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Production Capacities of Russian Agricultural Organizations: Assessment and Forecast

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Abstract

Russia currently leads in individual branches of the industry (in particular, in 2016, it was the world's third-largest wheat producer). However, in essential food products (like meat, meat products, milk, dairy products, or fruits) Russia fails to meet even threshold requirements according to the Russian Federation Food Security Doctrine, and their production levels are lower than that of the USSR. Anti-Russia sanctions restricting imports of agricultural products into Russia make things worse and pose a certain threat to national food security. This article reviews the body of literature on the topic, refines the key factors of intensification of production growth of agricultural products in Russia, develops an economic and mathematical model for assessment and making predictions of production capacity (the monetary volume of agricultural output) of agricultural organizations (the core category of agricultural producers) in the Russian Federation. A correlation and regression analysis revealed that the resultant indicator is formed mainly by two factors: (1) productivity of grains and grain legumes, and (2) the average monthly nominal job compensation at agricultural organizations. Factor (2) has a much greater impact on the output of agricultural organizations in Russia. If the tendency of the factors' changing is maintained in 2018–2021, in the medium term horizon, they are expected to grow. And this, in turn, should increase the resultant indicator. Despite the optimistic forecasts, Russian agricultural producers still have significant potential of increasing agricultural production output. It should be noted that agricultural economic growth in Russia is impossible without solving social problems.

Keywords: Economic and mathematical model, correlation and regression analysis, agricultural produce, agricultural organizations of Russia, production capacity, assessment, growth factors, forecast, trend extrapolation, multiple regression.

1 Introduction

In 2016, wheat production in Russia had grown to record-breaking 73.3 million tonnes (the year-to-year increase of 18.6%). That year, Russia was ahead of the US and ranked 3rd in the world after China and India (18). However, research performed by leading Russian scholars revealed that Russian agricultural producers currently do not fully meet public demand for certain essential food products (21). For example, according to A. G. Aganbegyan, a member of the Academy of Sciences, Russian agricultural organizations cannot fully meet the needs of the Russian population in milk, beef, oil, and fruits. At the same time, the actual current self-sufficiency in milk, dairy products, meat, and meat products in Russia is significantly below not only the threshold requirements set by the Russian Federation Food Security Doctrine, but also below that of the USSR (1). Therefore, the issue of food security in Russia still remains pressing.

