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PROBLEMS OF THEORY AND PRACTICE

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ЕКОНОМІКО-ТЕОРЕТИЧНІ АСПЕКТИ РОЗВИТКУ ФІНАНСОВО-КРЕДИТНИХ СИСТЕМ

ECONOMIC-THEORETICAL ASPECT OF FINANCIAL CREDIT SYSTEM'S DEVELOPMENT

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PROJECT MANAGEMENT OF INNOVATIVELY ORIENTED CLUSTER BUSINESS AGRO-STRUCTURES IN THE SMART ECONOMIC MODEL

ABSTRACT

The article examines the management and evaluation tools of innovation-oriented cluster business agrostructures operating in the context of a smart economy, with a special focus on the agricultural sector, where the introduction of innovations and new technologies is a decisive factor for increasing efficiency and sustainability. The main approaches to integrating smart technologies into the production and management processes of agro-industrial clusters are considered, which allows to significantly optimize operational activities, reduce costs and increase the competitiveness of products. The study focuses on how innovative solutions and technological achievements can contribute to the construction of flexible and adaptive business models that support the efficiency of operations and sustainable development of enterprises. The introduction of such technologies into agricultural clusters contributes to increasing environmental sustainability, reducing the negative impact on the environment through resource optimization and emission reduction. The results of the study contain practical recommendations for agricultural enterprises operating in clusters on the effective implementation of innovative technologies to support economic and social sustainability in the context of a modern smart economy. Such recommendations are focused on developing the innovative potential of enterprises, increasing their productivity and adaptability to the dynamic environment of the agro-industrial market. The article offers approaches to the implementation and evaluation of strategic innovations that help agricultural clusters better adapt to the requirements of the modern market and become competitive at the global level while ensuring sustainable economic and environmental development.

Keywords: management, innovations, agricultural structures, clusters, smart technologies, project management

JEL Classification: Q14, O15

INTRODUCTION

The management of innovatively oriented cluster business agro-structures in the conditions of a smart economy is an important topic of research since the agrarian sector is faced with the need to introduce the latest technologies and increase production efficiency. Given the global economic changes, the need for sustainable development, technological integration and innovative solutions is becoming more and more urgent. Clusters, as a form of business cooperation, play a key role in stimulating innovation, increasing productivity, and promoting economic growth, especially in rural areas where agriculture remains the main industry. The agricultural sector, as one of the main components of the economy, faces the need to modernize its production processes, adapt to new technological requirements, and ensure sustainable development. In this context, the smart economy is an important factor that allows agricultural enterprises to integrate innovations, increase the efficiency of management processes, and optimize production models. Innovative cluster business structures are becoming a key element in the transformation of the agricultural sector, ensuring cooperation between enterprises, state bodies, and scientific institutions to achieve common goals. The use of the latest smart solutions for data management and a sustainable approach to production

opens up new opportunities for the development of agricultural clusters and increases their competitiveness in the global market.

LITERATURE REVIEW

The problems of our research are reflected in a wide range of scientific works. Rehman et al. (2023) examine the role of technology in the development of smart agriculture, particularly in data-driven decision-making and food security. The research can be valuable for agroclusters, as blockchain is able to increase transparency, trust between market participants and the efficiency of supply chain management, which contributes to the formation of a more sustainable agribusiness model and the improvement of management processes in cluster structures.

Zhyvko et al. (2022) consider the security aspects of the digitalization of management accounting and finance in the national economy against the background of globalization. The work is useful for the management of innovation-oriented cluster structures in the agricultural sector, as the digitization of processes requires attention to cyber security and financial data protection, especially in large integrated structures, which will contribute to effective financial control and accounting, increasing data protection in a smart economic model.

Maraveas et al. (2024) demonstrate the possibilities of quantum computing for optimizing yield management and sustainable agriculture, which is relevant for agroclusters since quantum technologies can be applied to process large volumes of data in real-time, which will contribute to making accurate decisions and increasing the efficiency of agricultural production in the context of a smart economy.

Arnold et al. (2024) considers citizens' preferences for smart technologies for smart districts, which is useful for agricultural clusters, in particular for understanding the needs of smart energy solutions for agribusiness. The use of energy-efficient solutions in cluster structures will reduce costs and increase business sustainability, contributing to the development of innovative clusters in the smart economy.

A study by Sun et al. (2024) is of great importance for project management in agroclusters, as it suggests methods for achieving sustainable development through minimizing environmental impact. Implementation of such strategies will allow cluster structures to reduce their carbon footprint and ensure environmental responsibility, which is an important aspect of a smart economic model.

Scientific article Khodakivska et al. (2022) provides important tools for project management in cluster structures of the agricultural sector, helping to ensure economic stability and protect the interests of cluster participants, i.e., modeling and analysis of economic security will contribute to the development of innovation-oriented clusters and their adaptation to modern economic conditions.

A study by Xu et al. (2022) is important for cluster management in the agricultural sector, as it shows how the exchange of knowledge and technology among cluster participants can stimulate innovation and efficiency. This approach contributes to the strengthening of ties between cluster participants, which helps in the implementation of innovative projects and supports competitiveness.

Kang et al. (2022) investigate the impact of virtual clusters on innovation efficiency. Although the research is focused on hydropower, its findings can be applied to agricultural clusters as well. Virtual clusters allow participants to exchange knowledge and experience without the need for physical presence, which promotes innovation and faster implementation of new technologies. Such research emphasizes the importance of digitalization and the use of virtual means of collaboration to improve the efficiency of project management in smart economic models of agribusiness.

In the scientific article Rhoden et al. (2022) examines the spatio-temporal dynamics of innovation in Europe using multivariate functional data analysis. Such conclusions are important for cluster structures in the agricultural sector, as they allow a better understanding of how innovations spread in space and time, as well as how they change under the influence of local and regional factors, which will contribute to the optimization of the management of innovative agroclusters based on regional specifics and development trends.

Scientists Vasylchak et al. (2022) analyze the role of state regulation of employment on the labor market in the process of innovative development of entrepreneurship, which is relevant for cluster structures, as it offers recommendations for managing labor resources in conditions of innovative development. The management of labor resources in agroclusters will ensure the stability of employment and the availability of skilled labor, which is important in a smart economic model.

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Scientists Liu et al. (2022) examine the evolution of innovation networks in industrial clusters and multidimensional proximity, which is valuable for agroclusters because it analyzes the connections and interactions between cluster participants and suggests methods for enhancing innovativeness through collaboration. This helps to strengthen the innovation potential of agroclusters, improve coordination between participants, and develop effective innovation networks.

A study by Yin et al. (2022) is valuable for project management in agroclusters, as it shows the importance of state support to overcome the "valley of death" (a period of high risks and limited resources for innovation implementation) because it is state subsidies and an established support network that stimulate the development of new technologies and contribute to sustainable innovation development of agribusiness.

A research paper by Ahumada-Tello & Evans (2023) emphasizes the importance of human resources, innovation, and technology as the main drivers of new product development in cluster structures, which is useful for agroclusters because it points to the importance of innovation-oriented strategies and human capital that help to create competitive products and technologies.

In the scientific article Ovcharenko et al. (2022) investigate agroclusters and issues of ecological orientation, it is the implementation of ecologically oriented models that increases the efficiency and environmental friendliness of clusters, contributing to the development of sustainable agribusiness.

A study by Wu et al. (2023) is useful for agroclusters, where issues of environmental friendliness and social responsibility are becoming more and more relevant. Such financial support from institutional investors can facilitate the implementation of low-carbon technologies, important for innovation clusters in the agricultural sector.

Kim et al. (2023) emphasizes that the presence of diversity in clusters contributes to the development of new ideas and the increase of innovative potential, which is important for agroclusters since the implementation of different approaches to project management and the involvement of various organizations allows to increase efficiency and innovativeness in the smart economic model.

Scientists Xu et al. (2023) suggest important aspects for project management in agrocluster structures, as they show that effective coordination between cluster participants increases innovation and promotes the development of new products. The study also highlights the importance of conflict resolution for productivity.

Costantini et al. (2023) examine the development of eco-innovations in the EU, particularly through the convergence analysis of the eco-innovation index, which is useful for agroclusters as it examines the factors contributing to the development of eco-innovations. Knowledge of these factors will help cluster structures to create strategies for implementing environmental solutions, which will increase their competitiveness and environmental sustainability.

Kyryliuk et al. (2021) analyze the organizational and economic factors that ensure the safety and improvement of the quality of livestock products. Such research is valuable for agroclusters because it focuses on methods of ensuring product quality and safety, which is key to maintaining the reputation and competitiveness of clusters in the market. These factors contribute to the strengthening of quality standards, increasing the safety and stability of production processes.

The scientific work of Shevchenko (2014) is important for agroclusters because collective investment can contribute to the development of innovative projects in cluster structures, attracting financial resources for the introduction of new technologies and increasing competitiveness in the context of a smart economic model.

Blagun (2013) investigates cognitive modeling of the development of the banking system, which is important for managing financial aspects in cluster agricultural structures since cognitive modeling allows for predicting the impact of various economic factors on the financial system.

Scientific conclusions of Stolyarov et al. (2022) are relevant to agroclusters, as effective resource management is critical to ensuring the smooth functioning of agribusiness. Optimization of material and technical supply helps to reduce costs and increase the efficiency of operational processes in cluster structures.

Velychko (2014) emphasizes the importance of logistics processes for the effective functioning of agroclusters. The implementation of advanced logistics solutions will allow to optimize supply chains, which increases the competitiveness of clusters and contributes to the development of a smart economy.

The conclusions of Blahun et al. (2022) are important for agroclusters because market efficiency measures help assess the economic conditions for investing in the agrosector. The use of such indicators contributes to the adoption of strategic decisions regarding the development of innovative projects in cluster structures.

In the scientific article Rayets et al. (2023) examines the role of leadership in stimulating innovation and team creative potential. Such research is relevant for the management of agricultural clusters, as it emphasizes the importance of leadership in creating an innovative environment and mobilizing the creative potential of cluster participants. Effective leadership promotes the development of innovative projects, which is important for the implementation of a smart economic model.

