FACTORS AFFECTING THE FORMATION AND USE OF SCIENTIFIC AND INTELLECTUAL POTENTIAL OF THE AGRICULTURAL SECTOR OF THE ECONOMY

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Abstract

The development of the scientific and intellectual potential of the agricultural sector of the economy is undoubtedly a vector of sustainable development. The purpose of the article is to study the theory and methodology of factor analysis of the development of scientific and intellectual potential at the macro, meso and micro levels. A study of human resources in the agricultural sector was conducted from the perspective of improving human resources and research forces of society. Cross-country comparisons have been made of the area of agricultural land and the value of gross added value of agriculture in different countries, which may indicate an appropriate level of scientific and technological development of the agricultural sector of the economy. The article classifies positive and negative socio-economic, technological, demographic and organizational factors. Measures are proposed for the use of scientific and intellectual potential in agricultural production as a driver of scientific and technological development.

Key words: *scientific and intellectual potential, agricultural sector, factors, cross-country comparisons, principles, efficiency, innovation and investment support*

INTRODUCTION

Increasing the sustainability of the development of agricultural production is associated with the valorization of promising scientific developments and advanced innovative solutions. The level of development of human capital in the agricultural sector as a synthesis of skills, knowledge and competencies in the conditions of structural transformation is constantly growing. However, questions remain unresolved in the study of many factors influencing the formation and use of human resources in agricultural production.

Scientific research by T. Schultz and G. Becker is devoted to the study of human capital, its fundamental and practical aspects.

The most important characteristic of human capital is the ability to generate appropriate income for its owner [6].

G. Schultz substantiated the need for investment in human capital, especially in underdeveloped countries, considering the agricultural sector as a point of growth for the entire economy [5, 21].

Foreign researchers George N. Curry, Steven Nake, Gina Koczberski noted the priority role of technological transformations to increase the productivity of resources used in agriculture. At the same time, the unevenness of innovative development of agricultural organizations of various forms of management remains [8].

Amare, Darr, Dadi, Deressa note the financial difficulties in introducing new generation technologies among small farmers in developing countries, and therefore these processes are proceeding at a slow pace [4, 9].

Viaggi, D. noted the relationships between research results, innovation and resource productivity. It is noted that the development of new conceptual provisions on agricultural development raised the problem of measuring resource productivity. Researchers note the need to improve methodological approaches to measuring this indicator, taking into account the requirements of technological transformations, achieving economic and social sustainability, as well as increasing the efficiency of resource use. The authors propose to use, along with specific productivity indicators, also indicators of total factor productivity [24].

Widespread use of econometric models is recommended to study resource productivity factors. For example, the authors Alston, J.M., Andersen, Wang, S.L., Heisey, P.W., in their works considered research costs as one of the main factors of productivity [3, 25].

Along with established conceptual approaches to considering factors of production as a set of labor, land, and capital resources formed under the influence of scientific and technological progress and united by entrepreneurial abilities, there is now a need for a more detailed study of intellectual labor. In a narrow sense, intellectual work is characterized by the need for knowledge and skills, and the result of its use has a direct impact on reducing production costs. In the context of the formation of a new technological basis for economic sectors, intellectual work becomes a determining factor in increasing the scientific research potential of society, and the comprehensive formation of scientific and innovation chains in the agricultural sector made it possible to identify a new term “scientific research forces of society” [7].

These forces, as a set of scientific, research and educational organizations, are considered as the foundation for the acquisition of knowledge and innovative solutions that are introduced into the production process.

Russian researchers consider this new category of productive forces as a system for acquiring knowledge and introducing it into the production process.

A number of foreign scientists focus on the analysis of joint innovations based on the common values of participants in the institutional structure [11, 12, 22].

