

UDC 338.432:502.131

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<https://doi.org/10.25313/3083-7782-2026-5-80>

INVESTMENT SUPPORT FOR ECO-INNOVATIVE MEASURES AIMED AT ENHANCING THE COMPETITIVENESS OF AGRO-INDUSTRIAL ENTERPRISES

Summary. Introduction. Global ecological transformation requires agricultural enterprises to transition to sustainable development models in response to rising environmental risks and evolving ESG standards. The study is relevant given the need to develop new sources of investment support to implement environmental innovations as a key factor in competitiveness.

Purpose. The purpose of the article is to deepen the theoretical and methodological foundations for the formation of a system of investment support for environmentally innovative measures by agricultural enterprises to strengthen their market positions under conditions of sustainable development.

Materials and methods. The work uses methods of systemic and comparative analysis, theoretical generalization of concepts of innovative development ("Triple Helix" and "Porter's hypothesis"), and analytical reports from the OECD and FAO. Structural and functional modeling is used to develop the architectonics of integrated competitiveness.

Results. The formation of theoretical approaches to ecological development was studied, and the key areas of implementation of ecological innovations were systematized: the use of renewable energy sources (biogas plants, solar stations), energy-efficient technologies, digitalization of monitoring (IoT, GIS), biotechnological solutions, organic production, and precision farming systems. It was established that eco-innovations have a "double effect": ecological (emission reduction, soil restoration) and economic (cost optimization, value growth, increased investment attractiveness). The concept of integrated eco-innovation competitiveness was developed, based on the synergy among investment and financial (sources of capital), eco-innovation (technological renewal), and competitive and market (export potential, brand) components. It was determined that an effective investment support system should integrate "green" financing tools, ESG investments, grant resources, and public-private partnership mechanisms to achieve the goals of ecological modernization.

Further research in this area. The implementation of the proposed approaches will ensure the agricultural sector's adaptation to global challenges and strengthen market positions by introducing closed production cycles. Further research will focus on developing applied tools to assess enterprises' ESG maturity to access international financial resources.

Key words: innovation, eco-innovation, innovative development, investment support, enterprise competitiveness, agricultural enterprises, industrial enterprises.

Problem statement. The current state of the agro-industrial sector is characterized by systemic transformations driven by global economic, environmental, and technological challenges. The deepening instability in world agricultural markets, the increasing volatility of food and energy prices, and the worsening of climate change are creating new conditions



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for the operation of agro-industrial enterprises, which are increasingly dependent on environmental factors and the efficient use of natural resource potential. The degradation of natural resources is manifested in soil depletion, reduced fertility, water pollution, reduced biodiversity, and increased carbon burden on agroecosystems. Taken together, these processes not only worsen the ecological state of agricultural production but also directly limit its long-term productivity and competitiveness.

At the same time, the current state of global economic integration and the expansion of international value chains pose new requirements for agro-industrial enterprises regarding product environmental safety, traceability of production processes, compliance with sustainable development standards, and implementation of ESG principles. This necessitates a transition to an innovative and ecological model of development that is based on resource-saving, decarbonization of production, and digital transformation of the agricultural sector. Therefore, the problems of developing effective investment support for environmental and innovation measures are highly relevant, since implementing environmental modernization requires significant financial resources, institutional support, and long-term investment strategies. Insufficient investment support for environmental innovations limits enterprises' opportunities for technological renewal, slows adaptation to global challenges, and hinders the formation of their competitive advantages.

Analysis of recent research and publications. Modern global transformations in the economic environment that determine the conditions for the functioning of the agricultural sector are examined in the works of Batiuk L. A., Reznytska T. O. [1], Tolstova A. V. [2], and Fedorov E. V. [3]. In these studies, attention is focused on the role of environmental and innovation factors in increasingly determining the economic sustainability of enterprises.

The theoretical foundations of innovative development are laid down in the classic works of J. Schumpeter [4], who substantiated the concept of “creative destruction” as a driving force of economic progress. Further development of innovation theory is presented in the works of K. Freeman and L. Soete [5, 6], in which an approach to national innovation systems is developed. Of great importance to the formation of a modern understanding of the innovation ecosystem are the works of G. Etskowitz and L. Leidesdorf [7–9], who developed the concept of the “triple helix,” which posits that the interaction among the state, business, and science is a key driver of innovation.

