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AGRICULTURAL ENTERPRISES IN THE CONDITIONS OF TRANSFORMATIONAL CHANGES: INNOVATIVE STRATEGIES AND FINANCIAL SOLUTIONS FOR REGIONAL DEVELOPMENT

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ABSTRACT

In conditions of rapid change, the strategic stability of agricultural enterprises and the ability to innovate are key factors in ensuring regional economic stability and food security. The purpose of the article is to study the features of the functioning of agricultural enterprises in conditions of transformation when choosing innovative strategies and financial solutions for regional development. In the article, the features of the functioning of agricultural enterprises in conditions of transformational changes are examined, in particular, the key components of the organizational support of such transformations are analyzed, which allows for a structured assessment of strategic planning, institutional support, digitalization, and innovative development of enterprises. It is established that the effective implementation of innovative activity and the implementation of digital solutions is carried out based on the public management mechanism that integrates methods, approaches, tools, and tasks for the activation of agricultural enterprises as a component of regional development. An analysis of state and regional programs to support small and medium-sized businesses aimed at stimulating the development of the agricultural sector was conducted, and their significance for the restoration of production processes, modernization of infrastructure, and increasing the financial capacity of enterprises was shown. Particular attention was paid to the digital component of agribusiness transformations: it was demonstrated that the integration of digital platforms, machine learning technologies, automation of workflows, and big data processing systems allows for increasing the efficiency of management decisions, ensuring transparency of financial accounting, optimizing logistics and production processes, and also promoting the development of innovative strategies of enterprises. Based on the conducted research, the choice of innovative strategies for agricultural enterprises was substantiated, taking into account security risks, resource capacity, and opportunities for using digital solutions, which contribute to increasing the competitiveness of businesses and the development of territorial communities.

Keywords: innovation strategy, financial support, mechanism, public administration, national image, region; state and regional programs, digitalization, agricultural enterprises

JEL Classification: O33, Q10, H12, R58, L26

INTRODUCTION

Military aggression led to the transformation of the agricultural sector from an export-oriented production to a high-risk sector, in which efficiency is measured not only by yield and pricing policy, but also by flexibility in terms of speed of recovery and the ability to work in these conditions of limited infrastructure and logistics.

During the period of full-scale invasion, agricultural enterprises are forced to work under conditions of logistical constraints, energy crisis, unstable access to resources, threat to the lives of workers, etc. In such conditions, the restoration and transformation of the agricultural sector is a component of the overall strategy for rebuilding the state, which

requires appropriate consideration of losses and the need for investment and institutional reforms. It should be emphasized that today export risks associated with the destruction of infrastructure and logistics chains remain, which affects the cost of agricultural sector services and the competitive advantages of domestic producers in the international market. Therefore, the search for new business development strategies and their financial support at the level of state and regional authorities is one of the priority tasks of state policy during the period of post-war reconstruction of the country's economy, which determines the relevance of the selected study.

LITERATURE REVIEW

Studies of modern transformational changes in the agricultural sector indicate the need for strategic adaptation of enterprises to crisis conditions, technological changes, and environmental risks. Abilda et al. (2024) analyze corporate strategies of agricultural enterprises in the period of post-pandemic challenges, emphasizing the importance of flexibility, digital innovation, and rapid adaptation of business models. Chumpanya & Panpakdee (2025) consider strategies for farmers' resilience during COVID-19, focusing on the development of social and information capital for the recovery of activities. Dovgal et al. (2025) determine that the implementation of sustainable development strategies provides competitive advantages for agricultural enterprises, strengthening innovation and environmental responsibility. Poltorak et al. (2024) indicate the key role of strategies for the socio-economic recovery of rural areas in increasing the efficiency of management of agricultural enterprises after crisis events. Additionally, Kostyrko et al. (2024) emphasize that the formation of a financial strategy for enterprises during periods of economic uncertainty is an important element in ensuring their long-term competitiveness.

A separate block of research is devoted to the effectiveness of state financing programs and their role in strengthening agricultural enterprises. Metzger (2025) proves that state credit programs in Ukraine have undergone a transformation from anti-crisis mechanisms to long-term development programs, strengthening the investment capacity of businesses. Larionova & Kapinos (2025) confirm that lending to agricultural enterprises is a basic tool for preserving production capacities in wartime and achieving sustainable development goals. Maliy et al. (2025) analyze the problems of lending in conditions of military risks and point to the need to expand loan guarantee mechanisms. Hrubliak et al. (2025) emphasize the connection between financial globalization and the economic growth of Ukraine, which is important for assessing the participation of the agricultural sector in international financial flows. In this context, the study of Grosu et al. (2021) is also important, which substantiates the conceptual model of financial management in the agricultural sector and emphasizes the importance of effective financial planning mechanisms for ensuring the stability of enterprises.

A significant part of the current work is aimed at assessing the impact of the war on the agricultural sector of Ukraine. Skydan et al. (2023) analyze the state of the agricultural sector during the war and emphasize that farmers faced logistical, financial, and security barriers that slowed down the recovery processes. Kuzmenko & Telendiy (2024) define the role of public administration in the post-war recovery of the agricultural sector, emphasizing the need for targeted programs and digital services to support regions. The study by Popelo et al. (2025) demonstrates that digital business ecosystems strengthen the innovative and intellectual potential of regions, especially those that have suffered destruction.

Digital technologies, artificial intelligence, and innovative solutions in agribusiness are one of the most dynamic areas of modern research. Hai et al. (2024) substantiates the importance of the "state-enterprise" partnership in the digital transformation of the agricultural sector, using evolutionary game methods to determine optimal strategies. Fan (2023) proves that digital tools, combined with CSR and branding, significantly increase the financial efficiency of agricultural SMEs. A significant contribution was made by the review studies of Liakos et al. (2018) on the application of machine learning in agricultural production and Wolfert et al. (2017) on the use of big data in "smart farming." Barki & Rachmah (2024) systematize the trends of the digital transformation of global agriculture, emphasizing the role of technological innovations in increasing the efficiency of agricultural production.

In Ukraine, digitalization issues are explored by Samoilenko (2024), identified by practical barriers to the implementation of digital technologies in agribusiness, as well as Viknianska et al. (2021), who proved the importance of digital ecosystems for regional innovative development. Separate studies also emphasize the role of predictive digital models in increasing the productivity of the agricultural sector (Vărzaru, 2025) and the importance of developing farmers' digital competencies for the effective use of precision agriculture technologies (Michailidis et al., 2024).

The direction of research on innovation strategies in the agricultural sector and their impact on the efficiency of enterprises is important. Sun et al. (2023) shows that the introduction of blockchain in the production of fresh produce increases competitiveness through transparency of supplies. Nikishyna et al. (2024) formulate the concept of a circular ecosystem as an innovative model of sustainable development. The study of Makhmetova et al. (2023) demonstrates that innovations

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in waste management in the agricultural sector contribute to increasing the efficiency of rural development. Andrioaia et al. (2025) prove the importance of financial and intangible factors (intellectual capital) for the market value of enterprises, which also confirms the relevance of innovation strategies. Bhat et al. (2025), in a structured review, emphasize that the integration of artificial intelligence into agribusiness management increases the efficiency of decision-making, optimizes costs, and promotes sustainable development.

However, despite thorough research in this area, today there are still issues of effective choice of development strategies for agricultural enterprises and the use of digital solutions for the regional development of the agro-industrial sector.