The findings of Dmytryshyn & Blahun (2016) are useful for agroclusters, as the provision of effective credit financing is critical for the development of innovative projects. Optimizing access to credit resources will allow agricultural clusters to better finance innovations, thereby increasing the efficiency and sustainability of cluster structures in agriculture.

In the collective monograph, Ostapenko et al. (2022) examine the influence of nanoeconomics on the development of the national economy. This research is important for innovation-oriented clusters because it shows how even small economic units and processes can affect a large-scale economic system.

Although the study of Gryshchenko et al. (2021) refers to educational services, the principles of using competitive advantages can also be applied in agricultural clusters because it is the use of innovation potential and cooperation with universities that will contribute to the training of qualified personnel and the increase of innovation potential in agricultural cluster structures.

A study by Pryshliak et al. (2022) is valuable for agroclusters, as energy autonomy is a key factor in ensuring the stability and efficiency of cluster operations. The introduction of renewable energy sources and optimization of energy consumption will contribute to increasing the competitiveness of agroclusters and their sustainability in the smart economic model.

Scientists Oliynyk-Dunn et al. (2020) analyze the transformation of agribusiness financing models in the context of the financial crisis. Such research is important for cluster structures because it describes how financial crises affect access to capital and resources of agribusinesses. Understanding these processes allows agroclusters to develop financing management strategies, adapt to crisis conditions, and ensure the sustainability of projects in conditions of financial system instability.

Furman et al. (2023) suggest that staff motivation promotes productivity and employee engagement, which is particularly important for innovation-oriented cluster structures.

Velychko & Velychko (2017) analyze the management of shared use of agricultural machinery with the help of logistics systems, which is valuable for agroclusters since shared use of machinery allows to reduce costs and increase efficiency in cluster structures.

The scientific ideas of Kubitskyi et al. (2022) can be useful for agroclusters in terms of organizing training and improving the qualifications of personnel because the creation of training programs for employees of agroclusters helps to increase the professional level and improves the efficiency of the implementation of innovative projects.

The study of Yemelyanov et al. (2022) is important for agroclusters because ensuring information security is critical to protecting innovation and data. The use of such models will allow agroclusters to protect their innovations better and reduce the risks of intellectual capital loss.

The scientific findings of Spinelli et al. (2024) are important for agroclusters because they allow us to understand how resistance to innovation can affect the adoption of new technologies.

Michael et al. (2023) examines the impact of Internet technologies on the productivity of industrial clusters, which is valuable for agroclusters, as digital innovations contribute to increased management efficiency, resource optimization, and improved coordination.

Ponomarenko et al. (2018) explore strategic planning in universities. Although the article focuses on educational institutions, the principles of strategic planning can be useful for agroclusters as well. Strategic planning allows you to determine the long-term goals of clusters, effectively allocate resources, and increase the competitiveness of agribusiness in the smart economy.

The findings of Singh et al. (2023) are relevant for agroclusters since clean technologies are of great importance for the sustainable development of agribusiness, and the implementation of such technologies will contribute to reducing the environmental impact of clusters and increasing efficiency in a smart economic model.

Thus, these works cover various aspects, including motivation, resource management, information security, strategic planning, and clean technologies, which are key to the effective management of innovative projects in agrocluster structures.

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However, rapid changes in the external environment require a review of the philosophy of project management of innovatively oriented cluster business agro-structures in the smart economic model.

AIMS AND OBJECTIVES

The purpose of the article is to analyze and develop effective strategies for evaluating the management of projects of innovatively oriented cluster business agrostructures in the context of a smart economic model, taking into account the use of the latest technologies to optimize management processes and ensure the sustainable development of agrarian clusters.

Tasks of the article:

- to investigate modern innovative technologies and their impact on the development of agrarian clusters, in particular in the context of a smart economy;
- to develop a methodology for assessing the innovative potential and sustainability of cluster business agro-structures, in particular with the help of Harrington's desirability function and other tools;
- to analyze existing approaches to the use of digital and environmentally sustainable innovations in agricultural clusters, as well as their adaptation for small and medium-sized enterprises;
- to identify key success factors in the implementation of smart technologies in the agricultural sector and offer recommendations for improving management practices to ensure the competitiveness and sustainability of agricultural clusters.

METHODS

To study the project management system of innovatively oriented cluster business agro-structures in the smart economic model, the dynamic series method was used. The topic of using dynamic series in the management of projects of innovatively oriented cluster business agro-structures in the smart economic model involves the analysis and forecasting of the development of such structures over time, which allows for an increase in the efficiency of project management. Dynamic series, as a mathematical tool, helps to model changes in business processes, analyze trends, determine seasonal and cyclical fluctuations, and forecast future results.

The next tool is production functions. The construction of a linear trend for the production function in the context of project management of innovatively oriented cluster business agrostructures in the smart economic model involves the study of the dependence between the use of resources and the obtained results.

The article also uses Harrington's model, so in the management of projects of innovatively oriented cluster business agro-structures in the context of a smart economic model, it involves the use of a systemic approach to the management of projects aimed at introducing innovations into the agricultural sector. Harrington's model, based on the principles of quality and efficiency management, helps to optimize the processes of planning, implementation and monitoring of projects within such cluster structures. In a smart economic model that emphasizes the integration of digital technologies, sustainable development and efficient use of resources, the use of Harrington allows to create projects with a high level of efficiency and innovation. The application of this model helps to create a clear structure for managing innovation processes, to define the key stages of the project, and to assess the impact of each stage on the overall result. Using the Harrington model, it is possible to improve the quality of project management, optimize resources, and reduce costs, which is important in today's conditions of rapid changes and high competition in the agricultural sector.

Our article pays special attention to the analysis and evaluation of the following indicators: net income from sales of products, net profit, EBITDA and EBIT indicators. Net income from sales of products reflects the amount of funds received after deducting taxes, discounts and returns. In project management, this indicator assesses market success, the degree of demand for products, and the effectiveness of sales strategies. High net income indicates successful sales of goods and allows you to plan for expansion of production or diversification of the range. Net profit determines the balance of financial resources after covering all costs, including taxes, operating expenses, and other mandatory payments. In the context of project management, this indicator is used to assess the economic sustainability of the enterprise, determine dividend policy, finance innovations, and increase the level of investment in the modernization of production. EBITDA indicator demonstrates operating profit excluding debt service costs, taxes, and depreciation. It is used to assess the internal effi-

ciency of the business, showing how much the enterprise earns solely due to its core activities. This indicator helps investors and managers assess the profitability of projects, the effectiveness of cost management, and the potential for future investments. The EBIT indicator reflects the company's profit before taxes and interest on loans, including depreciation expenses. In the management of agricultural projects, it is used to analyze the profitability of the main activity, assess the efficiency of production processes, and compare competitiveness in the market. High values of this indicator indicate the ability of the business to generate significant financial results even under the conditions of debt burden. The use of these financial indicators allows for a comprehensive assessment of the financial stability, operational efficiency, and profitability of innovation-oriented agricultural clusters, which contributes to making informed management decisions.

RESULTS

Taking into account the relevance of the proposed topic, we will conduct a practical study of the project management system of innovatively oriented cluster business agro-structures in the smart economic model. In our view, it is important to determine the author's definition of the term innovative potential and to clarify what exactly we understand by it in our article. Thus, innovative potential is determined by the ability of an enterprise to generate economic value by implementing new ideas, technologies or processes. It is revealed through financial indicators that reflect the effectiveness of activities: net income from product sales signals competitiveness in the market, and net profit demonstrates the ability to maintain sustainability in the long term. EBITDA and EBIT indicators indicate the productivity of core activities without taking into account depreciation and financial expenses, reflecting the ability to invest in new projects. Thus, the economic dimension of innovative potential reflects the integration of financial results with the strategic vision of the enterprise's development.

In the context of our scientific article, the use of various terms such as strategy, methodology, management, and evaluation reflects a multi-level approach to the organization of the management process. Management in this case acts as an integrating category that covers planning, implementation, monitoring and evaluation of projects. Strategy indicates the general direction of development and definition of key goals of agricultural structures, which ensures long-term competitiveness. Methodology refers to the approaches, methods, and tools used to implement and control innovative solutions. Evaluation processes are a component of management, as they provide feedback and support the adoption of informed management decisions. Analysis, as part of the assessment, allows you to identify the strengths and weaknesses of the project, assess the level of achievement of the set goals, and determine further steps. Thus, the concept of management performs an integrative role, including all of the above functions, which together form an effective project management system in the smart economic model of agricultural clusters. The use of different terms is justified due to the complexity of the process, the multifaceted nature of the tasks, and the need for a systematic approach to organizing innovative business structures.

To achieve the goal and objectives of the research, we will use the opinions of experts in the agricultural sector, mathematical and economic-statistical models of the study of this topic. In Ukraine, there are Ukrainian agroclusters "Oberig" (rural green tourism), "First agrarian cluster" (producers of fruit and berry products of the Chernivtsi region), Regional Rivne agro-industrial cluster "Agroinnovation" (introduction of innovations in the agrarian industry of the region); "Natural milk" (support of business interaction in the field of dairy farming).

On the basis of statistical, economic, and financial reporting, we will conduct an analysis of the main indicators of the business agro-structures of the Natural Milk cluster (PSP Ukraine Limited Liability Company of Rivne Region; Agricultural Limited Liability Company "Progress-Plus" of Lviv Region; Limited Liability Company "Roztotske" of Ternopil region). Analyzing the results of the activities of business agro-structures of the "Natural Milk" cluster in the period 2019–2023, we can see different trends in the financial indicators of enterprises from different regions of Ukraine. LLC "PSP Ukraine" from the Rivne region shows a decrease in net income from the sale of products, especially after 2021. However, despite the drop in revenue, the company maintains a stable level of net profit, albeit with a slight decline in 2022-2023. The company's assets continue to grow, while liabilities increased substantially in 2021 and remain high. LLC "Roztotske" from the Ternopil region shows unstable results with negative net profit in 2019-2021, which changes to positive in 2022 and 2023. Revenue from product sales recovers from a decline in 2021, peaking in 2023. The company's assets remain at almost the same level, and liabilities are slightly reduced, which indicates a possible stabilization of the financial situation. "Progres-Plus" sewage treatment plant from the Lviv region shows stable growth in net income from product sales, reaching the highest values in 2023. Although net income and financial results from operations fluctuate slightly, they remain at a high level, which ensures the stability of the indicators of return on equity and assets. Despite a slight decrease in ROE since 2019, there is an upward trend in 2023.

