Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 25, Issue 1, 2025
PRINT ISSN 2284-7995, E-ISSN 2285-3952

DIRECTIONS FOR TRANSFERRING FOREIGN EXPERIENCE OF SUSTAINABLE DEVELOPMENT OF THE AGRO-FOOD COMPLEX TO THE RUSSIAN ECONOMY

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Abstract

Sustainable development of agriculture is a prerequisite for increasing food volumes and implementing technological transformations. The paper presents an assessment of various concepts and mechanisms for managing sustainability in agriculture in developed countries. The purpose of the work is to study foreign experience in managing sustainable agricultural development and to develop directions for transferring positive experience to the agricultural sector of the Russian economy. The important role of digital technologies in agriculture is confirmed and the need to stimulate their implementation in various sub-sectors is substantiated. The main options, models and technologies for achieving sustainable development of agriculture in advanced countries are studied. The need to apply a multi-level strategy for managing sustainable development of agriculture in Russia is substantiated. The foreign experience of sustainable development of the agro-food complex is generalized and systematized, the author's models are presented: European, American, Latin and Japanese. Based on these models, directions for transferring positive foreign experience of sustainable development of the agro-food complex to the Russian economy are proposed. The practical value of the results obtained lies in the possibility of their use in the development of programs, strategies and mechanisms for the sustainable development of the agro-food complex of the country and regions to increase food production and introduce advanced technologies.

Key words: *agro-food complex, foreign experience, investment policy, regulatory mechanisms, development strategy*

INTRODUCTION

The main directions of sustainable development of agriculture can be implemented by achieving a high level of science and technology.

Modern challenges of the growth of the world population, the complication of global food chains, and the growing anthropogenic load increase the attention of scientists in the world scientific community to the problems of sustainable development.

The main directions of sustainable development of agriculture can be implemented by achieving a high level of science and technology. Sustainable development is aimed at the production of high-quality environmentally friendly food products, rational use of production resources, and growth of the well-being of the rural population [19]. The development of national agro-food systems along the path of sustainability creates the prerequisites for solving the global problem of food security [15]. The growing global demand for food, especially meat and milk, affects the problem of using limited water and land resources. An increase in greenhouse gas emissions will cause irreversible climate change [1, 3, 8, 18, 25]. In European countries, programs and strategies for the sustainable development of agricultural sectors are being developed [20]. For example, in the Netherlands, an innovative technology is used to reduce emissions as a result of the reuse of production resources [2].

Analytical materials of FAO and the UN confirm the undeniable role of innovative technologies in achieving sustainability parameters in agriculture.

Digitalization of agriculture is a priority area in the EU countries.

Many foreign scientists are studying such sustainability factors as the use of innovations

and advanced production technologies. Khan, N., Ray, R. L., Kassem, H. S., Lykas, K., emphasized the importance of using agricultural land, reducing losses during processing, and introducing waste-free production. The authors studied the possibilities of using innovations at various stages of production. They noted the different innovative activity of enterprises in developed and developing countries [17, 24].

An important role in achieving sustainability of agricultural production has been identified for such digital technologies as intelligent agriculture, gene technology, artificial intelligence, robotic fertilization and weed removal systems, precision farming and selection [13,16]. Digital technologies such as robotics and blockchain are widely used in animal husbandry in European countries in the development of feed rations, monitoring animal health and regulating reproduction processes [22, 23]. Nigerian agricultural enterprises are activelyadopting various digital technologies [4]. R Laurett, A / Paco, E Mainardes studied sustainability factors in Brazilian agriculture, taking into account the opinions of farmers. The results of a questionnaire survey of more than 200 farmers confirmed the importance of the investment factor for technological transformations and achieving environmental safety [14].

Foreign authors note that entrepreneurs should take an active part in the formation and application of innovative business models in practice. This will achieve «strong» sustainability.

At the same time, the use of innovations in agriculture does not always correspond to the main priorities of sustainable development. An effective solution is to strengthen the interaction of enterprises at the intersectoral level, as well as improve regulation and management methods [9].

