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ORGANIZATIONAL AND ECONOMIC PRINCIPLES OF BIOECONOMY DEVELOPMENT IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT OF THE AGRARIAN SECTOR OF THE ECONOMY

ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНІ ЗАСАДИ РОЗВИТКУ БІОЕКОНОМІКИ В КОНТЕКСТІ ЗАБЕЗПЕЧЕННЯ СТАЛОГО РОЗВИТКУ АГРАРНОГО СЕКТОРУ ЕКОНОМІКИ

Summary. The article substantiates the place of the agricultural sector in ensuring sustainable development through the prism of bioeconomy and the organizational-economic foundations of bioeconomy development in the industry. It is substantiated that the transition to the economy as one of the directions of implementing the principles of circularity demonstrates the most significant compliance with the socio-economic-ecological approach in the agricultural sector. The agrarian sphere of the economy is the core of the economy, in view of which it concentrates significant potential for providing impetus for creating a synergistic effect of the development of economic, social, and environmental components on the scale of the national economy. The key directions for implementing the concepts of bioeconomy in the agricultural sector are outlined, including bioresources and their practical use, biomass processing, recycling, digital technologies, biotechnology, and environmental sustainability. Implementing these areas requires cooperation between science, business, and the public to create innovative and sustainable solutions in agriculture. The main priorities of the mechanism of state support for the development of biotechnologies according to world experience are highlighted: supporting the demand for biotechnological products; increasing the competitiveness of products created with the help of biotechnology, both in domestic and international markets; improving the quality of education in the field of training specialists in the field of biotechnology; strengthening the scientific component of biotechnology development includes the following activities; progression and spread biological collections; development of information and analytical infrastructure in the field of biotechnology. It is determined that the diversification of agricultural enterprises in the bioeconomy is based on environmentally friendly management and technological innovations. The main goals are the production of high-tech products and

clean energy through the efficient use of resources, the reduction of environmental risks, and the processing of biomass. Development prospects include markets for organic products, biomass, and alternative energy.

Keywords: bioeconomy, sustainable development, biomass, agriculture, state support, organizational and economic principles of development.

Анотація. У статті обґрунтовано місце аграрного сектору в забезпеченні сталого розвитку через призму біоекономіки та організаційно-економічні засади розвитку біоекономіки в галузі. Метою статті є покращення організаційно-економічних основ розвитку біоекономіки в контексті забезпечення сталого розвитку аграрного сектору економіки. Обґрунтовано, що найбільшу відповідність соціо-економіко-екологічному підходу в аграрному секторі демонструє перехід до біоекономіки як одного з напрямків реалізації принципів циркулярності. Аграрна сфера економіки виступає ядром біоекономіки, з огляду на що концентрує значний потенціал для надання імпульсу створення синергетичного ефекту розвитку економічної, соціальної та екологічної складових в масштабах національної економіки. Виявлено, що управління розвитком аграрного сектору економіки на основі єдності економічних, соціальних та екологічних інтересів суспільства здійснюється на основі організаційно-економічного механізму, який реалізується через використання інструментів макроекономічного впливу, що змінюють загальні траєкторії функціонування суб'єктів мікроекономічного рівня шляхом впровадження парадигм сталого розвитку в стратегічні, тактичні та операційні імперативи діяльності. Окреслені ключові напрямки реалізації концепцій біоекономіки в аграрному секторі, серед яких: біоресурси та їх ефективне використання; переробка біомаси; рециклінг; цифрові технології; біотехнології; екологічна стійкість. Реалізація цих напрямків вимагає співпраці між наукою, бізнесом та громадськістю для створення інноваційних та сталих рішень у сільському господарстві. Висвітлено основні пріоритетами механізму державної підтримки розвитку біотехнологій згідно світового досвіду: підтримка попиту на біотехнологічну продукцію; підвищення конкурентоспроможності продукції, створеної за допомогою біотехнологій, як на внутрішніх, так і на міжнародних ринках; покращення якості освіти в сфері підготовки фахівців у галузі біотехнологій; посилення наукового компонента розвитку біотехнологій включає наступні заходи; прогресування та поширення біологічних зібрань; розвиток інформаційно-аналітичної інфраструктури в галузі біотехнологій. Визначено, що диверсифікація аграрних підприємств у біоекономіці ґрунтується на екологічно безпечному господарюванні та технологічних інноваціях. Основні цілі – виробництво високотехнологічних продуктів і чистої енергії через ефективне використання ресурсів, зменшення екологічних ризиків і переробку біомаси. Перспективи розвитку включають ринки органічних продуктів, біомаси та альтернативної енергетики.