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The general analysis indicates that the most stable and successful enterprise is STOV "Progress-Plus," while LLC "Roztotske" is gradually improving its financial indicators, and LLC "PSP Ukraine" shows mixed results, in particular in terms of income. In general, we observe stable performance indicators of business agro-structures of the "Natural Milk" cluster over the past five years. Next, we calculate and analyze the EBIT and EBITDA indicators of business agro-structures of the Natural Milk cluster over the past five years.

In the smart economic model for project management of innovatively oriented cluster business agro-structures, EBIT and EBITDA indicators are of critical importance. EBIT (earnings before interest and taxes) allows you to evaluate the efficiency of the main activity of agricultural companies without taking into account tax and debt obligations, reflecting the ability to generate operating profit. This is a key indicator for comparing agricultural structures of different regions or sectors, as it excludes the influence of differences in the financial structure and tax environment. EBITDA (earnings before interest, taxes, depreciation, and amortization) is an even more in-depth measure of operating efficiency because it does not additionally take into account depreciation expenses. It enables innovative agricultural companies to demonstrate their real operating ability to generate profits for a longer period of time without asset depreciation. EBITDA is an important indicator for potential investors who assess the sustainability of cash flows and enables companies operating in the smart economy to demonstrate their ability to grow financially and develop innovative solutions despite high investments in technology and equipment. Thus, in the smart economy model for cluster agribusinesses, these indicators reflect financial stability, operational efficiency, and potential for scaling, which contributes to effective management decisions and investment attraction (Table 1).

Table 1. Dynamics of EBIT and EBITD indicators of business agro-structures of the "Natural Milk" cluster, 2019-2023.

EBIT and EBITD indicators "PSP Ukraine" Rivne region, UAH thousand					
Indicators	2019	2020	2021	2022	2023
EBITDA	4809.23	4825.23	4672.20	1536.70	1369.50
EBIT	4663.23	4671.23	4391.00	828.20	233.80
EBIT and EBITD indicators of LLC "Roztotske" Ternopil region, UAH thousand					
EBITDA	34039	34249	34459	36669	38879
EBIT	33893	34095	34297	36499	38701
EBIT and EBITDA indicators STOV "Progres-Plus," UAH thousand					
EBITDA	88192	99301	95610	94852	99094
EBIT	87893	99128	95363	94598	98833

A graphical comparison of performance indicators of business agro-structures of the "Natural Milk" cluster for the last year of 2023 is presented in Figure 1. As we can see, in the leaders in terms of indicators of successful production, financial management and efficiency and effectiveness of activities for the last year of 2023 "Progres-Plus" filling station, Lviv region.

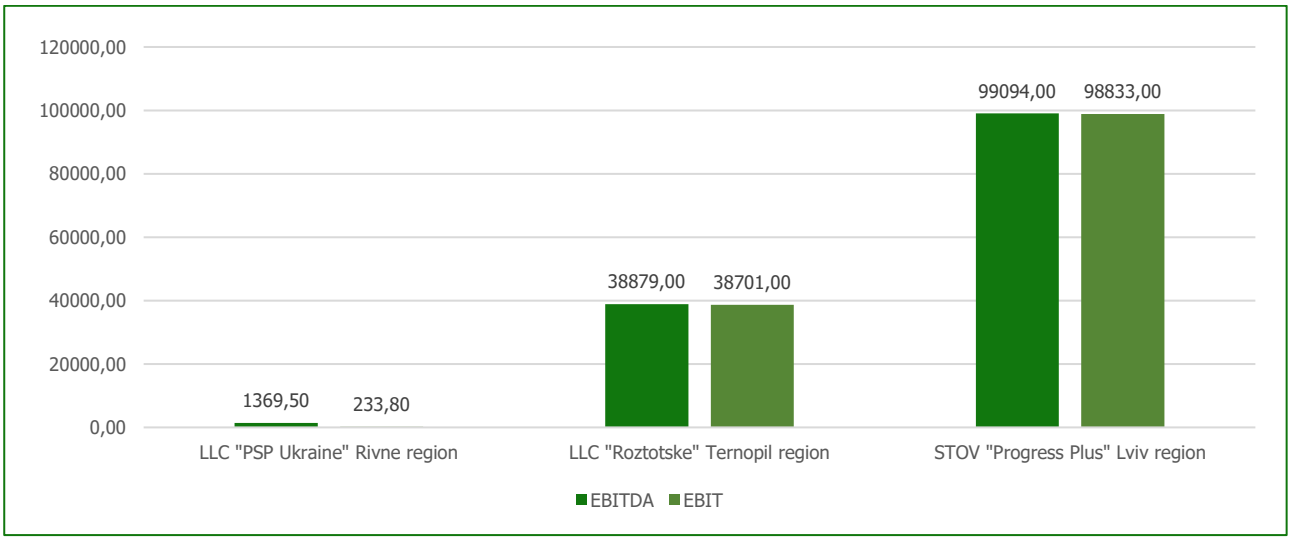

Figure 1. Comparative characteristics of EBIT and EBITD indicators of agricultural enterprises, cluster - "Natural milk," 2023.

Let's analyze the following cluster, which has been operating since 2009 in the Chernivtsi region, namely the "First Agrarian Cluster," which includes fruit and berry production enterprises of the Chernivtsi region (LLC "Gold Romy" and LLC "Sunny Garden" of the Chernivtsi region. Analyzing the financial performance of Gold Romy LLC from 2019 to 2023, fluctuations in net income from product sales are noticeable: after a significant increase in 2019–2021 to UAH 27,646.90 thousand in 2021 will see a sharp drop to UAH 8,505.70 thousand in 2022, with further recovery in 2023 to UAH 15,710.10 thousand. Net profit shows similar dynamics, in particular a significant decrease in 2022, although in 2023, it rises to UAH 875.00 thousand, which still does not reach the level of 2021. The company's assets peaked in 2021 but declined in 2022 and 2023. The company's liabilities show a similar trend, increasing until 2021 and gradually decreasing in 2022 and 2023. For "Sunny Garden" LLC, financial indicators demonstrate stability and gradual growth. Net income from product sales is constantly growing, reaching UAH 17,969.80 thousand in 2023. Net profit, although significantly higher than revenue, decreased in 2020 and 2022 but recovered to UAH 26,885.67 thousand in 2023. The company's assets increased sharply in 2021 and remain stable at the level of more than UAH 120,000 thousand in the following years. Commitments also increased, peaking in 2023. In general, "Gold Romy" shows unstable dynamics of revenues and profits, possibly due to external market factors or internal financial challenges, while "Sunny Garden" shows a more stable and predictable development with positive dynamics of revenues and increasing assets, which increases its financial sustainability. Table 2 shows the dynamics of EBIT and EBITDA of innovatively oriented business agro-structures of the "First Agricultural Cluster" cluster of Chernivtsi region, 2019-2023.

Table 2. Dynamics of EBIT and EBITDA of innovatively oriented business agro-structures of the "First Agricultural Cluster" cluster of Chernivtsi region, 2019-2023.

EBIT and EBITDA indicators LLC "Gold Romy," UAH thousand					
Indicators	**2019**	**2020**	**2021**	**2022**	**2023**
EBITDA	27614.00	30105.40	30105.40	29251.10	40404.70
EBIT	23198.00	24852.00	24852.00	15156.80	21610.90
EBIT and EBITDA indicators LLC "Sunny Garden," UAH thousand					
Indicators	**2019**	**2020**	**2021**	**2022**	**2023**
EBITDA	78066.00	91344.00	91344.00	92100.00	91478.00
EBIT	43850.00	35536.00	35536.00	34108.00	34227.33

Summary graphical comparison of performance indicators of business agro-structures of the "First Agrarian Cluster" cluster of Chernivtsi region for the last year of 2023 is presented in Figure 2. According to information processing data, the studied economic entities have positive financial results, which indicates the stability of the production of the entire activity cycle.

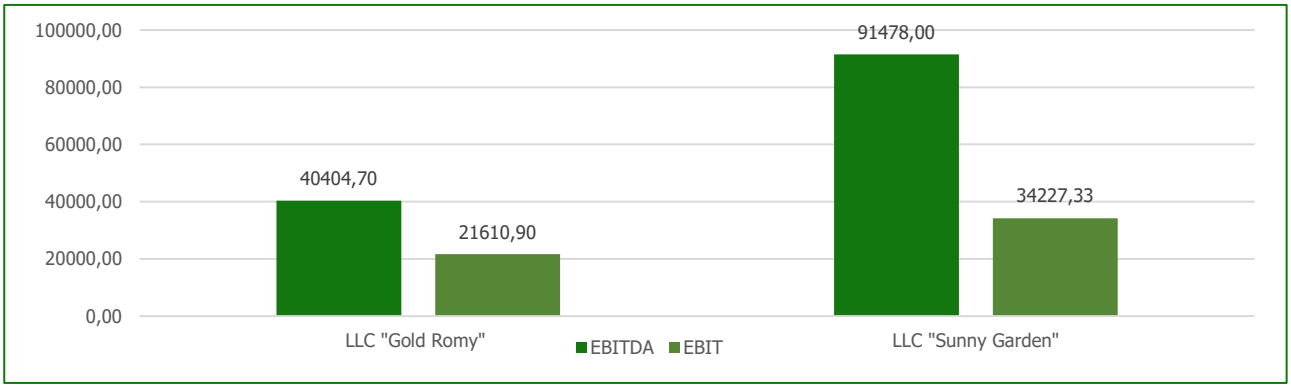

Figure 2. Comparative characteristics of EBITDA and EBIT indicators of fruit and berry producers of Chernivtsi region, cluster - "First Agrarian Cluster," 2023.