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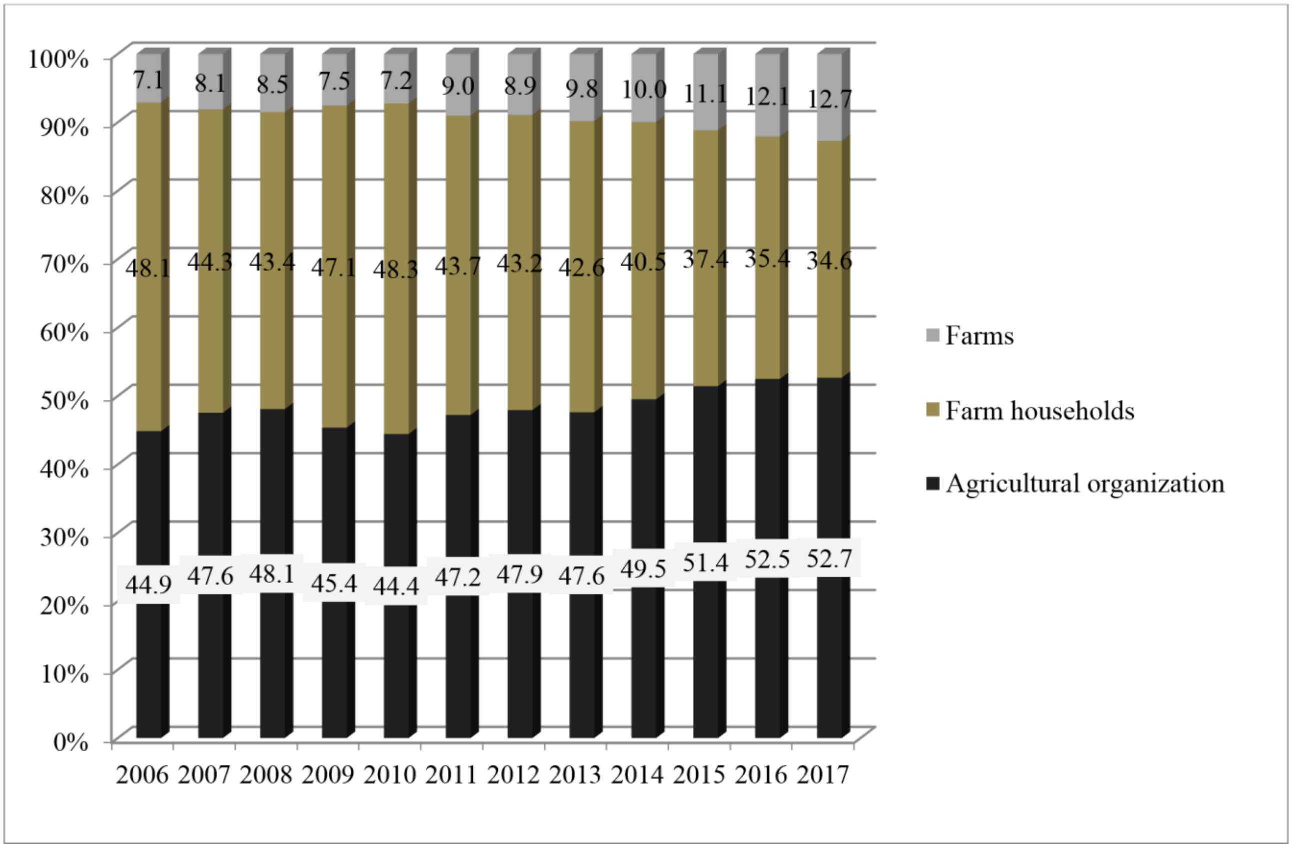

Figure 1: Structure of agricultural produce by categories of entities in the Russian Federation.

The situation (the solution to the problem of ensuring the country's food security) is exacerbated by the fact that the USA and EU member states initiated and imposed sanctions against Russia restricting the import of foreign agricultural products into Russia (5). Therefore, the Russian authorities face the challenge of increasing the volume of agricultural output, primarily by agricultural organizations. The structure of agricultural produce by categories of entities in Russia (Fig. 1) shows that, since 2011, it is mainly produced by agricultural organizations. At the same time, over the past three years, agricultural organizations have been producing more than 50% of the total agricultural output in the Russian Federation. The steady growth trend in the share of agricultural organizations in the agricultural output in Russia in 2013–2017 is also worth pointing out. This trend was due to the outperforming growth of agricultural output produced by Russian agricultural organizations as compared with the other categories of entities. In our opinion, the faster growth of agricultural output produced by Russian agricultural organizations was a response to external pressure on the Russian agricultural sector (in the form of restricted import of foreign agricultural products from the EU into Russia).

In view of the above, the purpose of the study was to address the increasingly urgent issue of improving the tools for assessing and forecasting production capacity, above all, of the Russian agricultural organizations. Before developing the economic and mathematical model, we reviewed the body of literature on the topic.

2 Literature review; materials and methods

Despite the Doctrine establishes the official definition of national food security, there is no generally accepted interpretation of this concept even among the leading Russian researches. Therefore, we will begin the literature review by clarifying the concept of national food security. Our view on this matter is closest to the opinion of Ya. Sh. Pappe, N. S. Antonenko, and D. A. Polzikov, who believe, from the economic standpoint, that the concept of food security "is equivalent to physical and economic availability of food for people and should not a priori include other conditions" (15). Developing the idea, the authors made a number of rightful important conclusions:

1. The need for food independence (or self-sufficiency) requires justification, whatever definition is used.

2. The successful development of Russian internal agricultural production is not always the necessary and sufficient condition for ensuring the physical and economic availability of food.

