DOI: 10.15838/esc.2020.4.70.9
UDC 338.43+330.356.7, LBC 65.054

Modeling the Impact of Resource Factors on Agricultural Output

Andrei P.
POTAPOV
Institute of Agrarian Problems of the Russian Academy of Sciences
Saratov, Russian Federation, 94, Moskovskaya Street, 410012
E-mail: app2008@yandex.ru
ORCID: 0000-0002-8327-4060

Abstract. The relevance of the research is justified by the need to find the sources of agricultural production growth due to the effective use of resource factors. The purpose of the work is to model the influence of the labor factor and the capital factor on the production of agricultural products. The research method consists in using the Cobb-Douglas production function to build a model of the influence of enlarged production factors on output. The novelty of the author's approach lies in using cost characteristics of labor and capital costs, which allows to obtain more reliable indicators of elasticity by presenting the resource costs in a single calculation. The data from international statistics presented in the development of the international research project World Input-Output Database (WIOD) is proposed to be use as indicators describing the costs of factors of production. Capital expenditure is characterized by the Capital compensation indicator; to estimate labor costs, it is more appropriate to use the Compensation of employees indicator, which reflects labor costs in the form of employees' total wages. Calculations of the production function for various time intervals allowed to estimate the elasticity of output of Russian agricultural production in terms of labor and capital costs in absolute and relative terms in retrospect. The author makes a conclusion about the priority influence of the labor factor on output in the agricultural sector, about the high labor intensity of agricultural production in Russia in the absolute measurement of labor costs. Based on the obtained parameters of the production function, using the data from Russian statistics, the researcher presents a three-variable forecast of gross agricultural production dynamics, depending on changes in labor productivity and capital return. The models built allow to make

For citation: Potapov A.P. Modeling the impact of resource factors on agricultural output. *Economic and Social Changes: Facts, Trends. Forecast*, 2020, vol. 13, no. 4, pp. 154–168. DOI: 10.15838/esc.2020.4.70.9

predictive assessments of the industry complexes development, and can also be used in the development and adjustment of the main directions of the state agricultural policy for the effective use of the resource potential.

Key words: resource potential, agricultural production, labor, capital, modeling, production function, forecasting.

Introduction

Improvement of the business entities' efficiency is an urgent task at the present development stage of the country's economy and its individual sectors. In relation to economic systems, efficiency is generally understood as the ratio of the product received to the resources spent on its production. Efficiency improvement is achieved by increasing the ratio between product and resources, which is the result of the growing return on a resource unit. Labor and capital are the key enlarged groups of resources needed to produce products in any sector of the economy. The influence of the labor factor and the capital output factor has its own characteristics depending on the industry, the level of productive forces development, the degree of innovative development, and the specific historical period which is analyzed in a particular study.

Agricultural production is one of the key areas of the national economy, as it forms the product necessary to meet people's life-sustaining needs for nutrition, to ensure country's food independence and security. Agricultural production in Russia accounts for 3.1% of GDP; it uses 2.0% of fixed assets, 6.1% of a number of employed, and 4.0% of investment in fixed assets[1]. In the agricultural sector, the impact of resource factors on output largely depends on the natural impact on production, biological and seasonal processes in crop and livestock production. Studying and assessing labor and capital factors' impact on the production of agricultural products will reveal the dependence of production results on the resources used, identify priorities for the formation of resource potential in order to increase output and economic efficiency, and predict the nature of production development and resource interactions in the most important sector of the national economy.

The solution of these problems requires economic and mathematical justification of the impact of the resources used on the volume and dynamics of production in order to implement the main tasks of the state agricultural policy and achieve its targets. To do this, it is necessary to build a model of agricultural production functioning in Russia, which allows identifying the degree of influence of main production factors – labor and capital – on the output of agricultural products.

The impact of resource factors on the final production results can be estimated using econometric models: the method of constructing the production function in particular. It is used to analyze the ratio of labor and capital factors at different levels of economy organization. Traditionally, the calculations of such ratios are carried out at the micro level, when the boundaries of an enterprise's production capabilities are investigated, depending on the structure of resource availability and technology. At the macroeconomic level, production functions are used for modeling and forecasting development of industry complexes and the country as a whole.

[1] *Agriculture in Russia. 2019: Stat. Coll.* Rosstat, M., 2019. Pp. 17–18.

The usage of the production function for calculating the impact of resource factors on the output of agricultural production is caused by the universal nature of this econometric method, which consists of the possibility of modeling on the basis of various economic indicators – natural and cost ones, presented in absolute, relative, or specific dimensions. This also allows taking into account the simultaneous impact of quantitative and qualitative indicators of resource availability and resource potential utilization on production results.

The influence of resources on the production in the sectors of the national economy has been studied in the works of domestic and foreign scientists. In Russian economics, we should highlight the work of G. Kleiner [1], in which the production function is presented as one of the methods of economic and mathematical modeling that characterizes the production process from the point of view of converting resources into products. Production processes in economic systems of any level – from an enterprise to national economy – can be a direct object for modeling. N. Fedorenko, A. Anchishkina, and Yu. Yaremenko [2] described the possibilities of the production function as one of the methods for predicting the structure of the economy. In some works, the authors touched upon the influence of production factors in relation to the conditions of the Russian economy at the macroeconomic level [3; 4; 5]. In the article by N. Orlova and S. Egieva [6], the method of constructing the production function is used to determine the level of the country's potential GDP and its growth rate, taking into account the full load of all factors. Thus, based on data on production factors, capital and labor, the potential annual growth of the Russian economy was estimated at 1.5–2.0%, which corresponded to the results of other scientists' research, including the foreign ones – D. Jorgenson, K. Vu, M. Kuboniwa [7; 8]. The production function is also used in integrated calculations as a method for evaluating the investments effectiveness, which allows calculating the impact of fixed assets input as the result of investment activities on the gross output increase using the financial flow matrix [9].