In his study, J. Björklund assessed the advantages and difficulties of implementing a sustainable business model by entrepreneurs in the Swedish agricultural sector. For the country's agriculture, the implementation of environmental measures to achieve ecological balance is of particular importance. The difficulties faced by many farmers in the country have been noted.

The number of small and medium-sized farms in Sweden has decreased significantly. The results of sociological studies have shown that small farmers have difficulty competing with large cooperatives, point to insufficient financial support from the state and weak advisory assistance. Small farmers also have significant concerns about changes in the institutional framework. The noted difficulties hinder the development of effective management decisions on running a business that meets the goals of sustainable development [5]. Scientists from the universities of Qatar and Sassari point to financial barriers and technical difficulties in the use of agricultural robots by Italian farmers [26]. Scientists from the University of Lisbon studied the implementation of new technological innovations in water resource management in individual regions [21]. Sustainable development management mechanisms are also constantly being improved. The experience of Germany is interesting, where various methods and tools are used: the Criteria System for Sustainable Agriculture (KSNL) in Thuringia, the Sustainable Agriculture Certificate of the German Agricultural Society (DLG) and the Swiss Sustainability Assessment. According to a sociological online survey of 600 farmers in Germany, many of them showed insufficient awareness of the Sustainable Agriculture Certificate (DLG), which contains nitrogen balance requirements for the farm [11].Thus, in developed countries there are many tools, approaches and methods for regulating agricultural production in the direction of sustainability.

The purpose of the work is to study foreign experience in managing sustainable agricultural development and to develop directions for transferring positive experience to the agricultural sector of the Russian economy.

MATERIALS AND METHODS

Various research methods were used. Using the analytical method, the main approaches to

studying sustainability issues by scientists from different countries of the world were studied. It was revealed that certain provisions of the European countries' policies are also relevant for Russian agriculture (saving production resources, efficient use of waste). Various mechanisms for managing sustainable development were compared. This method made it possible to determine the most effective practices and methods used in different countries, as well as to identify the factors that determine the possibility of successful adaptation and implementation of these approaches. The study also conducted a forecast assessment of changes in agricultural production volumes and technological development indicators in Russia in the next 5 years. Features of the use of innovative technologies in different sectors of Russian agriculture were identified.

RESULTS AND DISCUSSIONS

Digitalization processes play a positive role in achieving sustainability criteria for Russian agricultural sectors.

Table 1. Use of digital technologies by Russian agricultural organizations in 2023, units

Digital Technologies	Agriculture	Including:					
		Grain Oilseeds	Oilseeds	Vegetables	Dairy farming	Pig farming	Poultry farming
	Number of enterprises using relevant digital technologies, units						
Total number of digital technologies	4,091	979	161	145	986	192	298
Including:							
Digital platforms	698	182	17	53	155	38	30
Geographicalinformationsystems	929	273	62	19	180	51	69
Artificial intelligence	128	25	12	0	34	13	6
technologies for collecting, processing and analyzing big data	684	173	19	41	146	34	57

Source: Own calculations based on data [12].

Table 1 presents the main indicators of the use of various digital technologies in Russian agriculture. It was revealed that their use was not uniform in enterprises of various types of agricultural activity. For example, all of the above-mentioned digital technologies were actively used in grain production and dairy farming.

For example, digital platforms were used by 182 grain production organizations and 155 dairy farming organizations); geoinformation systems were used, respectively, by 273 and 180 organizations; technologies for collecting, processing and analyzing big data - by 173 and 146 organizations. Artificial intelligence technologies are slowly being introduced in poultry farming (6 organizations) and growing oilseeds (12).

By 2030, Russia plans to create a single digital platform for the agro-industrial complex; this will allow for quick and effective decisions on managing the sustainable development of the agricultural sector. A forecast assessment of changes in agricultural production volumes and investments in the modernization of production processes for the period up to 2030 was carried out (Fig. 1).

The trend of gross added value of agriculture reflects a linear dependence with positive dynamics, which suggests a certain impact of financial support for producers and innovative structural shifts. A sufficiently high coefficient of determination (0.95) confirms the reliability of a sustainable increase in gross added value.

