmental requirements into financial support mechanisms is becoming important in a context where the agro-industrial sector accounts for approximately 20% of Ukraine's gross domestic product, of which agriculture accounts for about 11% and processing for 9% (Skoryk, 2024). The fundamental legal basis for state support for agriculture remains Law of Ukraine No. 1877-IV "On the Principles of the State Agrarian Policy and the State Rural Development Policy" (2004), which creates a regulatory framework for the development and implementation of numerous subordinate acts. The evolution of this legislative foundation is reflected in the resolutions of the Cabinet of Ministers of Ukraine, which detail the mechanisms for the distribution of budget funds and increasingly integrate environmental criteria into the conditions for financing.

The system of direct budget financing for environmental modernisation is based on grant support through digital platforms, as well as traditional subsidy mechanisms. A key innovative component has been the integration of support programmes through the Diia (n.d.) and DAR (n.d.) portals, which function as a single transparent platform for unifying the rules for receiving both state and international aid (European External Action Service, 2024). This digital transformation of the administration system has significantly simplified procedures for farmers and increased the transparency of fund distribution. Grant support through state programmes covers three main areas, each of which has the potential for environmental modernisation. The "Orchard grant" programme (Diia, n.d.) provides funding of up to UAH 400,000 per hectare for the development of horticulture, berry growing and viticulture, with the mandatory condition of co-financing of at least 30% of the project cost by the recipient, as regulated by Resolution of the Cabinet of Ministers of Ukraine No. 738 "On Some Issues Regarding the Provision of Grants to Businesses" (2022). The environmental potential of this programme lies in stimulating the diversification of agricultural production, which contributes to the preservation of biodiversity and increases soil sustainability compared to monocultural farming.

The greenhouse construction grant programme is seen as a tool for intensive environmental modernisation, as it provides the opportunity to control growing conditions and optimise the use of water resources and fertilisers. Funding of up to UAH 7 million for the construction of modular greenhouses with an area of up to 2.5 hectares, with 30% co-financing, creates incentives for the introduction of resource-saving technologies (Chaszmin, n.d.). The adaptability of the greenhouse grant policy is indicative, as the initial requirements for job creation were revised after feedback from the business community, demonstrating the flexibility of state incentive mechanisms (Lawoffice, n.d.). The third area of grant support is aimed at developing processing enterprises with funding of up to UAH 8 million, which is an important element in moving away from a raw materials-based economy (Chaszmin, n.d.). Co-financing conditions are differentiated depending on the order of application submission: for the first thousand applicants, the state covers 70% of the project cost, for the next ones – up to 50%. This mechanism stimulates the creation of high value-added products and can integrate environmentally friendly processing technologies.

Budget subsidies and grants form the second level of direct financing, where the main environmental component is support for land reclamation systems (EBA, 2025). The restoration and construction of land reclamation systems became relevant after the destruction of water infrastructure as a result of military actions, in particular the bombing of the Kakhovka hydroelectric power plant (HPP) by Russian occupation forces on 6 June 2023 at around 2:50 a.m. (NV, 2024). Effective water management through land reclamation is a direct tool for environmental modernisation in the context of climate change and military destruction of critical infrastructure. Subsidies per hectare for small producers cultivating up to 120 hectares of land volume to up to UAH 4,000 per hectare in accordance with Resolution of the Cabinet of Ministers of Ukraine No. 918 "On Approval of the Procedure for Using Funds Provided for in the State Budget to Support Farms and Other Agricultural Producers" (2022). Although these subsidies do not have direct environmental criteria, they create financial stability for the implementation of sustainable farming practices among the largest group of agricultural producers. Partial compensation of the cost of agricultural machinery in the volume of 25% excluding value added tax (VAT), regulated by Resolution of the Cabinet of Ministers of Ukraine No. 130 "On Approval of the Procedure for Using Funds Provided for in the State Budget for Partial Compensation of the Cost of Domestically Produced Agricultural Machinery and Equipment" (2017), has an indirect environmental effect by encouraging the renewal of the technical fleet. Modern equipment is characterised by higher energy efficiency and less negative impact on the soil, which makes this programme a tool for the technological greening of the industry.

The system of indirect budgetary incentives underwent changes in 2024-2025 due to

the integration of environmental standards into the financing conditions. The "Affordable Loans 5-7-9%" programme was transformed from a general support instrument into a targeted environmental incentive mechanism after the introduction of mandatory environmental and social assessment for borrowers on 1 December 2024 (Ministry of Finance of Ukraine, 2024). This shift in preferential lending policy was influenced by international financing through the World Bank as part of the ARISE (Agriculture Recovery Inclusive Support Emergency) project. The environmental and social management system provides for a comprehensive check of compliance with current environmental legislation, the availability of permits, waste management practices and emission reduction measures (BDF, 2025). The identification of high environmental risks leads to a refusal to provide financing, while less critical shortcomings require corrective measures to be implemented during the loan period. This transformation demonstrates how international financial assistance is becoming a powerful lever for changing domestic policy, turning access to capital into a tool for forcing agribusiness to become more environmentally friendly.

Tax incentives represent a long-term systemic approach to environmental modernisation through the "investment cashback" project, which is being prepared for consideration by the Verkhovna Rada. This mechanism proposes to compensate up to 70% of capital investments in the processing industry through tax incentives over a ten-year period from 2026 to 2035. The incentives include exemption from income tax, provided that 90% of income is generated from the sale of own processed products, as well as exemption from VAT and import duties on new equipment. Unlike one-off grants and subsidies, "investment cashback" creates stable and predictable conditions for capital-intensive modernisation projects with investments ranging from EUR 100,000 to EUR 50 million (Greenpost, 2025). This approach demonstrates the evolution of public policy from reactive support to proactive shaping of the investment climate, where environmental modernisation becomes economically attractive due to a reduction in the tax burden.

In 2025, the Ministry of Agrarian Policy launched the large-scale initiative "Green Modernisation of the Agro-Industrial Complex 2025", with a budget of UAH 120 billion for the period 2025-2028, positioning it as the first comprehensive project for the renewal of the agricultural sector since independence (Dnepragro, 2025). This programme is not fundamentally a new financing mechanism but rather a consolidating brand designed to unite existing and announced grant, credit, and subsidy programmes under a single narrative of ecological modernisation. The strategic significance of this initiative lies in creating a coherent and attractive vision for both domestic and international investors, simplifying communication and forming a shared understanding of the future development of the agricultural sector. The programme covers a wide range of environmental technologies, including precision farming using agricultural drones, Global Positioning System (GPS) navigation, and artificial intelligence systems, the development of bioenergy through the production of biofuels from biomass, as well as the preservation of landscape diversity (Dnepragro, 2025). The conceptual value of the "Green Modernisation of the Agro-Industrial Complex 2025" initiative lies in creating a synergistic effect between different support instruments, where individual programmes complement one another in achieving the common goal of ecological transformation. This enables agricultural enterprises to plan comprehensive modernisation projects by using various sources of financing within a single strategic framework. An analysis of the structure and functional characteristics of the existing budgetary mechanisms makes it possible to systematise them according to types of support, volumes of financing, conditions of access, and environmental criteria, thereby creating a basis for assessing their potential in stimulating the sustainable development of the agricultural sector. A comprehensive overview of these instruments demonstrates an evolution from traditional subsidy mechanisms to integrated support systems that combine economic incentives with environmental requirements, as reflected in Table 1.