Using the example of Chinese agriculture, the positive role of general innovation among stakeholders, which includes universities, research institutes, business representatives and government agencies, is noted. Using the conceptual principles of the triple helix theory, the authors examined the structural transformation of innovation communications for the period 1985–2014, concluding that the innovation chain gradually developed from a single helix to a hierarchical network with a triple helix. To overcome the existing gap between the demand for innovation and its supply, investments in science and education are necessary, mainly in large agricultural regions of the country [15, 19].

Known in the global scientific community for his research on sustainable development, H. Daly considered various concepts distinguishing between environmental and social sustainability. He highlighted such important factors of sustainable development as climate change, fluctuations in oil production, and concentration of production [10].

William E. Rees explored the features of traditional and sustainable development on a global scale, since the increase in global production of energy and material resources results in the emergence of global environmental problems. For sustainable development, it is very important to preserve ecological diversity, mainly in underdeveloped regions[20].Fairly large number of works explore approaches to the relationship between investment in human capital and labor productivity in agriculture [17,18]. However, the issues of studying factors at various levels of management and their connection with sustainable growth are not sufficiently addressed.

MATERIALS AND METHODS

The purpose of the article is to study the theory and methodology of factor analysis of the development of scientific and intellectual potential at the macro, meso and micro levels.

The methodological basis of the study is regulatory documents and open data from the World Bank, OECD, Rosstat.

RESULTS AND DISCUSSIONS

The sustainable development of the country's agri-food complex largely depends on the rate of economic growth, improvement of the functioning of the rural environment, and compliance with environmental safety requirements.

A study of the area of agricultural land in various countries was carried out (Fig. 1).