The conceptual foundations of the relationship between environmental requirements and competitiveness of enterprises are revealed in the works of M. Porter [10], who substantiated the “Porter hypothesis”, according to which environmental regulation stimulates innovative activity and increases the efficiency of resource use. The development of this idea was further empirically confirmed in the studies of S. Rousselier and co-authors [11].

The financial and investment aspect of environmental innovations is considered in the works of S. Scarpellini, J. Valero-Gila and P. Portillo [13], who focus on the need to integrate financial and innovation mechanisms in the process of implementing environmental projects. In the work of S. Nosratobadi and co-authors [14], environmental innovations are considered as a component of sustainable business models that combine economic, environmental, and social goals.

Domestic scientists are also actively addressing the challenges of environmental innovation in the agricultural sector. M. Bahorka and Y. Yakubenko [16] investigated the mechanisms of introducing environmentally oriented innovations into the activities of agricultural enterprises. Gubanya Y. E., Zelisko N. B., and Reiter N. I. [17] focus on the role of ESG strategies in strengthening the economic potential of agricultural enterprises. The works of Chaikina A. and Musienko Y. [18] analyze the problems and prospects of introducing environmental innovations in agriculture. The works of V. Vovk [19] and I. Shostak [20] are devoted to the study of the ESG concept for the introduction of innovative technologies and ensuring the sustainable development of agricultural enterprises.

Despite recent scientific developments, the issue of investment support for environmentally innovative measures to enhance the competitiveness of agro-industrial enterprises requires further study and development.

The purpose of the study is to deepen the theoretical and methodological foundations for developing a system of investment support for environmental and innovation measures for agro-industrial enterprises, aimed at increasing their competitiveness in the context of sustainable development and the global ecological transformation of the economy.

To achieve this goal, the study outlines the following tasks:

- to analyze the formation of approaches to innovative and ecologically oriented development of economic systems;
- to investigate the impact of environmental policy and the ESG paradigm on the investment attractiveness of agro-industrial enterprises;
- to determine the essence and structural characteristics of investment support for environmental and innovative development;
- to substantiate the concept of integrated eco-innovative competitiveness of enterprises and its structural and functional model.

Materials and methods. The materials of the study are the fundamental provisions of classical and modern economic theory, in particular the concept of “creative destruction” by J. Schumpeter, which defines innovation as the driving force of economic dynamics, and the theory of national innovation systems by K. Freeman and L. Sauté. The theoretical basis is expanded by the concept of the “triple helix” by G. Itzkowitz and L. Leidesdorf, which substantiates the synergy among the state, business, and science, as well as the “Porter hypothesis”, which demonstrates the positive impact of environmental regulation in stimulating technological renewal and resource efficiency. An important source was the results of empirical research by domestic and foreign scientists in the fields of green financing, ESG-investing, circular economy, and ecological modernization of the agricultural sector, as well as analytical reports and methodological recommendations of international organizations, in particular OECD and FAO, on assessing the economic impact of environmental policy and implementing the principles of sustainable development in agricultural production.

During the research, a set of scientific methods was used, in particular, theoretical generalization, classification, and grouping, to systematize key areas of environmental innovation (energy efficiency, biotechnology, precision agriculture, and organic production) and to assess their impact on enterprises’ economic results. Methods of formalization, analysis, and synthesis were used to clarify the essence of the category of investment support for environmental innovation activities as an integral system of formation and distribution of resources to achieve an integrated environmental and economic effect. A special place is occupied by the method of structural and functional modelling, which was used to develop the architectonics of the concept of integrated eco-innovative competitiveness of an agro-industrial enterprise. This method allowed us to visualize and substantiate the relationship between the investment and financial, environmental innovation and competitive and market components as strategic vectors of adaptation of agricultural business to the conditions of global environmental transformation.

Presentation of the main material of the research. Modern agro-industrial enterprises operate in the conditions of transformation of the global economic environment. Modern scientific studies [1–3] characterize it by high uncertainty, instability in agricultural market conditions, exacerbation of food and environmental problems, increased competition, and increased requirements for the environmental safety of production.

A feature of the agro-industrial sector’s functioning is its significant dependence on natural resource potential, climatic conditions, energy resources, and environmental conditions. In this regard, the impact of environmental risks is increasing, including soil degradation, depletion of water resources, loss of biodiversity, increased carbon emissions, and intensified negative effects of climate change. At the same time, international integration processes and the expansion of global value chains impose new requirements on agro-industrial enterprises to meet international standards for quality, environmental friendliness, product traceability, and adherence to the principles of sustainable development [2].