Next, we calculate statistical indicators for further analysis and forecasting of net income from the sale of products of the researched innovatively oriented business agro-structures. Analytical characteristics of the net income from the sale of products of the researched innovatively oriented business agro-structures provide a detailed analysis of the dynamics of this indicator for 2019-2023. In particular, the comparison of enterprises according to the average level of net income shows that the "Progress-Plus" gas station of the Lviv region has the highest average net income (UAH 200.329 thousand), which indicates its significant economic power. LLC "PSP Ukraine" of the Rivne region has the lowest average level of net income among the respondents (UAH 1,141 thousand). The rates of growth and growth indicate that LLC "Roztotske" of the Ternopil region showed the highest growth, with an average base and chain growth rate of 6.85%. At the same time,

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LLC "Gold Romy" of Chernivtsi region shows a significant decrease of 25.27%, which indicates a decrease in income compared to previous years. Variation and stability of income show that STOV "Progress-Plus" has a high coefficient of stability (0.93) and low variation, which indicates the stability of its income, with a very low coefficient of variation (0.07 or 7.46%). LLC "PSP Ukraine" is characterized by significant volatility with a high coefficient of variation (0.47 or 46.87%). The coefficient of elasticity of "PSP Ukraine" LLC shows a high negative coefficient of elasticity (-0.84), which indicates a significant sensitivity of net income to changes in factor conditions. At that time, "Progress-Plus" WWTP has a low elasticity coefficient (0.15), which indicates low sensitivity to such changes. The range of fluctuations shows that the variation of income at STOV "Progress-Plus" is UAH 45.148 thousand, which is a relatively small range of fluctuations, but at LLC "PSP Ukraine," this indicator is much higher, which confirms the high level of instability. Thus, the analysis shows that among all enterprises of STOV, "Progress-Plus" demonstrates the best stability of income and the least variation, while LLC "PSP Ukraine" has the greatest instability and sensitivity of income to changes.

The next stage is the construction of a linear trend - a production function. As a result of calculations, the coefficients of the equation were obtained:

- LLC "PSP Ukraine" of the Rivne region a1= -321.03 and a0=2104.45;
- LLC "Roztotske" of Ternopil region a1= 66.14 and a0=1227.64;
- STOV "Progress-Plus" of Lviv region a1= 9787.00 and a0=170968.00;
- LLC "Gold Romy" of Chernivtsi region a1= -3023.51 and a0=28857.67;
- LLC "Sunny Garden" of Chernivtsi region a1= 626.96 and a0=14627.24.

The production function of the linear trend of net income from the sale of products of the researched innovation-oriented cluster business agro-structures over the past five years looks like this:

- LLC "PSP Ukraine" of the Rivne region Y= 2104.45- 321.03 X;
- LLC "Roztotske" of Ternopil region Y= 1227.64+ 66.14 X;
- STOV "Progress-Plus" of Lviv region Y= 170968.00+ 9787.00 X;
- LLC "Gold Romy" of Chernivtsi region Y= 28857.67- 3023.51 X;
- LLC "Sunny Garden" of Chernivtsi region Y= 14627.24+626.96 X.

In order to automate, compare and optimize the analysis of the net income from the sale of products of the researched innovation-oriented cluster business agro-structures, economic and statistical modeling can be carried out. Analytical alignment makes it possible to make a forecast of the net income from the sale of products of the researched innovation-oriented cluster business agro-structures for the next year 2025 (Table 3).

Table 3. Forecast value of net income from the sale of products of the researched innovation-oriented cluster business agro-structures, 2025.

Cluster - "Natural milk"		
LLC "PSP Ukraine" of the Rivne region		
Year	Sequence number of the time dimension, (x)	Net income from product sales, UAH thousand, (Y)
2025	7	271,18
LLC "Roztotske" of Ternopil region		
Year	Sequence number of the time dimension, (x)	Net income from product sales, UAH thousand, (Y)
2025	7	1743,53
STOV "Progress-Plus" of Lviv region		
Year	Sequence number of the time dimension, (x)	Net income from product sales, UAH thousand, (Y)
2025	7	239477,00
Cluster - "First Agrarian Cluster"		
LLC "Gold Romy" of Chernivtsi region		
Year	Sequence number of the time dimension, (x)	Net income from product sales, UAH thousand, (Y)
2025	7	16763,63
LLC "Sunny Garden" Chernivtsi region		
Year	Sequence number of the time dimension, (x)	Net income from product sales, UAH thousand, (Y)
2025	7	18389,00

Analyzing the forecast values of the net income from the sale of products of the researched innovatively oriented cluster business agro-structures for the next year, 2025, the following can be noted. For each of the clusters, it is indicated how much money the company plans to earn from the sale of products. The "Natural Milk" cluster consists of three companies: LLC "PSP Ukraine" from the Rivne region, "TZOV Roztotske" from the Ternopil region, and STOV "Progress-Plus" from the Lviv region. Their projected revenue from product sales varies from UAH 271.18 thousand to UAH 239,477.00 in the largest company of this cluster. The second cluster, the "First Agrarian Cluster", includes the companies "Gold Romy" and LLC "Sunny Garden", both from the Chernivtsi region. The net income of these enterprises is significantly lower compared to the "Natural milk" cluster, while the figures are UAH 16,763.63 thousand and UAH 18,389.00 thousand, respectively. The analysis of this table shows that the largest income in 2025 is expected from the company ST OV "Progress-Plus" within the "Natural milk" cluster, while the companies in the "First Agrarian Cluster" cluster have significantly lower indicators. Graphically, the actual, theoretical and forecast value of the net income from the sale of products of the researched innovation-oriented cluster business agro-structures, 2019-2023, 2025 is presented in Figures 3-7.

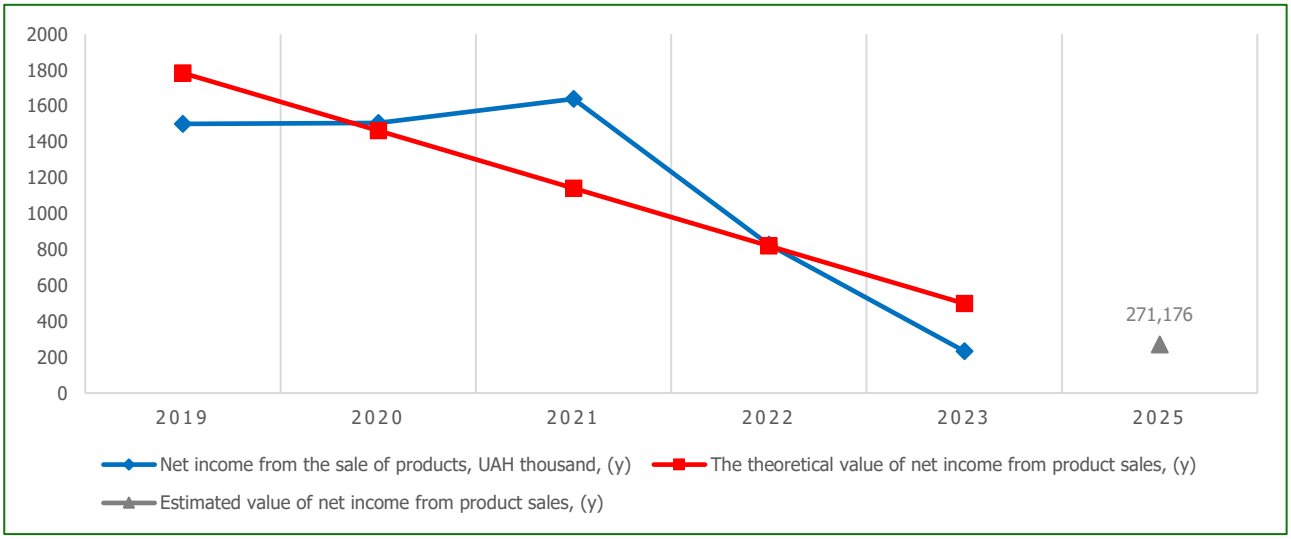

Figure 3. Actual, theoretical and forecast value of net income from the sale of products of LLC "PSP Ukraine" of the Rivne region - cluster - "Natural milk", 2019-2023, 2025.

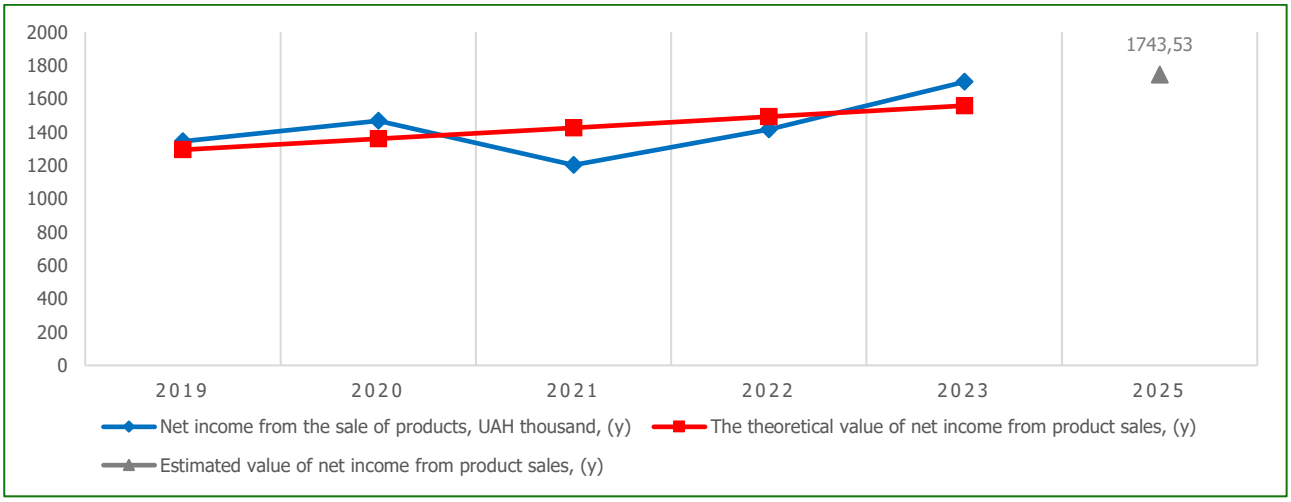

Figure 4. Actual, theoretical and forecast value of net income from the sale of products of LLC "Roztotske" of Ternopil region - cluster - "Natural milk", 2019-2023, 2025.