AIMS AND OBJECTIVES

The purpose of the article is to study the features of the functioning of agricultural enterprises in the conditions of transformations when choosing innovative strategies and financial solutions for regional development.

Within the framework of achieving the set goal, it is important to study the theoretical foundations of the functioning of agricultural enterprises in the conditions of transformational changes and substantiate the components of organizational support for their development; form a conceptual scheme of the mechanism of public management of the development of agricultural enterprises in the conditions of transformational changes; analyze the instruments of state financial support for the agricultural sector and assess their role in ensuring the stability of the activities of enterprises; study the use of digital technologies and innovative solutions in the activities of agricultural enterprises as a factor in increasing management efficiency and competitiveness; substantiate the main innovative strategies for the development of agricultural enterprises, taking into account the security situation and economic conditions of operation in the country.

METHODS

The study used a complex of general scientific and special methods that provided a comprehensive analysis of transformation processes in the agricultural sector. The system approach method allowed us to consider agricultural enterprises as a complex socio-economic system, the activity of which depends on external and internal factors of transformation.

The structural-functional method was used to isolate and scientifically substantiate the key components of the organizational support of transformational changes, in particular strategic planning, institutional support, digitalization, and innovative development.

The comparative analysis method provided the opportunity to compare the features of the transformations of agricultural enterprises in different regions of Ukraine, including territories destroyed by the war, as well as to assess the impact of state support programs and access to financial instruments.

The monographic method made it possible to study in depth the positions of scientists on the effectiveness of digital technologies, innovation strategies, and state policy in the field of agricultural development.

Methods of economic analysis and generalization were used to assess the effectiveness of the implementation of digital technologies, innovative solutions, and public management tools in the activities of agricultural enterprises, as well as to form generalized conclusions regarding their impact on the sustainability and competitiveness of the industry.

Logical and abstract-logical methods provided the opportunity to formulate theoretical provisions, clarify the conceptual apparatus, and build a scheme for organizational support of transformational changes.

RESULTS

The implementation of digital technologies and innovative processes requires appropriate organizational support, including change management and effective personnel policy. Of particular importance are flexible and adaptive strategies that use digital solutions that allow enterprises to quickly respond to changes in the external environment with minimal loss of resources. The effectiveness of innovative strategies and digital solutions in the agricultural sector depends on several factors, namely: climate change and increasing demand for food. Such factors require appropriate decisions from businesses, which determine the use of digital technologies as a driver of modernization of the sector, in the direction of updating equipment and technologies, and management processes. The use of innovative technologies in agricultural business is aimed not only at the field of management, but also at the field of improving crop growing technology, which, in combination, makes it possible to adapt to changing conditions of both climatic and organizational and economic nature.

Thus, Liakos et al. (2018) investigate how the use of machine learning (ML) methods contributes to increasing the efficiency of agricultural production. This makes digital solutions not only innovative but also cost-effective for farms. Wolfert et al. (2017) provide data on successful cases of using big data analytics on farms in different countries, where the use of digital solutions led to an increase in productivity by 10-25%. Michailidis et al. (2024) investigate the impact of digital strategies on regional agri-food systems and establish that the implementation of digital solutions not only enhances the competitiveness of individual enterprises but also contributes to increasing the socio-economic sustainability of regions.

To determine the most effective strategies for innovative development of agricultural enterprises, it is first necessary to conduct a diagnosis of the external environment, which will allow us to determine security and market factors, and the development of institutional support. This is especially relevant in the conditions of Ukraine, taking into account mining, risks of shelling, threats in the logistics and energy sectors. The general economic crisis affects the pricing policy of world prices for agricultural sector products, lending opportunities, and the establishment of export corridors. With the beginning of a full-scale invasion, an important direction for Ukraine is institutional support for the development of the industry, which is manifested in a balanced state policy aimed at creating conditions for the activation of enterprise activities.

For the agro-industrial sector, an important aspect is the assessment of business sustainability, which is manifested in the formation of critical nodes, such as storage, energy supply, and transportation. In the economic part, this is the ability to quickly restore and replace, which, in conditions of instability, is one of the determining factors of business flexibility and adaptability. In such conditions, it is important for enterprises to form their own concept for building a business development strategy, which includes innovation, digitalization, and security. The implementation of this concept is not possible without an appropriate, effective public management mechanism, which will include principles, methods, tools, approaches, and components that allow increasing the flexibility and adaptability of enterprises in conditions of risk and uncertainty.

Identifying risks and threats is one of the main stages of business management in the context of transformational change, which allows you to establish their impact on the stability of the enterprise's activities. In general, there are four types of risks and threats that are most often encountered in the assessment process:

- Economic threats include pricing policy, currency fluctuations, and instability of supply and demand in the agricultural sector. Ukraine is one of the largest exporters of agricultural products to the global market, so global trends have a significant impact on the ability of enterprises to carry out their activities.
- Environmental threats are the most unpredictable and least susceptible to mitigation or avoidance. Such threats are associated with climate change, adverse weather conditions that affect crop yields and soil fertility.
- Technical and technological threats are associated with the use of outdated equipment and technologies that do not meet the modern requirements of digitalization and Industry 4.0. The lack of innovative development becomes a barrier to increasing labor productivity and compliance of technology and products with global requirements, which may affect exports.
- Political and legal threats caused by changes in legislation, limited access to state programs to support agribusiness, and non-compliance with European standards significantly complicate the possibilities of business functioning.

To minimize the impact of these threats or avoid them, enterprises need to shape their development policy, taking into account such limitations. Counteraction to these threats is currently achieved by activating innovative development and the use of digital technologies that affect approaches to doing business.

The main goal of the digital transformation of agribusiness is to achieve a certain result in terms of increasing profits, increasing competitiveness, increasing the level of capitalization, increasing labor productivity, and rapid adaptation to changes in the external environment. If we consider the areas of digitalization, then today the top priority for enterprises is the adaptation of business processes and the implementation of data processing technologies. Ma et al. (2022) systematize data on the use of digital technologies - GPS monitoring, drones, AI algorithms, data analysis - and assess their impact on economic efficiency and found that enterprises using digital solutions have up to 15% higher yields and significantly lower production costs. Li et al. (2023) emphasize that artificial intelligence allows not only to automate routine tasks, but also to effectively predict risks, optimize resource use, logistics management, and promote the development of new business models.

The vector of development of digital technologies is chosen by the enterprise independently based on its capabilities and personnel potential, since the human factor plays a key role in the ability to use new technologies, as they must have the appropriate competencies. The selected tools are aimed at changing approaches to business management, interaction with consumers and partners, and establishing external communications. This approach allows agricultural enterprises to increase the efficiency of their activities and form a corresponding positive image in foreign and domestic markets.

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The formation of a positive brand and image helps increase the investment attractiveness of the enterprise, attract investors and partners, which in the future may lead to business expansion.

Modern authors (Bennett et al., 2021) use an organizational-functional model of managing the processes of innovative development of agricultural enterprises, which allows adapting the business to the conditions of digitalization. Such a model contributes to the integration of modern digital solutions into various production processes and contributes to the formation of competitive advantages and increasing business productivity. In general, such an approach allows for the formation of flexibility and adaptability of agricultural business in conditions of risk and uncertainty, which is one of the priority tasks today. Ensuring innovative and digital development of agribusiness enterprises requires appropriate organizational support, which creates opportunities for the implementation of such areas (Figure 1).

