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LONG-TERM TRENDS OF SCIENTIFIC AND INTELLECTUAL POTENTIAL OF AGRICULTURAL FOOD COMPLEX

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Abstract

The scientific and intellectual potential of the agri-food complex is a driver for ensuring food security and the independence of countries. The work aims to study long-term trends in the quantitative and qualitative development of scientific and intellectual potential, as well as the development of measures to increase the competitiveness of national agriculture. The article discusses indicators of state regulation of scientific and technological development of the agro-industrial complex. Theoretical and methodological aspects of the concept of developing the scientific and intellectual potential of the agri-food complex based on the synthesis of a pool of theories: knowledge economics, theories of innovative development, theories of economic growth are developed in the article. Disproportions in the functioning of the scientific and intellectual potential and its structure are revealed by the results of the analysis. It is substantiated that the level of scientific support of agrarian science in Russia is characterized by a tendency to increase the share of costs per unit of result compared with international best practices. Measures are proposed to develop employee competency standards in the context of the structural transformation of the agricultural economy. The study formulated organizational, legal, economic, and social measures to stimulate the influence of scientific support of the agri-food complex on improving the efficiency of agricultural production in the context of the transition to an export-oriented model of the agricultural economy.

Key words**:** *scientific and intellectual potential, agri-food complex, knowledge economy, development trends, digital economy*

INTRODUCTION

Currently, in the context of the structural restructuring of the economy, the development of the scientific and intellectual potential of the agri-food complex is becoming particularly relevant. The pace of innovative development depends on the effectiveness of the functioning of the institutional environment. The efficiency criterion is an increase in the volume of innovation in agricultural production, which is determined by a set of factors and conditions for using the scientific and intellectual potential of the agri-food complex. The dynamics of employment in the labor market and an increase in the share of high-tech high-performance jobs show the need for additional institutional regulation to predict the socio-economic development of the agri-food complex. With the digitalization of agricultural production, manufacturing emphasis is shifting to the creation of highly productive jobs.

The economies of developed countries increasingly rely on the knowledge, innovation, and new technologies, which are now considered the driving force behind economic growth. The scientific and intellectual potential is closely related to the production potential of the agricultural economy. The level of the current development of the scientific and intellectual potential of the agri-food complex and the degree of its contribution to the economic growth of national economies depend on the totality of conditions that the state creates for its development and use. Such conditions are related to the existing institutional environment, investment, business climate, and the quality of public administration [12]. The qualitative level of development of scientific and intellectual potential can be estimated by the degree of technological novelty of agricultural innovations, increased labor productivity, cost reduction, and other factors [31].

The National Project "Science" [26], the Project "International Cooperation and Export" [27], the State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials and Food Markets (as amended on March 31, 2020 [8] prioritized. development and transfer of innovations, diffusion of innovations, biologization, increasing the investment attractiveness of the industry, increasing the level of material and technical equipment by updating the fleet of agricultural machinery, improving the efficiency of use of fixed assets and investments [14].

To comprehensively solve the existing problems of scientific support of the agro-industrial complex, it is necessary to create conditions for the formation of competitive scientific and technical results, as well as for transferring scientific results to production and their subsequent involvement in economic circulation.

By the Strategy for Scientific and Technological Development of the Russian Federation, approved by Decree of the President of the Russian Federation dated December 1, 2016 No. 642 [33], the current stage of economic transformation is determined by the insufficient degree of connection between science and industry. Many sectors of the national economy, including the agrarian economy, are characterized by a weak level of coordination between research and development institutions and economic sectors, which impedes the scientific and technological development of Russia [13]. Recently, scientific and educational centers have been spreading, combining the capabilities of universities, academic institutes, and high-tech companies [9]. A significant problem is the uneven distribution of scientific and intellectual potential across industries and regions and interregional imbalances in the effectiveness of research activities in agriculture and the agri-food sector.