In modern conditions, the competitiveness of agro-industrial enterprises is increasingly determined not only by production volumes or financial results, but also by the ability of business entities to adapt to environmental challenges, introduce resource-saving technologies, ensure the environmental safety of production, and integrate innovative solutions into the strategic management system. That is why environmentally oriented innovations are becoming a key factor in the formation of long-term competitive advantages for agro-industrial enterprises. Their implementation enables optimization of resource use, minimization of environmental losses, increased energy efficiency, reduced production costs, and strengthened market position in domestic and foreign markets.

Investment support for ecological and innovative development is particularly important in modern conditions, as implementing environmental modernization requires significant financial resources, long-term planning, and a comprehensive transformation of production processes. Investment support is not only a source of financing for environmental measures but also a strategic tool for developing the enterprise’s innovative potential, ensuring its adaptability and increasing resilience to external challenges. In this context, the mechanisms for attracting ESG investments, green financing, international grant programs, environmental lending, and public-private partnerships are particularly important.

So, let’s study the formation of the doctrine of innovative development and its ecological orientation at different stages of the development of economic systems.

The theoretical foundations for innovative development were laid by the outstanding Austrian economist J. Schumpeter [4], who regarded innovation as a key driver of economic dynamics and a driving force in the development of a competitive environment. Within the framework of his concept, the scientist defined innovation as a process of “creative destruction”, the essence of which is the constant renewal of economic systems through the introduction of new technologies, organizational forms, market approaches, and management decisions. The scientist emphasized that economic development occurs not through the simple accumulation of resources, but through structural transformations provided by the innovative activity of enterprises.

Further development of the theory of the innovation economy was reflected in the work of K. Framan [5], who formulated the concept of national innovation systems. In his research [5, 6], the scientist emphasized that

the effectiveness of innovation development is determined not only by the activities of individual enterprises but also by the level of interaction among science, the state, financial institutions, and business.

An equally significant contribution to the development of innovation theory was made by G. Etzkowitz and L. Leidesdorf [7–9], who substantiated the concept of the “Triple Helix”. According to this approach, innovative development arises from the integrated interaction among three key institutions: the state, business, and science. It is this synergy that creates conditions for the generation of new knowledge, technological renewal, and the formation of an innovative economy.

Of great theoretical and methodological importance for the study of the relationship between environmental policy and enterprise competitiveness is the concept of M. Porter, known in scientific circles as “Porter’s hypothesis” [10]. The main idea of this concept is that strict environmental standards and regulatory mechanisms do not limit the economic development of enterprises; rather, they stimulate innovation, modernize production, and improve resource efficiency. According to this hypothesis, environmental constraints encourage enterprises to seek new technological solutions, thereby enabling them to reduce costs, increase productivity, and gain additional competitive advantages [11].

Research by the international organization OECD [12] also confirms that an effective environmental policy can stimulate technological renewal in enterprises and positively affect their productivity, especially at high levels of innovation potential. OECD documents [12] consistently emphasize that environmental regulation contributes to the intensification of investments in clean technologies, the development of circular business models, the reduction of emissions, and the increase in resource efficiency in production. In modern conditions, environmental modernization is increasingly considered not an additional burden on business but a strategic tool for ensuring long-term competitiveness.

Foreign scientists Scarpellini S., Valero-Gil J., and Portillo P. [13] considered environmental innovation as a complex integrated system of technological, organizational, managerial, financial, and social decisions aimed at achieving a balance between economic efficiency and environmental safety. The concept focuses on the need to transform traditional production models toward resource-saving, decarbonization, waste minimization, and the adoption of circular economy principles. Environmental innovations cover a wide range of activities: the use of renewable energy sources, the introduction of energy-efficient technologies, the digitalization of environmental monitoring, biotechnological solutions, organic production, precision farming systems, and environmentally oriented logistics processes (Table 1).

