

DIAGNOSIS OF THE STATE OF INNOVATION SUPPORT FOR THE SUSTAINABLE DEVELOPMENT OF THE AGRICULTURAL SECTOR

Inna Tomashuk¹, Kateryna Mazur², Olha Alieksieieva³

Abstract. The *purpose* of the study is to carry out a comprehensive diagnosis of the state of innovation support for the sustainable development of the agricultural sector in order to identify its level of formation, key trends, problematic aspects and constraining factors, as well as to substantiate directions for improving innovation development mechanisms in the context of ensuring economic efficiency, environmental balance and social resilience of the agricultural sphere. *Methodology.* The methodological framework of the study is based on a combination of general scientific and specialised research methods. Analysis and synthesis were employed for the conceptual examination of innovation support and sustainable development of the agricultural sector. The formation of theoretical propositions, conclusions and recommendations was carried out using the abstract-logical approach. The systems analysis method enabled the consideration of innovation support in the agricultural sector as a complex socio-economic system. The dynamics of innovation activity and the volume of financing for research and development were assessed using economic and statistical as well as index-based methods. SWOT and PEST analyses were applied to identify internal and external influencing factors. The generalisation and presentation of the research results were ensured through the use of graphical and tabular methods. *Results.* The results indicate that innovation support for the sustainable development of the agricultural sector in Ukraine has significant but insufficiently realised potential. It is revealed that the efficiency of agricultural production increases with the implementation of technological, digital and organisational innovations, the development of cooperation between enterprises, and the integration of science, education and business. Important factors include adaptation to climate change, the development of organic production, and the introduction of resource-saving technologies. At the same time, the agricultural sector faces problems of insufficient innovation financing, limited institutional support, a low level of innovation activity among enterprises, and regional development imbalances. Prospects for improvement include the development of public-private partnerships, modernisation of the technological base, improvement of infrastructure, support for organic production, and enhancement of product competitiveness in domestic and international markets. *Practical implications.* Diagnosing the state of innovation support for the sustainable development of the agricultural sector contributes to the formulation of well-grounded managerial decisions regarding the development of innovation activity at national and regional levels. Identifying the strengths and weaknesses of the innovation system enables the targeted implementation of technological and digital innovations, increasing agricultural productivity and resource-use efficiency. An increase in the competitiveness of agricultural enterprises in domestic and foreign markets is expected due to the greening of production, improved product quality and compliance with international standards. An important practical outcome is also the strengthening of state support for innovation, the development of innovation infrastructure, and the creation of favourable conditions for the implementation of green and digital solutions in the agricultural sector. *Value/originality.* The study provides a comprehensive understanding of the state and development trends of innovation

¹ Vinnytsia National Agrarian University, Ukraine (*corresponding author*)

E-mail: Tomashuk.inna@ukr.net

ORCID: <https://orcid.org/0000-0001-6847-3136>

ResearcherID: I-5387-2018

² Vinnytsia National Agrarian University, Ukraine

E-mail: kv_mazur@ukr.net

ORCID: <https://orcid.org/0000-0002-1137-3422>

ResearcherID: L-5795-2018

³ Vinnytsia National Agrarian University, Ukraine

E-mail: olga_alieksieieva@ukr.net

ORCID: <https://orcid.org/0000-0003-4430-624X>

ResearcherID: IZQ-0833-2023



This is an Open Access article, distributed under the terms
of the Creative Commons Attribution CC BY 4.0

support in the agricultural sector under conditions of environmental and socio-economic transformations, which is essential for shaping evidence-based national and regional agricultural policies. It emphasises the role of technological and digital innovations, human capital development, and interaction between science, education and agribusiness, creating prerequisites for enhancing production efficiency, environmental safety and the long-term competitiveness of the agricultural sector.

Keywords: innovation support, sustainable development, agricultural sector, diagnostics, innovation potential, agricultural innovations, environmental balance, digitalisation of agriculture, institutional environment, state support.

JEL Classification: Q16, O31, O13, Q01

1. Introduction

The current stage of development of the agricultural sector is characterised by the intensification of global and national challenges caused by climate change, degradation of natural resources, growing food demand, instability of the economic environment, and the need to adapt to European and global sustainable development standards. Under these conditions, the agricultural sector acts not only as a key component of national economic security, but also as an important factor in ensuring environmental balance and social stability in rural areas. Addressing these challenges largely depends on the level of innovation support for the sustainable development of the agricultural sector.

Innovations in the agricultural sector encompass the implementation of modern production technologies, digital solutions, resource-saving and environmentally friendly practices, new organisational and managerial models, and institutional mechanisms. At the same time, the effectiveness of innovation-driven development is determined not only by the availability of individual innovative solutions, but also by the coherence of innovation support elements, the degree of their integration into production processes, and their compliance with the principles of sustainable development. In this regard, the need for a comprehensive diagnosis of the state of innovation support for the sustainable development of the agricultural sector becomes particularly relevant.

Despite a substantial body of scientific research devoted to innovation development in agriculture, issues related to the systemic assessment of the state of innovation support specifically in the context of sustainable development remain insufficiently explored. Most existing approaches focus on individual aspects of innovation activity – technological, economic or environmental – which complicates the formation of a holistic view of the actual level of innovation capacity of the agricultural sector and its readiness for sustainable transformations.

In this context, diagnosing the state of innovation support for the sustainable development of the agricultural sector is a necessary scientific and practical tool for identifying strengths and weaknesses in

innovation development, determining imbalances between economic, environmental and social components, and substantiating priority directions for improving state policy and institutional mechanisms of innovation support. The results of such diagnostics provide a foundation for developing effective managerial decisions aimed at enhancing the competitiveness of agricultural production, reducing environmental pressure, and ensuring the long-term sustainability of agricultural sector development.

The purpose of the article is to conduct a comprehensive diagnosis of the state of innovation support for the sustainable development of the agricultural sector in order to identify its level of formation, key trends, problematic aspects and constraining factors, as well as to substantiate directions for improving innovation development mechanisms in the context of ensuring economic efficiency, environmental balance and social resilience of the agricultural sphere.