Regarding the agricultural sector, the calculations of the production function were carried out in the works of L.B. Vinnichek, B. Smagin [10; 11] and others. M. Vasilchenko [12] assessed the influence of technological factors on growth of milk production using the example of the livestock subcomplex. In the article by M. Ksenofontov et al. [13], in addition to production factors, the influence of consumption factors and export-import interactions on changes of gross output in Russian agriculture is studied.

In addition, we should also highlight the works of other foreign economists. R. Solow [14; 15] emphasizes the importance of technological factor in production output and provision of economic growth. In the works of E. Denison [16; 17], based on the calculations of the production function, the priority value of labor factor is justified, which is manifested in the fact that labor resources act as a carrier of knowledge obtained in the process of education, so labor factor determines the technological level of production and makes the greatest contribution to output.

Methodology

For the purpose of analyzing the impact of resource factors, the Cobb-Douglas two-factor production function was used, which shows the influence of labor and capital factors on output. In a general way, the classical Cobb-Douglas production function has the following form:

$$P = A \cdot L^{\alpha} \cdot K^{\beta}, \qquad (1)$$

where: P – is the volume of output,
L – labor costs,
K – capital expenditure,
A – technological coefficient,
α – labor elasticity coefficient,
β – capital elasticity coefficient.

Coefficient A shows total factor productivity and includes factors that are not quantifiable, including qualitative changes in the resources of production, changes in technological process, improving management, using knowledge, experience, etc. It reflects the impact on the output of scientific and technological progress, innovation, resource-saving technologies, and other unaccounted factors. Its value depends on the dimension of the initial indicators. If the initial indicators are denominated in different order units (for example, in millions and billions of rubles), or, if the calculation of the production function uses different-sized indicators (for example, absolute, relative, or specific), coefficient A will not show the real impact of factors, and it can be ignored when analyzing the parameters of the production function. For modeling purposes, the values of α coefficients (labor elasticity coefficient) and β coefficients (capital elasticity coefficient) are of the greatest interest.

Labor and capital factors determine the creation of gross value added in any sector of the economy. According to the System of National Accounts 2008 (SNA 2008), adopted by the United Nations, the European Commission, the Organization for Economic Cooperation and Development, the International Monetary Fund and the World Bank Group as the international statistical standard for national accounts, it is value added as a component of output that reflects the contribution to labor and capital production. After the part of the value added, received by the state administration in the form of other production taxes, is deducted from the value added and the value of subsidies is added, the sections showing compensation for labor and capital expenditures can be identified[2]. Indicators of labor compensation and capital compensation used in international statistics for macroeconomic calculations characterize the amount of value added that was created by the labor factor and the capital factor, respectively.

In the production function model, the economic content of labor and capital compensation indicators reflects what factors and in what volume and proportion the added value and final products of the industry, consisting of added value and intermediate consumption, were created. This makes it possible to extract those parts of the gross output value that were caused by the influence of labor and capital expenditures separately. This method of calculating the production function helps to eliminate methodological distortion in determining the efficiency of resource usage, when the entire volume of output is caused by the costs of each type of resource separately without correlation with the costs of other resources, the joint impact of several resources, and the synergistic effect of its usage in the production process.

To obtain reliable results related to the influence of production factors on the production of agricultural products, it is necessary to adjust the composition of the indicators used depending on their economic content. To calculate the parameters of the production function, it is proposed to use indicators that are widely used in international statistical studies and most accurately reflect the contribution of resource factors to the output of industrial complexes. So, if you need to use the Capital compensation indicator to estimate the annual cost of capital to create products, then

[2] *System of National Accounts 2008.* New York, 2012. P. 115.

it is more appropriate to use the indicator of compensation of employees, which reflects the total employees' remuneration, that is, labor costs.

Capital compensation indicator takes into account all producers' expenses incurred by the production output. Since capital transfers all or part of its value to the product produced, the total cost of capital fully covers the contribution of capital to the creation of the product and coincides with capital compensation indicator.

Labor compensation indicator also reflects the contribution of the labor factor to product creation, but it does not coincide with labor costs, since it is related to the value created by labor. To calculate the production function, it is the labor costs that are required, which are suggested to be calculated based on the employees' total remuneration, characterized by the indicator of employees' compensation.

Results

The indicators of compensation of employees and capital compensation are proposed to be taken as the initial data for calculating the Cobb-Douglas production function for the usage of labor and capital factors in agricultural production in Russia, respectively. The factual basis for calculating the production function is data of international statistics presented in developments of the international research project World Input-Output Database (WIOD) for individual countries of the world, including Russia. WIOD data were previously used in estimating the resource intensity of agricultural production [18].