Calculations have shown that with continuing trends in innovative development, gross added value will reach 6,770 billion rubles by 2030, an increase of 13.3% compared to 2022.

At the same time, the level of investment in agricultural modernization processes remains low, which hinders economic growth and innovative development. Therefore, further

growth in the agricultural sector is largely determined by investments in technological innovations. It is also necessary to constantly improve the mechanisms for managing sustainable agricultural development, using the best practices of foreign countries. A study of various options for sustainable agricultural development has been conducted, and the most effective models have been selected that can be used in the Russian agro-food complex.

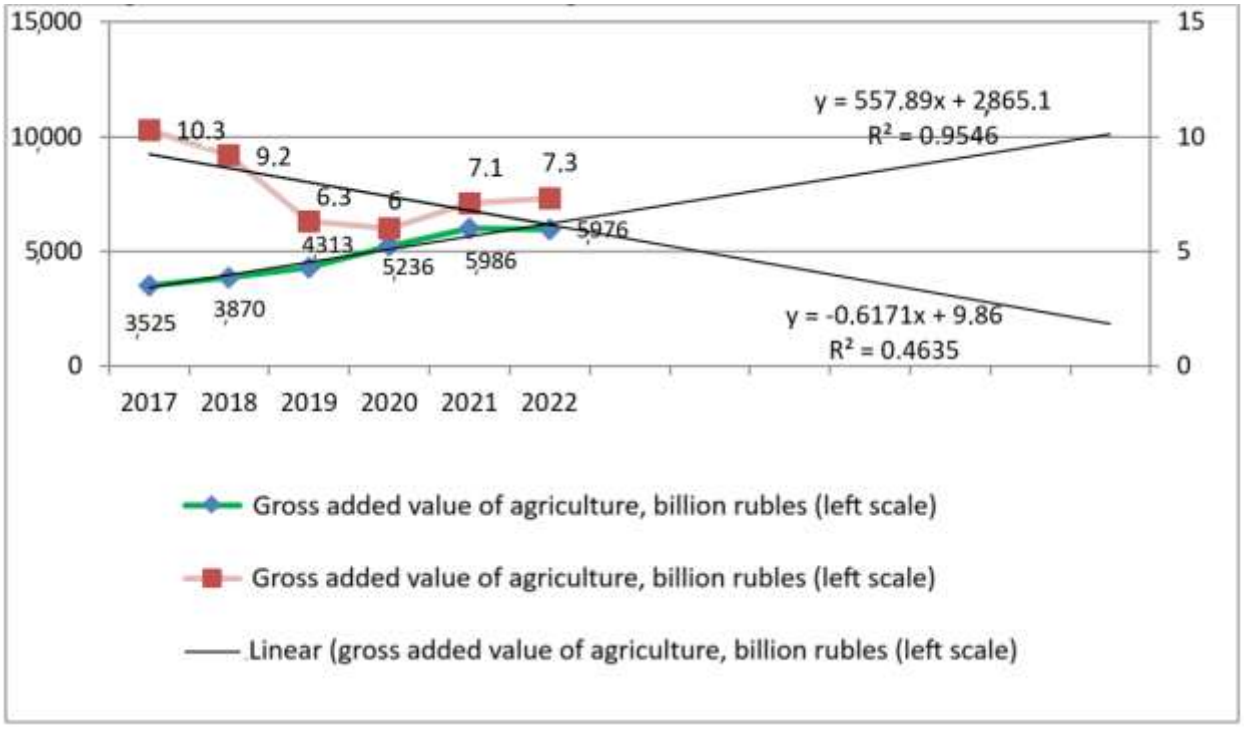

Fig.1. Analysis and forecasting of trends in economic growth and modernization of agriculture in Russia (2012-2022)
Source: Own calculations based on data [10, 12, 28].

The foreign experience of sustainable development of the agro-food complex is generalized and systematized, the author's models are presented: European, American, Latin and Japanese. Based on these models, directions for transferring positive foreign experience of sustainable development of the agro-food complex to the Russian economy are proposed.