To achieve this objective, the article addresses the following research tasks: analysing theoretical approaches to the interpretation of the essence of innovation support for the sustainable development of the agricultural sector; determining the role and place of innovations in ensuring economic efficiency, environmental balance and social resilience of the agricultural sphere; forming a system of criteria and indicators for diagnosing innovation development of the agricultural sector in the context of sustainable development; assessing the current state of innovation support for the sustainable development of the agricultural sector based on integral, economic, environmental and social indicators; identifying key problems, imbalances and constraining factors of innovation development in agriculture; conducting SWOT and PEST analyses of innovation support for the sustainable development of the agricultural sector; and substantiating priority directions for improving innovation support for the sustainable development of the agricultural sector, taking into account the roles of the state, science, education and agribusiness.

The study employs a set of general scientific and specialised methods, including: analysis and synthesis—to generalise scientific approaches to innovation

support and sustainable development of the agricultural sector; the abstract-logical method – to formulate theoretical generalisations, conclusions and recommendations; systems analysis – to examine innovation support of the agricultural sector as an integrated socio-economic system; economic and statistical methods – to assess the dynamics of innovation activity and expenditure on research and development; the index method – to calculate integral indicators of innovation development; SWOT analysis – to identify strengths, weaknesses, opportunities and threats of innovation support for sustainable development; PEST analysis – to assess the impact of political, economic, social and technological factors on innovation development in agriculture; and graphical and tabular methods – to clearly present the research results.

This study addresses the problem of insufficient effectiveness and systemic coherence of innovation support for the sustainable development of the agricultural sector amid intensifying economic, environmental and social challenges. Despite the availability of significant natural resource and scientific potential, innovation development in agriculture is characterised by fragmentation, a low level of innovation activity, limited financing, and weak integration of scientific developments into agricultural practice. This constrains the enhancement of the agricultural sector's competitiveness, slows down the greening of production processes, and complicates the achievement of sustainable development goals. Consequently, there is an increasing need for a comprehensive diagnosis of the current state of innovation support in the agricultural sector and for substantiating effective directions for its improvement, taking into account the interaction between the state, science, education and agribusiness.

2. The Essence and Role of Innovations in Ensuring the Sustainable Development of the Agricultural Sector

Innovations are a key factor in ensuring the sustainable development of the agricultural sector amid intensifying global economic, environmental and social challenges. Their essence lies in the introduction of new or improved technologies, products, organisational solutions and management approaches that enhance resource efficiency, increase labour productivity and minimise the negative environmental impact of agricultural production. In contemporary conditions, innovations are regarded not only as a tool for economic growth but also as a comprehensive mechanism for achieving a balance between economic performance, environmental security and social responsibility.

The sustainable development of the agricultural sector is intrinsically linked to the Sustainable Development Goals, which envisage meeting current food needs

without compromising the ability of future generations to meet their own needs. This necessitates a transition from extensive to innovation-oriented models of agricultural management (Chikov, Radko, Marshalok, Tepluk, Petrenko, Sharko, Sitkovska, 2022). In this context, innovations play a system-forming role by ensuring the rational use of land, water and biological resources, enhancing the adaptability of agricultural production to climate change, and facilitating the adoption of environmentally safe technologies. Table 1 presents a list of the United Nations Sustainable Development Goals, which reflects the key priorities of global development.

Technological and digital innovations play a crucial role in ensuring the sustainable development of the agricultural sector, in particular precision farming, biotechnologies, automation of production processes, the use of information and communication technologies, and monitoring systems. They contribute to the optimisation of production costs, improvement of the quality of agricultural products, and reduction of environmental pressure on natural ecosystems. At the same time, organisational and institutional innovations support the improvement of agricultural enterprise management, the development of cooperation, the integration of science, education and business, and the formation of a favourable innovation environment. Table 2 illustrates the types of innovations in the agricultural sector, showing how technological, digital, organisational, social and other innovations contribute to increased productivity, efficiency, and environmental and social sustainability.

The role of innovations in the sustainable development of the agricultural sector is also manifested in the social dimension, in particular through the creation of new jobs, an increase in employment levels in rural areas, the development of human capital, and improvements in the quality of life of the rural population. Innovations act not only as a tool for modernising agricultural production, but also as an important factor in ensuring social stability and food security.

3. Criteria and Indicators for Diagnosing the Innovative Development of the Agricultural Sector

The diagnosis of innovative development in the agricultural sector is based on a system of criteria and indicators that make it possible to comprehensively assess the level of innovation support for sustainable development and to identify key problems and reserves for its enhancement. The diagnostic criteria reflect the qualitative characteristics of innovation processes, while the indicators ensure their quantitative measurement and comparability over time and across space (Table 3).

Table 1

Sustainable Development Goals

№	Name of the sustainable development goal	Brief description
1	Poverty Alleviation	Eradicate poverty in all its forms and manifestations.
2	Hunger Alleviation	Ensure food security, improve nutrition and promote sustainable agriculture.
3	Good Health and Well-being	Ensuring healthy lifestyles and well-being for all.
4	Quality Education	Ensuring inclusive and equitable quality education.
5	Gender Equality	Ensuring gender equality and women's empowerment.
6	Clean Water and Sanitation	Ensuring access to water and sustainable water resources management.
7	Affordable and clean energy	Ensuring access to reliable, sustainable and modern energy.
8	Decent work and economic growth	Promoting sustainable economic growth and productive employment.
9	Industry, innovation and infrastructure	Developing sustainable infrastructure and stimulating innovation.
10	Reducing inequality	Reducing inequalities within and between countries.
11	Sustainable cities and communities	Ensuring sustainable development of human settlements.
12	Responsible consumption and production	Ensuring rational patterns of production and consumption.
13	Tackling climate change	Taking measures to mitigate the effects of climate change.
14	Conserving marine ecosystems	Protect and sustainably use marine resources.
15	Protecting terrestrial ecosystems	Conserve terrestrial ecosystems and biodiversity.
16	Peace, Justice and Strong Institutions	Promote effective and accountable institutions.
17	Partnership for Sustainable Development	Strengthen global partnerships to achieve the SDGs.