Currently, two dynamic data series are available within economic sectors: for the periods of 1995–2009 and 2000–2014[3]. The following industries, reflecting the socio-economic processes taking place in the agricultural production, have been used: "Agriculture, hunting, forestry, and fishing" (for the data series of the 1995–2009 period), "Crop and animal production, hunting, and related service sectors", "Forestry and logging", "Fisheries and aquaculture sectors" (for the data series of the period of 2000–2014). Mathematical calculation of the production function was performed using Microsoft Excel software based on regression analysis, as well as using methodological developments for calculating the Cobb-Douglas production function [19].

The advantage of the indicators proposed by the author is, first, its content as a cost characteristic of labor and capital usage. In WIOD methodological developments, the usage of labor and capital is presented as the costs of relevant factors in the structure of value added and gross output of the industry, which allows us to directly assess the factors' contribution to the final results of the industry complexes functioning. In the classical production function, the usage of labor and capital factors is represented as their corresponding availability, reserves, or accumulation, which characterizes not just the influence of labor and capital on output but the return on these factors depending on their quantity, quality, and structure. Second, the indicators of compensation of employees and capital compensation are denominated in comparable units, unlike the calculations of the production function, where the usage of factors can be represented in cost and in-kind indicators. Thus, in the calculation of the classical production function, the capital indicator is characterized by a volume of fixed assets in monetary units, and labor indicator – by a number of employees in real terms.

[3] Socio Economic Accounts. Basic data on output and employment, released July 2014. Available at: http://www.wiod.org/new_site/database/seas.htm; Socio Economic Accounts. Basic data on output, prices, capital stocks and employment, released November 2016. Available at: http://www.wiod.org/database/seas16

As the result of calculations, we obtained two production functions for agricultural production in Russia, reflecting the dependence of gross output on labor and capital expenditures separately for the periods of 1995–2009 and 2000–2014. Calculation of production functions for two time periods (although overlapping) allows comparing the indicators of production functions and assess the trends in the processes of production factors influence on agricultural output.

The production function for 1995–2009 is as follows:

$$P = 8{,}993 \cdot L^{0{,}743} \cdot K^{0{,}200}, \quad (2)$$

$$R^2 = 0.998;$$

p-values of α and β coefficients < 0.05

where:

P – gross agricultural output, million rubles,

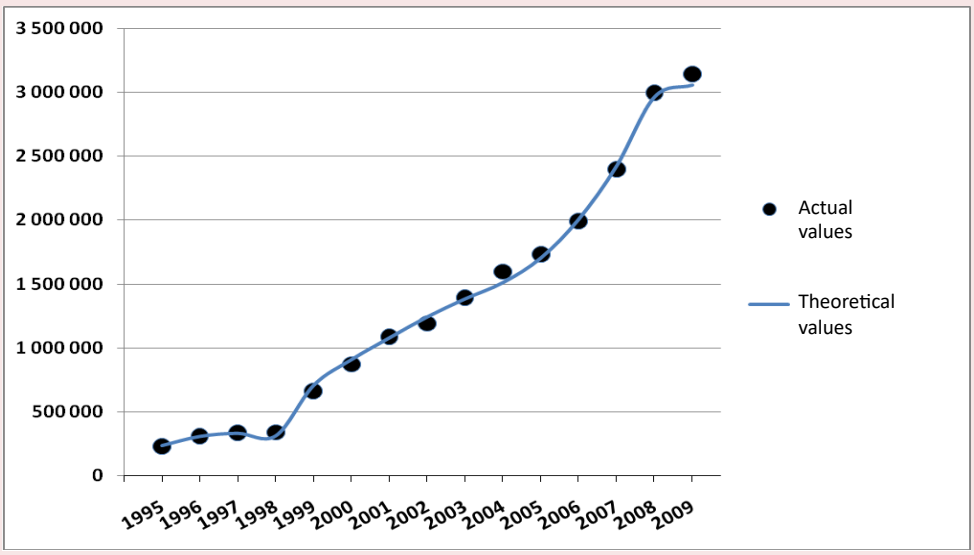
L – labor costs expressed in the total amount of compensation paid to employees, million rubles,

K – capital expenditure, reflecting the total amount of capital contribution to the creation of agricultural value added, million rubles.

During the specified period of time, the value of α degree for L shows that, when labor costs increase by 1%, the growth of gross agricultural output is 0.743%. The value of β degree for K shows that, when capital expenditures increase by 1%, the growth of gross agricultural output is 0.200%. In 1995–2009, the sum of the degree indicators (α+β) was 0.943, as the result, the increase of the availability of labor and capital resources by 1% led not to a proportional increase in production, but to a smaller one (0.943%), which indicates a decrease in the return on resources. This ratio characterizes the effect of quantitative changes in resource costs on the value of output. The overall 1% increase of resource expenditure in Russian agricultural production led to the increase of production by 0.943%, of which 0.743% is caused by the increase of labor costs, and 0.200% is caused by an increase of capital expenditures.

Actual values of the agricultural output indicator are close enough to the theoretical values calculated using the formula (2),

Fig. 1. Actual and theoretical values of the indicator of agricultural production output in Russia in 1995–2009, million rubles.



Source: author's calculations based on World Input-Output Database (WIOD) data.

therefore, the obtained parameters of the production function for the agricultural production conditions in Russia in 1995–2009 characterize the real impact of labor and capital factors on the volume and dynamics of output with maximum accuracy (*Fig. 1*).