Ключові слова: біоекономіка, сталий розвиток, біомаса, сільське господарство, державна підтримка, організаційно-економічні засади розвитку.

Problem statement. In modern conditions, agricultural enterprises in Ukraine and other countries face several challenges related to climate change, economic instability, and social pressures. In this context, sustainable development is becoming increasingly important to ensure the long-term viability of systems of different levels of abstraction. In modern times, the concept of sustainable development has been recognized by all UN member states as one of humanity's most important priorities. The transition to this concept should occur at the national and global levels [1]. The process of transformation of basic approaches in the philosophy of management, which is concentrated in the paradigm of sustainable development, which integrates three systematically combined components, is straightforward: economic, based on the basic principles of neoclassical theory, namely, on the ideas of John Hicks, who believed that society's ability to generate income is limited by the condition of preserving the total capital necessary to produce this income [2] The economic development agenda is complemented by the need for rational use of limited resources based on the use of nature-saving technologies; social, which defines a person as a priority of development, directing efforts to maintain the stability of social and cultural systems; ecological, in which the emphasis is on ensuring the preservation of the integrity of biological and physical natural systems.

Analysis of recent research and publications. The development of bioeconomy has become the subject of research by many foreign and domestic scientists, including A. Ryasnianska [11], V. Baydala [6], N.V. Belikova [10], I.Yu. Buntov [10], V. Butenko [6], L.M. Filipishyna [1], V. Gorbatenko [3], J.R. Hicks [2], I. Koshkalda [11], V.V. Kuzyoma [5], I.V. Martusenko [9], B.V. Pohreshchuk [9], S. Rudenko [11] and others. However, despite significant scientific achievements in the field of research on the development of bioeconomy, many questions remain open, which require the study of managerial and economic aspects of its development. In particular, in the context of ensuring sustainable development in specific sectors of the economy.

The purpose of the article. The article aims to improve the organizational and economic foundations of bioeconomy development in the context of ensuring sustainable development of the agrarian sector of the economy.

Summary of the main research material. The development of the paradigm of sustainable development is associated with the activities of the Club of Rome, which is an informal, non-governmental international organization that declares the following

goals: to develop a methodical approach to analyze the problems arising from the limited resources of the Earth, the rapid growth of production and consumption; to warn society about the critical situation in the world; to determine effective management strategies and achieve "global equilibrium" [3].

The study of the problems of sustainable development is of paramount importance, as it is based on increased attention to the predictive component of the dynamics of problems associated with contradictions in the systems' society – nature' and 'man – society'. The World Economic Forum (2023), based on a survey of 1200 experts, identified the risks that are most relevant over the next two years. Among them: the rise in the cost of living; natural disasters, in particular those associated with extreme temperatures; growing geo-economic confrontation; failure to mitigate climate change; polarization of society [4].

It is predicted that over the next ten years, the most critical issue will be the failure of efforts to reduce the impact of climate change. The second most threatening is the risk of failure to adapt to new climatic conditions successfully. In third place are the dangers associated with natural disasters, and experts assign the fourth place in importance to the decrease in biodiversity.

Thus, the key challenge for society's development in the foreseeable future is the deepening of environmental problems, which leads to an increase in researchers' interest in finding the theoretical foundations and applied mechanisms for reducing the anthropogenic impact on the environment through rational use as a basic prerequisite for improving mankind's quality of life in the strategic horizon of coverage.