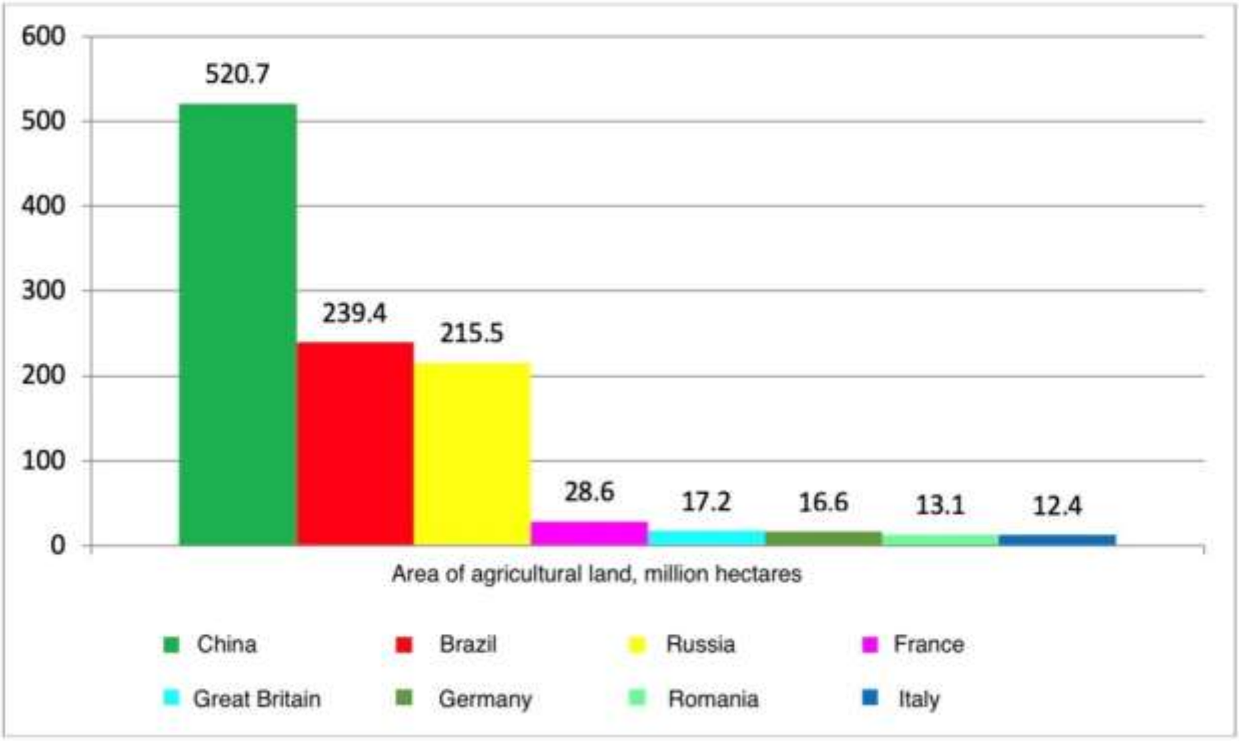

Fig. 1. Cross-country comparisons of agricultural land area (2021).
Source: Own calculations based on data [1].

Fig. 2 shows cross-country comparisons of agricultural value added. China ranks first in the world in terms of agricultural value added and agricultural area. Challenges to sustainable development and improved resource utilization remain for China's agricultural sector. According to experts, water use efficiency is 0.4-0.6, and nitrogen use efficiency is 30-35%, or 20% less than many developed countries. To increase the efficiency of use of land resources, a wider use of precision farming technology based on the design and production of domestic machinery and equipment is proposed [16].

Russia also occupies one of the leading places in the world in terms of agricultural land area and value added in agriculture.

However, under the conditions of sanctions and the need for national security in agriculture, the need for scientific and technological development is becoming more urgent.

Table 1 shows the dynamics of development of the main indicators of scientific research and development in Russia.

The analysis of the main indicators of the development of scientific activity in the country shows that scientific and innovative activity continues to develop.

During the period under study, the number of scientific organizations carrying out research and development increased by more than 16%.

In the overall structure of organizations, the number of research organizations over the past 10 years has decreased by 8%, while the number of design and engineering organizations has increased by more than 85%.

The number of personnel engaged in research and development decreased by 8%, including researchers with advanced degrees.

The number of people employed in agricultural sciences, according to Rosstat, has also experienced a decline. However, in recent years there has been an increase in funding for science from the federal budget, as well as internal expenditures on research and development, aimed at stimulating scientific and technological development and advanced production technologies as a priority direction for the country's development, improving scientific and innovative activities in many sectors of the national economy.

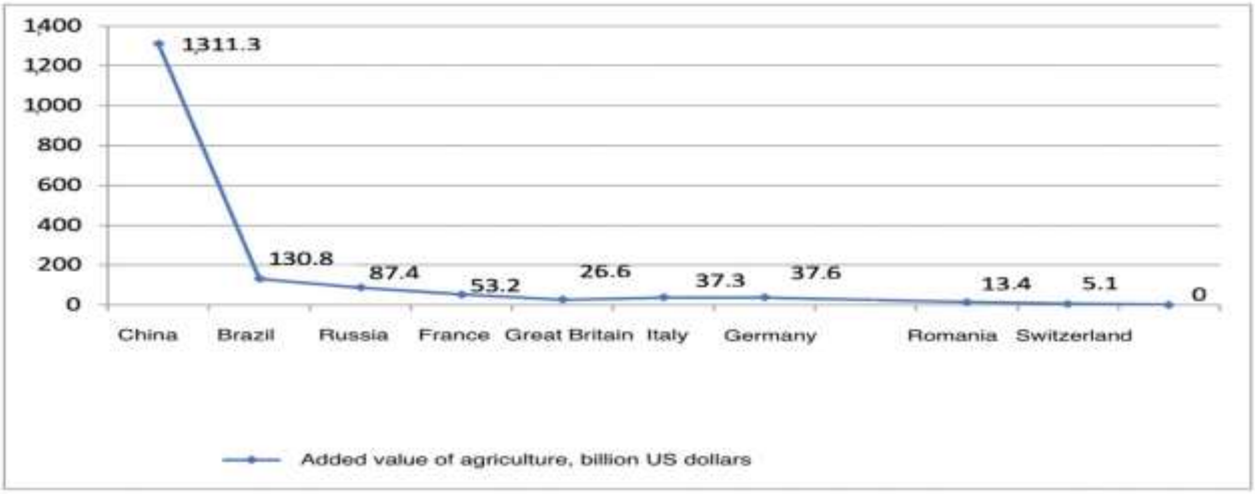

Fig. 2. The level of innovative activity of organizations in European countries, % (2021)
Source: Own calculations based on data [2].