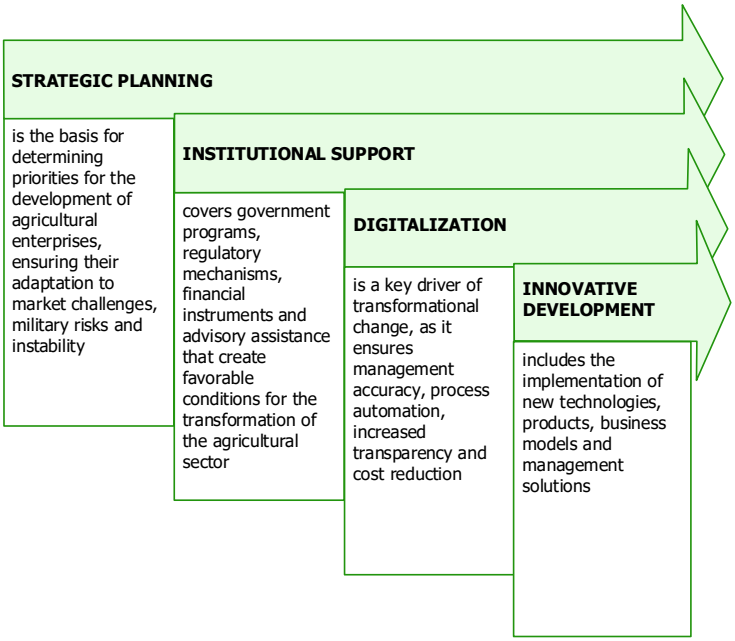

Figure 1. Organizational support for transformational changes in agricultural enterprises.

The implementation of adaptive management in the activities of agricultural enterprises based on innovative development is accompanied by certain difficulties associated with the instability of the environment. Such variability requires constant monitoring of changes in the situation in order to respond to negative changes in a timely manner.

For this purpose, it would be appropriate to develop a mechanism for public management of agricultural enterprises in the context of transformations to activate regional development. Such a mechanism is able to ensure the sustainable functioning and modernization of agricultural business at the regional level through innovative renewal, security adaptation, and digital solutions (Figure 2). The subject of such a mechanism is the state, regional authorities, and business that initiate the creation of such a mechanism. The object is the process of forming innovative strategies and directions for the digitalization of agricultural enterprises as a component of regional development.

The mechanism operates in accordance with basic and specific principles.

The basic principles include the following:

- legality, which determines compliance with and adherence to legal norms and requirements for the quality of products and services;
- accountability, which defines transparency and responsibility to stakeholders of enterprises, access to public information;
- effectiveness in terms of the measurability of the results obtained for further interpretation of the effectiveness of achieving the set goal or deviations in order to timely adjust the relevant areas;
- transparency, which determines access to all stages of project implementation, and the use of funds, which reduces the corruption component of the functioning of the agricultural sector;

- subsidiarity, which determines that decisions should be made within the powers in which they arose, that is, expanding decision-making opportunities at the community and regional levels in matters of agro-industrial sector development.

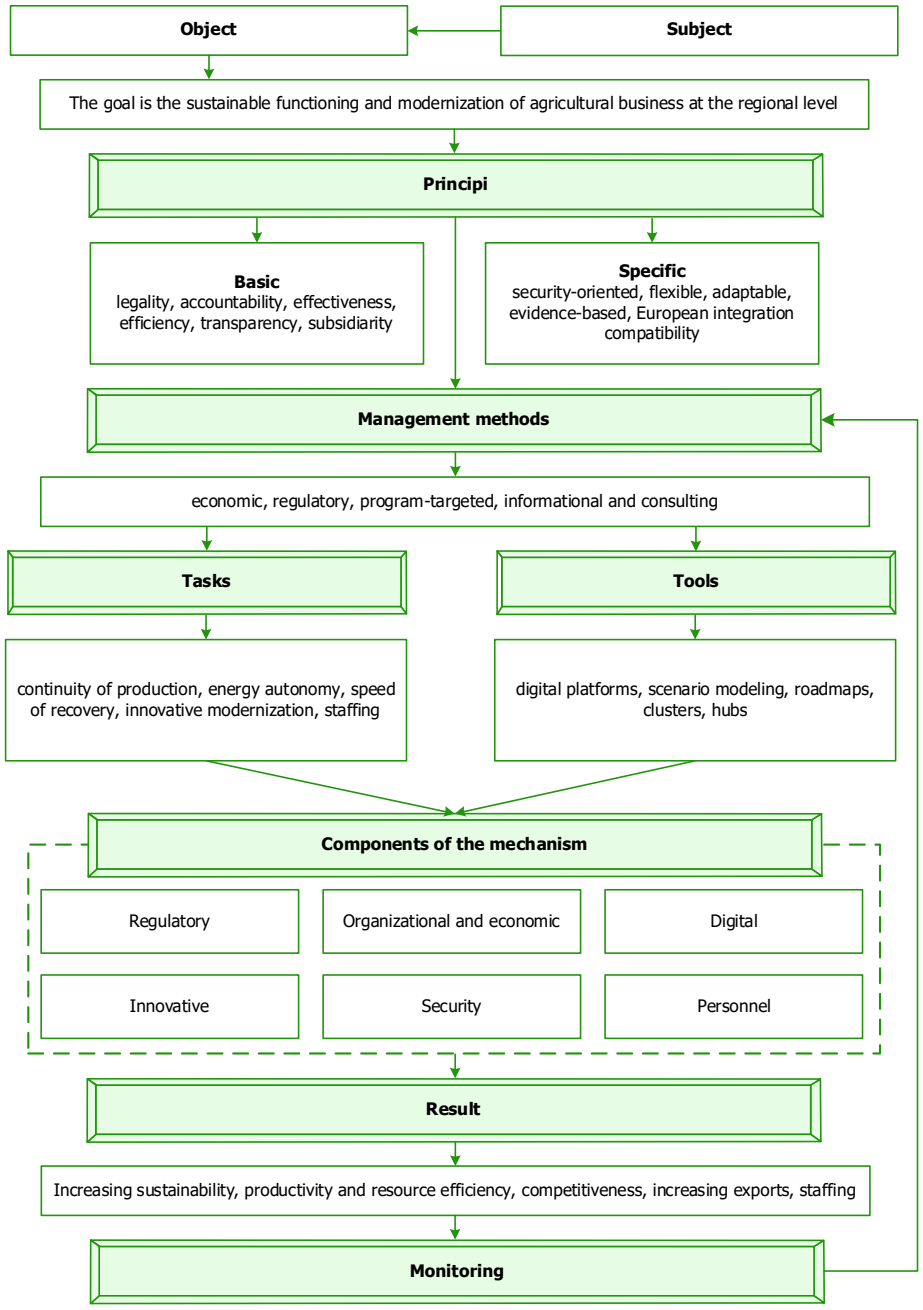

Figure 2. Conceptual diagram of the mechanism of public management of the development of agricultural enterprises in the conditions of transformation and change.