The theoretical and methodological basis for the qualitative and quantitative development of the scientific and intellectual potential of the agri-food complex is the theory of the knowledge economy. The study of the problems of the formation and development of the knowledge economy, the measurement of its contribution to production processes at the micro-, middle-, macroeconomic and international levels has been studied by many domestic and foreign scientists of various schools and areas. Among them, we note the research of Russian scientists L.I. Abalkina, A.V. Buzgalina, V.L. Inozemtseva, G.B. Kleiner, D.S. Lviv, V.L. Makarova, Yu.V. Yakovets. An integrated approach to the problem of measuring the parameters of the knowledge economy is proposed by E.D. Weissman [34]. In her work, an approach is proposed to assess the relationship between the level of innovative development, growth of labor productivity, and competitiveness of industries and regions using the knowledge economy. The knowledge economy of agriculture as an independent concept exploring the real changes in production processes is in the process of formation.

Domestic scientists researched to determine the effectiveness of the knowledge economy. B. Milner hypothesized that this type of economy appears if knowledge is a market product and its effectiveness can be estimated [24]. This approach does not include the study of economic risks and the impact of the social environment. A. Kozyrev developed a methodology for assessing the effectiveness of innovative production by profitable, comparative, and costly methods [21]. The cost of scientific research cannot fully justify the price of the final intellectual product. According to V. Makarov and A. Warsaw, the demand factor is the driver of the knowledge economy [22]. We share this paradigm and believe that the development of the knowledge economy is based on the modern concept of stimulating demand for innovation Demand-Driven Innovation Policy, DDI. In contrast to the concept of stimulating supply, the concept of stimulating demand uses direct methods for developing demand for innovations: public procurement, industry regulation, and the implementation of these tools based on foresight technological forecasts [11]. L. Mindeli and L. Pipia divided the knowledge economy into 5 aspects: resource, knowledge asset generation, productive, network, and

learning. They characterize the estimated data, focusing on poorly studied aspects of the knowledge economy [25]. The multidimensional nature of the knowledge economy does not allow to formulate of the totality of the evaluation criteria. There are also a lot of difficulties in applying foreign methodological programs related to the lack of analogs in domestic areas, and therefore the research horizon is becoming much narrower. Therefore, a wide range of work is underway to create indicators that can standardize all analyzes of economic research.
In connection with the existing world problem of ensuring food security of national economies, food accessibility in most developed countries, studies are being conducted on the problems of developing innovative activities in the agro-industrial complex and the growth of agricultural production based on the application of scientific achievements [2]. Innovative systems in the process of creating and commercializing new products, services, and processes. It is about optimizing the structure and activities of technology transfer centers, including the formation of relevant alliances. Al-Hassan R., Egyir I, Abakah J. revealed imbalances in the development of the scientific and intellectual potential of developing countries [1].
At the present stage, the determining trends in the deployment of innovative processes are the processes of globalization and regionalization. Therefore, these two global trends must be taken into account in the formation and development of the innovative activity of the Russian Federation [20].
Barrett C., Barbier E., Reardon T., Bush L., Bain C., Popescu A. [4, 5, 30] are devoted to the study of global economic trends and their influence on improving the efficiency of the scientific and intellectual potential of agriculture.
In the studies of Autor D.H. [3], Gandhi R., Veetaraghavan R., [17] Dasgupta S., Mamingi N., Oliver Y., Robertson M., Wong M. [6] trends in the development of production processes in agriculture based on the knowledge economy and information technologies are identified, directions for accelerating the transfer of innovations are substantiated.
An attempt is made to study the long-term trends and dynamics of the development of the scientific and intellectual potential of the agri-food complex in the context of the structural transformation of the agricultural economy.