Source: (<https://globalcompact.org.ua/tsili-stijkogo-rozvytku/>)

Table 2

Types of innovations in ensuring sustainable development of the agricultural sector

Type of innovation	Content and characteristics	Impact on sustainable development of the agricultural sector
Technological Innovation	Introduction of modern agricultural technologies, precision agriculture, biotechnology, resource-saving technologies	Increasing productivity, reducing resource consumption, reducing negative environmental impact
Digital Innovation	Use of digital platforms, Big Data, GPS navigation, drones, agro-IT solutions	Optimizing production management, increasing transparency and efficiency of decision-making
Environmental Innovation	Organic production, environmentally friendly technologies, soil restoration, emission reduction	Ensuring ecological balance, preserving natural resources
Product Innovation	Creation of new types of agricultural products with high added value, eco-products	Increasing competitiveness and meeting growing consumer demand
Process Innovation	Improvement of production and logistics processes, automation and robotization	Increasing production efficiency and reducing losses
Organizational Innovation	New forms of cooperation, cluster models, agricultural startups	Strengthening the integration of agricultural market participants, developing partnerships
Institutional Innovation	Improvement of the regulatory environment, state support programs, incentive mechanisms	Creating favorable conditions for innovative development
Social Innovation	Development of human capital, education, increasing employment in rural areas	Social sustainability, improving the quality of life of the rural population
Financial Innovation	Green financing, agricultural insurance, innovative credit and investment instruments	Providing access to financial resources for innovation

Source: (Sakhno, Polishchuk, Salkova, Kucher, 2019)

The diagnosis of innovative development in the agricultural sector is logically complemented by an assessment of innovation potential, as it makes it possible not only to identify the current state and problematic aspects of development, but also to determine the available resources and opportunities for further innovative transformation of the sector. The assessment of innovation potential is carried out using indicators of human resources for research activities, the level of funding for innovation, the availability of research and

production infrastructure, and access to investment resources. Innovation activity is characterised by the share of agricultural enterprises implementing innovations, the volume of expenditure on research and development, and the number of technological, organisational and digital solutions introduced.

Figure 1 illustrates the dynamics of expenditure on research and development in Ukraine over the period 2010-2024. The data indicate a gradual increase in funding during this period, with a particularly notable

Table 3

Criteria for innovative development of the agricultural sector in the context of sustainable development

Criterion	Content description	Key evaluation indicators	Dimension of sustainable development
Innovation potential	Reflects the existing capabilities of the agricultural sector to create and adopt innovations, determined by the resource, scientific and technological and human resources base	R&D funding; human resources; material and technical base; availability of scientific institutions	Economic, social
Innovative activity	Characterizes the intensity of the introduction of innovations into the production and management activities of agricultural enterprises	Share of enterprises implementing innovations; number of innovation projects; volume of innovation investments	Economic
Effectiveness of innovation activity	Reflects the economic, social and environmental effects of the introduction of innovations	Increase in productivity; decrease in costs; increase in competitiveness; environmental impact	Economic, ecological, social
Institutional and resource support	Characterizes the quality of the regulatory environment, financial and organizational conditions for innovative development	Level of state support; availability of innovation infrastructure; access to financial resources	Economic, social
Environmental orientation of innovations	Reflects the orientation of innovations towards the preservation of natural resources and minimizing negative impact on the environment	Use of resource-saving technologies; level of greening of production; restoration of soil fertility	Economic
Level of digitalization of agricultural production	Characterizes the degree of implementation of digital technologies into production, management and logistics processes	Use of precision agriculture; digital management platforms; process automation	Economic, social

Source: (Sakhno, Polishchuk, Salkova, Kucher, 2019; Pronko, Furman, Kucher, Gontaruk, 2020)

rise after 2021. This trend is confirmed by the trend line, which reflects a steady annual growth in expenditure, indicating the growing importance of science and innovation for the country's development.

An important place in the diagnosis is occupied by the performance of innovative development, which is determined by indicators of labour productivity, growth in value added in the agricultural sector, increased product competitiveness, as well as the efficiency of resource use (Sakhno, Polishchuk, Salkova, Kucher, 2019).

According to the Global Innovation Index, in 2023 Ukraine ranked 55th among 133 countries assessed worldwide, reflecting its innovation activity and potential for the development of an innovation-driven economy. In 2024, Ukraine's ranking declined to 60th place, indicating a deterioration of its position in the global innovation environment amid economic and social challenges (https://www.wipo.int/edocs/gii-ranking/2024/ua.pdf?utm_source=com).

In the context of sustainable development, particular attention is given to environmental indicators, including the reduction of anthropogenic pressure on natural resources, the implementation of environmentally safe technologies, and the rational use of land and water resources.

A separate criterion is the institutional environment of innovative development, which is assessed through

the availability of state support for innovation, the effectiveness of agricultural and innovation policy, and the development of partnerships between science, education and business. In 2024, expenditure on research and development in Ukraine increased by a factor of 1.33 compared to 2023 and reached UAH 28,328.17 million, indicating strengthened financial support for scientific and innovative activity. Increasing importance is also attached to digitalisation indicators, which reflect the level of implementation of precision farming, digital production management platforms, information and analytical systems, and smart technologies. According to the State Statistics Service of Ukraine, in 2025 the share of enterprises with a basic level of digital intensity in the total number of enterprises increased by 0.6 percentage points compared to 2024 and reached 22.8%. In addition, in 2024 agriculture, forestry and fisheries accounted for 7.11% of the country's gross domestic product calculated by the production method (<https://www.ukrstat.gov.ua/>).

The use of a system of interrelated criteria and indicators ensures a comprehensive diagnosis of the state of innovative development of the agricultural sector and provides a methodological basis for the formulation of well-grounded managerial decisions aimed at strengthening innovation support for the sustainable development of the agricultural sector.