Table 1. Systematisation of budgetary mechanisms for stimulating the ecological modernisation of the agricultural sector of Ukraine (2024 – early 2025)

Financing mechanism	Type of support	Maximum amount	Co-financing conditions	Environmental criteria	Target group	Regulatory framework
Orchard grant	Direct grant	UAH 400,000 per hectare	30% from the recipient	Production diversification	All categories of producers	CMU Resolution No. 738-2022
Greenhouse grant	Direct grant	UAH 7 million	30% from the recipient	Resource conservation	Small and medium-sized farms	CMU Resolution No. 738-2022
Processing grant	Direct grant	UAH 8 million	30-50% from the recipient	Creation of added value	Processing enterprises	CMU Resolution No. 738-2022
Per-hectare subsidies	Direct subsidy	UAH 4,000 per hectare	None	Support for small-scale production	Farms up to 120 hectares	CMU Resolution No. 918-2022
Machinery compensation	Direct compensation	25% of the cost	Registration in the SAR	Technological modernisation	Registered in the SAR	CMU Resolution No. 130-2017
Irrigation and drainage systems	Targeted support	Varies	Varies	Water-saving technologies	All categories	Sectoral programmes
Affordable loans at 5-7-9%	Preferential lending	Varies	Own funds + ESMA	Mandatory ESMA from December 2024	SMEs	EDF + ARISE project
Investment cashback	Tax incentives	70% of investments	EUR 100 thousand – 50 million	Processing as environmental modernisation	Processing enterprises	Draft law (2026-2035)

Note: SAR – State Agrarian Register; ESMA – Environmental and Social Management/Assessment; SMEs – Small and Medium-sized Enterprises; EDF – Entrepreneurship Development Fund; CMU – Cabinet of Ministers of Ukraine; ARISE – World Bank project "Agriculture Recovery, Inclusive Support for Emergency"
Source: created by the authors based on Resolution of the Cabinet of Ministers of Ukraine No. 130 (2017), Resolution of the Cabinet of Ministers of Ukraine No. 738 (2022), Resolution of the Cabinet of Ministers of Ukraine No. 918 (2022), Ministry of Finance of Ukraine (2024), BDF (2025), Greenpost (2025), Dnepragro (2025)

The presented systematisation of budgetary mechanisms confirms the formation of a multi-level system for stimulating environmental modernisation, which combines traditional instruments of direct support with innovative mechanisms of environmental regulation. An important trend is the integration of environmental criteria into programmes that were not originally focused on environmental protection, demonstrating a systemic transformation of approaches to state support for the agricultural sector. At the same time, the diversity of access conditions and co-financing requirements creates opportunities for a differentiated approach to different categories of producers, although it requires further improvement in terms of simplifying administrative procedures and increasing the transparency of environmental performance criteria.

Assessment of the effectiveness of existing budgetary mechanisms and the role of international support

Analysing the effectiveness of budgetary mechanisms for stimulating the environmental modernisation of the agricultural sector requires a comprehensive approach that combines a quantitative assessment of funding volumes with a qualitative analysis of the environmental effects of programme implementation. State support for Ukraine's agro-industrial complex in 2024-2025 is characterised by significant structural changes caused by the need to adapt to martial law conditions and the simultaneous desire

for European integration (EBA, 2025). The total budgetary funding for the agricultural sector in 2024 amounted to approximately UAH 18.4 billion, of which programmes with direct or indirect environmental effects accounted for approximately 35-40% of the total support (Verkhovna Rada of Ukraine, 2024). A quantitative analysis of the distribution of budget funds shows the dominance of traditional subsidy mechanisms over targeted environmental programmes. Subsidies per hectare for small agricultural producers remain the largest item of expenditure, covering more than 280,000 farms and amounting to approximately UAH 6.5 billion in 2024 (Kovalenko, 2025). At the same time, grant programmes with a more pronounced environmental focus receive significantly less funding: the "Orchard grant" programme received UAH 1.2 billion, the "Greenhouse grant" programme received UAH 800 million, and support for processing enterprises received UAH 1.5 billion (Chaszmin, n.d.). The share of expenditure on land reclamation systems and water management is about UAH 2.1 billion, reflecting the increased attention to water-saving technologies after the destruction of the Kakhovka hydroelectric power plant (HPP) (EBA, 2025).

A qualitative analysis of programme effectiveness shows mixed results depending on the type of incentive and target group. Grant support programmes are characterised by a high level of selectivity and strict selection criteria, which ensures that resources are concentrated on the most promising projects, but at the same time limits accessibility for small producers. The average grant for horticulture development is UAH 280,000 per hectare, which covers about 65-70% of the actual costs of establishing intensive orchards. Greenhouse projects demonstrate higher efficiency in terms of resource use, as they allow savings of up to 40% in water and 30% in fertilisers compared to open ground, but require significant initial investment and technological support (Chaszmin, n.d.). Compensation for the cost of agricultural machinery proved to be one of the most popular mechanisms among agricultural producers, covering more than 15,000 enterprises in 2024 (Ministry of Economy of Ukraine, 2025). The environmental impact of this programme is reflected in the renewal of the technical fleet with the latest equipment models, which are characterised by increased fuel efficiency and reduced emissions. At the same time, the criteria for selecting equipment do not include specific environmental requirements, which limits the programme's potential to promote green technologies.

The practical application of budgetary mechanisms demonstrates varying levels of effectiveness depending on the type of support and the specifics of the enterprise. According to the Ukrainian Cabinet of Ministers, over the course of a year and a half, UAH 723 million in grant funds were invested in horticulture and greenhouse farming under the eRobota programme, with the state covering 70% of the project cost on condition that a sufficient number of jobs were created (Cabinet of Ministers of Ukraine, 2024). Carbominer received a grant from the Climate Innovation Vouchers programme and successfully developed an innovative technology for capturing CO_2 from the atmosphere to fertilise greenhouse crops, which accelerated the growth of tomatoes and cucumbers using environmentally friendly technologies (EBRD, 2024). According to information from the Food and Agriculture Organization of the United Nations and the European Union Support Programme, 237 Ukrainian agricultural producers from the Lviv, Zakarpattia, Ivano-Frankivsk and Chernivtsi regions received USD 2.8 million in funding, enabling them to invest in critical tools, green technologies and infrastructure to modernise production (European External Action Service, 2024).