3. The successful agricultural industry is neither sufficient nor necessary condition for national self-sufficiency in agricultural products (15).

The above does not mean that the government should step back and not support domestic agricultural producers.

However, not all issues are related to the national food security policy, indeed. For example, the work toward a developed agricultural industry and protection of agricultural producers from current and potential threats are not related to food security but rather agrarian policy within the general national industrial policy. And the issue of sustainable development of rural areas in Russia should be handled as part of the national social policy.

Further, the literature review allowed to identify the leading obstacles to the intensive growth of the national agricultural output, including by subsectors. After that, we will briefly describe economic and mathematical models for accurate assessment and forecasting the production capabilities under study.

In our opinion, one of the leading problems of Russian agriculture is labor productivity considerably lagging behind countries like Denmark, Germany, Norway, Poland, and Sweden, whose climatic conditions are almost equivalent with Russia's (11). In turn, this is due to the relatively unfavorable situation in the availability of technology and relatively low labor quality in the Russian agricultural sector. For example, according to the long-term average annual data (2010–2016), Russian farmers have significantly higher yield losses compared to a number of countries (18% versus 2.3% in Germany, 1.6% in Denmark, and 3.52% in Sweden), higher losses of cattle (18% versus almost none in Germany and Denmark, 0.63% in Sweden), while the share of elite cultivars is considerably lower (9.5% versus 95.6% in Germany, 98.1 in Denmark, and 95.27% in Sweden), and elite livestock breeds (8% versus 98.5% in Germany, 99.5 in Denmark, and 94.47% in Sweden) (11). The seizure of land from producers for construction of housing and industrial facilities also are not conducive to increasing agricultural output. For instance, in 1995–2016, the seizure of agricultural land in Russia amounted to about 17% (10).

In view of the trend of depopulation of the country's rural areas (by 4.5% among people below working age and 15.7% among working age people by 2040) (4), the labor productivity in the industry and, above all, in the depressed Russian regions of the North-West, the center of the European part, and the Far East can be increased through active adoption of digital, intelligent and robotic technologies. E. A. Skvortsov, E. G. Skvortsova, E. S. Sandu, and G. A. Iovlev (22) assessed the current dynamics in implementation of robotic technologies and robotization density in Russia from the mid-2000s to 2016 inclusive. Based on the assessment, the authors developed an effective mechanism of transition of the Russian agricultural sector (considering its specific features) to robotics. In addition to increasing labor productivity, the authors believe, robotization of Russian agriculture will also: (1) improve safety and working conditions of agriculture employees, (2) improve the quality of agricultural products, (3) create more jobs in adjacent sectors, and (4) lead to work enrichment in the agricultural sector.

The Strategy of Sustainable Development of Rural Areas of the Russian Federation through to 2030 (23) lists an intensive growth of Russian agricultural output as only one of the core goals. Other equally important goals include improving the quality and standard of living of the Russian rural population, making the services of organizations in the sphere available for them, and improving the environmental situation in the Russian rural areas. Such closely related challenges cannot be solved without a systematic country-specific approach.

In the context of the study, rather interesting is the work by O. A. Cherednichenko, N. A. Dovgot'ko, and N. N. Yashalova, who further defined national priorities and guidelines for sustainable development of the national agri-food sector through systematization of key problems in the industry in Russia (27). For example, authors believe it possible to solve a wide array of goals of the Russian agri-food sector through achieving 14 closely related goals of the global agenda (in line with the UN Sustainable Development Goals): 1) No poverty; 2) Zero hunger and sustainable agriculture; 3) Good health and well-being; 4) gender equality; 5) Clean water and sanitation; 6) Affordable and clean energy; 7) Decent work and economic growth; 8) Industry, innovation and infrastructure; 9) Reduced inequalities; 10) Sustainable cities and communities; 11) Responsible consumption and production; 12) Climate action; 13) Conservation of marine ecosystems; and 14) conservation of terrestrial ecosystems.