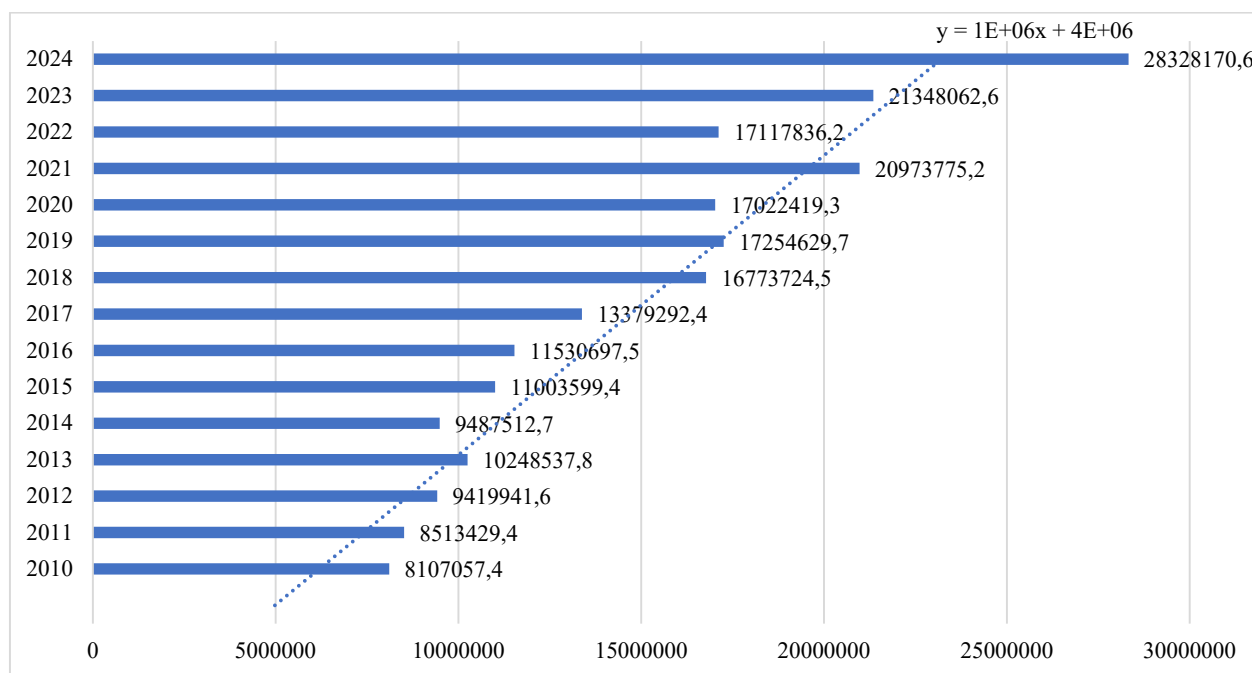


Figure 1. Expenditures on scientific research and development in Ukraine, 2010-2024, thousand UAH. ^{1,2,3}

Notes. 1. Data for 2010-2015 are listed without taking into account the costs of scientific and technical services.

2. Data for 2014-2021 are given without taking into account the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and part of the temporarily occupied territories in Donetsk and Luhansk regions; data for 2022-2024 are given without taking into account the territories temporarily occupied by the Russian Federation and part of the territories where hostilities are (were) conducted.

3. Information for 2021-2024 is formed on the basis of reports actually submitted by enterprises.

Source: (<https://www.ukrstat.gov.ua/>)

4. Assessment of the Current State of Innovative Support for Sustainable Development of the Agricultural Sector

Assessing the current state of innovation support for the sustainable development of the agricultural sector is a necessary prerequisite for identifying the existing innovation potential, as well as systemic imbalances and constraints to its realisation. In the context of intensifying global challenges, the transformation of agricultural markets, and growing requirements for environmental safety, a comprehensive analysis of the level of development of innovation infrastructure, investment activity, scientific and technological support, and human capital in the agricultural sector becomes particularly relevant. Such an assessment makes it possible to substantiate priority directions for further improvement of innovation policy and for ensuring the sustainable development of the agricultural sector.

We therefore propose to consider indicators for assessing the innovative development of the agricultural sector, in particular (Tomashuk, 2025):

1. *Integral Index of Innovative Development of the Agricultural Sector*, which is used for a comprehensive assessment of the level of innovative development, taking into account economic, technological, environmental and social components.

$$I_{inn} = \sum_{i=1}^n w_i \cdot Z_i$$

I_{inn} – integral index of innovative development of the agricultural sector;

Z_i – normalized value of the i -th indicator of innovative development;

w_i – weighting coefficient of significance of the i -th indicator;

n – number of selected indicators.

2. *Coefficient of Innovative Activity of Agricultural Enterprises* characterizes the level of involvement of agricultural enterprises in innovation activities.

$$K_{ia} = \frac{N_{inn}}{N_{tot}}$$

K_{ia} – innovation activity coefficient;

N_{inn} – number of agricultural enterprises that implemented innovations;

N_{tot} – total number of agricultural enterprises.

3. *Intensity of Innovation Expenditures* reflects the level of financial support for innovative development of the agricultural sector.

$$K_{iexp} = \frac{Exp_{inn}}{Exp_{tot}}$$

K_{iexp} – innovation expenditure intensity coefficient;

Exp_{inn} – costs of innovation activities;
 Exp_{tot} – total costs of agricultural production.

4. *Coefficient of Renewal of the Technological Base* characterizes the pace of technological modernization of agricultural production.

$$K_{tech} = \frac{FA_{new}}{FA_{avg}}$$

K_{tech} – coefficient of updating the technical and technological base;

FA_{new} – cost of new or upgraded fixed assets;

FA_{avg} – average annual cost of fixed assets.

5. *Innovation Productivity Indicator* shows the economic return on innovation and the efficiency of using innovation resources.

$$P_{inn} = \frac{Inc_{inn}}{Exp_{inn}}$$

P_{inn} – innovative productivity;

Inc_{inn} – additional income received from the implementation of innovations;

Exp_{inn} – costs of innovation activities.