Bioeconomy, a key direction for the implementation of the principles of circularity in social production, is a significant aspect of sustainable development. The main source of raw materials in the supply chains of bioproducts is agriculture, which accounts for the largest share of biomass. The specificity of the agricultural sector is manifested in the close combination of technological and biological cycles, which are connected within a special eco-socio-economic system [5]. The biological cycle encompasses flows of reproductive materials that can be returned to the biosphere and organized into a system of cascading resources of an open nature. This approach involves energy recovery, the return of nutrients to agriculture, and the conservation and restoration of biological and economic resources of the agro-industrial complex. Such a system of organization of production contributes to the creation of a biopyramid of values and limiting the amount of waste in agriculture. The main result of circular transformations in the agri-food sector of the economy is the transformation of waste and by-products into new value-added products. An important aspect of this process is the increase in the share and absolute value added to the final product. This solves another significant problem of agriculture in the national economy – the low share of added value.

The bioeconomy, proposed as an alternative to the conventional economy, is based on using fossil resources, focusing on the need for reasonable use of renewable resources. This concept is closely related to advances in biotechnology and other life sciences, which open up new opportunities for economic growth without putting undue pressure on natural resources in quantity and quality [6].

FAO (Food and Agriculture Organization of the United Nations) was the first UN agency to develop a strategic priority program in the bioeconomy field to transform agri-food systems towards improving efficiency, equity, and sustainability through innovation. According to forecasts, by 2030, the cost of the closed-loop bioeconomy could reach $7.7 trillion. About 60 countries and regions already have bioeconomy or related strategies, and 10 are developing them [7]. The agricultural sector serves as the core of the bioeconomy because it is here that the main raw material base is formed, first of all, renewable biomass [8].

Bioeconomy in agriculture involves using biological resources to produce food, energy, and other values while increasing efficiency and sustainability. There are several critical areas for the implementation of bioeconomy concepts in the agricultural sector:

1. Bioresources and their effective use: crop improvement – development of genetic technologies to obtain plant and animal varieties with high yields, resistance to pests and diseases, as well as an increase in the content of nutrients; Cultivation optimization – the use of precision farming technologies, modern irrigation systems, and agrotechnical solutions to increase the efficiency of growing agricultural products.
2. Biomass processing: bioenergy – the use of agricultural biomass to produce biofuels and other types of renewable energy. Biochemical processing is the development of technologies for producing chemicals, materials, and products from agricultural raw materials.
3. Recycling: Recycling is the development of a recycling system and the use of production waste to create new products and materials; composting is the use of organic waste to produce organic fertilizer that supports the stability of the soil and crop.
4. Digital technologies and Precision Agriculture: IoT and sensors – the use of the Internet of Things (IoT) and sensors to collect data on the state of the soil, plants, and animals, allowing for more accurate management of agricultural processes; Artificial Intelligence – Implementing artificial intelligence to analyze large amounts of data and train systems to make better decisions in the field of agriculture.

5. Biotechnology: Genetic technology – Using CRISPR and other techniques to improve the genetic structure of crops and animals. Biopharmacy is the production of medicines and other valuable substances using living organisms.

6. Environmental sustainability: biodiversity conservation – implementing agricultural production practices that contribute to conserving the natural environment and biodiversity.

Implementing these areas requires cooperation between science, business, and the public to create innovative and sustainable solutions in agriculture. The agricultural and bioeconomy sector is significantly dependent on innovation and investment decisions aimed at modernizing physical assets, expanding the use of digital technologies in production processes, and increasing resource use efficiency.

Management of the development of the agrarian sector of the economy based on the unity of economic, social, and environmental interests of society as the prerogative of the bioeconomy is carried out based on the organizational and economic mechanism, which is implemented through the use of tools of influence of macroeconomic influence, which change the general trajectories of the functioning of subjects of the microeconomic level through the implementation of sustainability paradigms in strategic, tactical and operational imperatives of activity.