Specific principles in the aforementioned mechanism are proposed to include:

- security orientation, which determines the orientation of management decisions, which should be aimed at the priority of protecting the lives of personnel, preserving critical business assets through risk assessment;
- flexibility as the ability of institutions to quickly adapt to changing external environments with minimal loss of resources;
- adaptability, as the ability of the management system to take into account the results of previous decisions in order to improve directions;

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- evidentiality, according to which management decisions are made based on reliable data and the use of open methods and approaches;
- the principle of European integration compatibility, which involves harmonizing the goals, tools, and procedures of public administration with EU norms and practices, ensuring environmental friendliness and compliance of products and technology with relevant international standards.

The main methods of public administration in the conceptual scheme of the mechanism include economic methods, which include various types of tax incentives, subsidies, and investments that allow the activation of the development of agrarian business within a certain territorial community. Regulatory methods, which include compliance with procedures at the general regulatory and legislative level, including adaptation to international norms and rules. Program-targeted methods, which are represented by state development programs and contain clear indicators for regulating their implementation. Information and consulting methods, which include precision farming practices, energy management, support for cyber-security, and digital literacy.

The main tasks of the specified public management mechanism include the continuity of production, which is implemented on the basis of supporting access to energy resources, repair facilities, especially during the period of active preparation of the industry. For Ukraine, the situation with ensuring the generation of the industry is particularly difficult, which requires solving these problems through the introduction of technologies for automation of generation, energy-saving technologies, and flexible consumption schedules.

In conditions of constant destruction of infrastructure facilities, enterprises and authorities need to ensure the speed of resource recovery, which affects production productivity and resource loss. Taking into account the principles of innovative improvement of the industry, today, ensuring the competitiveness of agricultural business is not possible without the introduction of new technologies that meet the principles of Industry 4.0 and sustainable development.

The implementation of the above-mentioned areas is not possible without appropriate staffing, which must possess the necessary competencies and skills, especially in matters of digitalization.

The practical implementation of the planned measures is carried out through the appropriate public management tools, namely the use of digital platforms, which is relevant for agrarian business, since it is international platforms that allow you to expand the search for partners, form a positive image of the business and the country as a whole. The variability of the external environment and the high unpredictability of changes require different approaches and taking into account the multivariate development of events, which is achieved through the use of scenario modeling, which, based on modern software products, allows you to take into account a significant number of influencing factors and build the most realistic scenarios for the development of events in the long term. The use of such tools allows the business to be more flexible and quicker in making management decisions.

One of the tools for long-term development of the agricultural sector is the construction of roadmaps, which are a kind of step-by-step vector for implementing the strategy of innovative business development. Such a roadmap is also used at the level of communities and regional authorities in order to more clearly structure activities.

To attract investors and be able to compete with large enterprises in the agricultural sector, it is advisable for enterprises to unite into various clusters and hubs, which allow them to form advantages both in the domestic and foreign markets. Such groupings are more stable for investors and the implementation of large investment projects, due to their scale.

To achieve the set goal, the following components are identified in the mechanism concept: regulatory, which regulates the rules of access to state and international support programs, establishes export regimes for agricultural sector products, and regulates land relations in the country.

The financial and economic component provides the resource basis for the transformations of agricultural enterprises, creates conditions for investment, modernization of production and increasing competitiveness and includes: instruments of state financial support, mechanisms for stimulating innovation and modernization, development of the agricultural lending market, increasing the availability of capital, minimizing risks for producers, attracting international financial resources and MSME support programs aimed at energy efficiency, technological renewal, increasing business sustainability, optimizing financial infrastructure, which ensures transparency and efficiency of financial flows at enterprises (Table 1).

Table 1. State programs of financial support for agricultural enterprises of Ukraine, 2024. (Source: prepared by the author using Report on the activities of the Entrepreneurship Development Fund)

Programs	Program Objectives	Volume of loans granted, USD million	Share of the agricultural sector in the total, %
Available loans 5-7-9% (from 2020)	Partial compensation by the Fund of interest rates on loans to micro, small, medium, and large businesses	3,790.48	45
Affordable financial leasing 5-7-9% (from 2020)	Business development, production modernization, job creation, energy efficiency, import substitution, and reconstruction of destroyed facilities	148.06	79.3
Credit guarantees of the Entrepreneurship Development Fund (from 2021)	Portfolio credit state guarantees through authorized banks for loans to MSMEs	32.67	43.9
Lending to MSMEs in priority sectors (since 2010)	Lending to MSMEs in priority sectors of the Ukrainian economy	52.1	25.7
Support for MSME investments in priority areas (since 2017)	Financing of investment projects of MSMEs in priority sectors of the Ukrainian economy	241	58
MSME Energy Efficiency Investment Support Program (from 2023)	Supporting the financing of energy-efficient business investments to reduce energy consumption and CO_2 emissions	2.38	44
Project "Access to Finance and Support for the Sustainability of MSMEs in Ukraine - Phase I" (from 2022)	Investment loans for the purchase, modernization, or reconstruction of fixed assets	6.96	61
Affordable Factoring Program (from 2023)	help businesses get money quickly, without waiting for payments from customers, and without the need for classic lending	0.48	4.8
Microcredit program (since 1997)	Lending to MSMEs and the introduction of a micro-lending system in partner banks	302.84	30.3

Key state support programs cover a wide range of needs of agribusiness: from interest rate compensation and portfolio guarantees to investment support, energy efficiency, and modernization of fixed assets, and the formation of a positive national image.

The largest in terms of financing is the program "Affordable Loans 5-7-9%", which provided over USD 3,790.48 billion in credit resources. The high share of loans falling on the agricultural sector (45%) indicates that this program has become a key source of liquidity for farmers, ensuring the stability of production processes, the possibility of carrying out seasonal work, and updating fixed assets. Its importance in a period of transformations and military challenges is difficult to overestimate, because access to cheap capital is critical for maintaining production.

No less indicative is the program "Affordable Financial Leasing 5-7-9%", which, although it has a smaller amount of financing - USD 150 million, is characterized by a record share of the agricultural sector - 79.3%. This means that agricultural enterprises are actively using leasing instruments to update equipment and modernize production. Such concentration indicates the high dependence of the agricultural sector on modern machinery and equipment, and that the leasing form of investment is especially effective for enterprises that need technical re-equipment.

Credit guarantees of the Entrepreneurship Development Fund are of significant importance, having provided over USD 30 million in credit resources in the absence of sufficient collateral from borrowers. The share of the agricultural sector, which is 43.9%, confirms the relevance of this instrument for small and medium-sized agricultural producers. For many farmers, guarantees are the main way to access credit funds, allowing them to start or expand their activities.

MSME lending programs in priority sectors of the economy, implemented since 2010, have significantly smaller volumes – about USD 52 million, and only 25.7% of loans are directed to the agricultural sector. This indicates a relatively low level of involvement of farmers in this program. In contrast, MSME investment programs, operating since 2017, have significantly larger volumes – USD 241 million, and the share of the agricultural sector is 58%. This difference demonstrates that agricultural enterprises more often choose investment programs that allow them to implement innovative solutions, update equipment and technologies, increase productivity, and develop processing.

A special place among modern tools is occupied by programs focused on energy efficiency and sustainability. The Energy Efficiency Investment Program, introduced in 2023, provided USD 2.37 million in financing, of which 44% went to agricul-

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tural enterprises. This indicates the growing demand of the agricultural sector for technologies that reduce energy consumption, optimize production processes, and reduce costs. The MSME Sustainability Support Project, which provides financing in the amount of USD 6.95 million and 61% involvement of the agricultural sector, demonstrates the priority of measures aimed at strengthening the adaptability of enterprises in crisis conditions.