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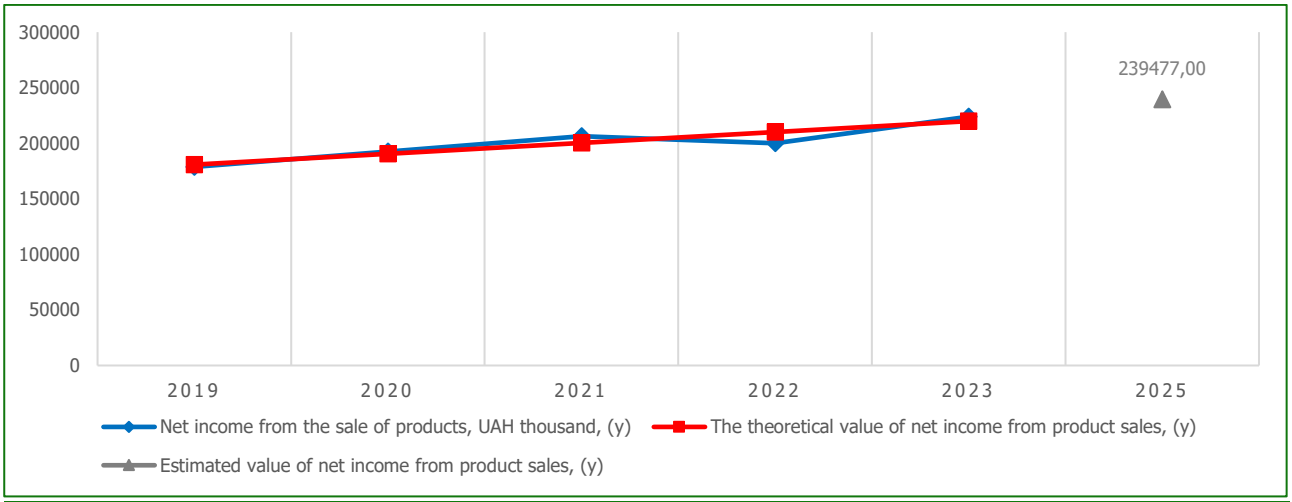

Figure 5. Actual, theoretical and forecast value of net income from the sale of products of the STOV "Progress-Plus" of Lviv region - cluster - "Natural milk", 2019-2023, 2025.

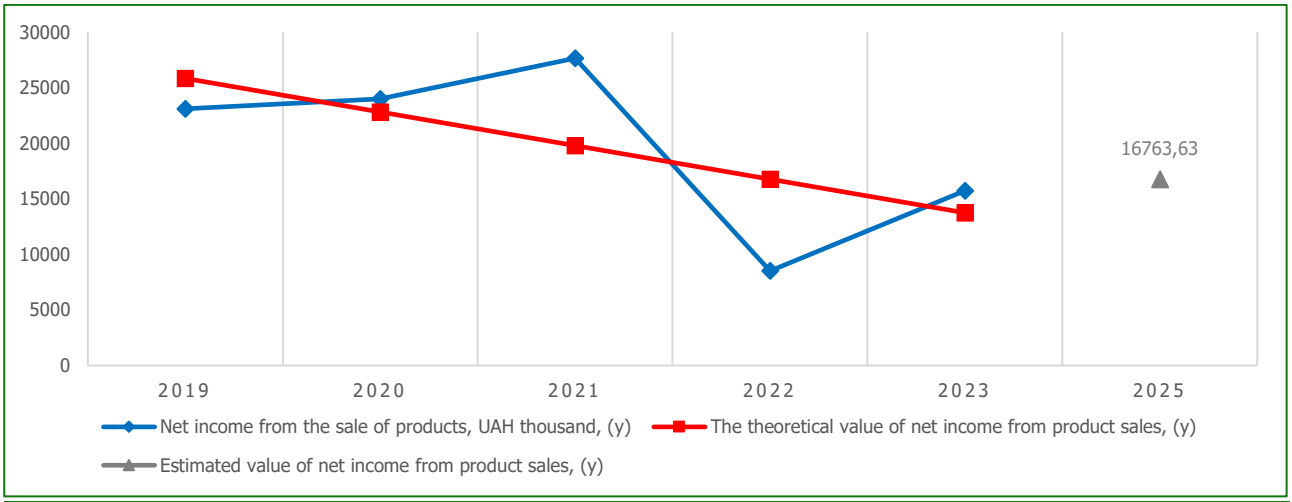

Figure 6. Actual, theoretical, and forecast value of net income from the sale of products of LLC "Gold Romy" of Chernivtsi region - cluster - "First Agrarian Cluster," 2019-2023, 2025.

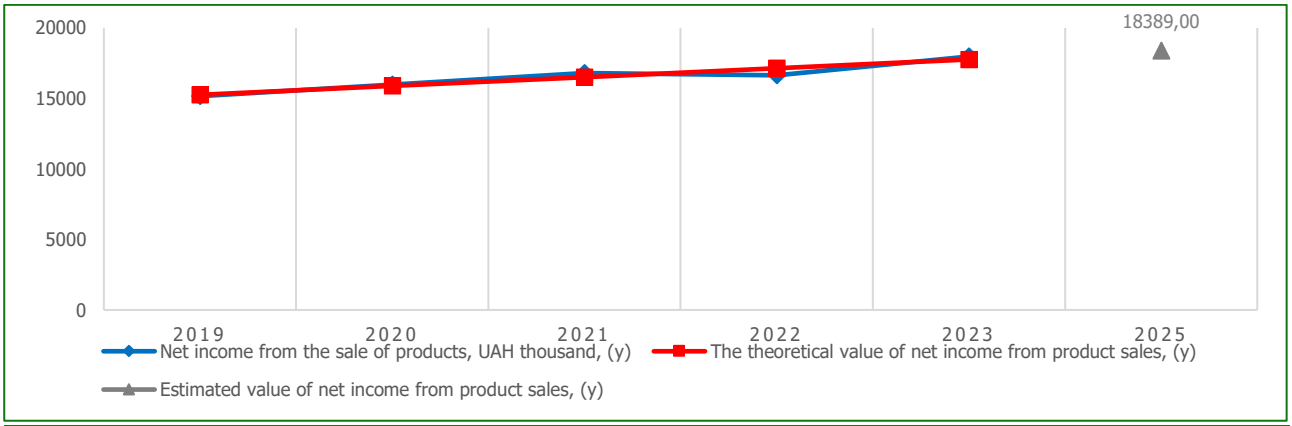

Figure 7. Actual, theoretical, and forecast value of net income from the sale of products of LLC "Sunny Garden" of Chernivtsi region - cluster - "First Agrarian Cluster," 2019-2023, 2025.

At the final stage of this block of research, a comparative characterization of the actual and forecast values of net income from the sale of products of the researched innovation-oriented cluster business agro-structures was carried out, 2023, 2025 (Table 4).

Table 4. Comparative characteristics of the actual and forecast values of net income from the sale of products of the researched innovation-oriented cluster business agro-structures, 2023, 2025.

Comparative characteristics of actual and forecast values of net income from the sale of products of agrarian enterprises of the Natural Milk cluster, 2023, 2025.						
Enterprises	**Net income from product sales, UAH thousand, 2023**	**Net income from product sales, UAH thousand, 2025**	**Deviation, +, - 2025 from 2023**	**Characteristic**	**Absolute deviation, % 2025 from 2023**	**Characteristic**
LLC "PSP Ukraine" of the Rivne region	233.80	271.18	37.38	growth	15.99%	growth
LLC "Roztotske" of Ternopil region	1700.80	1743.53	42.73	growth	2.51%	growth
STOV "Progress-Plus" of Lviv region	223903.00	239477.00	15574.00	growth	6.96%	growth
Comparative characteristics of actual and forecast values of net income from the sale of products of producers of fruit and berry products of Chernivtsi region, cluster "First Agrarian Cluster," 2023, 2025.						
LLC "Gold Romy" of Chernivtsi region	15710.10	16763.63	1053.53	growth	6.71%	growth
LLC "Sunny Garden" of Chernivtsi region	17969.80	18389.00	419.20	growth	2.33%	growth

An illustrative comparison of the actual and forecast values of net income from the sale of products of the researched innovation-oriented cluster business agro-structures, 2023, 2025, is presented in Figure 8 and Figure 9.

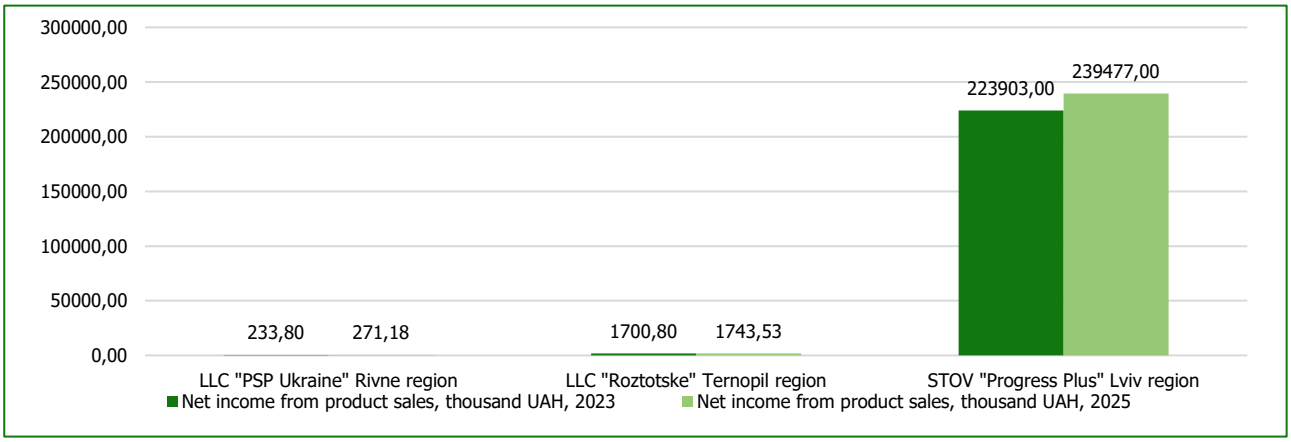

Figure 8. Graphical comparison of actual and forecast values of net income from the sale of products of agrarian enterprises of the Natural Milk cluster, 2023, 2025.