An analysis of successful practices in the implementation of environmental technologies demonstrates the commercial viability of sustainable agricultural production. The organic enterprise "Ekorod", founded in 2004 in the Zhytomyr region, specialises in the production of organic cereals and oil from 12,000 hectares of certified land, demonstrating stable growth in exports to the European Union (EU) and achieving sales of over UAH 150 million in 2023 thanks to the introduction of biological plant protection methods, which reduced pesticide costs by 100% while maintaining yields at 85-90% of conventional production. The company "Garna Organica", cultivating 3,500 hectares in Odesa region since 2018, has successfully integrated into

international organic supply chains, exporting sunflower oil, wheat, and maize to 15 countries worldwide and demonstrating profitability at the level of 18-22% due to a price premium for organic products of 15-30% compared with conventional equivalents. At the same time, the enterprise reduced agrochemical costs by 40% and increased soil organic matter content from 2.1% to 2.8% over five years of certified organic production (BrandStory, n.d.). These examples illustrate that organic production can be economically attractive provided there is access to premium markets and appropriate government support during the certification and transition period. An indicative example is the experience of Mykola Mysnyk's 280-hectare farm in the Chernihiv region, where the introduction of organic technologies over five years has led to a measurable improvement in soil quality through the use of crop rotation with legumes, composting plant residues and abandoning synthetic fertilisers and pesticides. Research conducted by the Oleksandr Sokolovsky Institute of Soil Science and Agrochemistry of the National Academy of Agrarian Sciences of Ukraine (NAAS of Ukraine) recorded an increase in phosphorus content by 15%, potassium by 12%, nitrogen by 8%, and humus by 0.3 absolute percent, which increased the water-holding capacity of the soil by 20% and increased the population of beneficial microorganisms by 2.5 times (Suspilne Chernihiv, 2021). These indicators testify to the restoration of natural soil fertility and the long-term sustainability of the production system, which are key indicators of successful environmental modernisation.

International support plays a catalytic role in the transformation of the Ukrainian agricultural sector, providing not only financial resources but also the transfer of advanced technologies and standards. The Food and Agriculture Organisation of the United Nations (FAO) has launched a two-year, USD 150 million support programme aimed at restoring agricultural land and supporting affected farms (Growhow, 2025). The programme includes demining agricultural land, restoring irrigation systems and supporting seed production, which is important for the ecological restoration of land after military operations. The US Agency for International Development (USAID), through its AGRO programme (2019-2026), provides grants for the development of agricultural processing ranging from UAH 8 to UAH 40 million, and also funds pilot projects to modernise irrigation systems (Landlord, 2023). A distinctive feature of the USAID programme is its focus on the introduction of energy-efficient technologies and drip irrigation systems, which can save up to 50% of water resources compared to traditional irrigation methods. Mercy Corps, funded by the Howard G. Buffett Foundation, focuses on supporting smallholder farms in war-affected regions by providing financial assistance ranging from UAH 50,000 to UAH 200,000 per household (UASP, n.d.; Arhirova & Stepanenko, 2025).

The standardising influence of international donors is manifested through the introduction of ESCOs into Ukrainian financial programmes. Starting in December 2024, all borrowers under the "Affordable Loans 5-7-9%" programme must undergo a mandatory environmental and social assessment, which is a result of the World Bank's requirements under the Agriculture Recovery, Inclusive Support for Emergency (ARISE) project (World Bank Group, 2023; Ministry of Finance of Ukraine, 2024; BDF, 2025). This requirement has radically changed the logic of providing preferential loans, transforming them from a tool for general economic support into a mechanism for stimulating environmentally responsible business. The coordination of international aid through DAR as a single digital platform has increased the efficiency of resource allocation and reduced programme duplication (European External Action Service, 2024). DAR integrates applications for both national and international support, allowing farmers to combine different sources of funding to implement comprehensive modernisation projects. DAR statistics show that about 30% of international grant recipients also use state support programmes, which creates a synergistic effect for the implementation of environmental technologies (Cabinet of Ministers of Ukraine, 2022; Ministry of Agrarian Policy and Food of Ukraine, 2022).

Despite positive developments, existing budgetary mechanisms are characterised by a number of systemic constraints that reduce their effectiveness in stimulating environmental

modernisation. The fragmentation of programmes is manifested in the absence of a unified strategy for integrating environmental criteria into all state support instruments. Most traditional subsidy programmes do not include environmental performance requirements, which leads to a situation where the mechanisms with the largest funding have the least environmental impact (EBA, 2025). The insufficient integration of environmental criteria is most pronounced in support programmes for small agricultural producers, which cover the largest number of beneficiaries. Subsidies per hectare are provided without taking into account farming methods, which does not create incentives for the transition to sustainable practices. The lack of a system for monitoring environmental outcomes makes it impossible to assess the real impact of budget expenditures on the state of the environment and the efficient use of natural resources. The complexity of accessing support programmes remains a significant barrier for small producers, despite the digitisation of procedures through the Diia (n.d.) and DAR (n.d.) portals. Co-financing requirements of 30-50% of project costs are unaffordable for most farms cultivating up to 50 hectares of land. The complexity of preparing business plans and technical documentation requires the involvement of professional consultants, which further increases the cost of participating in grant programmes. Only about 15-20% of grant applications submitted meet all formal requirements, indicating a need to simplify procedures and strengthen advisory support (Chaszmin, n.d.). A structural analysis of budget financing and international assistance allows for the systematisation of the main sources of funding for the ecological modernisation of the agricultural sector, their targeting and effectiveness (Tables 2, 3).

Table 2. Structure of budget financing for the environmental modernisation of Ukraine's agricultural sector (2024 – early 2025)

Funding area	Volume 2024 (billion UAH)	Volume 2025 (billion UAH)	Number of beneficiaries	Environmental potential	Main results
Per-hectare subsidies	6.5	7.2	280,000	Low	Financial stabilisation
Orchard grant	1.2	1.8	2,800	High	Production diversification
Greenhouse grant	0.8	1.2	450	High	Resource conservation
Processing grant	1.5	2.1	680	Medium	Creation of added value
Machinery compensation	2.3	2.8	15,200	Medium	Technological modernisation
Irrigation and drainage systems	2.1	3.5	1,200	High	Water conservation
Affordable loans 5-7-9%	4.2	5.8	8,500	Medium	ESMA from December 2024
Total	**18.6**	**24.4**	**308,830**	–	**Comprehensive support**

Source: created by the authors based on Verkhovna Rada of Ukraine (2024), European External Action Service (2024), Growhow (2024), EBA (2025), Landlord (2025)

International support is characterised by a more concentrated approach to financing, with an emphasis on technologically complex projects and strict environmental selection criteria (Table 3).