New tools, such as the Affordable Factoring program, have so far had limited distribution. The small amount of financing (USD 480 thousand) and the minimal share of agricultural loans (4.8%) indicate the lack of popularity of factoring among farmers, although it can potentially become an important tool for quickly attracting working capital. Against this background, the microcredit program, which has been operating since 1997 and has a volume of over USD 301.8 million, occupies an important place for small farms and family farms. The share of the agricultural sector of 30.3% demonstrates that microcredits remain a stable source of support for the smallest participants in the agricultural market.

Overall, the analysis shows that state financial support programs play a key role in the transformation of agricultural enterprises, providing access to capital, stimulating innovation, modernization, and increasing energy efficiency. These results are also confirmed by studies by scientists, in particular Metzger (2025), Larionova & Kapinos (2025), Maliy, Horokh, Makohon (2025). Different instruments have varying degrees of focus on the agricultural sector, but together they form a holistic financial and economic basis for the development of agricultural production at the regional level and ensure the sustainability of enterprises in conditions of economic and structural changes.

In the process of transformational changes in the agricultural sector, the development of mechanisms to support entrepreneurship at the regional level becomes especially important. Regions face different intensities of challenges - war destruction, changes in the employment structure, and the need to restore production and logistics infrastructure. Skydan et al. (2023) assess the state of the agricultural sector of Ukraine during the full-scale war and show that some producers were able to adapt to difficult conditions, but the overall need for state support remains critical. Kuzmenko & Telendiy (2024) examine specific problems faced by agricultural enterprises during the war period and emphasize that public administration, including support mechanisms and transformation programs, plays a crucial role in the restoration of the agricultural sector at the local level. Therefore, a significant place in the system of state financial and economic support is occupied by regional programs to support agricultural producers, which are implemented in partnership with regional state administrations, international funds, and the Entrepreneurship Development Fund.

Table 2 presents key regional financial programs that provide additional development opportunities for local agricultural enterprises. They focus on supporting business sustainability, modernizing production facilities, creating jobs, and financing sowing campaigns in strategically important agricultural regions of Ukraine. These programs strengthen the impact of national instruments, adapting them to the specific needs of territorial communities and regional economies.

Table 2. Regional programs of financial support for agricultural enterprises of Ukraine, 2024. *(Source: prepared by the author using Report on the activities of the Entrepreneurship Development Fund)*

Program	Program Objectives	Volume of loans granted, USD million	Share of the agricultural sector in the total, %
Supporting the development of MSMEs in the Kryvyi Rih district (from 2023)	Increasing the resilience of businesses that create jobs, provide income for the population, and support the country's ability to produce goods and services.	0.42	13
Project "Access to Finance and Support for the Sustainability of MSMEs in Ukraine - Phase II" (from 2024)	Investment loans for the purchase, modernization or reconstruction of fixed assets with a focus on de-occupied regions	11.17	46.1
Joint Program of the FRP with the Lviv Regional State Administration (from 2021)	Restoration, preservation, and creation of jobs during martial law at enterprises participating in the 5-7-9 Program	3.9	23.9
FRP program with Kyiv Regional State Administration (from 2023)	Restoration, preservation, and creation of jobs during the period of martial law at enterprises participating in the 5-7-9 Program	9.27	54.9
FINANCEAST program to support small farms in western Ukraine (from 2022)	Supporting the sowing campaign of Ukrainian farmers and taking into account the importance of Ukraine in the food supply chain of countries around the world, with grain crops	0.32	100

Regional programs demonstrate important trends in the financial and economic support of agricultural sector transformations. First of all, it is worth noting that these programs are aimed not only at supporting production but also at restoring

and stabilizing the regional business environment, which is critically important during the period of military and structural changes.

The MSME Development Support Program in Kryvyi Rih District, which provided USD 0.42 million in financing, has a relatively small share of loans allocated to the agricultural sector (13%). This is explained by the diversified structure of the region's economy, where agriculture is not a dominant industry. However, the very existence of such a program indicates awareness of the role of small businesses in ensuring employment, incomes, and stability of the regional economy. In the context of transformations, this program provides agricultural enterprises with the opportunity to attract investments to support basic processes.

The project "Access to Finance and Support for the Resilience of MSMEs in Ukraine - Phase II", focused on the deoccupied regions, demonstrates a much deeper impact on the agricultural sector - 46.1% of the total volume of loans provided was directed specifically to agricultural producers. The amount of financing of USD 11.17 million indicates the scale and priority of the restoration of agricultural production in the regions that have suffered destruction. For agricultural enterprises, this means the possibility of rebuilding fixed assets, modernizing equipment, and restoring technological processes, which directly affects the regional food balance and labor markets.

The joint program of the Entrepreneurship Development Fund with the Lviv Regional State Administration, launched in 2021, demonstrates an average level of involvement of agricultural enterprises - 23.9%. The amount of financing of USD 3.9 million is aimed primarily at supporting employment and production activity in conditions of martial law. The Lviv region plays the role of a logistics hub, and the program allows stabilizing the activities of enterprises, including agricultural ones, which are actively integrated into the logistics and processing chains of the region.

In contrast, the FRP program with the Kyiv Regional State Administration demonstrates a significantly higher focus on the agricultural sector – 54.9% of loans are for agriculture, and the total amount of financing is USD 9.27 million. This indicates a growing demand for financing among agricultural enterprises in the region, which are experiencing a period of adaptation to new logistical conditions and changes in the market structure. For the Kyiv region, where agricultural production traditionally has a significant share, such a program strengthens regional food stability and promotes innovative investments in production.

The FINANCEAST program deserves special attention, which is fully focused on the agricultural sector and has 100% involvement of agricultural producers. Although its volume (USD 320 thousand) is relatively small, it plays an extremely important role in western Ukraine, providing financing for the sowing campaign of small farms. This program is an example of targeted support, maximally adapted to the specifics of the region, which contributes to food security, support for local production, and preservation of the economic activity of rural communities.

Thus, the analysis shows that regional programs play an important role in the structure of financial support for the transformations of the agricultural sector and allow taking into account the specific needs of territories, support the sustainability of agricultural production, contribute to the creation of jobs, and ensure the modernization of enterprises. The regional focus of these programs makes them a key tool for implementing the policy of development of agricultural enterprises during the period of transformational changes, because it is at the regional level that conditions are formed for the practical implementation of innovative strategies and financial solutions.

In the context of transformational changes in the agricultural sector, the digital and innovative component acquires strategic importance, as it ensures the transition of agricultural enterprises to new management models based on the use of data, process automation, and the implementation of artificial intelligence technologies. Digitalization is a key factor in increasing the efficiency of agribusiness, optimizing production cycles, and accelerating management decision-making. Vărzaru (2025) studies the impact of digital technologies on the productivity of the agricultural sector and demonstrates that the use of digital solutions, including artificial intelligence, IoT, and predictive models, allows optimizing resources, reducing costs, and increasing the efficiency of agricultural production. Bhat et al. (2025) highlight the role of AI in optimizing resource utilization, automating tasks, improving decision-making, and optimizing the supply chain through data analytics and blockchain solutions, which demonstrates the strategic importance of digital technologies for the modernization of farms and food processing enterprises. Samoylenko (2024) shows that digital technologies contribute to increasing the sustainability, efficiency, and productivity of agricultural enterprises, but the process of digitalization also faces barriers related to human resources readiness and access to infrastructure. Therefore, the application of digital platforms, machine learning algorithms, automation tools, and solutions focused on working with big data is an important part of these processes.