Table 1. Dynamics of the main indicators of the development of scientific research and development in Russia in 2013-2022

Indicators	Years									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of organizations carrying out research and development	3,605	3,604	4,175	4,032	3,944	3,950	4,051	4,175	4,175	4,195
including: - researchorganizations	1,719	1,689	1,708	1,673	1,577	1,574	1,618	1,633	1,627	1,584
- designandengineeringdepartments	266	275	371	363	380	419	450	441	446	494
Number of personnel employed research and development, thousandpeople	727,029	732,274	738,857	722,291	707,887	682,580	682,464	679,333	662,702	669,870
Including those with an academic degree	108,248	109,598	111,533	108,388	103,327	100,330	99,912	99,122	97,537	95,204
Doctor of Sciences	27,485	27,969	28,046	27,430	26,076	25,288	24,844	24,473	24,074	23,306
PhD	80,763	81,629	83,487	80958	77,251	75,042	75,068	74,649	73,463	71,898
Funding of science from the federal budget, billion rubles	425,301.7	437,273.3	439,392.8	402,722.3	377,882.2	420,472.3	489,158, 4	549,602.2	626,574.3	631,701.6
Tofederalbudgetexpenditures	3.19	2.95	2.81	2.45	2.30	2.52	2.69	2.41	2.53	2.51
Internal costs for research and development, million rubles.	699,948.9	795,407.9	854,288.0	873,778.7	950,257.0	960,689.4	1,060,589.7	1,091,333.5	1,193,578.5	1,322,563.9

Source: Own calculations based on data [13].

The work contains a classification of positive and negative factors influencing the formation and application in the production process of the results of scientific and intellectual activity at the macroeconomic, territorial-industrial and local levels (Table 2).

Table 2. Classification of factors of scientific and intellectual capital

Name offactors	Impact on scientific and intellectual capital	
Macroeconomiclevel		
	Positiveinfluence	Negativeinfluence
Demographicfactors	Positive population dynamics and increasing life expectancy determine the possibilities for scaling scientific and intellectual capital	Reduction in the number of employees in the main sectors of agriculture. The outflow of human resources in the agricultural sector is associated with the insufficient level of importance of labor in rural areas.
	Positiveinfluence	Negativeinfluence
Economic forces	The growth of agricultural production and investment in R&D create the prerequisites for the scientific and technological development of agriculture.	Sanctions policy and macroeconomic instability create the preconditions for rising food prices, slowing technological breakthroughs and the development of the scientific and intellectual potential of agriculture.
Social factors	The social policy of the state predetermines the conditions for the development of rural areas on the basis of improving the knowledge, skills, and competencies of workers.	Lower levels of wages and income compared to other sectors of the economy, lower productivity growth labor is significantly lower than in other manufacturing industries
Institutionalfactors	A system of formal and informal institutions that implements effective mechanisms for regulating and supporting domestic science within the framework of the institutions of the Russian innovation system determines the prospects for the further development of scientific and intellectual capital	The insufficient level of support for agricultural producers (especially small businesses) limits the possibilities for the development of domestic agricultural science and the use of its results in production
Territorialandsectorallevel		
	Positiveinfluence	Negativeinfluence
Regional conditions, specialization and technical and technological features of the industry	Involvement in circulation of non-is used agricultural land values; diversification of the agricultural production structure; technical and technological modernization of the industry; development of new related industries and involvement of skilled labor in them determine the requirements for professional knowledge employees and develop appropriate competencies	Pronounced regional natural, climatic and economic conditions determine differences in specialization, level of innovation activity, technological transformations, and the need for skilled labor
Quality of life, income level of the rural population, availability of rural facilities infrastructure	Determine the comfort of work and rest in rural areas localities and contribute to the retention of personnel	Insufficient regional funding resources and income support reduce the quality of life and reduce motivation to acquire new knowledge
Local level (enterprise)		
	Positiveinfluence	Negativeinfluence
State of health and level of education of a person	Opportunities for generating income from the use of individual scientific and intellectual capital	Insufficient compliance of worker competencies with the requirements of the modern digital agricultural economy.
Personal investment in developing professional skills and acquiring new knowledge	Employee assessment of the results of implementing innovative technologies	Inversely proportional relationship between the existing level of human resources and the growth rate of agricultural production in the digital economy.
Personnelpolicy	Stimulating an employee to perform highly productive work is one of the most important factors in increasing individual productivity of workers	Ineffective personnel policy and the system of career guidance, training and retraining of personnel limit the opportunities for advanced training and acquisition of new knowledge
Social and psychological characteristics of personality- Personal qualities	Adaptability, receptivity to knowledge, absorption of innovative developments and technologies, pronounced leadership qualities contribute to increasing income from the use of individual scientific and intellectual capital	Insufficient level of education and professional training hinder the development of individual scientific and intellectual potential