Figure 2 shows the classification and transfer of foreign sustainable development options.

An analysis of foreign models of sustainable agriculture showed the widespread use of innovative and digital methods and technologies. The Japanese and American models are implemented mainly at the production stage. A distinctive feature of the Japanese model is the use of labor-saving technologies due to the reduction in the number of farmers. For example, "autonomous farming" is represented mainly by self-driving tractors and mowers, as well as remotely controlled rice planting machines. The Wagri digital platform operating in Japanese agriculture contains the necessary information for farmers on crop management and the state of the equipment market.

The American model with a predominance of large farms is characterized by the active use of technologies for monitoring yields and adjusting the application of fertilizers and agrochemicals, GPS soil mapping. Artificial intelligence technologies are actively used in the production process. Most farmers use irrigation sensors when cultivating fruit and berry crops.

Unlike the models considered, the sustainable development of European countries is associated with increasing the productivity of agricultural production and optimizing processes in the value chain, including logistics. In Germany, crop yield monitors are

used; in Greece, precision farming technologies are used in growing olives and potatoes. In the agricultural sector of France, digital methods for the consumption of plant protection products are being introduced. In the Netherlands, greenhouse products are export-oriented due to the widespread use of digital technologies for climate and moisture control. The Food Valley program addresses the task of forming a knowledge transfer infrastructure.