The main priorities of the mechanism of state support for the development of biotechnologies according to world experience are the following [9]:

support for the demand for biotechnology products: This includes justification of priority areas in the development of biotechnology, including specific proposals for a possible increase in production volumes; improvement of the system of state orders for products manufactured with the help of biotechnology; improvement of the system of state support for the development of biotechnology in the fields of agriculture, medicine, and other fields;

increasing the competitiveness of products created with the help of biotechnology, both in domestic and international markets: This includes establishing the exchange of innovative technologies between enterprises through the creation of unique technological platforms, increasing the amount of funding for scientific research, modernizing the equipment of innovative enterprises; It also provides support from the state in the processes of commercialization and distribution of both domestic biotechnologies and products created with their help, including measures to support the export of innovative biotechnologies;

improving the quality of education in the field of training specialists in the field of biotechnology: the introduction of new curricula and subjects, strengthening cooperation between educational institutions, the use of an interdisciplinary approach in teaching subjects related to biotechnology; deepening cooperation between business and education, taking into account the identification of the need for biotechnology specialists for various industries; improvement of the system of continuing professional education based on the principle of "lifelong learning"; renewal and further development of the material and technological base of educational institutions;

strengthening the scientific component of biotechnology development includes the following measures: increasing the amount of state funding for the development of priority biotechnologies by research institutions of various levels; financing of exploratory developments; improving the mechanism for attracting private investment in research and development; improving the system of planning of scientific and technical projects by national priorities; expanding the use of grant funding for the development and commercialization of innovative biotechnologies; increasing the efficiency and transparency of competitive procedures for the selection of scientific projects; implementation of the entire cycle of scientific research, including search, research and design and consulting work;

Progression and dissemination of biological collections involve the following measures: the creation of a national catalog of biological collections, improvement of the state mechanism for their support, strengthening of legislation on the protection of biological collections;

The development of information and analytical infrastructure in the biotechnology field involves introducing a system of electronic exchange of documents on the progress of biotechnology.

The directions mentioned above are aimed at the formation of the institutional foundations for rooting the principles of bioeconomy in the architecture of economic relations through mechanisms for stimulating interest on the part of agricultural producers, as well as creating resource and technological opportunities for the implementation of a strategy for ensuring the sustainability of the agricultural sector through the formation of an environment based on the partnership of three institutional sectors: state, science, business. The theory of the "triple helix," developed by Loyet Leidesphorus and Henry Itzkowitz, emphasizes the importance of forming cooperation between government, enterprises, and higher education institutions as critical elements of the innovation system at the national level. This concept focuses on creating an effective institutional environment conducive to developing innovations and successfully implementing their results in social production. In this approach, government, businesses, and universities act as critical participants in interacting to create an innovation ecosystem. These actors must collaborate, sharing knowledge, resources, and information. The government acts as a regulator, creating favorable legislative and financial conditions for innovation. Enterprises

are actively involved in research and development, introducing innovative solutions into production. Universities act as educational and research centers that train qualified personnel and conduct scientific research.

Diversification of activities of agricultural enterprises in the paradigm of bioeconomy is based on environmentally friendly management and bioeconomic transformations, the purpose of which is the production of high-tech products and clean types of energy based on the economical use and conservation of natural resources, reduction of environmental risks, large-scale use of biomass, waste from crop production, animal husbandry, fish farming, etc. The bioeconomic potential for developing the agricultural sector includes markets for organic products, biomass, and alternative energy.

Conclusions. Bioeconomy is one of the directions for the implementation of the principles of circularity as a transition in social production to a low-carbon and closed economy, which creates potential new markets with a growing demand for biomass (for bioenergy) and bio-based materials for the production of a wide variety of products. At the same time, the primary source of raw materials in the supply chains of bioproducts is agriculture, within which there is a close combination of technological and biological cycles. The agricultural sector accounts for the largest share of biomass – a non-fossil, biologically renewable substance of organic origin capable of biodegradability. This allows us to conclude that the agricultural sector is the core of the bioeconomy, acting as a supplier of resources for implementing this paradigm at the global and national economy levels in the diversity of their structure.

The advantages of bioeconomy in the implementation of the vector of sustainable development are realized in the following dimensions: economic (increasing the profitability of production; improving the quality of products; expanding the range of products manufactured using biotechnology); social (expansion of diversity in the agricultural economy; development of rural areas; improvement of the quality of life of the population); environmental (reduction of environmental pollution, creation of fuel and materials from biological raw materials).

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