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INSTITUTIONAL ASPECTS OF STIMULATING AGRICULTURAL INNOVATION: INTERNATIONAL EXPERIENCE

The aim of the article is to analyze the international experience of creating and using forms and directions of the institutional component of agro-innovation management in the context of sustainable development. System and comparative analyses, analytical methods and generalizations were used. Based on the analysis of the experience of forming the institutional component of innovation systems in the USA and Canada, it was concluded that innovations are a fundamental condition for the development of agricultural production both to ensure domestic consumption and to ensure the growth of export potential; for the effective functioning of innovation systems, it is necessary to have centers that coordinate scientific activities with highly qualified employees; for the high-quality selection of key areas of innovation, the real needs of end users of new technologies, it is necessary to ensure multi-level cooperation, which includes as many participants in the innovation network as possible, primarily among agricultural producers.

Keywords: innovative development, innovations, institutional aspect, agro-innovations, innovation system, sustainable economic development.

JEL classification: F29, O13, Q16.

ІНСТИТУЦІЙНИЙ АСПЕКТ СТИМУЛЮВАННЯ АГРОІННОВАЦІЙ: МІЖНАРОДНИЙ ДОСВІД

На рівні міжнародної взаємодії наука, технології та інновації займають центральне місце на порядку денному в галузі сталого розвитку на період до 2030 року та відображені у багатьох завданнях з досягнення цілей сталого розвитку. Впровадження інновацій є найважливішим завданням, що стоїть перед людством у контексті забезпечення зростання продуктивності сільськогосподарського виробництва, зміцнення продовольчої безпеки та скорочення несприятливих екологічних наслідків. Метою статті є аналіз міжнародного досвіду створення та використання форм та напрямів інституційної складової управління агроінноваціями у контексті сталого розвитку. Використані системний та порівняльний аналізи, аналітичний метод та узагальнення. На глобальному рівні для консолідації зусиль міжнародних організацій щодо впровадження технічних та технологічних інновацій у сільськогосподарське виробництво у всьому світі у 2019 році у структурі FAO було створено Управління інновацій. На національному рівні особливий інтерес з погляду вивчення досвіду управління інноваціями є стратегії впровадження агроінновацій в США та Канаді. У США в галузі сільського господарства працюють кілька наукових парків і створених на базі університетів інноваційних центрів. У Канаді діє п'ятирічний стратегічний план для підтримки агропромислового комплексу – програма Canadian Agricultural Partnership, у якій особливу увагу приділено інноваційному та сталому розвитку АПК. З цією метою федеральний уряд здійснює реалізацію двох програм: AgriScience Program та AgriInnovative Program. На основі аналізу досвіду формування інституційної складової інноваційних систем США та Канади зроблено висновок про те, що інновації є фундаментальною умовою розвитку сільськогосподарського виробництва як для забезпечення внутрішнього споживання, так і для забезпечення зростання експортного потенціалу; для ефективного функціонування інноваційних систем необхідна наявність центрів, що координують наукову діяльність, з висококваліфікованими співробітниками; для якісного відбору ключових напрямів інновацій, реальних потреб кінцевих споживачів нових технологій необхідне забезпечення багаторівневої співпраці, що включає якомога більше учасників інноваційної мережі, насамперед серед сільгоспвиробників.

Ключові слова: інноваційний розвиток, інновації, інституціональний аспект, агроінновації, інноваційна система, сталий економічний розвиток.

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Problem Statement. Innovation is one of the most important challenges facing humanity in the context of increasing agricultural productivity, strengthening food security, and reducing adverse environmental impacts. At the international level, science, technology, and innovation occupy a central place in the 2030 Agenda for Sustainable Development and are reflected in many targets for achieving the Sustainable Development Goals formulated by the UN in 2015.

The adoption of new technologies is featured in several Sustainable Development Goal targets related to agrifood systems (targets 2, 6, and 14 of the Sustainable Development Goals, which relate to agriculture and rural infrastructure, water management, and marine technology, respectively) [6]. Innovation is recognized internationally as a critical means of achieving the Sustainable Development Goals. Innovation efforts are aimed at increasing economic productivity, creating new jobs and improving working conditions in existing ones, developing industry, and strengthening the capacity of developing countries.

Analysis of recent research and publications. The study of the characteristics of qualitative changes in agrifood systems under the influence of agro-innovations was carried out by such scientists as Baldinyuk St., Willer H., Gambelli D., Zanoli R., Kept H., Plakkolm G., Tomashuk I., Harding T., Hermann G., Youssefi M., Freeman C., Hagen D., Kanter R.M. [4-5, 7-9].

An unresolved problem remains the lack of in-depth scientific understanding of the forms and directions of development of the institutional component for stimulating innovation in the agricultural sector, which is necessary to ensure sustainable growth in agricultural productivity within the framework of sustainable development.

The aim of the article is to analyze international experience in the creation and use of forms and approaches to institutional governance for agroinnovation in the context of sustainable development.