6. *Environmental Innovation Index of the Agricultural Sector* reflects the impact of innovations on the greening of agricultural activities.

$$E_{inn} = \frac{1}{m} \sum_{j=1}^m Zenv_j$$

E_{inn} – ecological index of innovative development;

Zenv_j – normalized environmental indicator (reduction of emissions, resource conservation, increase in soil fertility, etc.);

m – number of environmental indicators.

7. *Social Innovation Development Coefficient* characterizes the social effect of innovations, in particular their impact on income and employment levels in rural areas.

$$S_{inn} = \frac{W_{inn}}{W_{avg}}$$

S_{inn} – social coefficient of innovative development;

W_{inn} – average wage level at innovatively active agricultural enterprises;

W_{avg} – average wage level in the agricultural sector as a whole.

The proposed system of indicators provides a comprehensive approach to assessing the innovative development of the agricultural sector and can be used for interregional comparisons and the formulation of sustainable development strategies. For a comprehensive assessment of the innovative support for the sustainable development of the agricultural sector, it is advisable to apply analytical tools that help to systematise the key influencing factors (Balaniuk, Shelenko, Shpykuliak, Sas, Cherneviy, Diuk, 2023). Following the SWOT analysis, the next logical step is a PEST analysis, which allows for the consideration of political, economic, social, and technological factors influencing development. The results of this analysis are presented in Tables 4 and 5.

Ukraine's innovation potential is crucial for the agricultural sector, as it enables the implementation of modern technologies, enhances productivity, ensures environmental sustainability, and strengthens the competitiveness of the industry at both national and international levels (Ridei, Bakhmat, Plahtiy, Polova, Holovnia, 2021). To assess Ukraine's innovation potential, it is appropriate to refer to the 2024 European Innovation Scoreboard (EIS) data. As shown in Table 6, Ukraine is classified as an Emerging Innovator, demonstrating a gradual increase in the overall Summary Innovation Index to 32.5 % of the EU average. Among

Table 4

SWOT analysis of innovative support for sustainable development of the agricultural sector

Strengths	Weaknesses
The presence of significant natural resource potential of the agricultural sector	Insufficient level of financing for innovation activities
A developed network of research and educational institutions of the agricultural profile	Low innovation activity of most agricultural enterprises
Growing interest in "green" and resource-saving technologies	Gap between scientific developments and the practice of their implementation
The potential of digitalization and the implementation of precision agriculture	Insufficient development of innovation infrastructure
Integration of sustainable development principles into strategic documents	Shortage of qualified personnel and weak innovation culture
Opportunities	Threats
Attracting international investments and grant programs	Macroeconomic instability and limited investment resources
Developing public-private partnerships	Intensification of climate change and soil degradation
Spreading digital and biotechnological innovations	High risks of innovative projects
Expanding markets for environmentally friendly products	Human migration and aging of the rural population
Harmonizing standards with EU requirements	Institutional barriers and regulatory instability

Source: (Balaniuk, Shelenko, Shpykuliak, Sas, Cherneviy, Diuk, 2023; Tomashuk, 2025; Doran, 2023)

Table 5

PEST analysis of innovative support for sustainable development of the agricultural sector

Factor	The content of the impact on the innovative support of the agricultural sector
P – Political	State agrarian and innovation policy; level of institutional support for innovations; integration of sustainable development principles into national and regional strategies; impact of European integration processes; stability of the regulatory environment
E – Economic	Level of investment activity; availability of financial resources; macroeconomic instability; price conditions of agricultural markets; economic efficiency of implementing innovations
S – Social	Demographic situation in rural areas; migration and population aging; level of education and qualification of personnel; innovation culture; social receptivity to new technologies
T – Technological	Level of development of agricultural science; spread of digital, bio- and resource-saving technologies; state of innovation infrastructure; access to modern IT solutions; speed of technology transfer

Source: (Balaniuk, Shelenko, Shpykuliak, Sas, Cherneviy, Diuk, 2023; Lupenko, Malik, Shpykulyak, 2014; Blakenny, 2022)

its strengths are digitalisation, the development of knowledge-intensive services, and highly cited scientific publications, while the most significant challenges remain in the areas of public R&D funding, high-tech exports, and the integration of innovations into the business sector.

Overall, the current state of innovation support for the sustainable development of the agricultural sector is characterised by significant potential alongside fragmented implementation, highlighting the need to strengthen systematic government support, develop human capital, and enhance the interaction between science, business, and education.

5. Problems and Directions for Improving Innovative Support for Sustainable Development of the Agricultural Sector

Innovation support is a key prerequisite for the sustainable development of the agricultural sector, as innovations determine the potential to enhance production competitiveness, ensure the rational use of natural resources, and maintain social stability in rural areas (Kravchenko, Kucher, Yanchuk, Stavskaya, 2020). At the same time, the current state of the agricultural sector is marked by a number of innovation-related challenges, stemming from limited financial resources, an underdeveloped institutional environment, slow diffusion of modern technologies, and increasing environmental pressures (Fig. 2).

Taken together, these challenges highlight the need to establish an integrated system for the innovation support of sustainable development in the agricultural sector, based on a combination of economic efficiency, environmental security, and social responsibility, as well as on the enhanced role of the state, science, education, and agribusiness (Fig. 3).

Taking into account the results of the SWOT and PEST analyses, as well as the role of key participants in the innovation process, the priority directions for improving the innovation support of sustainable

development in the agricultural sector are identified. Specific directions and recommendations are presented in Table 7.

Improving the innovation support for the sustainable development of the agricultural sector requires increasing investment in science and R&D, developing human capital and digitalisation, strengthening collaboration between science and business, as well as implementing environmentally safe technologies to ensure the long-term sustainability of the industry.

6. Conclusions

Innovations play a system-forming role in ensuring the sustainable development of the agricultural sector, as they enable the integration of economic efficiency, environmental safety and social resilience. The transition from extensive to innovation-oriented models of management is a necessary prerequisite for adapting agricultural production to global economic, climatic and social challenges.