Based on these goals (to achieve them), the authors consider it expedient to propose and solve 78 objectives, making a fair point that no goal can be achieved in isolation from the other ones, and all the goals are related to the proposed objectives. At the same time, ensuring the balance and interrelation between different dimensions of sustainable development is reflected not only at the level of goals, but also at the level of objectives (27). For example, "doubling of agricultural performance and the income of small food producers by 2030 can be achieved through a substantial increase in productivity of crops by a more extensive use of methods to increase fertility, including biological methods, and the introduction of better performing agricultural technologies and equipment" (27).

It should be noted that while a number of important national agricultural subsectors are dominated by foreign producers (about 60% of milk processing, 70% of juices production, 80% and 90% of frozen and canned vegetables and fruits respectively), in the meat subsector, Russian producers provide the bulk of the agricultural output (29, 30). In our opinion, foreign investors are unwilling to invest in the production of meat and meat products in Russia, among other reasons, because of the lack of national legislation on holding companies (the most common form of business in this agricultural subsector both in Russia and worldwide) (16). Based on findings of an empirical research, E. V. Rodionova concluded that the activity of integrated forms of Russia meat subsector is a good demonstration of the advantages of large-scale production and agricultural and industrial integration (in particular, increasing agricultural performance and financial resources for purchasing modern technologies and equipment). However, it has negative social and economic impacts (e.g. market monopolization and reduced competition, lower development opportunities and ousting small and medium-sized businesses, barriers to entry to the market). Therefore, the author suggests vectors of further development of the integration processes for the government, business, industry associations and the scientific community should focus their action on (in particular, ensuring the effective entry of integrated structures to the international agri-food market and creating a national regulatory framework for property and administrative relations between members of such structures) (16, 31).

Another key agricultural subsector in Russia, dairy cattle breeding, still faces the problems of low profitability, growing production costs, shortage of proprietory funds, the annual reduction in cow numbers and milk production, unbalanced ration, shortage of forage and its poor quality, and other negative trends. One of the leading causes of the current situation in the subsector, according to K. A. Zadumkin, A. N. Anishchenko, V. V. Vakhrusheva, and N. Yu. Konovalov, and we share their opinion, is an unsatisfactory condition of the forage resources (12).

Another team of authors that included A. A. Kuzina, N. A. Medvedeva, K. A. Zadumkina, and V. V. Vakhrusheva concluded from their empirical study that the effective development of the Russian dairy industry is only possible through balanced measures of public policy that would take into consideration both the challenges facing the industry and international experience (13, 32). The authors analyzed the use of the best available techniques (BAT) and proposed a model for creating the concept of development of the subsector using such techniques. In our opinion, of practical interest are suggested scenarios of development of the Russian dairy industry and the conclusion that the public policy for its development should be based on an innovative scenario involving its systemic modernization to ensure the national food and environmental safety, and on exporting dairy products.

Concluding the literature review, we will briefly describe the known economic-mathematical models that can be used for estimating and forecasting production capacity with the necessary degree of accuracy.

Up to now, an effective assessment tool for production capacities of the country, region, industry sector (including agriculture), and enterprise, both in Russia and abroad, have been the Cobb–Douglas production function (14). The classic version of this function allows to estimate and forecast the output depending on two factors (labor and capital) (28):

$$Y = A \cdot K^{\alpha} \cdot L^{\beta}, \tag{1}$$

where A — production coefficient; L, K — production factors, labor (average number of employees) and capital (average fixed assets value for the period) respectively; α, β — output elasticity coefficients by capital and labor.