Source: Own calculations.

At the macroeconomic level, the formation and development of the scientific and intellectual potential of agriculture is determined by the action of demographic, economic, social and institutional factors. Changes in population size and life expectancy determine the possibilities for scaling scientific and intellectual capital. Economic growth, macroeconomic stability, investment in science and education create conditions for its more effective use. Effective mechanisms for regulating and supporting domestic science within the Russian innovation system determine the prospects for the further development of scientific and intellectual capital [23].

At the territorial and sectoral level, great importance is given to regional climatic and economic conditions, which determine the specialization of agriculture and the possibilities of technical and technological modernization of the industry and the development of new industries. These factors determine the requirements for the professional knowledge of workers and form the corresponding competencies.

At the enterprise level, an important role is played by an effective personnel policy aimed at stimulating workers, organizing training and retraining of personnel, which contributes to the disclosure of personal qualities in the process of forming individual scientific and intellectual capital.

Demographic factors determine the resources of scientific and educational capital, forming restrictions and incentives for its further development [5].

For example, changes in the mortality rate of the working-age population cause immediate shifts in the number of certain categories of labor resources, and fluctuations in the birth rate make it possible to predict the labor market in the long term [14].

Territorial and sectoral factors explain the specifics of the formation of scientific and educational capital of regional agricultural systems from the standpoint of land use characteristics, seasonality of labor processes, agricultural profitability, technical and technological features of the industry, and quality of life. For example, the underdevelopment of production and social infrastructure, unprofitability of production leads to an outflow of labor resources from lagging regions for the purpose of employment in the city or regions with more favorable socio-economic conditions for the use of their professional qualities.

Local level factors determine the level of individual scientific and educational capital of agricultural workers. Receiving income from the use of your professional abilities and knowledge potential allows you to shape your quality of life and level of well-being. Further development of personal qualities through additional education, mastering new competencies and self-development increases labor productivity and allows one to receive higher wages. Investing in education is becoming a necessary condition in the process of neo-industrialization of agriculture and the use of digital technologies.

CONCLUSIONS

Conceptual aspects of the study of human resources potential in the agricultural sector have been developed based on the works of foreign and Russian authors.

Cross-country comparisons of the area of agricultural land and the value of gross value added of agriculture in different countries were carried out.

The article presents a systematization and classification of socio-economic, technological, infrastructural and demographic factors that constrain and accelerate the development of scientific and intellectual potential at the macro, meso and micro levels.

The article classifies positive and negative socio-economic, technological, demographic and organizational factors. Measures are proposed for the use of scientific and intellectual potential in agricultural production as a driver of scientific and technological development.

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