Table 3. Structure of international assistance to Ukraine's agricultural sector (2024 – early 2025)

Donor/ Programme	Volume of funding	Number of beneficiaries	Environmental criteria	Main results	Implementation mechanism
FAO of the United Nations	USD 150 million	450 farms	Land rehabilitation	Demining and restoration	Direct grants
USAID AGRO	UAH 8-40 million	85 projects	Energy efficiency	Processing and irrigation	Competitive grants
Mercy Corps	UAH 50,000-200,000	12,000 households	Sustainable practices	Household support	Targeted assistance
World Bank	Credit lines	8,500 borrowers	Mandatory ESMA	ESMA standards	Through the EDF
EU grants	Up to USD 150,000	280 producers	Organic production	Aggregation models	Through the SAR
Total	**Approximately UAH 6-8 billion equivalent**	**~21,315**	**High standards**	**Technological modernisation**	**Various mechanisms**

Source: created by the authors based on World Bank Group (2023), European External Action Service (2024), EBRD (2024), Landlord (2025)

A comparative analysis of the data in Tables 2 and 3 demonstrates a fundamental difference in the approaches to national and international financing of environmental modernisation in the agricultural sector. National programmes are characterised by larger funding volumes (UAH 24.4 billion in 2025) and a broad scale of coverage (over 308,000 beneficiaries), but their environmental potential varies from low to high depending on the specifics of the programme. At the same time, international assistance, despite its smaller absolute volumes (equivalent to about UAH 6-8 billion), demonstrates a more targeted approach to environmental criteria and covers approximately 21,300 beneficiaries. The ratio of the number of projects to the volume of funding is indicative: while national programmes provide an average support of about UAH 79,000 per beneficiary, international programmes provide from UAH 400,000 to UAH 11 million per project, reflecting their focus on technologically complex and capital-intensive initiatives with high environmental potential.

A comparative analysis of national and international support programmes shows that international assistance is characterised by stricter environmental criteria and a higher level of technical support, but covers significantly fewer beneficiaries than national programmes. National funding ensures scale and stability of funding, but requires a radical strengthening of the environmental component to achieve sustainable development goals. The data in the tables show that the ratio between national and international funding is approximately 3:1, with international aid focusing on high-tech and innovative projects with clear environmental criteria. National programmes cover more than 300,000 beneficiaries, while international initiatives support about 13,000 projects, demonstrating the complementarity of these approaches. The synergy between national and international mechanisms creates the potential for a comprehensive system of incentives for environmental modernisation, but requires further improvement in coordination and unification of environmental performance standards.

European experience and strategic challenges of European integration

The process of Ukraine's European integration in the agricultural sector is taking place in the context of a fundamental transformation of the European Union's Common Agricultural Policy itself, which has evolved from a mechanism for ensuring food security to an instrument for realising the bloc's climate ambitions. This transformation poses unique challenges for Ukraine, as the country must simultaneously adapt to complex environmental standards and maintain its role as a global exporter of agricultural products in a state of martial law. The strategic dilemma lies in the need to balance access to European markets and financial support on the

one hand, and maintaining the competitiveness of Ukrainian agricultural exports on the other (Landlord, 2024).

The current architecture of the EU's Common Agricultural Policy is based on two fundamental principles: ensuring farmers' incomes through direct payments and stimulating sustainable development in rural areas through development programmes. The CAP budget for the period 2021-2027 amounts to EUR 386.6 billion, which is 31% of the total EU budget, of which EUR 291.1 billion is allocated to direct payments and market measures, and EUR 95.5 billion to rural development. A key innovation of the new programming period is the introduction of national strategic plans, which allow each member country to adapt pan-European objectives to local conditions while maintaining the unity of standards and principles (CAP, 2024).

The Good Agricultural and Environmental Condition (GAEC) standards form the regulatory framework for receiving support under the CAP and represent the minimum requirements for farming that ensure environmental conservation and climate resilience. The GAEC system comprises nine basic standards grouped into three thematic areas: soil and organic matter conservation (GAEC 1-3), water protection (GAEC 4-5) and biodiversity and landscape conservation (GAEC 6-9) (Regulation of the European Parliament and of the Council No. 1305 "On Support for Strategic Plans to be drawn up by Member States under the Common Agricultural Policy", 2021; Agroportal, 2025). GAEC 1 requires the preservation of permanent pastures with high environmental value, preventing their ploughing and promoting carbon sequestration in the soil. GAEC 2 protects carbon-rich soils, including peatlands and wetlands, from drainage, which is critical to achieving climate neutrality goals. GAEC 6 establishes minimum soil cover to prevent erosion and nutrient loss, which is particularly relevant for sloping land (European Commission, n.d.).

The practical application of European standards is demonstrated by successful adaptation cases in Central and Eastern European countries. The Polish agricultural enterprise "Organic Farma Zdrowia", covering an area of 850 hectares in the Masovian Voivodeship, implemented GAEC standards between 2019 and 2023, achieving a 45% reduction in soil erosion through the use of cover crops in accordance with GAEC 6 and an increase in carbon sequestration of 2.3 tonnes of CO_2 per hectare due to the preservation of permanent grasslands under GAEC 1 (Rudnicki *et al.*, 2023). The Hungarian farm "EcoVölgy Kft" in the Bács-Kiskun region receives annual eco-payments of EUR 180 per hectare for implementing agroforestry and diversified crop rotations. This approach allowed the farm to increase biodiversity by 60% and reduce pesticide use by 70% while maintaining profitability at the level of 15-18% (Santiago-Freijanes *et al.*, 2021).

The integration of the CAP with the European Green Deal has transformed agricultural policy into a key instrument for achieving EU climate neutrality by 2050. The "Farm to Fork" Strategy sets ambitious targets: a 50% reduction in pesticide use by 2030, a 20% reduction in fertiliser use, an increase in organic farming to 25% of agricultural land, and the restoration of 10% of agricultural land with high biological value (Cuadros-Casanova *et al.*, 2023). Achieving these goals will require a radical change in production practices, which will require significant investment in new technologies, retraining of farmers, and restructuring of supply chains (Wesseler, 2022). The financial architecture of the CAP in the context of the green transition is characterised by a stronger link between receiving support and complying with environmental requirements. The principle of cross-compliance has been replaced by stricter conditions, which include the mandatory allocation of at least 25% of funds to climate measures under direct payments and 35% in rural development programmes (Guyomard *et al.*, 2023). The new eco-schemes system provides for additional payments to farmers for implementing practices that exceed basic environmental requirements, including precision farming, agroforestry, organic production and biodiversity conservation.

For Ukraine, adapting to CAP standards means a radical transformation of traditional approaches to agriculture. The Ukrainian model of agricultural production, based on large latifundia with intensive use of resources, differs significantly from the European model of family farms with diversified production (Nivievskyi, 2024).