The diagnosis of innovative development in the agricultural sector, based on a system of interrelated criteria and indicators, made it possible to comprehensively assess innovation potential, innovation activity, the effectiveness of innovation processes, the level of digitalisation, the environmental orientation of innovations and institutional support. The proposed approach ensures the comparability of results over time and provides a methodological basis for the formulation of well-grounded managerial decisions.

An analysis of the dynamics of expenditure on research and development demonstrated an increase in financial support for innovative activity in Ukraine. In particular, in 2024 R&D funding rose by a factor of 1.33 compared to the previous year. At the same time, the level of public and business financing of innovations remains insufficient for the full realisation of the innovation potential of the agricultural sector.

The results of the SWOT and PEST analyses revealed that the strengths of innovation support in the agricultural sector include a substantial natural resource

Table 6
EIS of Ukraine 2024

Indicator	Performance relative to the EU in 2024	Performance change 2017–2024	Performance change 2023–2024
Summary Innovation Index	32.5	3.7	0.1
Human resources	29.8	-7.7	0
New doctorate graduates	27.8	-6.1	0
Attractive research systems	13	11.2	3.9
International scientific co-publications	6.1	6.5	0
Scientific publications among top 10% most cited	17.8	14.4	10.1
Foreign doctorate students as % of all doctorate students	11.4	7.6	-6.9
Digitalisation	115.6	5.2	0
Broadband penetration	99.5	5.2	0
Finance and support	28.4	12.6	-2
R&D expenditure in the public sector	4.9	-4.9	-4.9
Venture capital expenditures	64.6	45.6	0
Direct and indirect government support of business R&D	11	0	0
Firm investments	30.2	-1.1	-1.1
R&D expenditure in the business sector	9.7	-2.3	-2.3
Non-R&D innovation expenditures	54.2	0.2	0.2
Use of information technologies	21.5	-3.9	0
Enterprises providing ICT training	21.8	-3.8	0
Linkages	21.4	4.4	0
Innovative SMEs collaborating with others	31.3	0	0
Public-private co-publications	14.3	14.2	0
Intellectual assets	20	2.7	1.2
PCT patent applications	34.4	-1.4	-0.6
Trademark applications	16.6	14.5	5.6
Design applications	0.5	-1.5	-0.3
Employment impacts	73.7	0	0
Employment in knowledge-intensive activities	80.1	0	0
Sales impacts	34.8	6.1	0.5
Exports of medium and high technology products	8.6	-19.4	-5.6
Knowledge-intensive services exports	81.8	37.9	5.5
Sales of new-to-market and new-to-firm innovations	3.1	3.1	3.1
Environmental sustainability	71.5	-10.7	-3
Environment-related technologies	78.3	-11.5	-3.3

Source: (https://ec.europa.eu/assets/rtd/eis/2024/ec_rtd_eis-country-profile-ua.pdf?utm_source=com)

base, a well-developed scientific and educational system, and growing interest in green and digital technologies. However, constraining factors persist, including low innovation activity among the majority of agricultural enterprises, limited access to financial resources, institutional barriers, and a gap between scientific developments and their practical implementation.

The assessment of Ukraine's innovation potential based on the European Innovation Scoreboard confirmed the country's classification as an Emerging Innovator. This indicates the presence of considerable opportunities for innovative development, while simultaneously highlighting the need to strengthen state support for R&D, stimulate high-technology exports and deepen the integration of innovations into the business sector, particularly in agriculture.

It was established that the innovative development of the agricultural sector generates a pronounced socio-environmental effect, manifested in increased labour productivity, higher employment levels in rural areas, improved quality of life, and reduced anthropogenic pressure on natural resources. Digital and environmental innovations aimed at resource efficiency and climate change adaptation are of particular importance.

The generalisation of the research findings made it possible to identify priority directions for improving innovation support for the sustainable development of the agricultural sector. Key priorities include expanding financial and investment support for innovations, improving the institutional environment, developing innovation infrastructure, pursuing technological modernisation of production, greening innovation activities, and fostering human capital development.

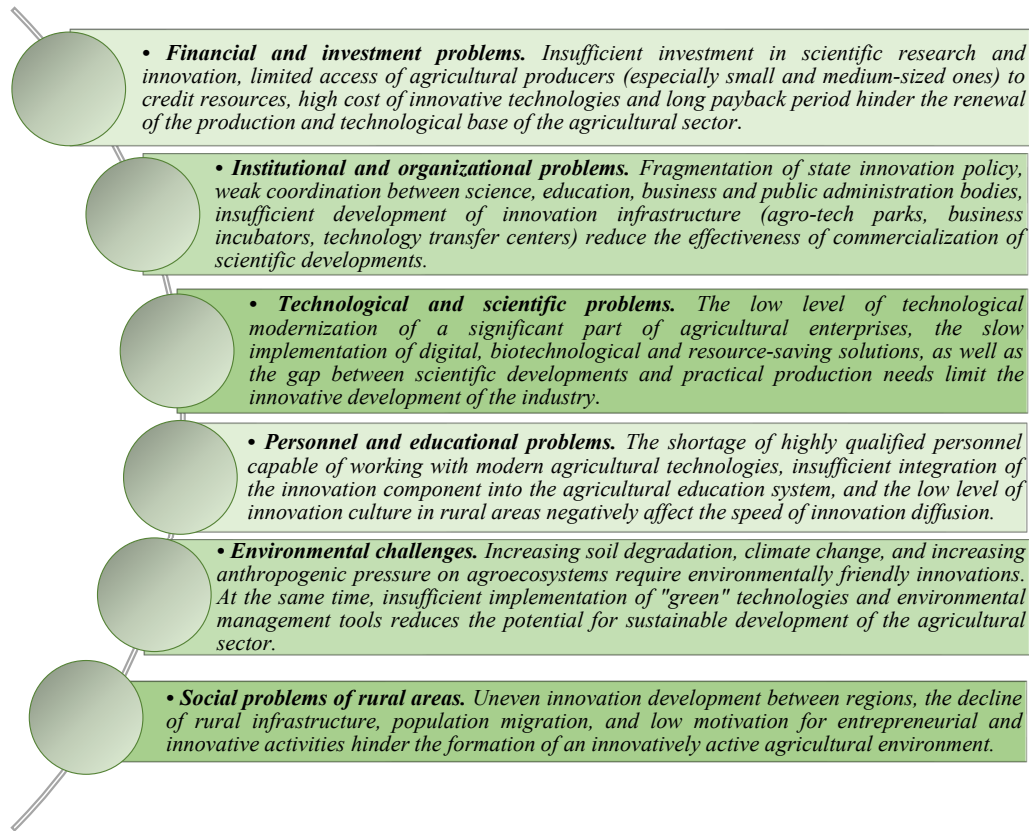


Figure 2. Problems of innovative support for sustainable development of the agricultural sector