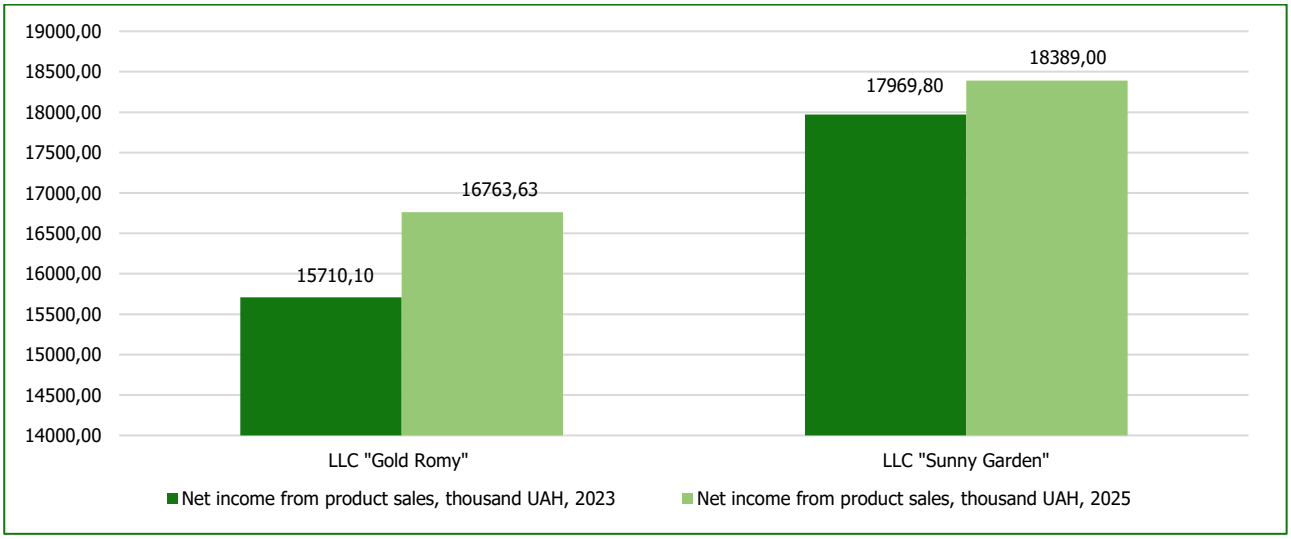

Figure 9. Graphical comparison of the actual and forecast values of net income from the sale of products of producers of fruit and berry products of the Chernivtsi region, cluster "First Agrarian Cluster," 2023, 2025.

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So, the summary of this block of conducted research, the use of dynamic series, their analysis, and forecasting allows effective management of projects of innovatively oriented cluster business agro-structures in a smart economic model.

The next block of research, analysis, modeling, and forecasting of the project management system of innovation-oriented cluster business agro-structures in the smart economic model can be used to calculate the integral indicator of the efficiency of the innovative enterprise (Harrington's function). The justification for the selection of factor characteristics and the effective indicator of innovatively oriented cluster business agro-structures for the study of the management system of these economic entities using the model for calculating the integral indicator of the efficiency of the innovative enterprise (universal indicator - Harrington's desirability (advantage) function) for the last five years is obvious and justified:

- net income from product sales, UAH thousand;
- net profit, UAH thousand;
- EBITDA indicator, UAH thousand;
- EBIT indicator, UAH thousand.

The next stage of calculating actual and forecast indicators according to Harrington's partial desirability function of the evaluation of the management system of innovatively oriented cluster business agro-structures for the last studied period Figures 10-14.

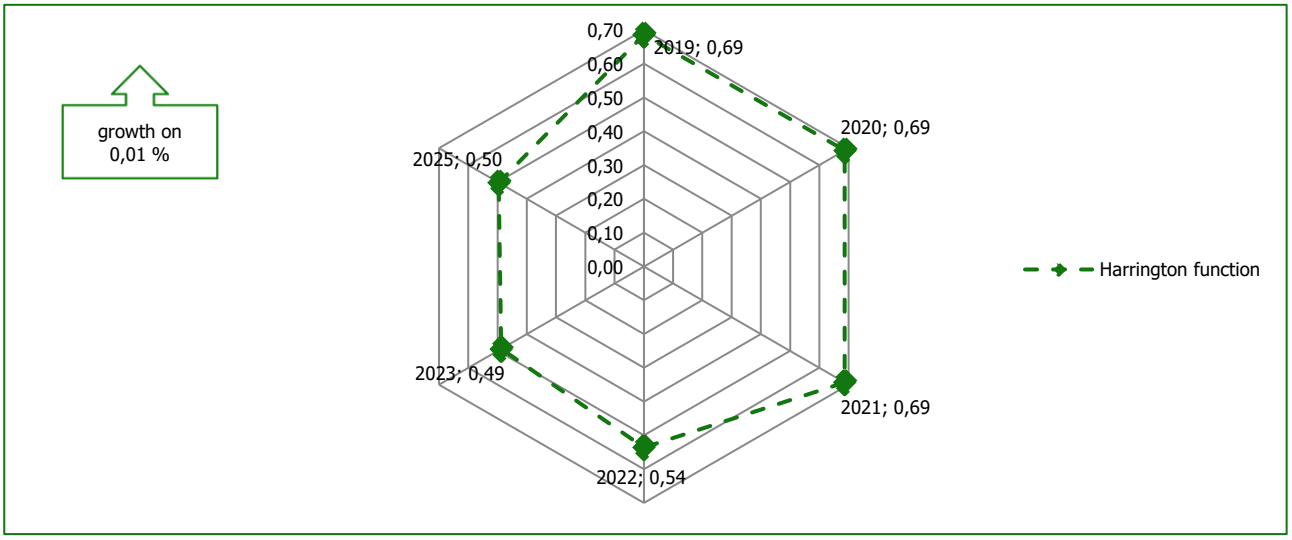

Figure 10. Indicators according to Harrington's partial desirability function of LLC "PSP Ukraine" Rivne region cluster - "Natural milk," 2019-2023, 2025.

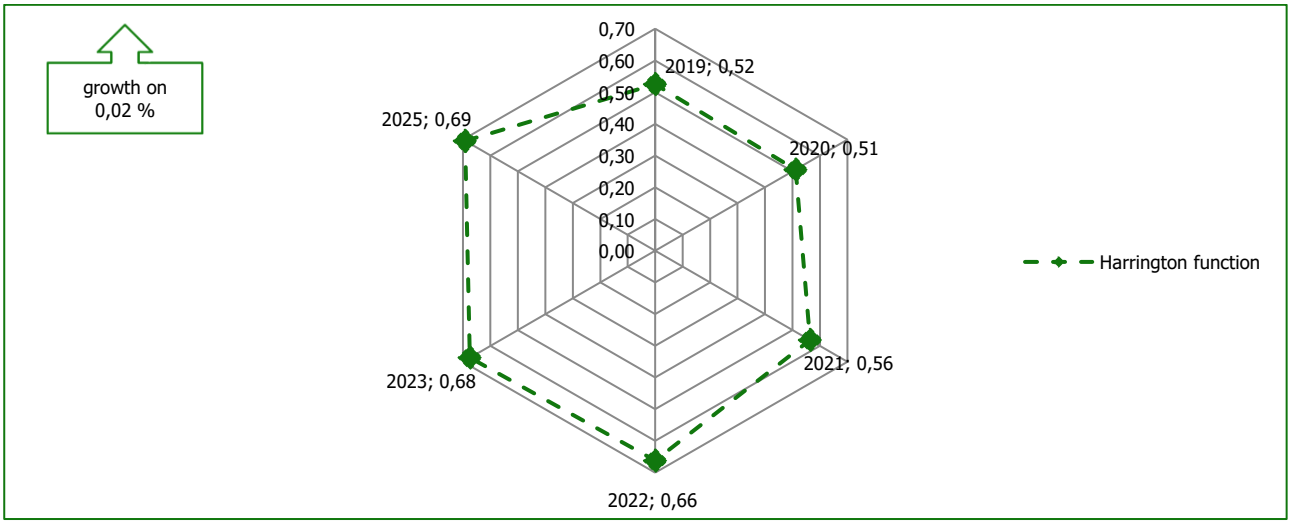

Figure 11. Indicators according to Harrington's partial desirability function LLC "Roztotske" of Ternopil region cluster - "Natural milk, 2019-2023, 2025.

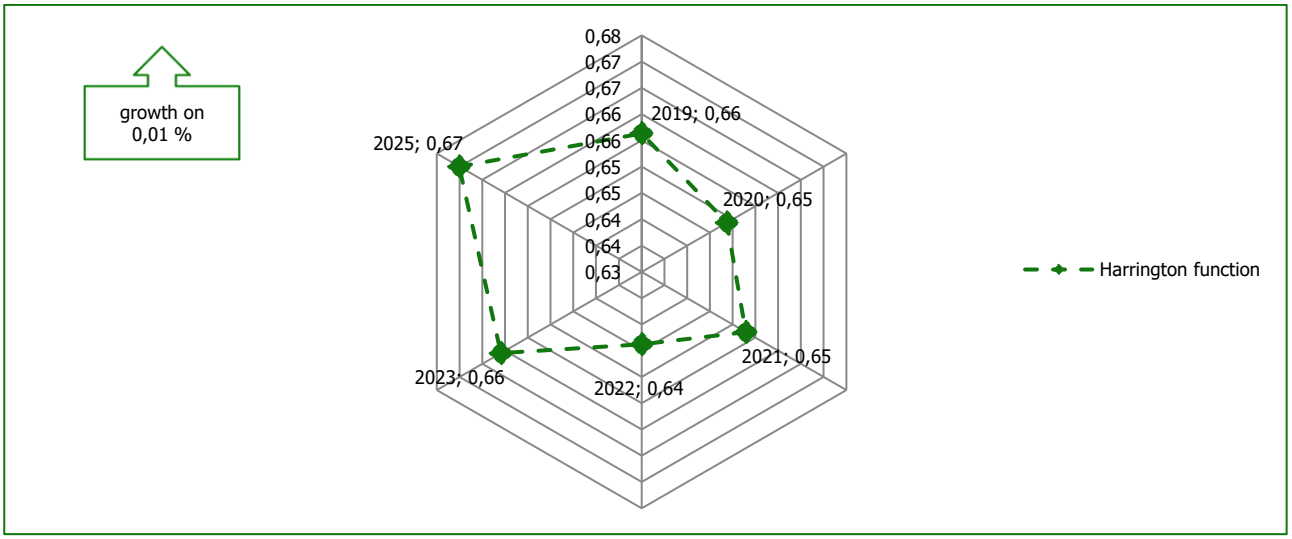

Figure 12. Indicators according to Harrington's partial desirability function of the "Progress-Plus" STOV of the Lviv region cluster - "Natural milk," 2019-2023, 2025.