MATERIALS AND METHODS

The methodological basis of the study was government laws, decrees and government decrees, scientific works of domestic and foreign scientists - economists and agricultural experts on the issue under study. In the research process, monographic, abstract-logical, analytical, economic-statistical, and expert research methods were used. The information base of the study used information from the Federal State Statistics Service, the Higher School of Economics, the Ministry of Agriculture of the Russian Federation, as well as special reference books.
The scientific and managerial literature presents a variety of approaches and methods for assessing the scientific and intellectual potential of sectors of the national economy. The purpose of the article is to analyze and evaluate long-term trends in the quantitative and qualitative development of scientific and intellectual potential, factors affecting the policy of its improvement, as well as the development of a set of practical measures to increase the efficiency of agricultural production on a scientific basis.
The information base was the data of departmental statistical monitoring for the period 2013-2018 according to form No. 2K "Information on the number and level of professional education of employees of agricultural organizations". To assess the level of professional education employed in the fields and sectors of the agro-industrial complex, analytical, monographic, abstract-logical methods, the method of economic observation, economic induction and deduction, selective observation, and the system method was used.
International experience in assessing innovative development based on the achievements of scientific and technological

progress accumulates a set of indicators: Knowledge Economy Index; Global Innovation Index, Global Competitiveness Index, Human Development Index and others [18]. These indices were proposed by the UN, UNESCO, the World Bank, the European Commission, and others. The proposed integrated indicators do not fully take into account the specific features of each country. According to the calculation of the indices, the highest expenses for science and education and the stimulating conditions for introducing innovations are typical for Sweden, Denmark, and the Netherlands. Among the countries of East Asia can be noted China, Singapore, Japan. The share of innovative enterprises in OECD countries is 49%, in Germany, Finland and Sweden it is 55%, in Russia it is 10%. Russia is in 55th place in the knowledge economy index. In agriculture and the agro-industrial complex as a whole, the situation is aggravated not only by the insufficient effectiveness of state regulation measures but also by the low innovative activity of agricultural producers, associated with well-established views on innovation and high risks of agricultural production. Positive foreign and domestic experience in assessing the knowledge economy and scientific and intellectual potential allows us to highlight effective and resource-based approaches.

Blyakhman L.S., Merson F.L., Peat E.M. are oriented towards a productive approach [23]. At the macro level, an assessment is made of the financial results obtained by the economy from goods with elements of intellectual property. The resource approach is an assessment of the effectiveness of the use of natural, material, financial, information resources. Several studies combine resource and productive approaches. Assessment of intellectual potential is proposed based on an integral indicator that accumulates, including the results of scientific and intellectual activity. As for indicators in this approach, we can distinguish the volume of innovations or implemented innovations, and resources - a depreciation of fixed assets, capital productivity, turnover of working capital, the share of the salary of research personnel in the cost of production). With this interpretation, we present the author's definition of the category of scientific and intellectual potential of the agri-food complex, which is a measure of the efficiency, effectiveness, productivity of an innovative economy for the socio-economic development of industries and regions. We share the opinion of Sandu I.S. the fact that the main indicators of scientific research in agriculture are the number of organizations performing research and development, the number of people engaged in research and development, the cost of research and development, the volume of scientific and technological work [32].

The study offers an analysis of long-term trends in the development of scientific and intellectual potential, an assessment of its contribution to the innovative development of agriculture. The article tests the hypothesis about the dependence of the level of production of innovative products in agriculture of the Russian regions on the quantitative and qualitative composition of researchers in agriculture.

RESULTS AND DISCUSSIONS

In the current conditions of the development of agriculture and the agro-industrial complex of Russia, of particular interest are the problems of increasing innovative activity in the agricultural sector of the economy, including based on the qualitative and quantitative development of scientific and intellectual potential.

A system for assessing scientific and intellectual potential should be built taking into account the specific characteristics of the economy of a particular region. On the whole, Russia has a developed scientific and educational structure, which in some areas has world-leading positions. In our country, state funding for higher education and research prevails, and a significant share of the extractive industry is also an important factor. In various sectors of the economy, there are significant imbalances in technological processes compared to foreign countries. Specific features of identifying the knowledge economy in the regions are strengthened due to the characteristic structural differentiation of

regions by type of production [15]. Thus, different regions are characterized by differentiation in the growth rate of agricultural production depending on changes in the dynamics of scientific and intellectual potential.

