

Main methodology provisions of forecasting socio-economic results of agriculture's innovative development

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Abstract. The monographic analysis of the subject area under consideration was performed and the peculiarities of innovative development forecasting organization of the economy in Russia and abroad were defined, including the list of approaches and methods that have become most practically common in different countries. The peculiarities of innovative development of agriculture in Russia, its main directions and groups of applied innovations were revealed. It was established that at present agricultural producers are poorly involved in innovations' creation and mainly act only as their consumers at high prices set by high-tech companies. Conceptual methodology scheme for forecasting socio-economic results of agriculture's innovative development was proposed including a system of principles, approaches, methods, and expected results and allowing it to justify individual forecasts for separate enterprises with different organizational and economic characteristics and level of technical and technological development.

1 Introduction

At present, the world economy is at the stage of a historic transition to a new technological structure mainly based on the use of advances in nano- and biotechnology that will create new competitive products with lower energy and material intensity of production and high productivity together with developed information and communication technologies and artificial intelligence. It is critical for Russia to take a leading position in the implementation of the next technological revolution and thereby eliminate the technological lagging behind developed countries accumulated in many sectors of the economy; without it, in the coming years there will be its avalanching increase, followed by an increase in import dependence on goods and services with high intellectual rent and income decrease from raw materials exports as a result of their world consumption's reduction in the context of an inequivalent foreign economic exchange accompanied by a significant decrease in the population's standard of living [1].

Agriculture is one of the most important sectors of Russia's economy, which largely ensures food security and territorial connectedness of the country; in the last 10 years, it is

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demonstrating notable positive results in increasing the production of most products with enhanced protectionist state protection measures in the form of a domestic food embargo. Over the years, agricultural producers managed to improve their financial situation and partially update their material and technical base. Maintaining high development rates of the industry in midterm and long term is possible only with wide introduction of innovations that ensure the growth of efficiency, labor productivity, unit production costs reduction and as a result - an increase in operations' profitability.

However, most innovations applied in agriculture are created in other industries and agricultural producers are only their consumers, forming the demand for expensive machinery, equipment, and materials of predominantly imported origin, while overpaying considerable amounts in the form of intellectual rents to high-tech companies for their products; with this, the economic impact of investing in its purchase is in some cases unproven and even questionable.

The current forecasting methods do not fully consider the peculiarities of innovative agricultural development, including many producers of various organizational and legal forms with different scopes of land use, financial capabilities and state of material and technical base, as well as particularly long diffusion nature of sectoral innovations in agrarian production.

2 Materials and methods

In Russia, the scientific foundations of economic innovative development forecasting (scientific and technological progress forecasting) were created in the 1970s by outstanding scientists N.P. Fedorenko, A.I. Anchishkin, S.S. Shatalin, Yu.V. Yaremenko et al., who used a wide arsenal of economic and mathematical methods, including specific tools of technological forecasting, production functions, balance models, econometric and statistical methods [2]. Currently, the innovative development forecasting of the economy of the country as a whole is carried out mainly in indicative form using expert assessments [3].

In EU countries, foresight or strategic information technologies are becoming increasingly prevalent in the area of innovation development forecasting, which are largely designed not for the forecasting on the basis of current trends extrapolation itself, but to form a vision of the desired future by identifying and analyzing all possible development alternatives, existing challenges, threats and opportunities, and bringing the obtained results to parties concerned in science, business and politics to coordinate their efforts in making the right decisions [4]. In our opinion, this approach to forecasting is based on the development of theoretical and methodical provisions of normative technological forecasting, supplemented by modern instruments of theory and management practices.

In 2016, the Ministry of Agriculture and the Higher School of Economics developed a medium-term forecast of scientific and technological development of domestic agro-industrial complex (AIC) using foresight methodology, including two alternative scenarios with differing basic conditions and priorities. This forecast provides an in-depth analysis of technological trends in the innovative AIC development, including the use of precise and smart agricultural technologies, unmanned aerial vehicles, nano- and biotechnology, as well as artificial intelligence capabilities in support of management decision-making [5].