The development of economic and mathematical modeling of the production capacity is currently actively researched, precisely on the basis of the Cobb–Douglas production function. In our view, they can be categorized into two groups: 1) modification of functional specification by including (apart from the classic factors) a number of alternative independent variables; 2) development of authorial econometric methods allowing to correctly determine both static (unchanging over time) and dynamic (varying by periods) parameters of the Cobb–Douglas production function. Most interesting are studies of the second variety, as they are generally intended to improve the accuracy of assessment and forecasting of production capacities at the macro-, meso-, and microlevel, and by industry. The work by N. V. Suvorov, in our opinion, deserves special attention: the author developed and tested the alternative method of linear regression (AMLR) on the data of industry statistics of the USSR and Russia. The method allows accurate calculation of the dynamic parameters of the Cobb–Douglas production function (24, 25, 26). In addition to the high accuracy of verification of the model's parameters (calculations are carried out on growth rates of the variables, i.e. on small numbers), his method guarantees their positive economic outcome under all the factors. Of equal interest, in our opinion, is the joint study by V. K. Gorbunov and A. K. L'vov that presents an authorial method of assessing the value of effective funds (formed in the process of utilization of business investments) and simultaneously creating capital production function (8). The researchers achieved the high accuracy of economic and mathematical modeling of the object's production capacity through using a special variation of the parameter continuation method, a known effective method of solving systems of nonlinear equations. At the same time, case studies suggest that not all attempts to develop the method were successful. For example, a number of publications incorrectly applied the method of spatial regression for creating a universal investment production function of any Russian region based on regional statistical data for one year or more. V. K. Gorbunov and V. G. Derevenskii published a critical analysis of such studies and refuted the validity of using the method for such purposes (7).

Let's proceed to the methodological aspect of the study. The study employed a number of methods of economic and mathematical analysis (graphical, tabular, comparisons analysis, etc.) The key role was played by well-known methods of economic and mathematical modeling, namely: correlation and regression analysis and trend extrapolation method.

Based on the literature review on the topic, the objective was set for this study to develop an economic and mathematical model that would allow assessment and forecasting the agricultural output of Russian agricultural organizations with the required accuracy.

3 Results and discussion

In this study, the modeling was carried out through the correlation and regression analysis that allows not only to deepen the factor analysis of the effective indicator but also to realize the forecast function. The multifactor correlation and regression model is created through a number of steps (3): (1) a-priori study of the economic problem, (2) listing factors, their logical analysis, 3) collection of initial data and their original processing, (4) specification of the regression equation, (5) assessment of the regression equation, (6) selection of the main factors, (7) verification of the model vaildity, (8) economic interpretation, and (9) forecasting of unknown values of the dependent variable. Table 1 shows the initial data for the economic and mathematical modeling of the agricultural output of Russian agricultural organizations over the last 12 years.

This information, in turn, was obtained from the Russian state statistical monitoring agency (17). In our case, the resultant indicator (dependent variable) is the monetary agricultural output of agricultural organizations (actual prices) in billion rubles. Previously, on the basis of the system analysis, a set of 7 factors (independent variables) was obtained that, according to the author, play the biggest role in the resultant indicator. They included variables that describe key indicators of the lines of business of agricultural organizations (crop farming and animal husbandry), assess the condition of infrastructure and facilities, utilization efficiency of the basic resources (labor and capital), and the level of job compensation in Russian agricultural sector.

Table 1: Initial data for the economic and mathematical modeling of the agricultural output of Russian agricultural organizations, 2006–2017.

Indicator	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Agricultural output of agricultural organizations (actual prices) (Y), billion rubles.	704.5	918.5	1183.7	1141.5	1150.0	1540.6	1600.8	1756.0	2139.0	2657.1	2890.4	2978.0
Cultivation areas of grains and grain legumes crops belonging to agricultural organizations (X_1), thousand hectares	33,632	33,754	35,363	35,713	32,048	32,114	32,120	32,644	32,147	32,052	31,933	31,618
Productivity of grains and grain legumes in agricultural organizations (X_2), metric centners per hectare of harvested area	19.2	20.5	24.6	23.6	19.0	23.3	19.3	23.1	25.4	25.0	27.6	31.0
Cattle numbers in agricultural organizations (X_3), thousand heads	10,840.4	10,456.4	10,079.9	9,709.3	9,405.8	9,210.8	9,112.6	8,930.3	8,661.5	8,485.2	8,401.8	8,304.0
Milk yield per cow in agricultural organizations (X_4), kilograms	3,564	3,758	3,892	4,089	4,189	4,306	4,521	4,519	4,841	5,140	5,370	5,660
Load of land per tractor in agricultural organizations (X_5), hectare	187	197	210	226	236	247	258	274	290	307	318	327
Combine harvesters per thousand hectares of planted areas of crops in agricultural organizations (X_6), pcs	4	3	3	3	3	3	3	3	2	2	2	2
Average monthly nominal job compensation of agricultural organizations employees (X_7), RUB	4,569	6,144	8,475	9,619	10,668	12,464	14,129	15,724	17,724	19,721	21,445	25,156