The scientific and intellectual potential of the agri-food complex of Russia is represented by specialists with higher education numbering 40,998 people, who are trained by 54 higher education institutions of the Ministry of Agriculture of Russia, including 31 agricultural universities, 22 agricultural academies, and one agricultural institute and 34 higher education institutions of the Russian Ministry of Education and Science. Agricultural research and educational organizations are located in 58 constituent entities of the Russian Federation.

The dynamics of the number of people employed in agriculture in Russia, the Volga Federal District, and the Saratov Region is shown in Fig. 1.

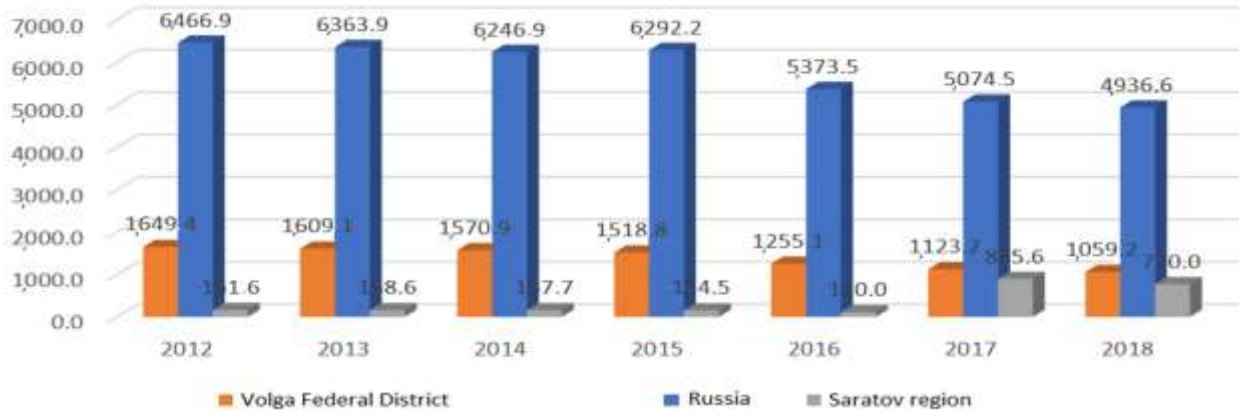

Fig.1. The average annual number of employees in the direction "Agriculture, hunting and forestry" in 2012-2018, thousand people
Source: Design based on the Rosstat data.