The production function for the period of 2000–2014 is as follows:

$$P = 0{,}135 \cdot L^{0{,}995} \cdot K^{0{,}279} \qquad (3)$$

$$R^2 = 0.992;$$

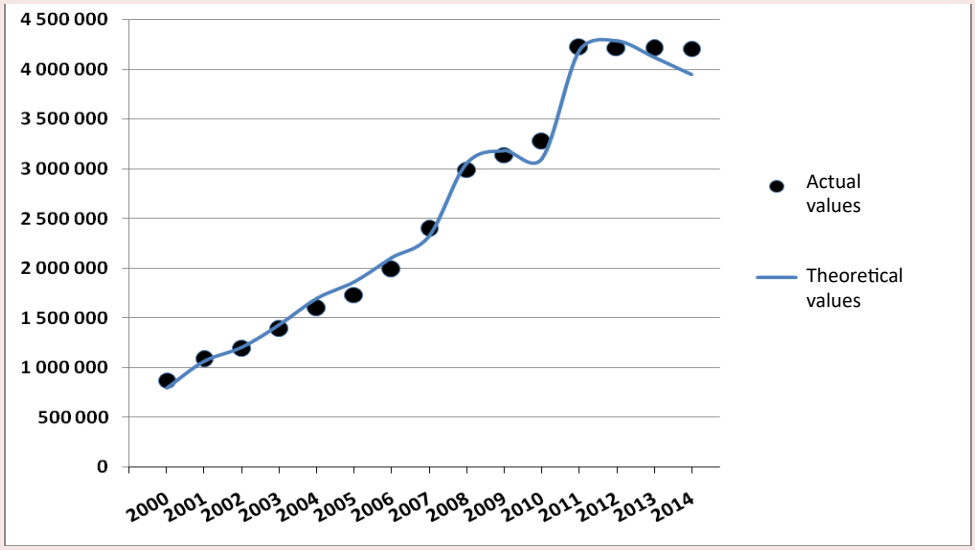
p-values of α and β coefficients < 0.05

In comparison with the period of 1995–2009, the influence of production factors on agricultural output in 2000–2014 increased. The output elasticity for labor costs was 0.995, for capital costs – 0.279. In 2000-2014, the sum of the degree indicators (α+β) was 1.274. The 1% increase in the availability of labor and capital resources led not to a proportional increase in production, but to a larger one (1.274%), which indicates the increase in the return on resources. Despite the decrease in the technological coefficient A, development of agricultural production in Russia in 2000–2014 was characterized by efficiency improvement, since efficiency was revealed as a factor taken into account in the growth of returns on labor and capital. The impact of qualitative changes in the structure of the resource potential of agricultural production is reflected in the increase of the return on resources.

The production function graph, constructed by formula (3), shows that the theoretical value of agricultural production output is as close to actual values as possible; hence, the parameters of the production function fully reflect the real contribution of labor and capital factors in agricultural product recovery (*Fig. 2*).

The analysis of the agricultural production functions in Russia in 1995–2009 and 2000–2014 may identify the trends of the established ratios and the dynamics of the factors usage, and also make the following conclusions:

Fig. 2. Actual and theoretical values of the indicator of agricultural production output in Russia in 2000–2014, million rubles.



Source: author's calculations based on World Input-Output Database (WIOD) data.

1. Agricultural production in Russia is primarily labor-intensive, not capital-intensive. The share of labor's contribution to the output of agricultural production is higher than the share of capital, which is justified by the presence of a significant sector of private farms that produced most of the country's agricultural products in the 1990s–early 2000s. The farms mainly use manual labor and small-scale mechanization, there are no opportunities to attract investment in technical and technological modernization, due to low production volumes per economic entity, the access to state support funds is limited. Currently, there is a gradual decline in the share of households in the structure of agricultural production (38.1% in 2014, 32.5% in 2016 and 31.0% in 2018). Private farms keep producing the largest share of potatoes (68.0% in the structure of production in all categories of farms), vegetables (55.1%), and also make up 38.7% of milk resources and 18.0% of meat resources[4].

2. In Russia's agricultural production, the potential for extensive growth decreases, since the quantitative growth of resources used does not lead to a proportional increase of production. Changes in the resource potential show the impact of qualitative changes on the results of agricultural production. The increase in the rate of production growth was achieved not by increasing the quantity of resources, but by improving their quality. This trend is caused by the impact of government support measures for the growth of resource availability of agricultural producers provided for in strategic and program documents (subsidies for updating technical capacity, investment loans for the construction of new capacities, reimbursement of part of capital expenditures for the modernization of production, compensation for the share of investments in development of the melioration system, implementation of scientific and technical policy in the agricultural sector).

3. The value of the labor elasticity coefficient shows that the labor factor had a greater influence on output than capital during the studied period. To ensure long-term sustainable growth of agricultural production, it is necessary to increase labor productivity and improve the structure of labor resources. This can be done through the introduction of innovative developments, resource-saving technologies, the usage of intellectual capital, organizational and managerial innovations that will improve labor productivity not only by increasing the volume of output but also by increasing the return on a labor unit.

4. The value of the sum of α and β elasticity coefficients greater than 1, and the low value of the technological coefficient indicate a continued overall high resource intensity of agricultural production, the potential of agricultural production growth due to resource factors. Russian agriculture has one of the lowest depreciation rates of fixed assets among all types of economic activity, 38.2% against 46.6% in the economy on average[5], which allows getting products in short and medium term by using the existing material and technical potential. In addition, Russia is one of the most affluent countries in the world in terms of available land resources, which are the main means of production in agriculture.