Use of foresight methods and regulatory forecasting with the formulation of "emotional" scenarios describing the possible future of the industry in "bad" and "good" conditions is certainly an important element in the strategic agricultural planning system, creating an understanding among industry representatives regarding the existing challenges, threats, and opportunities of economic, technical and technological development. At the same time, the results of such forecasts are mainly based on expert assessments of leading scientists, practitioners, and politicians in the field under consideration and poorly consider

individual agricultural producers' characteristics and do not allow to perform quantitative forecasts of the socio-economic results of their innovative development.

3 Results and Discussion

Innovative development of agriculture is carried out mainly in the form of variety changing, breed composition improvement of cattle and poultry, continuous qualitative changes in agrotechnologies and technical means of their implementation, which create a basis for growth of industry efficiency, labor productivity and profitability of agricultural commodity producers. These directions form the most numerous group of technical and technological innovations in agriculture.

However, most of them tend to be of improving or catching-up nature, thus gradually increasing production in the industry with few savings in money and labor but does not yet yield the results typical for agriculture in developed countries. The advanced development of domestic agriculture is possible only with the creation and development of world-class basic innovations capable of eliminating the existing technical and technological lags of our country in the shortest term and to ensure the shifts of the boundaries of production capabilities in the industry with the subsequent rapid growth of competitive agricultural products' production of different types in foreign and domestic markets [6].

Other types of innovations, including product, marketing and organizational, unfortunately make a relatively small contribution to the development of agriculture in Russia at the present stage [7].

The proposed methodology for forecasting socio-economic results of innovative development of agriculture includes a system of principles, approaches, methods, and private techniques considering the leading role of technical and technological group innovations. Its conceptual scheme is presented in Figure 1.

When predicting the socio-economic results of agriculture's innovative development, it is important to consider that as a rule, they are a consequence of integrated development of various innovations in the conditions of continuous scientific and technological progress. At the same time, basic innovations resulting from major scientific discoveries and their commercialization in the form of new inventions, products, and technologies create great opportunities for advanced industry's development with a transition to a new technological structure with the continued support of improving technical and technological innovations. Therefore, the methods used should allow to aggregate the expected results of basic innovations' development, which set the main trajectories of agricultural development within their technological structure and numerous improvements that accompany them.

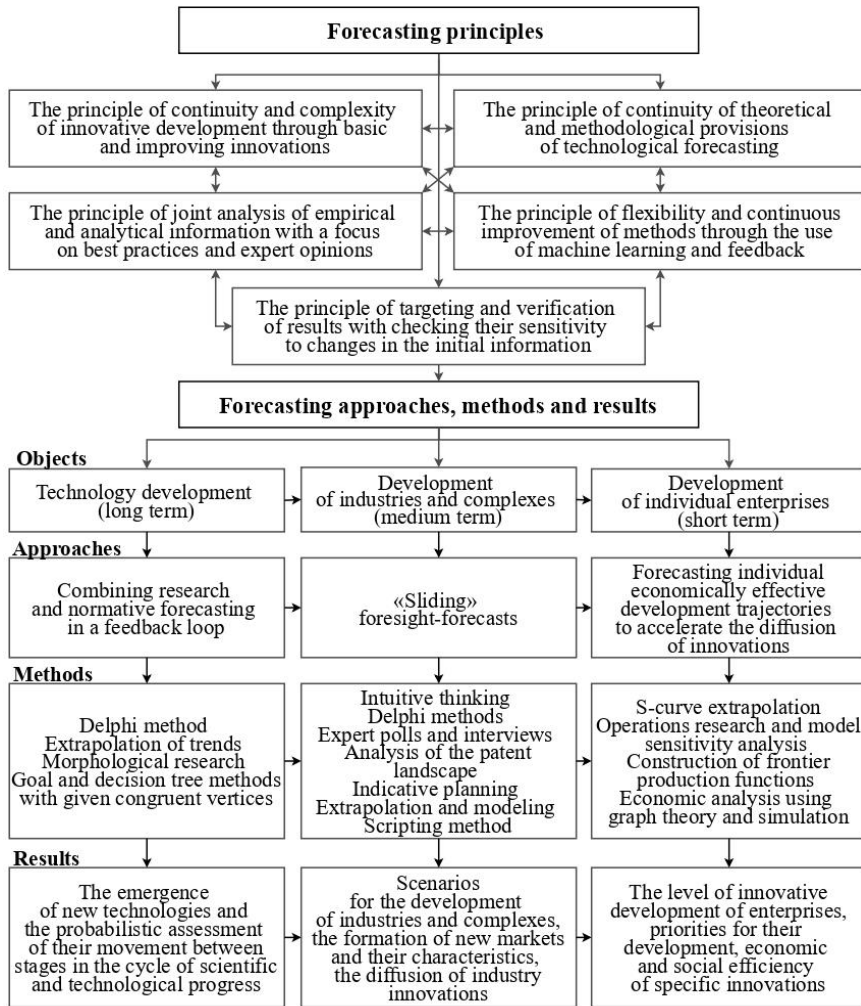


Fig. 1. Conceptual methodology scheme for forecasting socio-economic results of innovative development of agriculture.