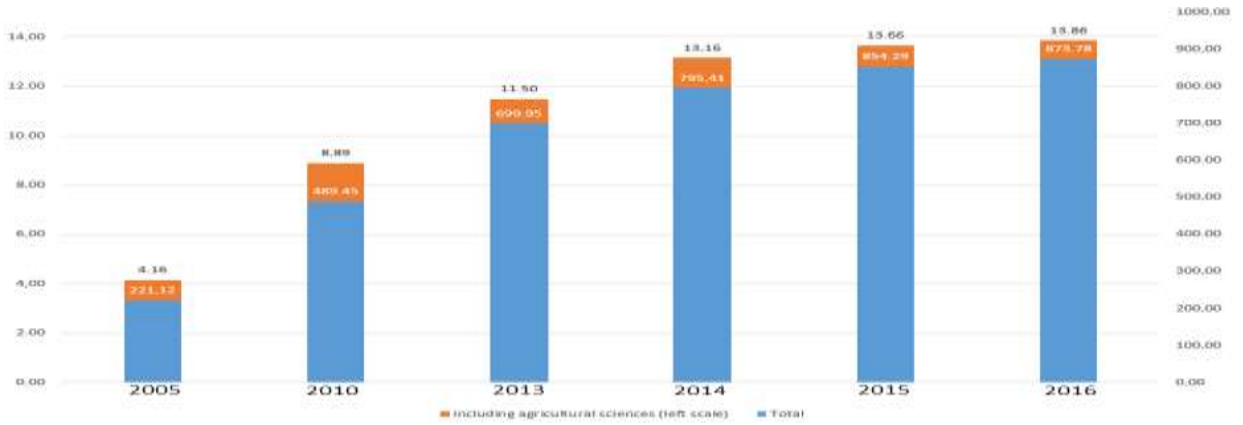

Fig. 2. Dynamics of domestic current expenditures on research and development in Russia, billion rubles
Source: Design based on the Rosstat data.

According to statistics, domestic current expenditures on research and development quadrupled by 2016 compared to 2005 and amounted to 873.78 billion rubles (Fig. 2). Costs in the field of agricultural sciences increased 3.3 times. The costs of basic research grew 4.1 times, for applied research - 2.8 times, for development - 2.3 times. A high increase in costs by 8 times was in the field of agricultural sciences was in the higher education sector. The largest amount of funds is allocated in the public sector. In the business sector, funding for research and development is reduced compared to 2005 [19].

Figure 3 shows the share of domestic agricultural research and development costs in different countries.

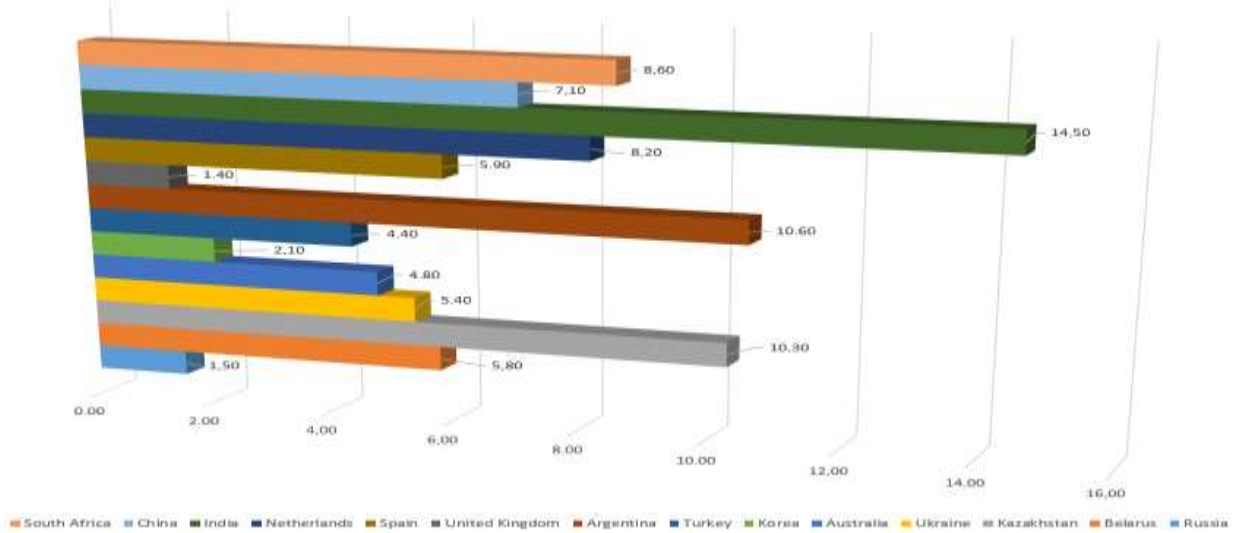

Fig. 3. The share of domestic expenditures on research and development in the field of agricultural sciences in various countries in 2017, percent
Source: Design based on the Rosstat data.

The size of financial investments does not fully correspond to the importance of the agro-industrial complex for ensuring the food independence of Russia. For the period 1994-2015 the structure of scientific activity in the field of agricultural sciences has changed: the cost of basic research has increased by 2.6 times with a decrease in funding for applied research by half [16]. Thus, the share of basic research in the total volume of domestic current expenditures on research and development has increased from 22% to 58.9%, while applied research has decreased from 48% to 27.1%.