The empirical basis for the study is data from the UN Food and Agriculture Organization (FAO), the United States Department of Agriculture (USDA), Agriculture and Agri-Food Canada, regulatory documents, and scientific literature in the field of agroinnovation.

Research methods. To achieve this goal, general theoretical and specialized scientific research methods were used, including systems analysis to summarize global experience in agroinnovation management in the United States and Canada; comparative analysis to compare the forms and results of agroinnovation management in the United States and Canada; and analytical methods and generalization to evaluate the results of various approaches to stimulating agroinnovation and drawing conclusions.

Presentation of the main research results. The Technology Facilitation Mechanism (TFM) of the 2030 Agenda, including the UN Inter-Agency Task Force on Science, Technology and Innovation (IATF), is a multi-stakeholder collaborative mechanism that ensures coordinated efforts within the UN system.

The Food and Agriculture Organization of the United Nations (FAO) plays a key role in the work of the TFM.

FAO's Innovation Strategy aims to empower member countries to leverage science and innovation to implement context-specific, systemic solutions that foster more efficient, inclusive, resilient, and sustainable agriculture and food systems that intensify production, improve nutrition, enhance the environment, and enhance human well-being, while leaving no one behind [6].

To consolidate the efforts of international organizations to introduce technical and technological innovations in agricultural production worldwide, the Office of Innovation was established within the FAO in 2019 (OIN) [6].

OIN ensures that FAO integrates innovation into its programming and promotes collaboration across FAO's various divisions. Science and innovation are identified as key enablers for achieving the SDGs. Similarly, FAO's Strategic Framework for 2022–2031 views science and innovation as key drivers for ridding the world of hunger and malnutrition. OIN currently consists of three divisions: the Global Forum on Agricultural Research and Innovation (GFAR) Secretariat, the Division of Research and Extension (OINR), and the Division of Digital Agriculture Innovation [2].

The Agricultural Research and Extension Division (OINR) supports FAO members in transforming and strengthening their national agricultural research systems (NARS). This support includes promoting coherent agricultural innovation systems to enhance the functional capacity of various actors, including agricultural education, research, farmer extension, and agricultural organizations.

The Division's activities include developing tools, methods, and management principles for assessing national research, extension, and advisory systems, recommending policy recommendations, reforms, capacity development, convening expert consultations on emerging issues, conducting technical research, sharing technologies and practices, and providing technical support for project preparation and implementation.

Furthermore, the Division serves as FAO's technical focal point for collaboration with global research and extension fora. The Secretariat of the Global Forum on Agricultural Research and Innovation (GFAR) was established jointly by FAO, the International Fund for Agricultural Development, and the World Bank. GFAR brings together partners from various fields to address development challenges at all levels. The ultimate goal of innovation is the ordinary farmer, taking into account their real needs and capabilities. As part of the GFAR work, the DeSiRA Initiative (2018-2020) was launched in 2018 [2].

It was created to increase productivity and sustainable transformation of agricultural and food systems in low- and middle-income countries in Africa, Asia, and Latin America and to strengthen research capacity.

The Digital Agriculture Innovation Unit within the Innovation Directorate supports FAO in developing policies and implementing projects related to digital agriculture innovation and collaborates with other FAO units to expand digital agriculture through their projects and programs.

Key activities:

- Fostering digital agriculture innovation for

FAO Members;

- Providing policy support to countries on digital agriculture through the development of national digital agriculture strategies;
- Scaling up cutting-edge and emerging technologies (blockchain, artificial intelligence, Internet of Things, etc.) for FAO and its Members;
- Facilitating the development of a global e-agriculture community and related events on digital agriculture innovation.
- Enhance knowledge sharing and capacity development in digital agriculture through various activities, including the Global AgriInno Challenge [2].

As part of its Innovation Unit, FAO launched the "1000 Digital Villages" concept, which helps translate digital agriculture strategies into action on the ground, accelerate the digital transformation of rural areas, and bridge the rural-urban digital divide.

The concept examines the digitalization of agriculture from various perspectives:

- in terms of agricultural production, it refers to "Digital Agriculture" and aims to increase productivity through the use of innovation and digital solutions, such as climate-smart agriculture and precision farming;
- in terms of sustainable rural development, it aims to increase the availability of various types of social, economic, and financial services;
- in terms of the availability of digital services to support rural transformation, focusing on how to improve the delivery of public services in the areas of health, education, employment, social security, and tourism (ecotourism/agritourism) [2].

At the national level, the strategy for implementing innovation in agricultural production in the United States is of particular interest in studying the management experience of innovation implementation. The country has a long history of global leadership in the use of innovative approaches and new technologies in agriculture. The widespread adoption of innovation in agricultural production ensures that the needs of both the domestic food market are met, even given a growing population, and the ability to increase export potential is also enhanced. Total agricultural production increased by 175% between 1948 and 2019 in physical terms [10].

The implementation of innovations in the US agro-industrial complex is carried out with the help of innovation centers [3].