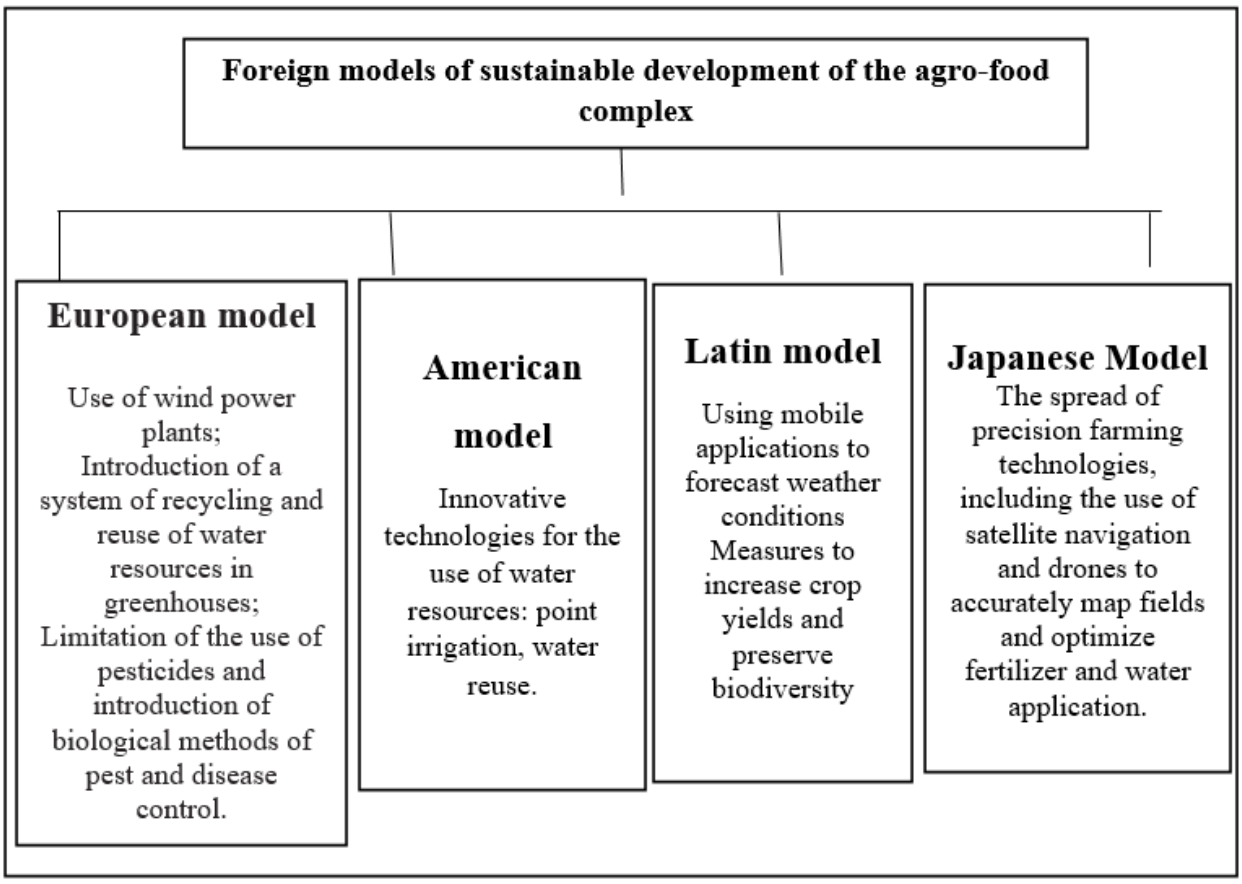

Fig. 2. Scheme of transfer of experience of foreign models of sustainable development of agro-food complex to the Russian economy
Source: Own conception.

In Germany, technologies called "digital fields" are quite widespread. The main ones are digital technologies in milk production (Digimilch); digital technologies in crop production with remote sensing (Agrisens-DEMMIN 4.0), as well as digital technologies in viticulture (DigiVine).

The digital development directions "Upstream" and "Downstream" are being developed in a number of European countries on the basis of technology startups with the corresponding financial support from the state.

The study showed that many countries view technological innovations and resource-saving technologies as the most important sustainability factors that contribute to the successful solution of environmental problems, the achievement of high production indicators and the reduction of production costs. It is necessary to carry out a continuous transfer of knowledge, advanced methods and technologies, including at the international level [6,7]. Innovations of the future should include genetically modified organisms adapted to natural changes, as well as innovative methods of weed and plant pest control.

To achieve sustainable development of the agro-food complex of Russia, it is necessary to develop a multi-level strategy.

It is based on close communication between scientists-developers and users of advanced technologies, which is possible as a result of

training, knowledge exchange, and the formation of appropriate digital competencies among management and employees.

An increase in public funds is required to create new scientific and educational centers. It is also necessary to form a system of package solutions of digital technologies between stakeholders ready for implementation in agricultural production, as well as the creation of sustainable and adaptive agricultural systems. Only through the joint efforts of the state, business and science can we overcome the difficulties of forming a sustainable agricultural sector and increase the level of well-being of the population in the near future. The practical value of the results obtained lies in the possibility of their use in developing programs, strategies and mechanisms for the sustainable development of the agro-food complex of both the country and individual regions to increase food production and introduce advanced technologies [27].

CONCLUSIONS

Sustainable development of agriculture is a prerequisite for increasing food volumes and implementing technological transformations.

The paper presents an assessment of various concepts and mechanisms for managing sustainability in agriculture in developed countries.

The important role of digital technologies in agriculture is confirmed and the need to stimulate their implementation in various sub-sectors is substantiated.

Forecasting the gross added value of agriculture showed a linear dependence with a positive trend. However, further growth in the agricultural sector is largely determined by investments in technological innovations. It is also necessary to constantly improve the mechanisms for managing sustainable development of agriculture, using the best practices of foreign countries. The main options, models and technologies for achieving sustainable development of agriculture in advanced countries are studied. A study of various options for sustainable agricultural development has been conducted, and the most effective models have been selected, which are recommended for use in the Russian agro-food complex.

The foreign experience of sustainable development of the agro-food complex is generalized and systematized, the author's models are presented: European, American, Latin and Japanese. Based on these models, directions for transferring positive foreign experience of sustainable development of the agro-food complex to the Russian economy are proposed.

The use of technological innovations and economical consumption of production resources will reduce production costs and reduce the impact on the environment, while ensuring high yields and product quality. It should also be noted that stimulating sustainable growth involves a constant exchange of knowledge, experience and best practices at both the regional and international levels.

The practical value of the results obtained lies in the possibility of using them in developing programs, strategies and mechanisms for sustainable development of the agro-food complex of the country and regions to increase food production and introduce advanced technologies.

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