This situation contributed to the increase in imbalances and the gap between the stages of the research cycle, the loss of applied competencies demanded by business and the ability to solve priority scientific and technological problems.

Figure 4 shows the number of researchers in general and in the field of agricultural sciences. In 2016, 11.1 thousand Russian researchers were employed in the field of agricultural sciences, of which 1.5 thousand people had a doctorate degree, 4.5 thousand people had a PhD degree.

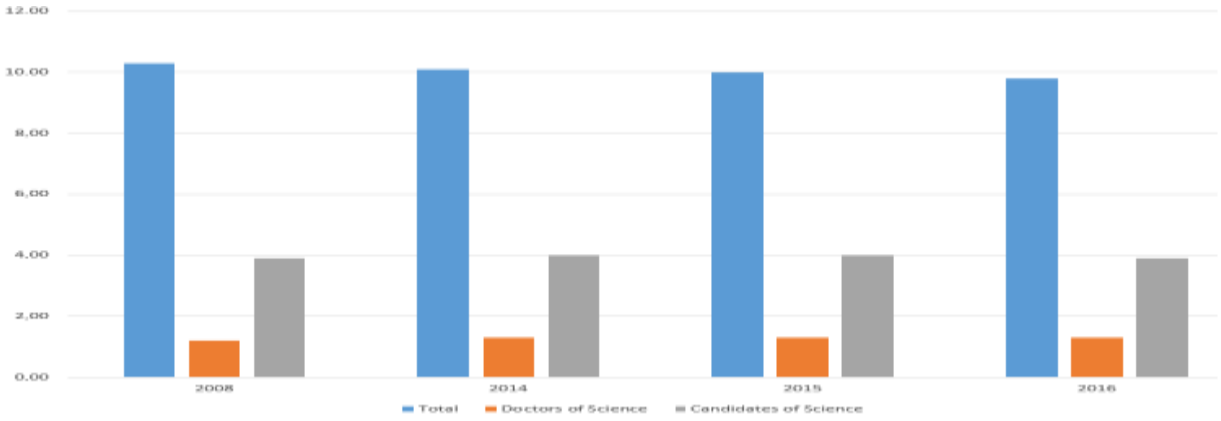

Fig.4. Number of researchers in the field of agricultural sciences, thousand people
Source: Design based on the Rosstat data.

The most important problem of Russian agricultural science is the aging of scientific personnel and the deformation of their age structure. This situation leads to the loss of continuity of generations, slowing down the transfer of knowledge, skills, and experience to young specialists.

Analysis and evaluation of patent activity in agriculture are characterized by growing dynamics. The number of patent applications

filed nearly tripled. By the thematic structure, until 2000 basic agricultural sectors dominated, in 2013 = 2015 the share of food production technologies increased. The priority thematic area remains the development in the field of biochemical processes.

By 2015, patent activity in agriculture amounted to 33 applications filed under the Treaty on International Patent Cooperation (PCT), which is 0.13% of their total number in the world. This result is significantly lower than similar indicators of both large and technologically advanced economies of the USA, Korea, China, Great Britain, the Netherlands, and developing countries of India and Brazil. Patenting of developments is an international form of protecting the results of intellectual activity for their commercialization. The current situation in this area speaks of an unstable innovative climate and insufficiently effective directions for stimulating innovative activity.

During the period from 2005-2016, there is a tendency for the steady growth of investment injections in fixed assets. In the economy as a whole, it increased by 11,028.7 billion rubles. or 4.1 times. Interest in innovation in Russia has been growing in recent years. However, in various industries, its level varies. So, for example, in the field of food production, including drinks, the indicator of innovative activity of organizations in the economy increased by 2016 compared to 2010 by 0.6%. The proportion of organizations implementing technological innovations underwent similar changes: against the background of an annual decline in the economy as a whole since 2012, this indicator in food production increased in 2016 compared to 2012 by 0.7%.