Source: (Tomashuk, 2025; Kaletnik, Sakhno, Pryshliak, Lutkovska, Kolomiets, 2025; Lupenko, Malik, Shpykulyak, 2014)

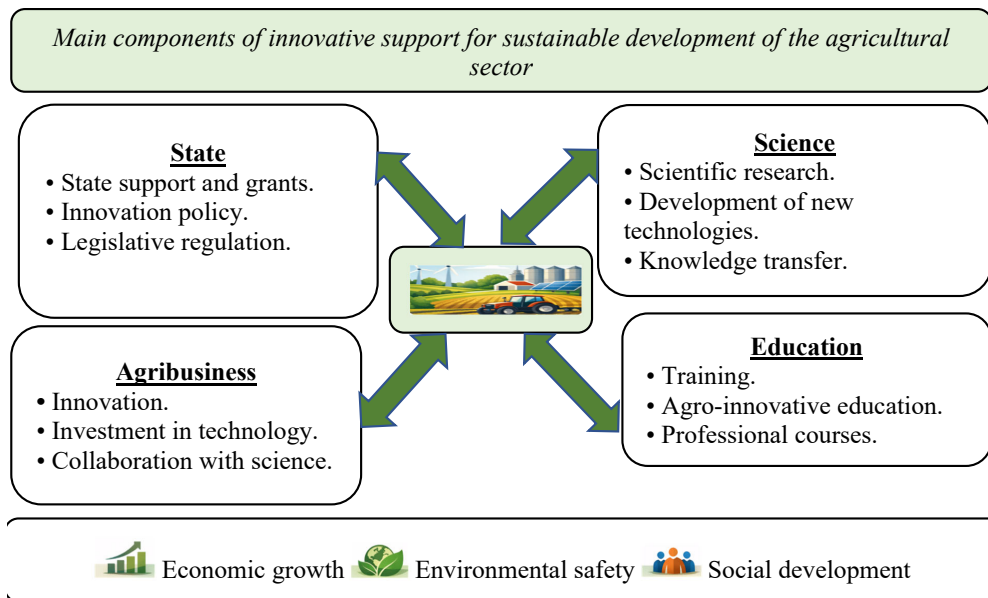


Figure 3. Activation of the role of the state, science, education and agribusiness in innovative provision of sustainable development of the agricultural sector

Source: (Kirieieva, Pryshliak, Shamanska, Salkova, Kucher, 2019; Kaletnik, Lutkovska, 2020; Zarembo, Sakhno, Chesnik, Nitsenko, Chikov, Zakharova, Boltovska, 2025)

Table 7

Directions for improving innovative support for sustainable development of the agricultural sector

Direction of improvement	Content and key activities	Expected impact on sustainable development
Financial and investment support for innovations	Expanding state support for innovation projects; developing preferential lending mechanisms and agricultural investment funds; stimulating public-private partnerships	Growth of investment activity; acceleration of innovation implementation; increase of economic efficiency of agricultural production
Improvement of the institutional environment	Forming a holistic state innovation policy; strengthening coordination between science, business and government; developing regional innovation ecosystems	Increasing manageability of innovation processes; reduction of the gap between science and production
Development of innovation infrastructure	Creating agro-tech parks, business incubators, technology transfer centers; supporting startups in the agricultural sector	Activation of commercialization of scientific developments; acceleration of diffusion of innovations
Technological modernization of agricultural production	Implementing digital, biotechnological, resource-saving and precision agricultural technologies; automating production processes	Increasing productivity and competitiveness; reduction of production costs and environmental burden
Greening of innovation activity	Developing "green" innovations; implementing environmental management and circular production models; restoring soil fertility	Ensuring environmental safety; preservation of natural capital; adaptation to climate change
Human resource and educational support for innovations	Modernizing agricultural education; developing dual education; improving the skills of personnel in the field of innovation and digital technologies	Formation of innovation-oriented human capital; increase of capacity to implement new solutions
Social development of rural areas	Supporting innovative entrepreneurship in rural areas; developing social and digital infrastructure; improving the quality of life	Reducing population migration; strengthening of social sustainability of the agricultural sector
Information and consulting support	Developing advisory services; disseminating information about innovative technologies; digital knowledge exchange platforms	Increasing the level of innovation culture; acceleration of managerial decision-making
Regional differentiation of innovation policy	Taking into account the natural, climatic and socio-economic characteristics of the regions; supporting local innovation initiatives	Balanced development of the agricultural sector; increasing the effectiveness of regional strategies for sustainable development

Source: (Tomashuk, 2025; Kirieieva, Pryshliak, Shamanska, Salkova, Kucher, 2019; Kaletnik, Lutkovska, 2020; Biletskyi, Kolesnyk, Shymanovska-Dianychn, Spitsyna, Shkoda, Krasnoshtan, 2024; Zarembo, Sakhno, Chesnik, Nitsenko, Chikov, Zakharova, Boltovska, 2025; Gutiérrez Cano, Pérez, Martínez, 2023)

The implementation of the proposed directions will contribute to the formation of an integrated system of innovation support for the sustainable development

of the agricultural sector, enhance its competitiveness, environmental and social sustainability, and strengthen national food security in the long term.