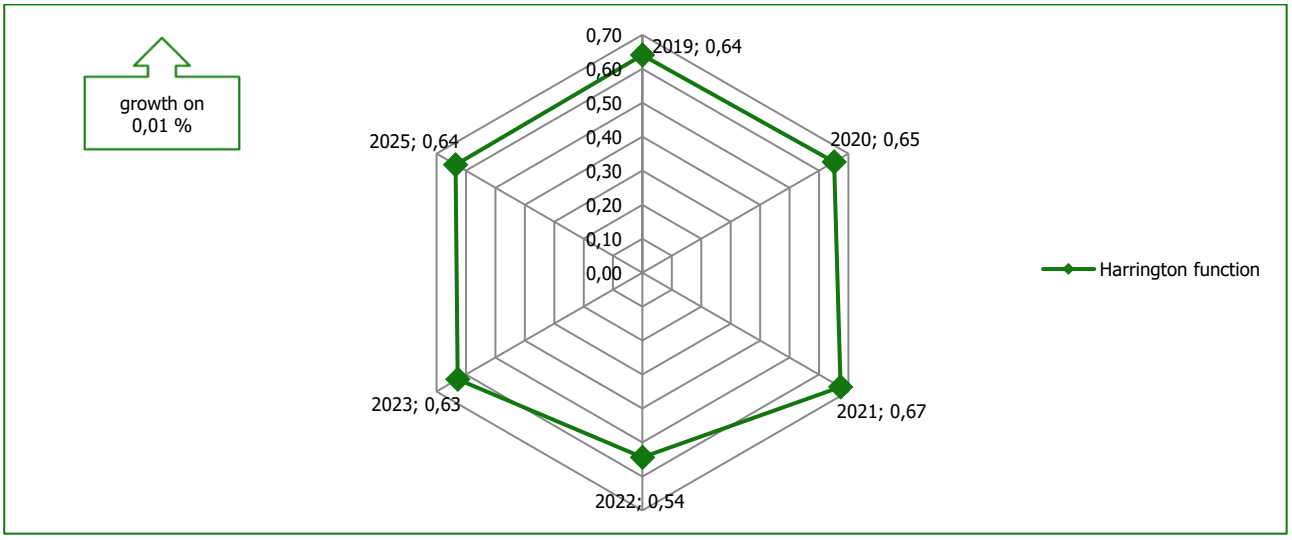

Figure 13. Indicators according to Harrington's partial desirability function of "Gold Romy" LLC of Chernivtsi region cluster - "First agrarian cluster," 2019-2023, 2025.

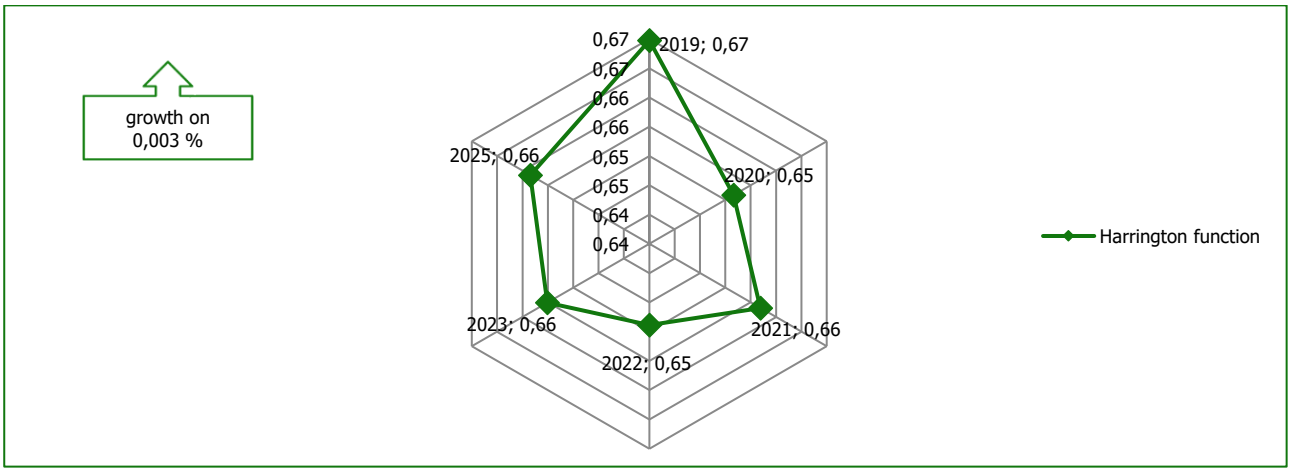

Figure 14. Indicators according to Harrington's partial desirability function of "Sunny Garden" LLC, Chernivtsi region cluster - "First Agrarian Cluster," 2019-2023, 2025.

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The last stage of this block of research into the management system of innovatively oriented cluster business agro-structures is a comparison and graphical representation of correlation coefficients, coefficients of determination, calculated and characterized in advance using dynamic series, and a universal indicator - Harrington's desirability function, qualitative coefficients for evaluating the activities of business entities, 2019-2023, 2025 (Figures 15-16).

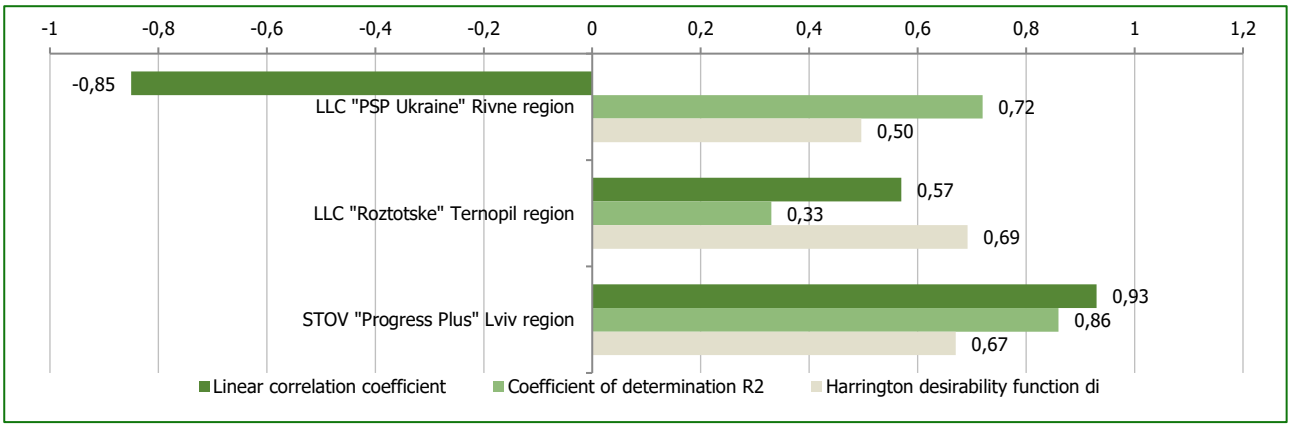

Figure 15. Comparative characteristics of the coefficients of correlation and determination, as a determinant of the dependence and quality of production models and a universal indicator - Harrington's desirability function, as a determinant of innovativeness of economic entities of cluster business agro-structures in the smart economic model of enterprises of the "Natural Milk" cluster, 2019-2023, 2025.

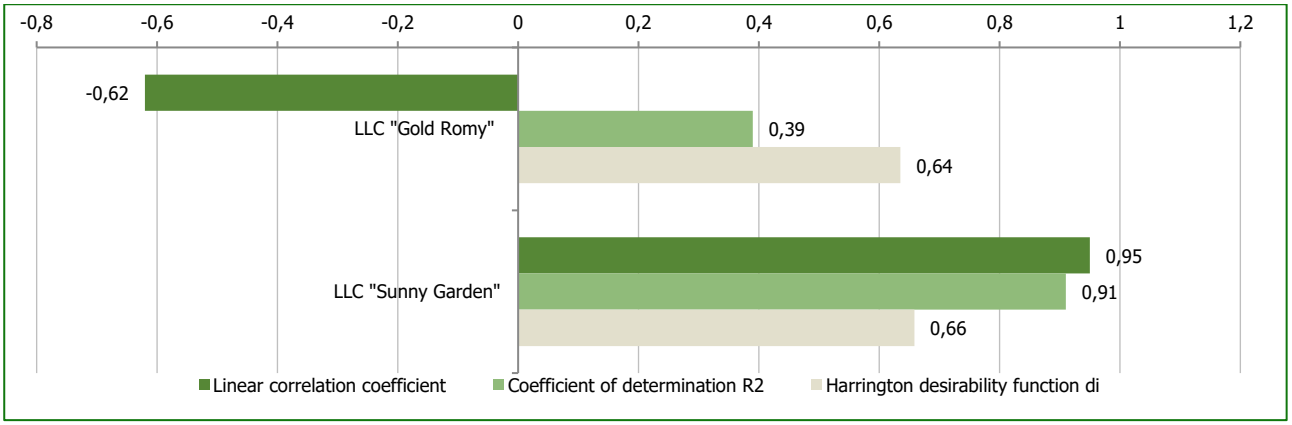

Figure 16. Comparative characteristics of the coefficients of correlation and determination, as a determinant of the dependence and quality of production models and a universal indicator - Harrington's desirability function, as a determinant of innovativeness of business entities of cluster business agro-structures in the smart economic model of enterprises of the "First Agrarian Cluster" cluster, 2019-2023, 2025.