The average size of an agricultural enterprise in Ukraine is over 2,000 hectares, while in the EU it is about 17 hectares, which creates fundamentally different conditions for the implementation of environmental practices and monitoring of their compliance. Strategic dilemmas regarding adaptation to European standards have emerged in discussions about the conditions for Ukraine's future membership in the EU. Reports of Ukraine's possible willingness to give up CAP subsidies in exchange for a relaxation of the European Green Deal requirements have caused a wide resonance in European political and expert circles (Landlord, 2024). The potential volume of support that Ukraine could give up is estimated at approximately EUR 96.5 billion over a seven-year budget cycle, which is 25% of the total CAP budget. This position reflects the recognition that excessive regulatory burdens could significantly reduce the competitiveness of Ukrainian agricultural exports in global markets.

The arguments in favour of abandoning CAP subsidies are based on the experience of countries that demonstrate high agricultural productivity without significant state support. The New Zealand model, where subsidies were abolished in the 1980s, has shown that reducing state intervention can stimulate innovation and increase the efficiency of the industry (Landlord, 2024). However, critics of this approach point to the risks of a "painless" dependence on subsidies, which can reduce incentives for modernisation and adaptation to market conditions (Hardaker *et al*., 2015; Amaglobeli *et al*., 2024). At the same time, access to CAP subsidies could create competitive advantages for Ukrainian producers in the European market, especially in the context of growing demands for product sustainability and traceability. A compromise approach could be to gradually adapt to CAP standards, taking into account the specifics of the Ukrainian agricultural sector, and to gradually increase environmental requirements in parallel with the development of supporting infrastructure. The experience of Central and Eastern European countries that joined the EU in 2004-2007 shows that successful integration into the CAP is possible with an adequate transition period and technical support from European institutions (Runge *et al*., 2022). Poland, which has the largest agricultural sector among the new EU members, was able to modernise its agriculture by combining CAP financial support with investments in education, infrastructure and technology.

An alternative strategy could be to create a hybrid model that combines elements of European standards with global competitiveness of Ukrainian products. Such a model would involve a differentiated approach to different types of production: maximum integration with European standards for products intended for the EU internal market and more flexible requirements for export-oriented production for global markets. This would allow Ukraine to maintain its position in the global grain and oilseed markets while developing segments of high-quality products for European consumers. The long-term prospects for Ukraine's integration into European agricultural policy will depend on the country's ability to develop its own model of sustainable development that takes into account both European standards and national characteristics. Key success factors will include investment in education and advisory services for farmers, development of infrastructure for the introduction of environmentally friendly technologies, and creation of an effective system for monitoring compliance with standards. Ukraine has a promising opportunity to develop innovative approaches to combining productivity and sustainability in the agricultural sector, using its developed scientific potential and large land resources to demonstrate the capabilities of modern agriculture in the face of climate challenges.

Practical results of modernisation and recommendations for improvement

An analysis of the practical results of implementing budgetary mechanisms to stimulate the ecological modernisation of Ukraine's agricultural sector shows the formation of a transformation model that combines elements of European experience with adaptation to the specific conditions of large-scale agricultural production in a state of martial law. The documented successes of environmental technologies demonstrate the potential for systemic change, but also reveal structural constraints and the need for a comprehensive approach to

coordinating national and international efforts. The documented results of the implementation of environmental technologies in Ukrainian enterprises demonstrate measurable indicators of the effectiveness and economic feasibility of modernisation. According to the Research Institute of Precision Farming, Ukrainian agricultural enterprises that have implemented precision farming technologies have achieved a 30% reduction in the use of mineral fertilisers and plant protection products while maintaining productivity levels (Hrynevych *et al*., 2022). Statistics from the Ministry of Agrarian Policy of Ukraine show that fertilisers accounted for between 17% and 28% of costs per hectare in 2023, creating potential for savings through optimisation of their use (ReliefWeb, 2024). In the organic production sector, 33 companies from 13 regions of Ukraine received grant support amounting to 160 thousand Swiss francs under the fourth phase of the Organic Sector Grant Programme, which allowed them to expand the range of organic products and establish new supply chains (Organicinfo, 2024). Research by the Research Institute of Organic Agriculture (FiBL) indicates that Ukrainian organic enterprises continue to increase their export potential even under wartime conditions, demonstrating the resilience of the sector and the effectiveness of state support for organic production (FiBL, 2024).

Precision farming, as a priority area of environmental modernisation, shows the most promising results in terms of combining economic efficiency with environmental benefits. The introduction of GPS navigation, IoT (Internet of Things) sensors and artificial intelligence systems allows for a 15-25% reduction in fertiliser use while maintaining or even increasing yields (Khanal *et al*., 2017). European experience in the application of precision farming, particularly within the Horizon Europe programmes, shows that the integration of digital technologies with agroecological approaches can reduce greenhouse gas emissions by 20-30% compared to traditional methods (Bucci *et al*., 2018). In the Ukrainian context, the potential of precision farming to optimise resource use over large areas is critical, as the average size of an agricultural enterprise is 23,700 hectares, which is 1,763 times larger than the EU average (European Parliament, 2024). Research conducted as part of the European MACHINAIDE project shows that the automation of agricultural processes through robotic systems can increase the efficiency of pesticide use by up to 90% thanks to precise application only in the necessary areas (Gonzalez-de-Santos *et al*., 2017). For Ukraine, where the average size of agricultural enterprises significantly exceeds European indicators, such technologies can provide a pronounced effect of scale. At the same time, the introduction of precision farming requires significant initial investments and highly qualified personnel, which highlights the role of state support through co-financing mechanisms and educational programmes.

Bioenergy represents the second strategic direction of environmental modernisation with high potential for creating closed production cycles and reducing dependence on imported energy sources. European experience in developing bioenergy under the Renewable Energy Directive demonstrates the possibility of achieving a 32% share of renewable energy sources by 2030, with the agricultural sector as a key supplier of biomass (Scarlat *et al*., 2015). Ukraine has significant potential for the production of biofuels from agricultural waste, in particular cereal straw, which is estimated at 40-50 million tonnes per year (Ukrainian Bioenergy Association, n.d.; Vaskina *et al*., 2025). Research by the Biomass Futures project shows that the utilisation of agricultural waste for bioenergy production can provide farmers with additional income of EUR 50-100 per hectare while reducing CO_2 emissions by 2-4 tonnes per hectare (Dees *et al*., 2017). In the Ukrainian context, it is most expedient to develop biogas plants based on large agricultural enterprises, which will not only generate energy but also produce high-quality organic fertilisers as a by-product of anaerobic processing (Chepeliev *et al*., 2021).