References:

- Blaniuk, I., Shelenko, D., Shpykuliak, O., Sas, L., Cherneviy, Y., & Diuk, A. (2023). Determinants of performance indicators of agricultural enterprises. *Management Theory and Studies for Rural Business and Infrastructure Development*, 45, 1: 25–36. DOI: <https://doi.org/10.15544/mts.2023.04>
- Biletskyi, O., Kolesnyk, T., Shymanovska-Dianychn, L., Spitsyna, A., Shkoda, M., & Krasnoshtan, O. (2024). Innovative management of integrated business structures in the financial mechanism of post-war recovery. *Financial and Credit Activity: Problems of Theory and Practice*, 6, 59: 293–310. DOI: <https://doi.org/10.55643/fcactp.6.59.2024.4663>
- Blakeney, M. (2022). Agricultural innovation and sustainable development. *Sustainability*, 14(5), 2698. DOI: <https://doi.org/10.3390/su14052698>
- Chikov, I., Radko, V., Marshalok, M., Tepluk, M., Petrenko, O., Sharko, I., & Sitkovska, A. (2022). Economic development of agricultural food enterprises on an innovative basis. *Financial and credit activity-problems of theory and practice*, 1 (42) : 98–106. DOI: <https://doi.org/10.55643/fcactp.1.42.2022.3672>
- Doran, N. M. (2023). Is innovation a driver of agricultural sustainability? Evidence from Eastern European countries under the SDG 2 framework. *Agriculture*, 15(21), 2282. DOI: <https://doi.org/10.3390/agriculture15212282>
- European Innovation Scoreboard 2024 Country Profile Ukraine. Available at: https://ec.europa.eu/assets/rtd/eis/2024/ec_rtd_eis-country-profile-ua.pdf?utm_source.com
- Global Innovation Index 2024. Available at: https://www.wipo.int/edocs/gii-ranking/2024/ua.pdf?utm_source.com

- Gutiérrez Cano, L. F., Pérez, J., & Martínez, A. (2023). Agricultural innovation system: Analysis from the subsystems of R&D, training, extension, and sustainability. *Frontiers in Sustainable Food Systems*, 7, 1176366. DOI: <https://doi.org/10.3389/fsufs.2023.1176366>
- Kaletnik, G., & Lutkovska, S. (2020). Innovative Environmental Strategy for Sustainable Development. *European Journal of Sustainable Development*, 9, 2: 89–98. DOI: <https://doi.org/10.14207/ejsd.2020.v9n2p89>
- Kaletnik, G., Sakhno, A., Pryshliak, N., Lutkovska, S., & Kolomiets, T. (2025). Economic evaluation of environmental protection activities in the context of sustainable development: the experience of Ukraine. *Polityka Energetyczna-Energy Policy Journal*, 28, 3: 217–236. DOI: <https://doi.org/10.33223/epj/207022>
- Kirieieva, E. A., Pryshliak, N. V., Shamanska, O. I., Salkova, I. Yu., & Kucher, A. V. (2019). Strategic Priorities and Financial Support of Ukrainian Agricultural Sector Development. *International Journal of Ecological Economics & Statistics*, 40, 2: 25–37.
- Kravchenko, O., Kucher, A., Yanchuk T., & Stavska Y. (2020). Methodology for assessing the harmony of economic relations between participants of the agrofood market. *European Journal of Sustainable Development*, 9 (2): 291–303. DOI: <https://doi.org/10.14207/ejsd.2020.v9n2p291>
- Lupenko, Yu.O., Malik, M.Y., & Shpykulyak, O.G. (2014). Innovative support for the development of agriculture in Ukraine: problems and prospects: monograph. Kyiv: NNC "IAE". 514 p. Available at: <https://socrates.vsau.org/repository/getfile.php/25873.pdf>
- Official website of the State Statistics Service of Ukraine. Available at: <https://www.ukrstat.gov.ua/>
- Pronko, L., Furman, I., Kucher, A., & Gontaruk, Y. (2020). Formation of a State Support Program for Agricultural Producers in Ukraine Considering World Experience. *European Journal of Sustainable Development*, 9, 1: 364–379. DOI: <https://doi.org/10.14207/ejsd.2020.v9n1p364>
- Ridei, N., Bakhmat, O., Plahtiy, D., Polova, O., & Holovnia, Y. (2021). The activities of amalgamated territorial communities in the context of sustainable development of the environment: the experience of Ukraine and the EU STATES. *International Journal of Computer Science and Network Security*, 21 (9): 323–331. DOI: <https://doi.org/10.22937/IJCSNS.2021.21.9.42>
- Sakhno, A., Polishchuk, N., Salkova, I., & Kucher, A. (2019). Impact of Credit and Investment Resources on the Productivity of Agricultural Sector. *European Journal of Sustainable Development*, 8, 2: 335–345. DOI: <https://doi.org/10.14207/ejsd.2019.v8n2p335>
- 17 Sustainable Development Goals. Available at: <https://globalcompact.org.ua/tsili-stijkogo-rozvytku/>
- Tomashuk, I.V. (2025). Formation of the scientific paradigm of innovative support for sustainable development of the agricultural sector. *Economic Space*, 208: 354–365. DOI: <https://doi.org/10.30838/EP.208.354-365>
- Tomashuk, I.V. (2025). Strategic priorities of sustainable development of the agricultural sector in the context of global challenges. *Sustainable Development of the Economy*, 6 (57) : 302–312. DOI: <https://doi.org/10.32782/2308-1988/2025-57-40>
- Zaremba, O., Sakhno, A., Chesnik, N., Nitsenko, V., Chikov, I., Zakharova, T., & Boltovska, L. (2025). Capital Investments in Sustainable Development of Land Resources of Ukrainian Agrarian and Industrial Complex Enterprises: Assessment, Modeling, Optimization. *Rocznik Ochrona Srodowiska*, 27: 722–737. DOI: <https://doi.org/10.54740/ros.2025.058>

Received on: 04th of January, 2026

Accepted on: 06th of March, 2026

Published on: 10th of April, 2026