Source: the author's compilation.

Table 2: Matrix of Pearson's paired correlation coefficients.

Indicator	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y	1							
X_1	-0.633	1						
X_2	0.822	-0.21	1					
X_3	-0.918	0.69	-0.67	1				
X_4	0.986	-0.67	0.79	-0.95	1			
X_5	0.977	-0.69	0.75	-0.97	0.99	1		
X_6	-0.942	0.57	-0.78	0.91	-0.94	-0.94	1	
X_7	0.980	-0.67	0.79	-0.96	0.99	0.99	-0.93	1

Source: the author's compilation.

The factors for the model were selected based on the calculation and analysis of Pearson's paired correlation coefficients (see Table 2). The formula for calculating such coefficients on the example of the resultant or any other factor is below (3):

$$r_{xy} = \frac{\sum_{i=1}^{n}[(x_i-\bar{x})(y_i-\bar{y})]}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2}}, \quad (2)$$

where x_i, y_i — empirical value, respectively, of any factor and resultant indicator; $\bar{x}, \bar{y}$— arithmetic mean of the factor and resultant indicators. The paired correlation coefficients for any combination of factors is calculated in the same manner. The decision to include a factor in the model is taken according to a number of rules (19). According to Table 2, Factors 2, 3, 4, 5, and 7 (3 and 6) have a direct/inverse strong impact on the resultant indicator. The moderate relationship was found between the dependent variable and Factor 1. There is also a strong relationship between certain factors. In view of the calculation, analysis and the above rules, it was decided that only two factors (Factor 2 and 7) should be included in the model. First, both factors have a direct strong impact on the resultant indicator. Secondly, they are loosely bound with one another. Such indicators will hereinafter be referred to as Factors 1 and 2. After that, the initial data are verified (in terms of the indicators included in the model) for consistency and compliance with the normal distribution law based on calculation and analysis of the following indicators: the variation coefficient and the ratio of skewness/kurtosis to their error (see Table 3). The calculations are carried out according to the formulas given in (19). The calculation and analysis of the variation coefficient show that while Factor 1 is characterized by a medium variation, for other indicators it is considerable. However, in this case, it is inexpedient to exclude atypical observations to reduce the variation coefficient of the resultant indicator and Factor 2, as it would adversely affect the adequacy of the model. Therefore, we will assume the initial data to be conditionally consistent. The ratio of skewness/kurtosis to their error is significantly lower than 3 in absolute terms. This means that skewness and kurtosis are insignificant, and therefore the initial data complies with the normal distribution law. Therefore, the data can be used for the correlation and regression analysis. The specification of the model was determined through the regression analysis:

$$Y_{X_i} = -391.3 + 26.3X_1 + 0.108X_2, \quad (3)$$

where X_1 and X_2 — Factors 2 and 7, respectively, of the initial set of indicators.

Table 3: Results of verification of the initial data for consistency and compliance with the normal distribution law

Indicator	Y	X_1	X_2
Arithmetic mean	1721.7	23.5	13,820
Mean-square deviation	745.8	3.5	6,075
Variation coefficient	0.433	0.148	0.440
Skewness	0.54	0.55	0.29
Skewness error	0.71	0.71	0.71
The ratio of skewness to its error	0.77	0.78	0.40
Kurtosis	-1.06	0.14	-0.79
Kurtosis error	1.41	1.41	1.41
The ratio of kurtosis to its error	-0.75	0.10	-0.56

Source: the author's compilation.