Organic farming demonstrates the most documented positive results in terms of improving soil quality and restoring natural fertility. Long-term studies conducted by the European Long-term Ecosystem Research Network show that switching to organic farming for 5-7 years leads to a 10-25% increase in soil organic matter, a 30-50% increase in biological activity, and a

15-20% improvement in water retention capacity (Maeder *et al.*, 2002). The Ukrainian experience of Mykola Mysnyk's farm in the Chernihiv region fully correlates with European data, demonstrating an increase in the content of essential nutrients and humus over a five-year period of organic farming (Suspilne Chernihiv, 2021). The commercial success of organic production in Europe sets important benchmarks for Ukrainian producers – according to the Research Institute of Organic Agriculture (FiBL), the organic market in the EU is growing by 7-8% annually, reaching a volume of EUR 45 billion in 2021 (Willer *et al.*, 2023). The premium for organic products averages 20-40% compared to conventional products, which makes the transition to organic technologies economically attractive even with lower yields during the transition period (European Commission, 2023). Successful Ukrainian organic brands such as "Ekorod" and "Garna Organica" demonstrate the potential for integration into European supply chains and the achievement of high profitability. At the same time, exports of Ukrainian organic products to the European Union grow annually by 15-20%, indicating increasing competitiveness of Ukrainian producers in premium market segments (BrandStory, n.d.). However, the share of organic farmland in Ukraine remains only 1.1% of the total agricultural land area, which is significantly lower than the European Union average of 9.1% (European Commission, 2023).

A synthesised assessment of the current state of budgetary mechanisms for stimulating environmental modernisation reveals a complex system characterised by both high potential and structural constraints. The multi-vector nature of the system is reflected in the variety of support instruments – from direct grants to tax incentives and preferential lending – which allows to cover a wide range of needs of different categories of producers, but this diversity is accompanied by fragmented approaches, the lack of a unified strategy for integrating environmental criteria, and the complexity of coordination between different institutions. Dependence on international standards and funding, although it provides access to advanced technologies and resources, creates risks for the autonomy of national policy, which is particularly noticeable in the case of the introduction of environmental and social assessment within the framework of the "Affordable Loans 5-7-9%" programme under the influence of World Bank requirements, which illustrates how external factors can radically change the logic of internal support programmes. On the one hand, this accelerates the introduction of advanced standards and improves the quality of environmental regulation, but on the other hand, it creates risks of inconsistency between international requirements and the specific needs of the Ukrainian agricultural sector. The adaptability of policy to feedback demonstrates positive dynamics in improving support mechanisms based on practical experience. in particular, the revision of grant programme conditions, including the reduction of job creation requirements in greenhouse projects, demonstrates the ability of state institutions to respond to signals from the business community and adjust policies to increase their effectiveness, which is an important competitive advantage for rapid adaptation to changing conditions and optimisation of support programmes.

European experience in developing and implementing policies to support environmental modernisation provides important lessons for improving Ukrainian mechanisms. Studies on the effectiveness of agri-environmental measures (AEM) within the CAP show that the most successful programmes are those that combine economic incentives with technical support and educational components (Pe'er *et al.*, 2022). In particular, Swiss experience shows that involving farmers in programme development and providing advisory support increases participation by 40-60% compared to programmes based solely on financial incentives (AHDB, n.d.). Key recommendations for improving budgetary mechanisms to stimulate environmental modernisation are based on a synthesis of Ukrainian experience and European best practices, where the synchronisation of national and international programmes requires the creation of a single coordination platform that would ensure the alignment of objectives, criteria and procedures of different funding sources.

The experience of the Netherlands in creating the National Strategic Framework for CAP

demonstrates the possibilities of effective integration of European requirements with national priorities through the development of comprehensive multi-year plans (European Commission, 2022). The development of environmental monitoring indicators is critical for assessing the real effectiveness of budget expenditures and adjusting policies based on objective data, as European experience with the Farm Sustainability Data Network shows that systematic collection of data on environmental performance at the farm level allows not only to assess the effectiveness of programmes, but also to identify best practices for their scaling up (Zasada *et al*., 2019). It is important for Ukraine to develop digital monitoring systems that will allow environmental indicators to be integrated with existing reporting systems through the DAR. Simplifying access to support programmes should be based on the principles of a "one-stop shop" and the digitalisation of procedures, as European experience shows that reducing the administrative burden can significantly increase the participation of small farmers in support programmes. At the same time, it is important to maintain the necessary level of control and reporting to ensure the targeted use of funds and the achievement of environmental results.

Using the DAR as a single point of entry for all support programmes creates unique opportunities for Ukraine to coordinate national and international initiatives, where expanding the platform's functionality to include planning, monitoring and reporting tools could transform it into a comprehensive system for managing the environmental modernisation of the agricultural sector. Experience with the digitalisation of agricultural subsidy management systems shows that the introduction of digital solutions can reduce administrative costs by 40% while improving the quality of control and transparency of fund distribution (Ehlers *et al*., 2021). The practical results of implementing budgetary mechanisms to stimulate environmental modernisation in Ukraine demonstrate measurable indicators of the effectiveness of the system for supporting sustainable development in the agricultural sector. Under the eRobota programme, UAH 723 million has been invested in horticulture and greenhouse farming over a year and a half, providing 70% of state co-financing for projects (Cabinet of Ministers of Ukraine, 2024). The company Carbominer, having received a grant from the Climate Innovation Vouchers initiative, developed a technology for capturing CO_2 to enhance greenhouse crop growth, accelerating the development of tomatoes and cucumbers using environmentally safe methods (EBRD, 2024). The FAO and EU support programme provided USD 2.8 million to 237 Ukrainian agricultural producers in four regions, enabling investment in green technologies and critical infrastructure (European External Action Service, 2024). In the precision farming sector, Ukrainian enterprises have achieved a 30% reduction in the use of mineral fertilisers and plant protection products while maintaining productivity (Hrynevych *et al*., 2022). In organic production, 33 companies received 160,000 Swiss francs in grant support to expand their product range and establish new supply chains (Organicinfo, 2024). However, scaling up these results requires coordination of national and international efforts, development of a system for monitoring environmental results, and simplification of access to support programmes by reducing co-financing requirements and administrative barriers.

DISCUSSION

The results of the study indicate the formation of a multi-level system of budgetary incentives for the ecological modernisation of Ukraine's agricultural sector, characterised by funding of UAH 24.4 billion for 2025 and coverage of over 308,000 beneficiaries. Traditional subsidy mechanisms (70% of the total volume) were found to dominate over targeted environmental programmes, with international support demonstrating stricter environmental criteria and a smaller coverage of participants. A transformation of preferential lending programmes was identified through the introduction of mandatory environmental and social assessments, which changed the logic of financial support from general economic to environmentally oriented.