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Figure 3 demonstrates the dynamics of the implementation of various artificial intelligence technologies by agricultural enterprises in 2022 and 2024. Comparing these indicators allows us to assess the intensity of digital transformation and identify technologies that form the basis of the transition to an innovative type of agricultural production.

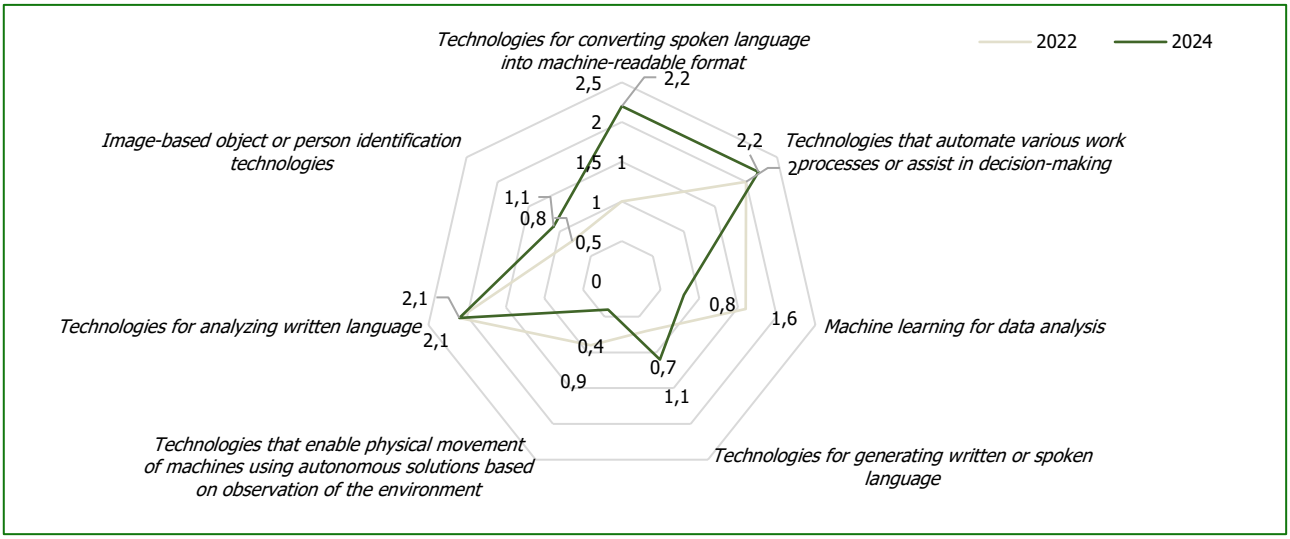

Figure 3. Share of the number of agricultural enterprises in Ukraine that use artificial intelligence technologies, %. *(Source: constructed by the authors based on data from the State Statistics Service of Ukraine)*

A comparative analysis of the share of agricultural enterprises using various artificial intelligence technologies indicates the uneven development of the digital component in the agricultural sector, as well as a shift in emphasis towards those solutions that most support operational efficiency and automation.

The most notable growth is observed in the use of speech-to-machine translation technologies: the figure increased from 1% in 2022 to 2.2% in 2024, which indicates the active spread of voice interfaces, digital assistants, and solutions that allow for the acceleration of data capture, processing, and integration into the management systems of agricultural enterprises. Such growth reflects the general trend towards automation of internal communications and integration of IT solutions into production processes.

The share of the use of technologies for analyzing written language remains stable (2.1% in 2022 and 2024), which indicates their already established and relatively high level of integration into document flow processes, contract management, text information analysis, and technical documentation.

Technologies for automating workflows and decision-making increased from 2% to 2.2%, confirming a consistent trend towards increasing the digital maturity of agricultural enterprises, which is associated with the implementation of production monitoring systems, planning algorithms, and logistics management tools, which are critical for increasing the efficiency of agricultural supply chains.

Indicators of the use of technologies for generating written or spoken language also showed an increase, from 0.7% to 1.1%, which indicates the spread of systems for automatically creating reports, forming technical descriptions, marketing texts, as well as the use of multimedia tools for interacting with customers and partners.

At the same time, some areas are showing a decline. In particular, the use of machine learning technologies for data analysis decreased from 1.6% to 0.8%, which is associated with the high cost of implementation, a shortage of specialists, or a reorientation of enterprises towards more applied and easy-to-implement solutions. A decrease was also noted in the category of technologies that provide physical movement of autonomous machines (0.9% to 0.4%), indicating a temporary slowdown in investments in robotic systems due to military risks, logistical challenges, or equipment shortages.

At the same time, the use of image-based object and person identification technologies increased from 0.8% to 1.1%. This reflects the growing interest of agricultural enterprises in visual quality control systems, automated product sorting, and security technologies, which are becoming increasingly relevant for large-scale production.

Overall, the analysis shows that the digital transformation of the agribusiness sector is selective: growth occurs primarily in those areas that provide a quick effect on operational activities, reduce costs, and improve the speed of information processing and decision-making. Also, Barki and Rachmah (2024) emphasize that the integration of IoT, big data, artificial

intelligence, and digital platforms is radically changing the productivity and efficiency of agri-food systems and is a key factor in the sustainable development of modern agriculture. Technologies that require high investment or complex integration are showing a slowdown or even a decline in their adoption. This is logical for a period when enterprises are adapting to economic and military challenges, but remain on course for gradual digitalization.

Continuing the description of the digital component of agribusiness transformation, it is advisable to consider not only what artificial intelligence technologies are implemented by enterprises, but also for what purpose they are used. This allows us to assess the depth of integration of digital solutions into business processes and identify which areas of activity of food enterprises are most dependent on digitalization. This is reflected in Figure 4, which shows the share of food industry enterprises that apply AI technologies in specific areas of work.