The above regression equation suggests that both factors have a direct impact on the resultant indicator. This means that an increase in both productivity of grains and grain legumes in agricultural organizations and the average monthly job compensation of their employees increases agricultural output of Russian economic entities. The key step of the correlation and regression analysis is verifying the model's adequacy (its main findings are shown in Table 4). Such verification is carried out according to the method given in (3) and (6). Table 4 preliminarily suggests that the model is adequate and, therefore, the results of correlation and regression analysis can be used in practical work. To determine the impact of each of the factors on the resultant indicator, we calculated another special indicator: elasticity.

$$Э_{X_i} = A_i \frac{\overline{X_i}}{\overline{Y}}, \quad (4)$$

where A_i — previously determined coefficients (parameters) of the regression equation under each factor. In our case, the elasticity was 0.36 and 0.87, respectively for factors 1 and 2. This means that while a 1% increase in the productivity of grains and grain legumes in agricultural organizations increases the resultant indicator only by 0.36%, increasing the average nominal monthly pay for their employees increases the resultant indicator by 0.87%. Therefore, the calculation and analysis of the elasticity for each factor suggest that the greatest potential for growth of agricultural output of Russian agricultural organizations rests with increasing the level of job compensation for employees.

An equally important marker of the model's adequacy is the average approximation error:

Table 4: Assessment of the model's adequacy.

Hypothesis (indicator)	Indicator's value		Note
	Calculated	Tabulated (standard)	
1. Hypothesis of the statistical significance of the regression coefficients (Student's t-test)	-1 for A_0; 1.2 for A_1, and 8.66 for A_2	2.2622*	Only A_2 is a significant coefficient of the regression equation
2. Hypothesis of the statistical significance of the regression equation (the Fischer–Snedecor F-test)	125.18	4.26*	The regression equation is significant
3. Coefficient of determination	0.965	0.8–0.9**	The model allows to carry out an accurate assessment of the phenomenon under study
4. Adjusted coefficient of determination	0.958	0.8–0.9**	

Note: * and ** — data obtained from (9) and (6), respectively
Source: the author's compilation.

$$E = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i - y_{i\tau}}{y_i}\right| 100\%, \quad (5)$$

where y_i and $y_{i\tau}$ — values of the resultant indicator, empirical and obtained through the modeling, respectively; n — the number of observations. In this case, the approximation error was 7.3%. Given that in economic calculations the permissible error is within 5–8% (19), the following conclusion can be made: the regression equation describes the dependencies under study with sufficient accuracy.

Therefore, the model's adequacy test indicates that the above results of correlation and regression analysis can be used in practice, namely not only for calculating growth potential of the resultant indicator but also for forecasting it. The factors are forecasted through the trend extrapolation method (see Fig. 2 and 3).

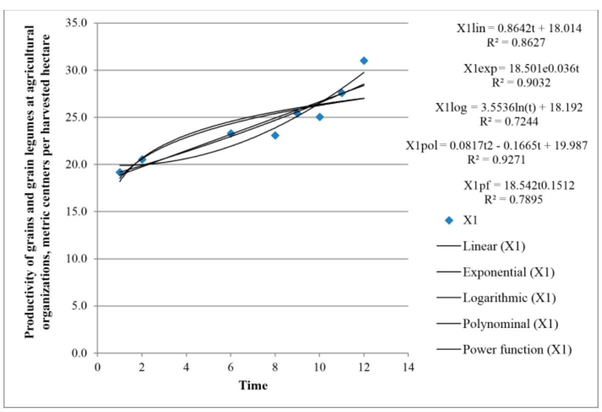

Figure 2: Changes in X_1 over time

The trend type (changes over time) is selected through the analysis of the coefficient of determination. In our case, the trend is considered to be detected if the above indicator exceeds 0.9. In order to fulfill this condition, a number of atypical observations were excluded from the time series for factor 1. Figures 2 and 3 show that the change over time in each of the two factors is described by a polynomial trendline.