Table 1

Key Areas of Environmental Innovations of Agro-Industrial Enterprises

Direction of environmental innovations	Characteristics of events	Economic effect	Environmental effect
Use of renewable energy sources	Implementation of solar power plants, biogas plants, wind energy, and use of agricultural biomass	Reducing energy costs, increasing energy independence, and reducing fuel costs	Reducing CO ₂ emissions and reducing the use of fossil fuels
Implementation of energy-efficient technologies	Equipment Modernization, Production Automation, Energy-Saving Lighting, and Heat Supply Systems	Optimization of production costs, increase productivity	Reduction of energy consumption and environmental burden
Digitalization of environmental monitoring	Use of IoT technologies, GIS systems, and sensor monitoring of soils, water, and atmospheric air	Reduction of costs for resource control and efficiency of management decisions	Improving environmental control and pollution prevention
Biotechnology solutions	Use of biofertilizers, biological products, biological plant protection products, and biotechnologies for waste processing	Reducing the cost of chemicals, increasing yields	Reducing the chemical burden on ecosystems
Organic production	Production of environmentally friendly products without the use of synthetic fertilizers and pesticides	Growth of the added value of products, expansion of export opportunities	Restoration of soil fertility and conservation of biodiversity
Precision Farming Systems	Use of GPS navigation, drones, automated fertilization, and protective equipment	Increase in yield and resource efficiency	Minimization of resource overruns and environmental pollution
Ecologically oriented logistics processes	Optimization of transport routes, use of ecological transport, and ecological packaging	Reduction of logistics costs, increase in supply efficiency	Reducing emissions and the negative impact of transport

Source: systematized by [13]

Also, in modern scientific literature [14], special attention is paid to the so-called “double effect” of environmental innovations. On the one hand, they provide a positive environmental outcome by reducing negative impacts, lowering emissions and resource intensity, and improving the environmental safety of production.

On the other hand, environmental innovations have economic effects, including reduced production costs, increased labor productivity, optimized logistics processes, increased investment attractiveness of the enterprise, and strengthened market reputation. As a result, environmental innovations have become an important factor in shaping the strategic competitiveness of agro-industrial enterprises.

The modern ESG paradigm no longer considers only the economic effects of innovation but also examines financial aspects. Investment support for environmental and innovative measures is an integral part of the enterprise’s strategic management and a key tool for ensuring sustainable development. Currently, an enterprise’s ESG maturity level increasingly affects its investment attractiveness, access to international financial resources, and ability to integrate into global markets.

An OECD study [15] showed that integrating ESG criteria into the financing system can reduce investment risk, ensure stable financial flow, increase investor confidence, and create prerequisites for the enterprise’s long-term economic sustainability. In this regard, environmentally oriented investments are becoming a key tool for modernizing the agro-industrial sector, developing its innovation potential, and increasing competitiveness amid the global transformation of the economy.

Domestic scientists are also actively researching issues related to the environmental modernization of the agricultural sector. In the works of Ukrainian researchers [16–20], it is determined that the introduction of environmental innovations in agricultural production increases the efficiency of natural resource use, reduces the environmental burden, and creates new competitive positions for enterprises in international markets. The introduction of organic production [16], digitalization of environmental monitoring [17], the use of alternative energy [16–18], circular business models [17, 18], and ESG strategies [19, 20] have been studied.

Having studied the theoretical and methodological provisions presented in the works of leading researchers, we consider it expedient to refine the existing understanding of the category “investment support of environmental and innovative measures of agro-industrial enterprises” in the literature. It is proposed to understand this concept as a system for the formation, attraction, distribution, and use of financial resources to implement environmental innovations that increase the enterprise’s competitiveness by integrating economic, environmental, and social effects.

We also propose an approach to the study of investment support for the ecological and innovative development of agro-industrial enterprises, which, in comparison with the existing ones, is based on the concept of