The results of calculating the production function as a whole for the generalized period of 1995–2014 have some conditionality, which

[4] *Agriculture in Russia. 2019: Stat. Coll.* Rosstat, M., 2019. Pp. 21, 28.

[5] *Russian Statistical Yearbook. 2019: Stat. Coll.* Rosstat. M., 2019. P. 327.

was caused by the following circumstances. First, there is a partial discrepancy in the source data for some years in the overlapping period of 2000–2009, caused by a discrepancy in the methodology for calculating the value added volume created by the labor factor and the capital factor separately. Second, over the past period, there were significant changes in the technological basis of agricultural production, as the result, the technical and technological characteristics of resources, used in agricultural production, differ significantly at the beginning and at the end of the studied period. Despite this, the parameters of the generalized production function for 1995–2014 characterize the general pattern of production factors influence on agricultural output.

The production function for 1995–2014 is as follows

$$P = 13{,}403 \cdot L^{0{,}834} \cdot K^{0{,}069} \qquad (4)$$

$$R^2 = 0.995;$$

p-values of α and β coefficients < 0.05

The presented function emphasizes the long-term trend of increased influence of the labor factor on the output of agricultural production.

The usage of the method of production functions construction allows determining the influence of not only enlarged production factors, such as labor and capital in its quantitative terms, but also assessing the impact of qualitative indicators of labor and capital usage results on agricultural production. The result of using the resource potential in terms of its quality is characterized by relative cost indicators of resource usage. Thus, the usage of labor resources is characterized by labor productivity, the usage of capital – by capital productivity.

To determine the impact of labor and capital productivity on agricultural output, we used data from Russian statistics for 2005–2018 in a comparable form[6]. After calculating the parameters of the production function, we have obtained the results that partially differ from those obtained on the basis of international statistics. The production function, according to data for 2005–2018, is as follows:

$$P = 20{,}814 \cdot L^{0{,}398} \cdot K^{0{,}510}, \qquad (5)$$

$$R^2 = 0.991;$$

p-values of α and β coefficients < 0.05

where: P – gross agricultural output, billion rubles,

L – labor productivity, rubles per 1 employee,

K – capital productivity, rubles per 1 rub. of fixed assets.

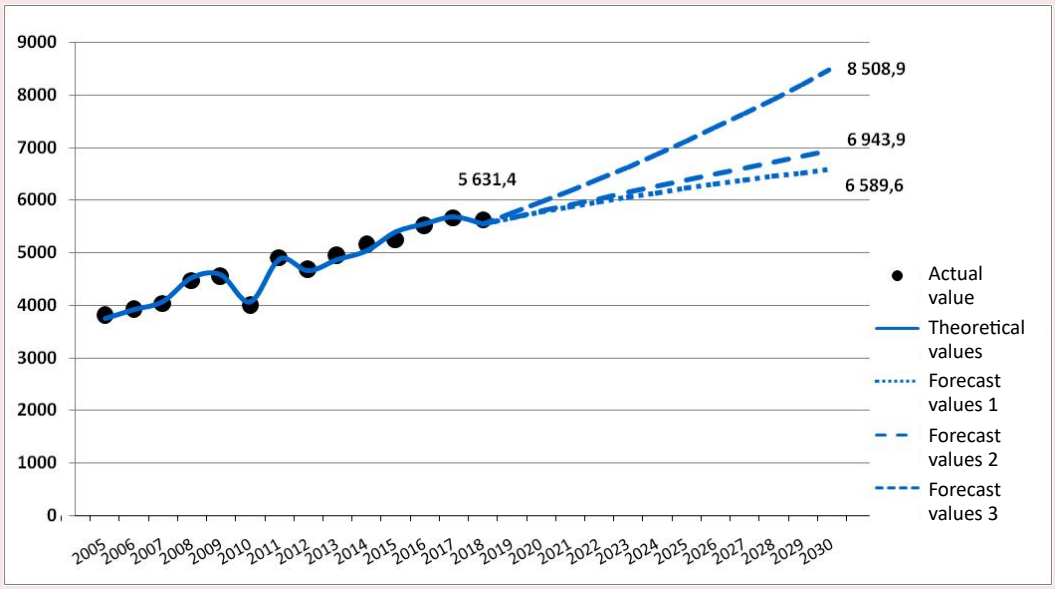
The indicator of labor output elasticity was 0.398, capital output elasticity – 0.510. The calculations, made on the basis of Russian statistics, generally also reflect the high influence of labor factor with the increasing influence of capital, expressed in the relative indicator of efficiency of its usage, i.e. capital productivity. The difference in proportions of the influence of labor and capital in formulas (2)–(4) from the parameters of the production function in formula (5) is caused by the different nature of the indicators used. In calculations, based on international statistics, absolute values of labor and capital expenditures on output were used, and the production function calculated on the basis of the Russian statistics showed the influence of specific values of labor and capital expenditures reflecting the efficiency of resource potential use. The exceedance of the

[6] Compiled and calculated by the author by: *Russian Statistical Yearbook. 2010: Stat. Coll.* Rosstat. M., 2010. Pp. 344, 345, 425; *Russian Statistical Yearbook. 2012: Stat. Coll.* Rosstat. M., 2012. Pp. 134, 425; *Russian Statistical Yearbook. 2016: Stat. Coll.* Rosstat. M., 2016. Pp. 109, 290, 291, 379; *Russian Statistical Yearbook. 2017: Stat. Coll.* Rosstat. M., 2017. Pp. 278, 358, 359; *Russian Statistical Yearbook. 2018: Stat. Coll.* Rosstat. M., 2018. Pp. 115, 301; *Russia in Figures. 2019: Brief Stat. Coll.* Rosstat. M., 2019. P. 309.