The proposed methodology is based on the theoretical and methodological provisions of technological forecasting, which is a probabilistic assessment of the creation of new inventions and technologies, improvement of their parameters, trajectories, and duration of movements between stages in cycles of scientific and technological progress and subsequent distribution in the national economy's sectors [8, 9]. However, as a rule, classical scientific works in the field of technological forecasting have been developed and tested on companies in the high-tech economy sectors, which are mainly developing based on their own innovations, which allows enterprises to repeatedly increase sales volumes, increase profits and take leading positions in domestic and foreign markets.

For agriculture, the expected socio-economic results of innovative development will always be subject to restrictions on the size of enterprises' land use and partly by the biological productivity level of crops, farm animals and poultry, which do not allow to occupy disproportionately large market shares with available resource potential. It is also important to bear in mind that most of the innovations currently applied in agriculture were created in other sectors of the economy; with this, as a rule, agricultural producers tend not to conduct own

research for the purpose of creating scientific products in the field of production, marketing, or organization of activities, but act only as consumers of innovation mainly in the second half of their life cycle.

With the development of information technologies and computer hardware, the theory and practice of forecasting gained new opportunities for collecting and processing large amounts of data on the objects under study and creation of complex predictive models at their structure based on machine learning elements [10]. For agriculture, this is still of great value and can significantly improve the quality of decisions made in the field of production planning, pricing, marketing, etc. For the area under consideration, forecasting should be performed using a wide variety of flexible classification and regression tools with learning parameters on the data of specific enterprises' sampling with quality control of the predictive opportunities created and rather accurate determination of the innovation component's contribution to the formation of production and economic potential of particular producers and the industry as a whole.

Prediction of socio-economic results of innovative agricultural development is proposed to be performed on the data of enterprises' representative panel sample with the chance of accurate identification of their individual development in the form of specific graph-mathematical objects - "sequences" or "trajectories". The economic and mathematical models and methods used should determine the dependencies and trends in the analysis of both individual "trajectories" of individual producers' development and their groups belonging to the same enterprises' class with a close level of innovative development and other production and economic characteristics.

Compliance with the described principles in the implementation of forecasting in the area under consideration will allow not only to create generalized economic forecasts of certain agricultural industries' development at transition to a new technological structure, but also to formulate and justify targeted conclusions and recommendations based on individual "trajectories" analysis of specific agricultural enterprises. The adequacy of the selected mathematical tools and the correctness of the results obtained during their use should be ensured by a constant process of learning and testing in the form of selecting the most appropriate regression or classification functions from their existing set, as well as the determination of their parameters that provide the extremes of the formulated learning criteria.

4 Conclusions

Currently, in technological forecasting, the most widely spread methods are foresight methods, which in the new century have formed almost a separate direction of professional activity in management, as well as the combination of research (survey) and regulatory forecasting in the feedback cycle developed by scientists and practitioners for more than 50 years. These approaches contain elements of indicative planning and allow to obtain forecasts on the state of technologies, technical means, markets, and industries in the future with expected estimates of the time of their innovative transformations' onset. However, for agricultural producers taking barely any part in the creation of technical and technological innovations in the industry and acting as their consumers at ready-made innovations diffusion stage, such forecasts are predominantly informational and do not have a strong impact on their current activities. Therefore, information on the socio-economic implications of specific innovations' development and expected changes in their products' competitiveness in the market will be more important for agricultural producers. When solving the stated problem, the dominant approach should be the assessment of innovative development level of specific agricultural producers and responsiveness of their activities' results for the development of technical and technological

innovations with the possibility of further results' aggregation to formulate more generalized conclusions for groups of enterprises with similar characteristics.

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