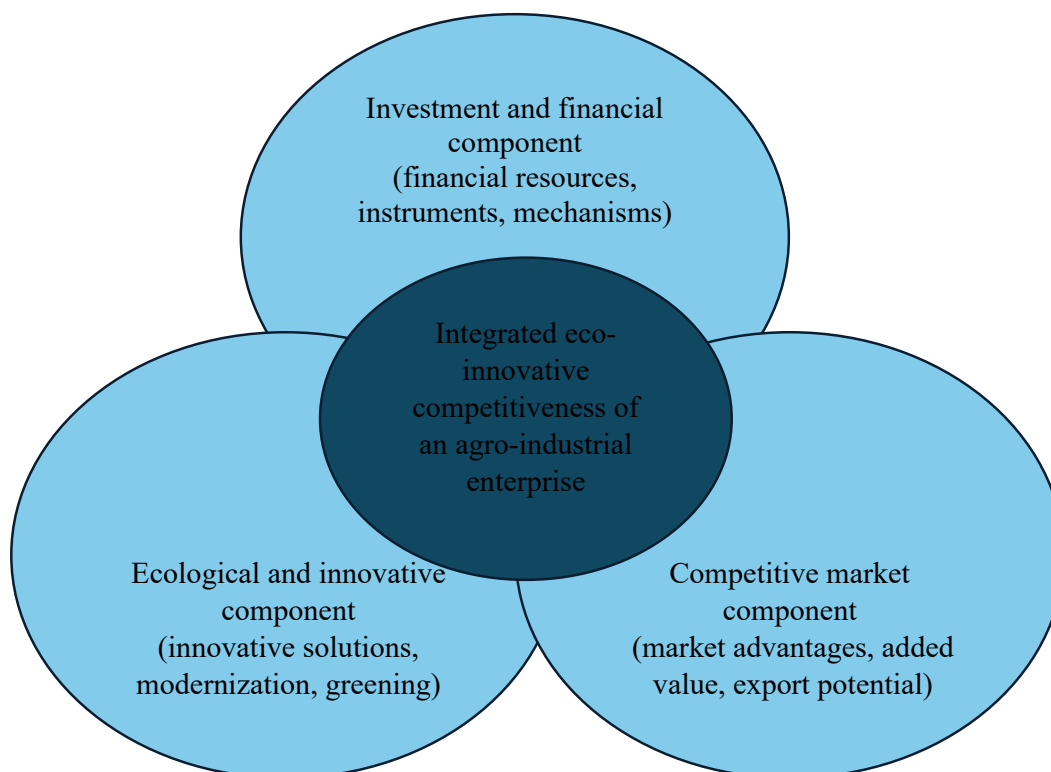


Fig. 1. Architectonics of the concept of integrated eco-innovative competitiveness of an agro-industrial enterprise
Source: author’s development

integrated eco-innovative competitiveness, which is considered as a systemic category that reflects the ability of an enterprise to provide long-term competitive advantages based on a harmonious combination of economic, environmental, and innovative components of development. Within this framework, competitiveness is understood not only as a function of market interactions but also of the level of investment support for environmental modernization and of the enterprise's ability to generate, implement, and commercialize environmental innovations.

Structurally, the concept of integrated eco-innovative competitiveness is based on the interaction of three interrelated and interdependent components: investment-financial, environmental-innovative, and competitive-market (Fig. 1).

The investment and financial component reflects the totality of sources of financial resource formation, tools for their attraction, and mechanisms for their effective distribution to implement environmental and innovative projects. It determines an enterprise's financial capacity to carry out environmental transformation, its access to capital, investment attractiveness, and its ability to integrate into modern global financial markets, including ESG-oriented investment flows.

The ecological-innovative component reflects the technological and organizational dimensions of enterprise development that enable the introduction of innovative solutions to minimize negative environmental impacts, increase resource efficiency, reduce the energy and material intensity of production, and establish closed cycles of resource use. This component covers a wide range of environmental modernization tools, including the digitalization of production processes, the use of renewable energy sources, the introduction of biotechnology, the development of precision agriculture, and environmentally oriented production and logistics systems.

The competitive and market component characterizes the ability of an agro-industrial enterprise to transform the results of investment and innovation activities into sustainable market advantages, to ensure the growth of added value of products, the expansion of sales markets, the increase of export potential, and the strengthening of brand position at the domestic and international levels. It reflects the degree of the enterprise's integration into global value chains and its ability to meet the modern requirements of sustainable development and environmental responsibility.

Thus, properly designed investment support for environmental and innovation measures is key to increasing the competitiveness of agro-industrial enterprises. The formation of a modern green investment system should be based on the integration of ESG approaches, digital technologies, circular-economy principles, and innovative management. This model can ensure the agricultural sector's adaptation to global challenges, increase its investment attractiveness, and achieve sustainable development goals.

Conclusions. In modern conditions, agro-industrial enterprises operate in a complex, multidimensional environment characterized by high resource dependence, growing environmental risks, and increased requirements for sustainable development. This necessitates a transition to a new model of development, in which environmental innovations are a key tool for increasing production efficiency and forming long-term competitive advantages.