elasticity indicator of output by capital over the elasticity indicator by labor in relative values is caused by the fact that production is carried out using means of production, the quality of which affects productivity. Consequently, a lower relative level of labor utilization will be accompanied by a higher return on capital; a lower relative expenditure of capital on output growth will compensate for a relatively low return on labor. Thus, the calculation of the parameters of the production function in relative values reflects the impact of a resource unit usage on output, in which the return on resources is transformed in favor of capital, while the overall efficiency of using the resource potential remains unchanged.

Adjustment of the implemented agricultural policy and development of its new directions, taking into account the current and future changes in the national economy development, should be based on reliable forecasts of agricultural production development, taking into account various options for changes in the resource potential. The obtained parameters of the production function based on qualitative indicators of labor and capital use allow predicting the further development of agricultural production in Russia, assessing the dynamics and volumes of output depending on factor characteristics changes, and identifying priority areas of government support for the agricultural sector in order to increase the efficiency of using the resource potential. Based on formula (5), a three-variant forecast of agricultural output is made depending on changes of labor productivity and capital productivity in Russia for the period up to 2030 (*Fig. 3*).

Fig. 3. Actual (for 2005–2018), theoretical (based on the parameters of the production function) and forecast (until 2030) values of agricultural output depending on changes in capital productivity and labor productivity, billion rubles in comparable prices



Source: author's calculations based on Rosstat data.

Table 1. Main parameters of forecast scenarios for agricultural output in 2030

Forecast parameter	Forecast 1	Forecast 2	Forecast 3
Content	Growth rates of resource factors in 2013-2018	Growth rates of resource factors in 2005–2018	Growth rates of resource factors in accordance with the State program
Average annual increase in labor productivity, rub. / 1 employed	70959	48036	4% per year
Average annual increase in capital productivity, rub. / 1 rub. of fixed assets	-0.009	0.011	4% per year
Agricultural production output in 2030, billion rubles	6589.6	6943.9	8508.9
Total increase in agricultural production to the base year of 2018, %	17.0	23.3	51.1
Average annual growth of agricultural production, %	1.3	1.8	3.5
Note: All cost indicators are shown in comparable prices of 2016. Source: author's calculations based on Rosstat data.			

The first forecast scenario is based on the current average annual values of labor productivity and capital return in 2013–2018, which reflect the trends of recent years in the development of agricultural production in Russia (*Tab. 1*). This allowed to forecast agricultural production growth to 6589.6 billion rubles by 2030 (an increase by 958.2 billion rubles, or 17.0%). Production growth of 17.0% over the entire forecast period corresponds to an average annual growth rate of 1.3%.

The second forecast scenario is founded on the trends of average annual changes in labor productivity and capital productivity for the entire period of 2005–2018, based on which the production function parameters were calculated. According to this option, Russian agricultural output will have increased by 1312.5 billion rubles or 23.3%, making up 6943.9 billion rubles, by 2030. Production growth by 23.3% over the entire forecast period corresponds to an average annual growth rate by 1.8%.

The third forecast scenario is founded on the key parameters of the latest version of the State Program for the Development of Agriculture and Regulation of Agricultural Commodities Markets in 2013–2020. According to it, annual 4% increase of labor productivity is expected, which will cause a corresponding increase of capital productivity[7]. The production function shows that agricultural production is projected at the level of 8508.9 billion rubles (an increase of 2877.6 billion rubles, or 51.1%) in 2030. Production growth by 51.1% over the entire forecast period corresponds to an average annual growth rate by 3.5%.

Development of agricultural production according to the second forecast scenario, which assumes moderate growth efficiency rates of labor and capital usage, meeting the current technical and technological management conditions, seems to be the most realistic. This option takes into account long-term trends in the efficiency of production factors usage and the need to achieve the targets of the state agricultural policy, such as ensuring food independence and security, increasing exports of agri-food products to 45 billion dollars by 2024, which requires a significant increase of agricultural production at

[7] State Program for the Development of Agriculture and Regulation of Agricultural Commodities Markets in 2013–2020. *GARANT Legal Information Resource Complex*. Available at: http://ivo.garant.ru/#/document/70210644/paragraph/1:0

the expense of more efficient usage of resource potential. The third forecast scenario is more promising, since it takes into account the preservation of maximum achieved efficiency growth rates with the usage of resource factors throughout the forecast period. This will require full implementation and financing of the main directions of economic policy in the agricultural sector and the implementation of state support measures for agricultural producers.

Discussion

Despite the fact that the calculations of the production function parameters for the conditions of agricultural sector in Russia have shown a high degree of influence of the labor factor on output, in reality, the specific influence of factors are interrelated. Labor resources produce products using the means of production in which capital is embodied. The increase in output is not possible only with an increase in the quantity and quality of labor resources, it should be accompanied by appropriate technical and technological changes in the production sector. The influence of the capital factor on output is manifested directly in the form of returns on capital and indirectly through the increase of labor productivity. In economic calculations, the factors of "labor" and "capital" are used in a broad sense and are not limited only to the production and material form of their representation. For example, "labor" refers not only to the direct participation of labor resources in the production output, but also to its knowledge, qualifications, and experience. "Capital" implements the results of production, scientific, technical and innovative activities. Produced products are the result of the resources usage, taking into account their quantitative and qualitative characteristics.