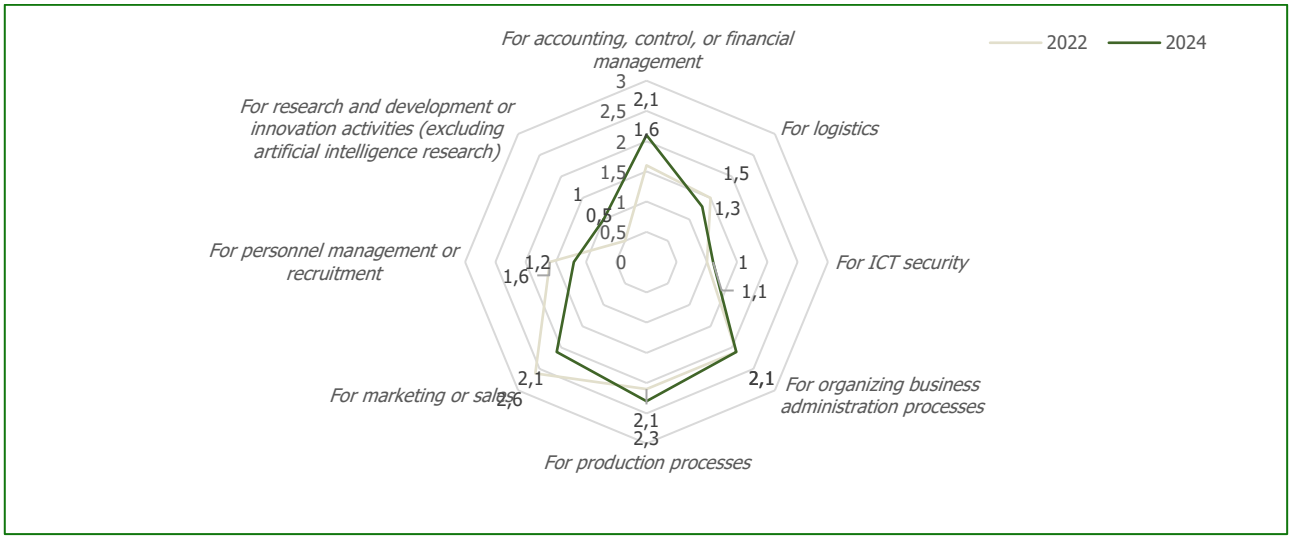

Figure 4. Share of the number of agricultural enterprises in Ukraine that use artificial intelligence technologies, %. *(Source: constructed by the authors based on data from the State Statistics Service of Ukraine)*

Data for 2022-2024 show that agricultural enterprises are the most actively integrating artificial intelligence technologies into production processes and activities related to administration. The share of companies using AI in production increased from 2.1% to 2.3%, which indicates a gradual increase in automation, resource optimization, and the implementation of quality control systems. The use of AI in administrative processes remains stable at 2.1%, which indicates the established practice of using digital tools for document management, planning, and organization of internal processes.

The use of technologies for accounting and financial management shows positive dynamics, where the indicator increased from 1.6% to 2.1%. This indicates growing trust in automated systems for controlling financial flows, forecasting, and identifying risks. Interest in the use of AI in innovation and research has also increased significantly, from 0.5% to 1%, which means the formation of a new stage of industry development, focused on creating value-added products and implementing innovative approaches to technological processes.

At the same time, some areas showed a decline in indicators. In particular, the use of AI for marketing and sales decreased from 2.6% to 2.1%, which may be due to both a general reduction in marketing activity in an unstable market and a shift in focus to other areas of digitalization. There is also a decline in the use of AI for human resources management - from 1.6% to 1.2%, which is likely due to reduced investments in HR technologies or changes in personnel strategies.

The share of agricultural enterprises using AI for ICT security remains stable, with a slight increase to 1.1%. This confirms the importance of protecting data and digital infrastructures in the face of increasing cyber threats. For logistics, the use of AI has slightly decreased from 1.5% to 1.3%, which may be a result of supply optimization or complications related to external factors.

Thus, agricultural enterprises are reorienting digital investments towards areas directly related to increasing production efficiency, management stability, and financial accuracy, while secondary areas are experiencing some reduction. This indicates a gradual but strategically balanced development of the digital component of the industry.

The security component implements an assessment of risks and threats of both physical and production nature in order to develop measures to ensure infrastructure security, energy autonomy, and the physical safety of the population.

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The human resource component is the driver of innovative changes in the agricultural sector and the introduction of digital technologies, through the acquisition of digital skills, competencies in working with relevant software, and the implementation of new business processes.

The effectiveness of using the specified mechanism of public management of the development of agricultural enterprises within the region is to increase the resilience of businesses to the influence of external environmental factors, ensure the continuity of the production process due to the adaptability and flexibility of production, and increase productivity due to innovative technologies. This stability of functioning allows for ensuring competitive advantages for enterprises and the sector in the long term, provided that digital technologies and innovative activity develop. Compliance with these measures will allow for improvement in the export potential of both the industry and the state as a whole due to the quality of products and an increase in production volumes that meet international quality standards.

The final stage of the functioning of the mechanism of public management of the development of agricultural enterprises is the monitoring procedure, which allows for the timely detection of deviations from planned standards in order to quickly respond to such changes to minimize their negative impact. In conditions of increased risk and threats, agricultural sector enterprises must choose innovative development strategies, taking into account the influence of environmental factors and the security component. Given the diversity of business resource capacity and the security and economic situation in the regions of Ukraine, it is advisable to single out the strategic choice, taking into account the above-mentioned features. The portfolio of the most appropriate innovative strategies for the agricultural industry, taking into account the security situation, is shown in Figure 5.

Figure 5. Main innovative strategies for the development of agricultural enterprises, taking into account the security situation in the country.

The strategy of sustainability and continuity is based on the conservation and rational use of resources, diversification of suppliers, and the use of mobile repair teams to ensure the rapid restoration of production processes during their disruption. This strategy is implemented through production planning, monitoring of equipment and inventories, which allows for reducing yield losses and increasing its predictability.

The productivity strategy is more focused on the use of the latest fertilizer technologies and the use of genetically modified plants, which increases the productivity and yield of crops, as they become more resistant to weather conditions. Reducing energy costs, the use of drones for production needs, and the use of digital solutions for yield modeling. The main goal of such a strategy is maximum return per unit of resource.

In conditions of limited energy resources and constant destruction of infrastructure, it is important to implement strategies that can ensure the autonomy of sources. The main goal of such a strategy is to use autonomous sources, which will increase the energy efficiency of production and reduce costs. For this, it is advisable to use modern technologies and equipment that are economical, consume little fuel, and can use various sources of generation.

The strategy of flexibility and adaptability is built primarily on taking into account and minimizing risks based on the formation of clusters, hubs that allow for more flexible use of supply conditions, and risk insurance. Diversification of logistics routes for the export of goods and services, which is relevant for Ukraine in the face of external threats to export potential. Therefore, it is the formation and improvement of supply chains that will ensure the sale of products and reduce the risk of property loss. Adaptive capacity is implemented on the basis of production from the export of raw materials to the processing industry, that is, a full production cycle, which contributes to increasing added value for business. Such a production cycle is effective not only for enterprises but also for regions, as it provides working cities, budgets of various levels, and reduces vulnerability to export risks. Therefore, the industry must transition from raw material production to a full cycle of finished products, which will ensure the competitiveness and profitability of the business.

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The digital governance and compliance strategy is based on the integration of enterprises with digital government services to reduce transaction costs. The use of digital platforms and applications allows for an increase in transparency and openness of business activities, which forms a positive image of the enterprise. Transparency of procedures for obtaining state and grant support reduces the level of corruption in cities and promotes the attraction of investment funds on the basis of openness and controllability of processes.

In general, each enterprise should choose the type of innovation strategies that best match the business's goals and resource capabilities.

DISCUSSION

The study confirmed that transformational changes in agricultural enterprises in Ukraine are formed under the influence of a complex of factors - institutional, financial, digital, innovative, and security. Its results are consistent with international and domestic scientific approaches, but at the same time, they indicate a number of debatable aspects that require broader interdisciplinary consideration.

First, the question of assessing the value of enterprises and the role of intangible assets in the period of active digitalization remains open. Research by Andrioaia et al. (2025) showed that the market value of companies is increasingly determined by intangible factors and digital development. Similar conclusions are also confirmed by Grigoraș-Ichim et al. (2018), who emphasize the importance of transparency of financial information and modern reporting systems for building investor confidence. This is consistent with the results of our study, which demonstrates that digital technologies in the agricultural sector go beyond instrumental use and become a strategic asset. However, the mechanism for integrating these assets into the financial model of agricultural enterprises requires further theoretical formalization.