In turn, other indicators show a steady growth trend. For example, the costs of technological innovation of organizations over the entire period increased throughout the economy as a whole by 883,786.5 million rubles (or 3.2 times), in food production - by 14,953.0 million rubles. (or 2.9 times). The volume of innovative goods works and services increased over the study period both in the economy as a whole and in food production by 3.5 and 2.0 times, respectively. The growth in the number of advanced production technologies developed and used is also characteristic: in the economy as a whole, an increase of 76.1%, in the field of food production - by 3.6 times. This analysis shows pronounced imbalances between the costs of scientific and intellectual potential and indicators of its functioning. The level of scientific support of agrarian science in Russia is characterized by a tendency to increase the share of costs per unit of result compared with other sectors of the national economy and international best practices.

However, despite the difficulties in organizing the innovation process in agriculture, large-scale projects that bring good results are spreading in modern times. Further development of the sector largely depends on the pace of development of innovations and the competitive position in world markets [28, 29]. Thus, based on the analysis, a hypothesis is proved that the level of production of innovative products in the Russian regions depends on the quantitative and qualitative composition of researchers in agriculture. The process of the digital transformation of agriculture is associated with the need to increase not only the quantitative but also the qualitative level of scientific and intellectual potential. Currently, there is a problem in motivating the choice of work in agriculture, the consolidation of specialists in rural areas. Also, in the context of the development of the digital economy, the problem of matching workers' qualifications to current requirements has become more acute.

In the current transformation of the agricultural economy, there is an acute problem between the existing scientific and intellectual potential of agriculture and the efficiency of its use. These imbalances are associated with a lack of competencies in light of the introduction of modern digital technologies in agriculture. The cause of the gap may be the scientific and intellectual potential of poor quality, which is inefficiently managed. Deloitte highlighted global HR management trends: organizational change; career and training in real-time, continuously; attraction of talents; employee experience is defined as a holistic view of life and work, new leaders with flexible solutions. digital HR and HR analytics; social diversity

and integration; workforce expansion. Thus, following the above trends, agribusiness can reach a new “crest” of the technological wave.

To develop the scientific, intellectual and human potential of the agricultural sector of the economy, it is proposed to develop training standards and competency maps by industry, formulate qualification requirements for employees, create a personnel certification system for agricultural production, and develop approaches to the development of information support for the scientific and technological policy in agriculture.

The development of the scientific and intellectual potential of the agri-food complex and its influence on the development of production processes is regulated by a set of laws, programs, and legal acts.

Measures for the qualitative development of scientific and intellectual potential are reflected in the State program "Integrated Development of Rural Areas", a departmental project "Promotion of Employment of the Rural Population" has been developed, which provides for the planning of training and retraining of personnel as part of measures to increase the production of value-added in the agricultural sector. By this project, it is planned to ensure the level of employment of the rural population, including those who have undergone additional training (retraining), up to 80 percent of the working population; as well as a decrease in the unemployment rate of the rural working-age population to 5.7 percent by 2025. In the direction “Development of the labor market (human resources potential) in rural areas”, the following targets have been formulated: an increase in the number of workers studying under student agreements, as well as an increase in the number of students involved in agricultural practices for practical training (cumulative total)

The Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025 is aimed at providing the population with high-quality and competitive agricultural products of domestic production.

The priority subprograms are “Development of selection and seed production of potatoes in the Russian Federation”; “Creation of domestic competitive broiler-type meat crosses; "Development of selection and seed production of sugar beets in the Russian Federation."

This Program presents the target indicators and indicators. Target indicators include increasing innovative activity in agriculture; attracting investment in agriculture; increasing the level of security of the agro-industrial complex with infrastructure facilities, providing the industry with training programs for new and promising areas of training and specialties that are in demand on the labor market.