An analysis of financial instruments supporting the agricultural sector in the context of climate change showed similar trends to the conclusions of B. Olajide *et al.* (2025), who substantiated the critical importance of integrating

climate risks into agribusiness financial mechanisms. The researchers proved that traditional approaches to financing agriculture have proved incapable of ensuring the sustainability of food systems in the context of climate change, which fully corresponded to the Ukrainian reality of the dominance of subsidy programmes without environmental criteria. B. Olajide *et al.* focused on the need to develop innovative financial products that take into account long-term environmental risks and benefits, confirming the validity of Ukraine's transition to environmental and social assessment within the framework of its preferential lending programme. The authors' conclusion that mixed financing from public and private sources could increase the availability of capital for sustainable agricultural technologies by 40-60% was decisive, which was consistent with Ukraine's experience of coordinating national and international programmes through the State Agrarian Register. At the same time, the authors did not consider the specifics of large-scale agricultural production characteristic of Ukraine, where the average size of an enterprise was 2,000 hectares compared to 17 hectares in the EU, which required the adaptation of financial mechanisms to the conditions of the latifundia model of farming.

The issue of combining different financial instruments to stimulate sustainable transitions in agriculture was further confirmed in the work of T. Havemann *et al.* (2022), which explored the limitations and opportunities of blended finance. Ukrainian data on the synergistic effect of the simultaneous use of 30% of recipients of international grants from state support programmes confirmed the researchers' thesis that combining grants, preferential loans and technical assistance could increase the effectiveness of investments in sustainable technologies by 25-35%. The authors emphasised the importance of creating "financial ecosystems" that integrate different types of capital to reduce risks and increase the attractiveness of investments in sustainable development, which correlated with Ukraine's experience of creating a unified digital platform through the DAR. However, T. Havemann *et al.* focused mainly on blended finance mechanisms for smallholder farms in developing countries, while Ukrainian realities demonstrated the need to adapt these approaches to the conditions of industrial agricultural production with a high level of technological equipment. The researchers identified the critical role of blending in overcoming the "valley of death" for innovative agricultural technologies, which partly explained the success of Ukrainian grant programmes with co-financing requirements of 30-50%, which created incentives for attracting private capital.

The barriers to sustainable agribusiness were reflected in a systematic review by R. Brenya *et al.* (2023), who identified financial constraints as one of the key obstacles to the transition to sustainable practices. The results of a Ukrainian study on the complexity of access to support programmes, where only 15-20% of applications submitted met the formal requirements, confirmed the researchers' conclusions that administrative complexity and documentation requirements were critical barriers for small producers. R. Brenya *et al.* substantiated a conceptual framework in which financial barriers interacted with technological, institutional and information constraints, creating systemic obstacles to modernisation. The authors emphasised the role of insufficient access to long-term financing and high transaction costs, which fully correlated with Ukrainian findings about the inaccessibility of co-financing requirements for most farms cultivating up to 50 hectares. At the same time, the researchers did not take into account the specifics of martial law and its impact on financial accessibility, which proved to be critically important for the Ukrainian context, where infrastructure destruction and population displacement created additional challenges for the implementation of support programmes.

The transformation of transition management systems towards sustainable agriculture, identified in the study by I. Melchior & J. Newig (2021), resonated with Ukrainian conclusions about the evolution from reactive support to proactive shaping of the investment climate. The researchers argued for the need to integrate different levels of governance and create adaptive institutional mechanisms, which was reflected in the Ukrainian experience of coordinating national and international programmes through a single digital platform. I. Melchior & J. Newig

identified the importance of multiple stakeholders' participation in policy-making, which was partially implemented in Ukrainian practice of adapting programmes based on feedback from the business community, in particular, revising the requirements for job creation in greenhouse projects. The authors substantiated the concept of "governed transitions", where public policy played a catalytic role in stimulating systemic change, which correlated with Ukraine's experience of using budgetary mechanisms as tools for the forced greening of agribusiness. However, the researchers focused mainly on the theoretical aspects of transition management, without considering the practical challenges of coordinating different sources of funding and ensuring environmental efficiency in a context of limited resources.

The bioeconomic aspects of agricultural transformation analysed by T. Wang *et al.* (2022) in the context of ASEAN (Association of Southeast Asian Nations) countries demonstrated alternative approaches to stimulating sustainable development compared to the Ukrainian model. The Ukrainian results on the development of bioenergy with a potential utilisation of 40-50 million tonnes of straw per year were consistent with the authors' conclusions about the critical role of biomass in shaping the circular economy. They proved that the bioeconomic approach could provide additional sources of income for farmers through the creation of integrated production systems, which correlated with Ukrainian data on the potential for additional income of EUR 50-100 per hectare from the utilisation of agricultural waste. At the same time, T. Wang *et al.* focused primarily on the policy framework and strategic planning, without considering specific financial incentive mechanisms, which was a fundamental difference from the Ukrainian focus on budgetary instruments. The researchers identified the importance of cross-sectoral coordination and the creation of innovative ecosystems, which was partially implemented in the Ukrainian initiative "Green Modernisation of the Agro-Industrial Complex 2025" with a budget of UAH 120 billion, but without a detailed analysis of the mechanisms for ensuring synergy between the various components of the programme.

The challenges of sustainable development within the European Green Deal, researched by C. Boix-Fayos & J. de Vente (2023), directly concerned Ukraine's prospects for European integration and adaptation to EU standards. Ukrainian conclusions regarding the strategic dilemma between access to European markets and maintaining the competitiveness of agricultural exports were confirmed by the work of scientists who substantiated the complexity of balancing ambitious environmental goals and the economic viability of agriculture. C. Boix-Fayos & J. de Vente found that achieving the goals of the "Farm to Fork" strategy required a radical change in production practices and significant investment, which correlated with Ukrainian estimates of potential losses from excessive regulatory burdens. The authors argued for the need for a differentiated approach to different agro-ecological zones and types of farming, which resonated with Ukrainian proposals to create a hybrid model with different requirements for domestic and export production. However, the authors focused mainly on the environmental aspects of the transformation, paying insufficient attention to financial mechanisms and their effectiveness in stimulating the necessary changes.

The role of digitalisation in achieving sustainable development goals, analysed by J. MacPherson *et al.* (2022), correlated with Ukrainian conclusions regarding the potential of precision farming to combine economic efficiency with environmental benefits. The results of the Ukrainian study on the possibility of reducing fertiliser use by 15-25% while maintaining crop yields confirmed the thesis that the integration of IoT sensors, GPS navigation and artificial intelligence could radically increase the resource efficiency of agricultural production. The authors identified a synergistic effect from combining digital technologies with agroecological approaches, which could reduce greenhouse gas emissions by 20-30%, consistent with Ukrainian estimates of the environmental potential of precision farming. At the same time, J. MacPherson *et al.* did not consider specific financial mechanisms to stimulate the adoption of digital technologies, while the Ukrainian study demonstrated the critical role

of state support through equipment cost compensation programmes and grant funding to ensure the accessibility of innovative solutions to a wide range of producers.