Analysis of figures depicting the comparative characteristics of correlation and determination coefficients together with Harrington's desirability function for cluster business agro-structures allows us to draw conclusions about the relationships between various factors and the level of innovativeness of enterprises in each of the clusters. Figures 15-16 demonstrate a comparison between two groups of clusters — "Natural Milk" and "First Agrarian Cluster" — in the context of evaluating the activity of their business entities using correlation and determination coefficients that determine the degree of dependence and quality of production models. They allow us to assess the extent to which production processes and innovations in these clusters are interconnected and to the extent that these processes meet the requirements of the smart economic model. Correlation coefficients indicate the level of relationship between different variables related to innovative and production aspects of activity. Coefficients of determination, in turn, assess how much of the changes in performance can be explained by the influence of other variables. The interaction of these coefficients with the Harrington desirability function, which is used to evaluate the innovativeness of enterprises, helps to obtain a more comprehensive picture of the efficiency of clusters, taking into account various factors.

Figures 15-16 show how the value of these coefficients' changes during 2019-2023 and in the forecasted year 2025. Such changes may reflect the influence of various internal and external factors, such as the modernization of production processes, the introduction of new technologies, or changes in the policy of agricultural sector development. For example, in the Natural Milk cluster, there may be more visible trends to improve results due to innovative approaches in production,

while in the First Agrarian Cluster, indicators may be lower due to other organizational or technological challenges. Harrington's desirability function acts as a universal indicator that allows you to assess the desirability of changes in production processes for business agro-structures. In combination with the coefficients of correlation and determination, it allows not only to determine innovativeness but also to forecast the further development of enterprises in the context of the smart economy, helping to make strategic management decisions. Thus, the analysis of the drawings makes it possible to identify the key factors that determine the success and innovativeness of cluster business agro-structures, as well as to assess their ability to adapt to rapidly changing market conditions and technological challenges.

Based on data analysis, several recommendations for enterprises can be formulated. Firstly, the enterprises of the agrarian sector, which are part of the clusters, need to focus on improving the quality of their production models, as this directly affects their innovation potential. Given that correlation and determination coefficients show the degree of dependence between innovative processes and business efficiency, enterprises should focus on optimizing internal production processes, which will allow for reducing inefficiency and improving results, in particular in the production of natural products and products that meet the requirements of the smart economy. Secondly, enterprises should actively use universal indicators, such as Harrington's desirability function, to evaluate the innovativeness of their projects, which will allow them to more accurately measure and compare the innovative potential of different business agro-structures, on the basis of which it is possible to develop purposeful development strategies, focusing them on maximizing desired results and risk minimization. Further, to ensure stability and competitiveness, it is important to consider that innovations should be not only technological but also economic and social. The evaluation of the coefficients of correlation and determination for different periods allows us to understand how changes in innovative activity affect the performance, which makes it possible to promptly adjust strategies to support the stable development of agrarian clusters. Enterprises should also pay special attention to the integration of smart technologies into their strategies, in particular, to optimize management processes and reduce costs. Innovative technologies such as digitization, blockchain, and other smart solutions can provide greater transparency, lower operating costs, and increase the efficiency of production processes. Given the high innovation activity in such clusters as "Natural Milk" and "First Agrarian Cluster," these technologies can become a key element in project management.

In general, enterprises must constantly monitor innovation trends and adjust their strategies depending on the results of the evaluation of innovativeness and quality of production processes. Thus, through the strategic implementation of the latest technologies and the use of universal indicators, it is possible to achieve significant progress in the development of cluster business agro-structures, ensuring sustainable economic development and competitiveness in a smart economic environment.

DISCUSSION

The conducted analysis allows us to identify several shortcomings and debatable points in the context of project management of innovatively oriented cluster business agro-structures in the smart economic model. In works devoted to innovative cluster structures, such as Rehman et al. (2023) and Maraveas et al. (2024), the main focus is on the application of the latest technologies (e.g., quantum computing) in the field of agriculture. However, these works often do not take into account the specific challenges that agricultural enterprises face in the context of local markets, such as the adaptation of technologies to small and medium-sized farms. In addition, the issue of integration of such technologies into the national infrastructure of agrarian business also remains insufficiently considered. So, in general, these works pay insufficient attention to the specifics of agrarian clusters.

In the following scientific works, the study of social aspects and the impact on small business, which are important in the formation of a smart economy, is limited. Works, Wu et al. (2023) and Xu et al. (2023) focused on innovation in the context of large or capital-intensive enterprises, which may limit the applicability of the results to small and medium-sized agricultural enterprises where financial and institutional resources are limited. It is important to investigate how innovative technologies can be adapted for small producers and contribute to their integration into a smart economic model, which is an important component of the effective functioning of cluster business agro-structures.

Many of the cited works focus on the technological aspects of innovation, such as the integration of smart technologies or technological computing (Maraveas et al., 2024), but do not pay enough attention to the economic efficiency of implementing such models in the real agricultural sector. More research is needed that assesses the costs of implementing such innovations and their economic sustainability, especially in the face of a changing market and global challenges.

In works such as Arnold et al. (2024) and Zhyvko et al. (2022), there are attempts to assess the impact of innovative technologies on various sectors of the economy, but insufficient attention is paid to the development of clear criteria for

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measuring innovativeness in the agricultural context. For a full-fledged analysis of the effectiveness of innovations in cluster business agro-structures, it is necessary to develop adapted tools and methodologies that take into account the specifics of agricultural production and the diversity of cluster participants.

Some works, including Sun et al. (2024) and Costantini et al. (2023), focus on the impact of climate change and sustainable development on agriculture, but often, these studies do not link social and environmental innovations to management patterns in agricultural clusters. In smart economic models, it is especially important to combine innovative and ecological approaches, as well as take into account the social consequences of the introduction of new technologies.

Works like Wu et al. (2023) and Zhyvko et al. (2022), focused on local or national aspects. However, in a globalized world, it is important to take into account international practices and trends in the innovative development of agrarian clusters. For further research, it is important to compare national approaches to the management of cluster business agro-structures, as well as the impact of global initiatives on the agricultural sector in different countries.

The indicated shortcomings and discussions point to the need for more comprehensive research that combines technological, economic, ecological, and social aspects to optimize the management of innovatively oriented cluster business agro-structures in a smart economic model.

CONCLUSIONS

Based on the conducted research, we provided the importance for project management of innovatively oriented cluster business agro-structures in the smart economic model. The use of the proposed mathematical tools makes it possible to more accurately assess the relationships between key factors affecting the efficiency of production processes and the innovative potential of enterprises within clusters. This makes it possible to determine which factors have the greatest impact on performance, which is important for strategic project management. The desirability function, as a universal tool, allows you to assess the level of innovation and the desirability of changes aimed at increasing the efficiency of cluster structures. It is an important addition to classic performance indicators, as it indicates strategic directions of development that meet the requirements of the smart economy.

Thus, the comparative analysis of these indicators in the context of different clusters makes it possible to better understand the innovative orientation of enterprises and adaptation to changing market conditions. This also allows for the development of effective strategies for the development of business agro-structures operating in conditions of high competition and dynamic technological changes. The use of such management tools contributes to the optimization of resources, increasing the innovative capacity and resistance of enterprises to changes, which are key to success in the smart economy.

Prospects for further research in the field of project management of innovatively oriented cluster business agro-structures in the context of a smart economic model cover several important directions. One of these is a deeper analysis of the impact of digital technologies on the development of clusters, which will help to optimize production processes and improve management strategies. In addition, there is a need to create more accurate models for predicting the impact of innovations on the development of clusters, which will provide an opportunity to better understand how various factors interact and how they determine the success of innovative projects in the agricultural sector. Another important topic for future research is the integration of the principles of sustainable development in the business model of clusters, which includes taking into account environmental, social and economic aspects in the formation of strategies, which will allow creating sustainable and efficient agricultural structures oriented towards long-term stability. In this context, it is also worth developing and adapting Harrington's desirability functions to new economic and technological conditions, which will allow more accurate assessment of innovation potential in changing market conditions. In addition, an important direction is the development of interdisciplinary approaches combining economics, information technology, ecology, and sociology. This approach will make it possible to create comprehensive strategies for managing innovations in the agricultural sector, focusing on increasing economic efficiency and social and environmental stability.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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The Authors received no funding for this research.

CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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МЕНЕДЖМЕНТ ПРОЄКТІВ ІННОВАЦІЙНО ОРІЄНТОВАНИХ КЛАСТЕРНИХ БІЗНЕС-АГРОСТРУКТУР У СМАРТ-ЕКОНОМІЧНІЙ МОДЕЛІ

У статті описане дослідження інструментів управління інноваційно орієнтованими кластерними бізнес-агроструктурами, які функціонують в умовах смарт-економіки, та оцінювання їх із особливим фокусом на аграрний сектор, де впровадження інновацій і новітніх технологій є вирішальним фактором для підвищення ефективності та стійкості. Розглянуто основні підходи до інтеграції смарт-технологій у виробничі та управлінські процеси агропромислових кластерів, що дозволяє суттєво оптимізувати операційну діяльність, знижувати витрати та підвищувати конкурентоспроможність продукції. Дослідження акцентує увагу на тому, як інноваційні рішення й технологічні досягнення можуть сприяти побудові гнучких і адаптивних бізнес-моделей, що підтримують ефективність діяльності й сталий розвиток підприємств. Упровадження таких технологій в аграрні кластери сприяє підвищенню екологічної стійкості, знижуючи негативний вплив на довкілля через оптимізацію ресурсів і зменшення викидів. Результати дослідження містять практичні рекомендації для агропідприємств, що працюють у складі кластерів, щодо ефективного впровадження інноваційних технологій для підтримки економічної та соціальної стійкості в умовах сучасної смарт-економіки. Такі рекомендації орієнтовані на розвиток інноваційного потенціалу підприємств, підвищення їхньої продуктивності та адаптивності до динамічного середовища агропромислового ринку. Стаття пропонує підходи до впровадження та оцінювання стратегічних інновацій, які допомагають аграрним кластерам краще пристосуватися до вимог сучасного ринку й стати конкурентоспроможними на глобальному рівні, забезпечуючи при цьому сталий економічний та екологічний розвиток.

Ключові слова: менеджмент, інновації, агроструктури, кластери, смарт-технології, управління проєктами

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