Typically, they are created within universities. It should be noted that the United States lacks a large number of research institutes. From this perspective, studying the US experience in creating innovative agriculture is of great practical and theoretical interest. Currently, several science parks and university-based innovation centers operate in the agricultural sector, ensuring the effective innovative development of the industry [3].

Since 2020, the Agricultural Innovation Initiative (AIA) has been working with scientific organizations, government agencies, and farmers to advance innovation in agricultural production in the United States [10].

The program sets an ambitious goal of increasing U.S. agricultural production by 40% while halving the environmental impact of U.S. agriculture by 2050.

Among the key objectives of the AIA program are:

- reducing food loss and waste by 50% in the US by 2050 compared to 2010 levels;
- reducing the carbon footprint; - Improving soil health;
- increasing the share of renewable energy in the agricultural production sector.

Most of these objectives are aimed at optimizing resource use and reducing the environmental impacts of agricultural production. One component of the AIA is the USDA's development of the Strategy for Innovative Research in US Agriculture [10], which was carried out in three main stages:

Stage I. To identify innovation clusters where, according to experts, scientific advances will have the greatest impact on agricultural production, the USDA used the National Academy of Sciences report «Scientific Breakthroughs in Advancing Food and Agriculture Research to 2050».

Stage II. During the second phase of developing the Agricultural Innovation Strategy, the focus was on collecting information on the needs of technology end users—farmers, foresters, and ranchers. This was accomplished by publishing relevant requests on dedicated resources and holding workshops or public hearings.

Stage III. During the third phase of developing the Agricultural Innovation Strategy, the goals and objectives of the strategy were formulated.

Thus, the Agricultural Innovation Program and the Innovation Research Strategy aim to develop partnerships between university research, business, and government agencies. Innovative developments are initiated with consideration of the needs of all stakeholders. A distinctive feature of innovation activity in the United States is the drive to commercialize developments. Funding for innovative research is provided through both public investment and private organizations, and public funding can take various forms, including direct funding and tax incentives.

In Canada, the development of innovative activity in agricultural production is also regulated by strategies developed by Agriculture and Agri-Food Canada. These strategies are developed with the participation of representatives of academia and business and define the directions of scientific research and technology transfer in accordance with four objectives:

- increasing agricultural productivity;
- improving environmental performance;
- improving the quality of agricultural products for food and non-food use;
- eliminating potential threats to the functioning of agri-food value chains. The strategies form the basis for investing federal funds in research programs [1].

Since 2018, Canada has been implementing a five-year strategic plan to support the agricultural sector—the Canadian Agricultural Partnership program—with a particular focus on innovative and sustainable development of the

agricultural sector. To this end, the federal government is implementing two programs: the AgriScience Program and the AgriInnovative Program [1].

Within the AgriScience Program, the government is implementing two subprograms: the formation of sector-specific research clusters (AgriScience – Clusters) and the implementation of individual agricultural research projects (AgriScience – Projects). In our opinion, the Canadian AgriInnovative Program deserves particular interest in studying the experience of implementing projects to support innovation. This program is aimed at accelerating the commercialization, implementation, and demonstration of innovative products, technologies, processes, or services that enhance the competitiveness and sustainability of agricultural production. The program provides for reimbursement of up to 50% of the costs of commercial organizations for the implementation of innovative products, technologies, and processes that enhance the competitiveness and sustainability of the agricultural sector. Applicants can apply for AgriInnovative Program funding of up to 50% of total eligible costs, but not more than \$10 million. The maximum level of government funding (federal, provincial/territorial, and municipal) that an applicant can receive in relation to total project costs cannot exceed 75% of project funding. To be eligible for government support, applicants must clearly articulate in their application how their proposed projects will commercialize, adopt, and implement the innovation for a sector or country [1].

Once the innovation requirements are established, the program prioritizes project proposals that advance the government's agenda in one or more of the following priority areas:

- implementing new or world-leading green technologies (including precision agriculture);
- improving productivity through advanced manufacturing, automation, or robotics;
- ensuring access to new or expanding existing export markets. We believe that implementing support programs in the form of repayable grants or partial co-financing, on the one hand, allows for support of scientific research, and on the other, increases the responsibility of grantees and their interest in the successful implementation of the project. As with the innovation systems in the United States, universities in Canada are becoming centers of concentration for scientific research.

Conclusions. Based on an analysis of the most effective global practices for stimulating innovation in agricultural production, the following conclusions can be drawn:

- 1) Innovation is a fundamental condition for the development of agricultural production, both to meet domestic consumption and to increase export potential.
- 2) For innovation systems to function effectively, centers with highly qualified staff coordinating research activities are essential. Given that such centers in the United States and Canada are being established at universities, such staff may include faculty, graduate students, and undergraduates.
- 3) To effectively select key innovation areas and meet the real needs of end users of new technologies, it is necessary to ensure multi-level collaboration involving as many participants in the innovation network as possible, particularly among agricultural producers.

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