The second important area of discussion is the issue of modeling transformation processes in the economy and the agricultural sector in areas of risk and instability. Buiak et al. (2023) in their studies of socio-economic clustering prove that complex economic systems are characterized by uneven development and asymmetric response to shocks. In this context, Tkachuk et al. (2023) emphasize the significant influence of political and institutional factors on the formation of the state's financial policy, which also determines the possibilities of implementing strategic programs to support the agricultural sector.

Conceptual models of financial management presented by Grosu et al. (2021) confirm that strategic transformations in the agricultural sector are impossible without sustainable financial mechanisms. This study demonstrates that state credit programs play a key stabilizing role, but the issues of their long-term effectiveness and adaptation to the conditions of war and post-war reconstruction remain open. In addition, Kostyrko et al. (2024) update the role of financial strategy in conditions of uncertainty, emphasizing the need for flexible audit and risk assessment mechanisms.

The use of digital technologies, as noted by Wang (2023), is becoming a key factor in the competitiveness of agricultural enterprises, especially in the context of mobile Internet and digital marketing. Along with this, modern research also emphasizes the importance of increasing the level of digital competencies of agricultural workers and the formation of new educational programs for training specialists in precision agriculture (Michailidis et al., 2024). This study confirms this trend, but emphasizes that the issue of the level of digital competence of personnel in the agricultural sector and access to high-speed Internet in rural areas remains unresolved.

In addition, the research results have certain limitations due to the use of aggregated data and generalized approaches, which do not allow for taking into account the specifics of the activities of enterprises at the micro level. Such an approach may not take into account the differences that exist in the agricultural sector, in particular between different types of agricultural enterprises, their geographical location, and specific market conditions. The research results reflect the special circumstances that are characteristic of the agricultural sector of Ukraine under martial law. This unique context imposes specific limitations and challenges that may not be applicable to other sectors or regions, thereby limiting the generalizability of the results. It is worth noting that the assessment of the effectiveness of innovative and digital solutions is predominantly qualitative in nature. While quantitative methods could provide a more reliable basis for assessing the impact of these solutions, allowing a clearer understanding of their effectiveness in terms of measurable outcomes, such as productivity, economic efficiency, and market expansion. The dynamics of the external environment may also affect the relevance of the conclusions, which determines the feasibility of further research in this area.

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CONCLUSIONS

Theoretical and applied research into the development processes of agricultural enterprises in the context of transformations has allowed us to establish that for Ukrainian agricultural producers, the vector of strategic development has significantly changed, due to the security, economic, and infrastructural challenges of wartime. Enterprises found themselves in conditions of destruction of logistical, production, and social infrastructure, which requires the formation of new approaches to the organizational support of their activities.

Today, the ability of agricultural enterprises to quickly restore production processes and increase the resilience and adaptability of business models is critically important. In this context, state and regional financial support programs play a significant role, serving as a stimulus for the activation of investment activities of enterprises. The analysis showed that regional programs - such as support for MSMEs in the Kryvyi Rih district, programs of the Lviv and Kyiv regional administrations, as well as specialized initiatives for farmers (for example, FINANCEAST) - contribute to the restoration of entrepreneurial activity in regions, including those affected by the war, and provide access to credit resources for the modernization and revival of production.

An important direction of transformation is the digitalization of the activities of agricultural enterprises, which is a key factor in increasing their competitiveness. The growth of the use of artificial intelligence technologies, from the automation of production and management processes to the implementation of data analysis tools, object identification, logistics, and financial management. The increase in the share of enterprises using digital solutions indicates the formation of a new technological model of agribusiness. This is consistent with international research, which proves that digital and intangible assets significantly affect the market value of enterprises and their innovation dynamics.

Therefore, the organizational support for the development of agricultural enterprises should be comprehensive and include four key components:

- strategic planning;
- institutional support (state, regional, and donor programs);
- digitalization of production and management processes;
- innovative development, including the introduction of modern technologies and new business models.

The implementation of such directions is possible within the framework of the mechanism of public management of the development of agricultural enterprises, which combines methods, tools, regulatory solutions, and support programs. This is especially important in the context of regional uneven recovery, the need for reconstruction, and asymmetric access to resources in war-affected territories. The effectiveness of innovative development of enterprises depends on their resource capacity, the level of digital readiness, the quality of management decisions, and access to financing. The choice of transformation strategies should take into account industry risks, the state of the local economic environment, and the capabilities of enterprises to integrate digital tools.

Thus, the agricultural sector becomes a key driver of regional development, and its transformation determines the sustainability of the economy at the national level.

Although modern research is actively developing areas of digitalization, innovative development, and financial stability of agricultural enterprises, a number of important aspects remain insufficiently studied. These include:

- formation of a comprehensive model of agricultural sector transformations in post-conflict regions;
- assessment of the long-term effects of state support programs;
- integration of digital and intangible assets into the financial management system;
- creation of a methodology for measuring the digital readiness of agricultural enterprises.

These areas are extremely relevant and form a promising scientific agenda that requires further interdisciplinary research.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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АГРАРНІ ПІДПРИЄМСТВА В УМОВАХ ТРАНСФОРМАЦІЙНИХ ЗМІН: ІННОВАЦІЙНІ СТРАТЕГІЇ ТА ФІНАНСОВІ РІШЕННЯ ДЛЯ РЕГІОНАЛЬНОГО РОЗВИТКУ

В умовах швидких змін стратегічна стійкість аграрних підприємств і здатність до інноваційного розвитку є ключовими факторами забезпечення регіональної економічної стабільності й продовольчої безпеки. Мета дослідження полягає у вивченні особливостей функціонування аграрних підприємств в умовах трансформацій при виборі інноваційних стратегій і фінансових рішень для регіонального розвитку. Досліджено особливості функціонування аграрних підприємств в умовах трансформаційних змін, зокрема визначено ключові складові організаційного забезпечення таких трансформацій, що дозволяє структуровано оцінити стратегічне планування, інституційну підтримку,

цифровізацію та інноваційний розвиток підприємств. Установлено, що ефективна реалізація інноваційної активності й упровадження цифрових рішень здійснюються на основі механізму публічного управління, який інтегрує методи, підходи, інструменти й завдання для активізації аграрних підприємств як складової регіонального розвитку. Проведено аналіз державних і регіональних програм підтримки малого та середнього підприємництва, спрямованих на стимулювання розвитку аграрного сектора, показано їхню значущість для відновлення виробничих процесів, модернізації інфраструктури та підвищення фінансової спроможності підприємств. Особлива увага приділена цифровій складовій трансформацій агробізнесу: продемонстровано, що інтеграція цифрових платформ, технологій машинного навчання, автоматизації робочих процесів і систем обробки великих даних дозволяє підвищити ефективність управлінських рішень, забезпечити прозорість фінансового обліку, оптимізувати логістичні та виробничі процеси, а також сприяти розвиткові інноваційних стратегій підприємств. На основі проведеного дослідження обґрунтовано вибір інноваційних стратегій для аграрних підприємств з урахуванням безпекових ризиків, ресурсної спроможності й можливостей використання цифрових рішень, що сприяє підвищенню конкурентоспроможності бізнесу та розвиткові територіальних громад.

Ключові слова: інноваційна стратегія, фінансова підтримка, механізм, публічне управління, національний імідж, регіон; державні та регіональні програми, цифровізація, аграрні підприємства

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