The indicators of the Federal Scientific and Technical Program for the Development of Agriculture for 2017-2025 are classified according to three main measures: “Creation of scientific and (or) scientific and technical results and products for the agricultural sector”, “Transfer of scientific and (or) scientific and technical results and products for practical use and advanced training of participants in scientific and technical support for agricultural development Commercialization of scientific and (or) scientific and technical results and products for the agricultural industry industrial complex. In the framework of the event "Creation of scientific and (or) scientific and technical results and products for the agro-industrial complex", 4 indicators appear as prospects for the development of the scientific and intellectual potential of the agro-industrial complex: an increase in the number of publications on the results of research and development in scientific journals indexed in the Scopus database or in the database "Network of Science" (WEB of Science), in relation to the previous year, an increase in the number of protected results of intellectual activity in the field of agricultural technologies in relation to to the previous year; an increase in the number of protected results of intellectual activity in the field of agricultural technologies abroad in relation to the previous year, the number of licensing agreements of enterprises with scientific and educational, as well as other organizations engaged in and (or) facilitating the implementation of scientific, scientific, technical and innovative activities in the field agriculture [7].

In the Russian regions, there is a pronounced differentiation in terms of level, quality, and human resources by the specific needs of the region. In the context of structural innovation transformation, an increase in the quality level of scientific and intellectual potential is associated with the introduction of qualitatively new knowledge and competencies at all levels of management, the creation of innovative principles and teaching methods. It is also necessary to develop tools for assessing the degree of qualification of employees, identifying trends in the most popular specialties, and creating new requirements and standards for training specialists for the agricultural sector of the economy in terms of their professional competencies. The solution to this problem is possible through the development and implementation of new staffing strategies. Thus, improving the management of scientific and intellectual potential requires the implementation of a package of measures at the federal, regional, and sectoral management levels [10]. Organizational, legal, economic, social and other measures include:

1) the implementation of long-term programs for staffing agriculture at the federal, regional and municipal levels of agricultural management;

2) the creation of an effective monitoring system for staffing the development of rural territories on a regional basis based on the development of information technologies;

3) increasing the financial stability of agricultural producers by increasing labor productivity based on the growth of the technological level of production, as well as improving the economic mechanisms of managing organizations;

4) the formation of a new prestigious image of an agricultural worker, the creation of conditions for increasing the level of labor motivation of workers in the agricultural sector of the economy; propaganda of workers' specialties, legal consolidation of social guarantees for agricultural producers;

5) the introduction of a system of training and advanced training of personnel potential by the requirements of digitalization of agribusiness;

6) integration of educational institutions with agricultural unions of employers and business representatives, bringing the educational system closer to the interests and needs of agricultural producers, introducing new specialties and training areas by the needs of agribusiness.

Implementation of the proposed measures will allow preparing promising specialists for the needs of the agricultural sector in the context of structural transformation, providing the agri-food complex with highly qualified personnel to solve its priority tasks.

CONCLUSIONS

The article discusses the tools of state support for research and development in agriculture. Theoretical and methodological principles of the formation of a concept for the development of the scientific and intellectual potential of the agri-food complex based on the synthesis of theories of economic growth, theories of the post-industrial, information society and knowledge economy are developed.

Resource and productive approaches to assessing the scientific and intellectual potential of the agri-food complex are considered. The study analyzes the trends in the development of scientific and intellectual potential from the position of its contribution to innovative development. It is proved that the level of scientific support of agrarian science in Russia is characterized by a tendency to increase the share of costs per unit of result compared with international best practices. A hypothesis is proved that the level of production of innovative products in the Russian regions depends on the quantitative and qualitative composition of researchers in agriculture. The necessity of identifying the trends of the most popular specialties, the formation of new requirements and standards for the training of specialists for the agricultural sector in terms of the development of professional competencies is substantiated. The trends of the transition of agribusiness to a new technological level are formulated. Organizational, legal, economic, and social measures have been developed to increase the qualitative and quantitative level of the

scientific and intellectual potential of the agri-food complex.

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