Investment support of environmental and innovative measures is a system-forming element of environmental modernization of agro-industrial enterprises, as it determines their ability to implement technological, organizational, and managerial innovations. In this context, ESG investments, green finance instruments, public-private partnership mechanisms, and international grant programs are particularly important.

The proposed concept of integrated eco-innovative competitiveness allows us to consider enterprise development as the result of the interaction among investment-financial, ecological-innovative, and competitive-market components. It provides a comprehensive view of the processes for developing competitive advantages through environmental modernization and innovation.

The developed structural and functional model of investment support for the environmental and innovative development of the agro-industrial enterprise systematizes tools, mechanisms, and resources for implementing environmental innovations, ensuring their consistency with the enterprise's strategic goals. The implementation of the proposed approach will increase the investment attractiveness of agro-industrial enterprises, strengthen their market positions, expand export potential, and ensure long-term economic, environmental, and social sustainability.

ДОДАТКОВА ІНФОРМАЦІЯ

ВНЕСОК АВТОРІВ: Усі автори зробили внесок порівну.

ФІНАНСУВАННЯ: Автори не отримували фінансування для цього дослідження.

ЗАЯВА ПРО ДОСТУПНІСТЬ ДАНИХ: Не застосовується.

КОНФЛІКТ ІНТЕРЕСІВ: Автори заявляють про відсутність конфлікту інтересів.

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Дата першого надходження статті до видання: 27.04.2026

Дата прийняття статті до друку після рецензування: 24.05.2026

Дата публікації: 31.05.2026

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ІНВЕСТИЦІЙНЕ ЗАБЕЗПЕЧЕННЯ ЕКОЛОГІЧНО-ІННОВАЦІЙНИХ ЗАХОДІВ НАПРАВЛЕНИХ НА ПІДВИЩЕННЯ КОНКУРЕНТОСПРОМОЖНОСТІ АГРОПРОМИСЛОВИХ ПІДПРИЄМСТВ

Анотація. Вступ. Глобальна екологічна трансформація вимагає від агропідприємств переходу до сталих моделей розвитку через посилення екологічних ризиків і вимог ESG-стандартів. Актуальність дослідження зумовлена необхідністю формування нових джерел інвестиційного забезпечення для впровадження екологічних інновацій як ключового чинника конкурентоспроможності.

Мета. Метою статті є поглиблення теоретико-методологічних засад формування системи інвестиційного забезпечення екологічно-інноваційних заходів агропідприємств для зміцнення їхніх позицій на ринку в умовах сталого розвитку.

Матеріали і методи. У роботі використано методи системного та порівняльного аналізу, теоретичного узагальнення концепцій інноваційного розвитку («Triple Helix», «гіпотеза Портера») та аналітичних звітів OECD і FAO. Структурно-функціональне моделювання застосовано для розробки архітектури інтегрованої конкурентоспроможності.

Результати. Досліджено становлення теоретичних підходів до екологічного розвитку та систематизовано ключові напрями впровадження екологічних інновацій: використання відновлюваних джерел енергії (біогазові установки, сонячні станції), енергоефективні технології, цифровізацію моніторингу (IoT, GIS), біотехнологічні рішення, органічне виробництво та системи точного землеробства. Обґрунтовано, що екоінновації мають «подвійний ефект»: екологічний (зниження викидів, відновлення ґрунтів) та економічний (оптимізація витрат, зростання годаної вартості, підвищення інвестиційної привабливості). Розроблено концепцію інтегрованої еко-інноваційної конкурентоспроможності, що базується на синергії інвестиційно-фінансової (джерела капіталу), екологічно-інноваційної (технологічне оновлення) та конкурентно-ринкової (експортний потенціал, бренд) складових. Визначено, що ефективна система інвестиційного забезпечення має інтегрувати інструменти «зеленого» фінансування, ESG-інвестиції, грантові ресурси та механізми державно-приватного партнерства для досягнення цілей екологічної модернізації.

Перспективи. Реалізація запропонованих підходів забезпечить адаптацію аграрного сектору до глобальних викликів і зміцнення його ринкових позицій завдяки впровадженню замкнених виробничих циклів. Подальші дослідження будуть спрямовані на розробку прикладного інструментарію для оцінки ESG-зрілості підприємств з метою доступу до міжнародних фінансових ресурсів.

Ключові слова: інновації, екологічні інновації, інноваційний розвиток, інвестиційне забезпечення, конкурентоспроможність підприємств, аграрні підприємства, промислові підприємства.