The correspondence between labor resources and embodied capital is a necessary condition for realizing the potential of production growth at the expense of resource factors. Calculations show that Russia is 2.5–5 times behind developed countries in terms of labor productivity; for non-resource sectors of the economy, this lag of 33–39% is explained by a lower labor capital ratio and 58–65% lag – by a lower level of technology (the level of multi-factor productivity). The quality of human capital in Russia is slightly below the level of developed countries and, therefore, it explains only 2–4% of the gap of labor productivity [20, p. 67].

In Russia, there are reserves associated with increased productivity and intensity of labor, as, at least, a third of Russian employees are engaged in low-skilled and poorly organized labor. More than 20% of production capacities, including high-efficiency ones, put into operation in the last 5–7 years, are not loaded and may provide a rapid output increase. Even a partial transfer of Russia's labor resources to modern jobs will ensure the growth of production in the country by dozens of percent [21, p. 4].

The key direction that contributes to the growth of labor productivity, as a factor having a decisive impact on the agricultural production output, is a set of organizational and economic measures, and its implementation will help to increase the role of labor resources as an essential element of agricultural production resource potential. These measures include:

– creating favorable economic and social conditions for people engaged in agriculture. This area includes increasing the level of wages in agriculture, increasing the availability of social infrastructure, stimulating employment in rural areas, and securing personnel through the implementation of social policy measures in rural areas;

– increasing the innovative activity of agricultural employees. Main areas here are the increase of educational level, assistance in the

employment of people who received higher or secondary special education, creating incentives for professional development and education, training to work with new technological equipment, improving professional skills of employees, engaged in repair and maintenance of modern domestic and foreign equipment or directly working with it [22, p. 52].

Acceleration of labor productivity growth rates within the framework of an innovative strategy for agricultural sector development involves not only technological renewal of production but also the improvement of the quality characteristics of the agricultural organizations employees (their education, qualifications, health, motivation) [23, p. 317].

Conclusion

The calculation of the production function for agricultural sector in Russia revealed the need to move from extensive to intensive resources usage and to increase the resource potential on an innovative basis. The development of the Russian agro-industrial complex in modern economic conditions requires a wide application of innovative factors in order to achieve the sustainability of agricultural production and solve the most important state task, i.e. ensuring food independence and security of the country. The sustainability of domestic agricultural production is based on the efficient usage of all types of resources in the production process, on the formation of a balanced resource potential.

To improve the methodology for modeling the impact of resource factors on agricultural output, the following key areas should be implemented:

1. Specifying the composition of indicators that reflect the impact of factors of production on agricultural output. As factor features, it is proposed to use cost indicators that reflect the contribution of labor and capital to the output of agricultural production. In order to expand the methodological justification of resource factors influence on output, it is necessary to combine quantitative (absolute) and qualitative (relative) indicators of labor and capital usage.

2. Ensuring full comparability of indicators from different dynamic data series for calculating the parameters of the production function over a long period of time, which will allow taking into account the impact of long-term trends in the formation and usage of resource potential on development of agricultural production and avoid accidental impact on the output of factors that are not dependent on humans, such as weather conditions, which is especially important for agriculture.

3. Improving domestic statistics on determining the contribution of labor and capital to agricultural output, as well as ensuring comparability of indicators of domestic and foreign statistics to expand the modeling capabilities.

Thus, modeling the influence of resource factors on agricultural output for Russia's conditions allowed assessing the dependence of changes in gross agricultural output on the enlarged elements of resource potential, i.e. labor and capital. Based on the model of the two-factor production function, it was concluded that the labor factor has an increased influence on the production of final products in the industry, which determines the strategic priorities for the agricultural production development in Russia, based on the formation and usage of its resource potential. Efficient usage of labor resources will help solve important problems of modern development of the Russian agri-food complex: economic growth in certain sectors of the economy, the formation of the revenue part of budgets at all

levels, reducing social tension, ensuring food independence, and security. Modeling the influence of resource factors on output based on the method of constructing and calculating the parameters of the production function allows predictive assessments of agricultural production development, taking into account the influence of quantitative and qualitative changes in the usage of labor and capital.

The study contributes to the theoretical and methodological foundations of modeling the impact of resource factors on output by using cost characteristics of labor and capital expenditures, as well as through the integrated usage of statistical information about the object from different sources, which allows increasing the reliability of the predictive and analytical calculations. Applied significance of the results obtained in this article is caused by the universal nature of the modeling performed, which could be the base for similar calculations in relation to other sectors of the national economy.