The importance of legumes in the transition toward sustainable agri-food systems, substantiated by H. Ferreira *et al.* (2021), further confirms Ukrainian conclusions regarding the importance of production diversification for improving environmental resilience. Ukrainian findings on the ecological potential of the "Orchard Grant" programme aimed at stimulating diversification of agricultural production find theoretical support in the work of H. Ferreira *et al.*, who demonstrated the role of legumes in preserving biodiversity and restoring soil fertility. The authors found that integrating legumes into crop rotations could reduce the need for synthetic fertilisers by 40-60% and increase carbon sequestration in the soil, which correlated with Ukrainian data on soil quality improvement in organic farms. H. Ferreira *et al.* argued for the need for policy support to encourage legume cultivation through financial incentives and educational programmes, which resonated with the Ukrainian experience of grant support for production diversification. However, the researchers focused mainly on agronomic aspects, without considering specific budgetary mechanisms and their effectiveness in stimulating the necessary changes in the structure of cultivated areas.

Thus, the study of budgetary mechanisms for stimulating the ecological modernisation of Ukraine's agricultural sector revealed the formation of a unique model that combined elements of international experience with adaptation to specific national conditions. A comparative analysis with the works of leading researchers confirmed the validity of Ukrainian approaches to integrating environmental criteria into financial programmes, while also revealing the need for further improvement in coordination between different levels of support and strengthening the targeting of budget expenditures to achieve specific environmental results.

CONCLUSIONS

The study shows that Ukraine is developing a comprehensive system of budgetary incentives for the ecological modernisation of the agricultural sector, characterised by significant structural transformations and adaptation to European standards in conditions of martial law. An analysis of existing budgetary instruments has revealed a multi-level support architecture with total funding of over UAH 24 billion in 2025, covering more than 300,000 beneficiaries through various mechanisms ranging from direct grants to tax incentives. At the same time, a fundamental imbalance has been identified between the volume of traditional subsidy programmes, which account for the bulk of funding, and targeted environmental initiatives with clear environmental criteria. A key trend in the development of the system has been the integration of environmental standards into financial programmes under the influence of international partners, which has been most evident in the introduction of mandatory environmental and social assessments as part of the preferential lending programme. This demonstrates an evolution from reactive support to proactive shaping of the investment climate, where access to financial resources becomes a tool for enforcing the greening of agribusiness. International support, despite its smaller absolute volumes compared to national programmes, is characterised by stricter environmental criteria and higher funding intensity per beneficiary, creating a synergistic effect with government initiatives.

The systematisation of European experience has revealed Ukraine's strategic dilemma between the need to adapt to the standards of the EU's Common Agricultural Policy and maintaining the competitiveness of agricultural exports on global markets. An analysis of the CAP architecture demonstrates a fundamental transformation of European agricultural policy from a mechanism for ensuring food security to an instrument for implementing climate ambitions, which creates additional challenges for Ukraine's integration into the European agricultural space. The specifics of the Ukrainian agricultural sector, with an average enterprise size of over 2,000 hectares, differ radically from the European model of family farms, requiring the development of hybrid approaches to environmental modernisation that take into account the large scale of Ukrainian agricultural production.

Potentially giving up CAP subsidies in exchange for relaxing the European Green Deal requirements could be a compromise that would let the industry keep its export potential while gradually adapting to environmental standards. The practical results of the implementation of precision farming, bioenergy and organic production technologies demonstrate the potential of combining economic efficiency with environmental benefits, showing the possibility of reducing resource use while maintaining productivity. However, scaling up these technologies requires coordinated state support through the creation of comprehensive financing and technical support programmes.

The main limitations to the effectiveness of the existing system are the fragmentation of environmental criteria in traditional support programmes, the difficulty of access to grant funding for small producers due to high co-financing requirements, and the lack of a comprehensive system for monitoring the environmental results of budget expenditures. To improve the effectiveness of budgetary mechanisms, it is necessary to develop a unified coordination platform that will ensure the synchronisation of national and international programmes, the introduction of digital technology-based environmental monitoring indicators, and the simplification of administrative procedures while maintaining control functions. The limitations of the study are related to the dynamic nature of transformation processes in a state of martial law and the lack of long-term data to assess the environmental effects of the programmes implemented. Prospects for further research include analysing the impact of digitalisation on the effectiveness of budgetary mechanisms, studying models for financing the transition to a circular economy in the agricultural sector, and developing a methodology for assessing ecosystem services as a basis for new budgetary incentive tools.

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Бюджетні механізми стимулювання екологічної модернізації аграрного бізнесу в Україні

Анотація. Метою даного дослідження було здійснення комплексного аналізу системи бюджетних інструментів стимулювання екологічної трансформації українського агросектору та розроблення науково обґрунтованих рекомендацій щодо оптимізації механізмів державного фінансування сталого розвитку аграрного виробництва. Методологічну основу склали принципи системності, об'єктивності та історизму, застосовувалися структурно-функціональний аналіз, порівняльний аналіз, контент-аналіз та аналіз вторинних даних для дослідження нормативно-правової бази, офіційних звітів та статистичних матеріалів за період 2024 – початку 2025 років. Встановлено формування багаторівневої системи бюджетного стимулювання з обсягом фінансування понад 24 млрд грн у 2025 році, що охоплює понад 300 тисяч бенефіціарів через механізми від прямих грантів до податкових стимулів, при цьому виявлено диспропорцію між традиційними субсидійними програмами, які становлять 70 % від загального обсягу, та цільовими екологічними ініціативами. Ключовою тенденцією стала інтеграція екологічних стандартів у фінансові програми під впливом міжнародних партнерів, що проявилося у впровадженні обов'язкової екологічної та соціальної оцінки в рамках програми пільгового кредитування, демонструючи еволюцію від реактивної підтримки до проактивного формування інвестиційного клімату. Систематизація європейського досвіду виявила стратегічну дилему України між адаптацією до стандартів Спільної аграрної політики Європейського Союзу та збереженням конкурентоспроможності агроекспорту, при цьому практичні результати впровадження технологій точного землеробства, біоенергетики та органічного виробництва засвідчили потенціал скорочення використання ресурсів на 15-25 % при збереженні продуктивності. Основними обмеженнями ефективності визначено фрагментарність екологічних критеріїв у традиційних програмах підтримки, складність доступу до грантового фінансування для малих виробників через високі вимоги до співфінансування та відсутність комплексної системи моніторингу екологічних результатів бюджетних витрат. Дослідження сформувало науково-методичну основу для удосконалення державної політики стимулювання екологічної модернізації агросектору через створення координаційних платформ, впровадження цифрових систем екологічного моніторингу та розроблення диференційованих підходів до фінансування різних категорій виробників

Ключові слова: державна підтримка; фінансові інструменти; грантові програми; субсидії; податкові пільги