References

1. Kleiner G.B. *Proizvodstvennye funktsii: teoriya, metody, primenenie* [Production Functions: Theory, Methods, Application]. Moscow: Finansy i statistika, 1986. 239 p.
2. Fedorenko N.P., Anchishkin A.I., Yaremenko Yu.V. (red.). *Metody narodnokhozyaistvennogo prognozirovaniya* [Methods of Economic Forecasting]. Moscow: «Nauka», 1985. 472 p.
3. Plyshevskii B. Theoretical issues of the analysis of surplus product. *Ekonomist=Ekonomist*, 2013, no. 9, pp. 58–69 (in Russian).
4. Kirilyuk I.L. The dynamics of the return of production factors in the Russian economy from 1995 to 2011. In: *Fenomen vozrastayushchei otdachi v ekonomike i politike* [The phenomenon of increasing returns in economics and politics]. Ed. by S.G. Kirdina, V.I. Maevskii. St. Petersburg: Aleteiya, 2014. Pp. 73–106 (in Russian).
5. Lavrovskii B. Assessment of labor productivity in Russia and the world. *Ekonomist=Ekonomist*, 2014, no. 12, pp. 27–35 (in Russian).
6. Orlova N., Egiev S. Structural factors of Russian economic slowdown. *Voprosy ekonomiki=Voprosy Ekonomiki*, 2015, no. 12, pp. 69–84 (in Russian).
7. Jorgenson D.W., Vu K.M. Potential growth of the world economy. *Journal of Policy Modelling*, 2010, vol. 32, no. 5, pp. 615–631.
8. Kuboniwa M. The Russian growth path and TFP changes in light of estimation of the production function using quarterly data. *Post-Communist Economies*, 2011, vol. 23, no. 3, pp. 311–325.
9. Naumov I.V., Trynov A.V. Modeling the investment attractiveness of the types of economic activities in the region with the use of the matrix of financial flows. *Ekonomicheskie i sotsial'nye peremeny: fakty, tendentsii, prognoz=Economic and Social Changes: Facts, Trends, Forecast*, 2019, vol. 12, no. 4, pp. 53–66 (in Russian).
10. Vinnichek L.B., Zyablikova O.A., Terzova G.V. *Resursnyi potentsial sel'skokhozyaistvennykh organizatsii i effektivnost' ego ispol'zovaniya* [Resource Potential of Agricultural Organizations and the Effectiveness of its Use]. Penza: RIO PGSKhA, 2015. 176 p.
11. Smagin B.I., Akindinov V.V. *Effektivnost' ispol'zovaniya resursnogo potentsiala v agrarnom proizvodstve* [Efficiency of Using Resource Potential in Agricultural Production]. Michurinsk: Izdatel'stvo Michurinskogo gosudarstvennogo agrarnogo universiteta, 2007. 150 p.
12. Vasilchenko M.Ya. Technological factors of increasing the efficiency of the production potential of the livestock subcomplex in Russia. *Ekonomicheskie nauki=Economic Sciences*, 2018, no. 5 (162), pp. 91–95 (in Russian).
13. Ksenofontov M.Yu., Polzikov D.A., Verbitskiy Yu.S., Melnikova Y.S. On the assessment of the potential expansion of agricultural production and its structural shifts. *Studies on Russian Economic Development*, 2017, vol. 28, no. 6, pp. 624–636.
14. Solow R.M. The production function and the theory of capital. *Review of Economic Studies*, 1953, vol. 23, no. 2, pp. 101–108.

15. Solow R.M. Technical change and the aggregate production function. *The Review of Economics and Statistics*, 1957, vol. 39, no. 3 (Aug.), pp. 312–320.
16. Denison E.F. *The Sources of Economic Growth in the United States & the Alternatives before us*. New York: Comm. of Economic Development, 1962. 308 p.
17. Denison E.F. *Estimates of Productivity Changes by Industry: An Evaluation and an Alternative*. Washington DC: Brookings Institution, 1989. 78 p.
18. Potapov A.P. Estimation of dynamics of resource expenditure and resource intensity of agrarian manufacture of Russia. *Agrarnyi nauchnyi zhurnal=The Agrarian Scientific Journal*, 2018, no. 5, pp. 85–91 (in Russian).
19. Salko D.Yu, Iskandarov K.M., Ivchenko Yu.S. Dependence of output on the used work and the invested capital as the example of the peculiarities of production functions creation. *Izvestiya SPbGTI(TU)=Bulletin of the Saint Petersburg State Institute of Technology (Technical University)*, 2014, no. 26, pp. 109–112 (in Russian).
20. Zaitsev A. International differences in labor productivity: Role of capital, technological level and resource rent. *Voprosy ekonomiki=Voprosy Ekonomiki*, 2016, no. 9, pp. 67–93 (in Russian).
21. Ivanter V.V., Govtvan' O.D., Gusev M.S., Ksenofontov M.Yu., Kuvalin D.B., Moiseev A.K., Porfiryev B.N., Semikashev V.V., Uzyakov M.N., Shirov A.A. System of measures to recovery of economic growth in Russia. *Problemy prognozirovaniya=Studies on Russian Economic Development*, 2018, no. 1, pp. 3–9 (in Russian).
22. Potapov A.P Innovative development resources of agrarian production of Russia. *Ekonomika sel'skokhozyaistvennykh i pererabatyvayushchikh predpriyatii=Economy of Agricultural and Processing Enterprises*, 2011, no. 12, pp. 49–53 (in Russian).
23. Blinova T.V., Potapov A.P. Labor potential of modernization of the Russian village. *Vestnik SGTU=Vestnik of Saratov State Technical University*, 2011, no. 2, issue 1, pp. 313–323 (in Russian).

Information about the Author

Andrei P. Potapov – Candidate of Sciences (Economics), Associate Professor, Leading Researcher, Institute of Agrarian Problems of the Russian Academy of Sciences (94, Moskovskaya Street, Saratov, 410012, Russian Federation; e-mail: app2008@yandex.ru)

Received November 19, 2019.