This allows to generate a forecast of the resultant and factor indicators for the mid-term perspective (4 years) (Table 5). As Table 5 shows, if the trend of the two factors changing over time is maintained (annual growth since 2017), the resultant indicator is expected to grow in the medium-term horizon.

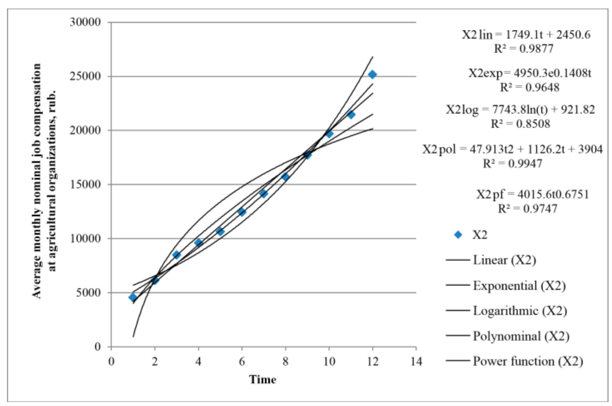

Figure 3: Changes in X_2 over time

Table 5: Resultant and factorial indicators — forecast

Forecasting period	Time	X_{1np}	X_{2np}	Y_{np}
2018	13	31.6	26,642	3,324.9
2019	14	33.7	29,062	3,640.5
2,020	15	35.9	31,577	3,970.8
2,021	16	38.2	34,189	4,315.8

Source: the author's compilation.

The forecast for the core indicator (monetary agricultural output) indicates an optimistic scenario for Russian agricultural organizations for 2018–2021. Despite this forecast, Russian agricultural organizations currently have significant growth potential in agricultural output. Among other things, this is shown by the analysis of job compensation level at Russian agricultural organizations over the past 12 years (Table 6).

Despite in 2013–2017 the job compensation was steadily growing for employees of agricultural organizations in Russia, the average salary of Russian agricultural employees was 35.7% lower than overall in Russian economy. In our opinion, this problem cannot be solved without the development and implementation of a strategy to increase the income of the rural population.

Table 6: Analysis of job compensation level at agricultural organizations in Russia

Year	Average monthly nominal job compensation of organizations' employees by industry, RUB		Job compensation in agriculture, %
	Overall throughout the economy	Agriculture	
2006	10,634	4,569	43.0
2007	13,593	6,144	45.2
2008	17,290	8,475	49.0
2009	18,638	9,619	51.6
2010	20,952	10,668	50.9
2011	23,369	12,464	53.3
2012	26,629	14,129	53.1
2013	29,792	15,724	52.8
2014	32,495	17,724	54.5
2015	34,030	19,721	58.0
2016	36,746	21,445	58.4
2017	39,144	25,156	64.3

Source: the author's compilation.

R. Sagatgareev proposes a set of measures to significantly increase the salaries of agricultural organizations' employees in Russia (20). The following important problems in agriculture are equally pressing in almost every Russian region (2): high physical depreciation of fixed assets, lack of operating assets, low farming standards, and the return to primitive and low-performance techniques and organizational forms of business.

4 Conclusion

Based on the body of literature on the topic, this study set and solved the problem of assessment and forecasting the production capabilities of Russian agricultural organizations through economic and mathematical modeling, namely the correlation and regression analysis. The analysis found that the most impact on the agricultural output of Russian agricultural organizations was exerted by the level of job compensation of their employees, not the productivity of the leading crops. Given its relatively low value compared to the overall average salary in Russian organizations, the problem of raising the job compensation level in Russian agricultural organizations has become more urgent. In addition, Russian agricultural organizations have a number of other unresolved problems. The leading problems include highly depreciated fixed assets, deficiency of operating assets, etc. Therefore, the optimistic scenario (growth of agricultural output of agricultural organizations) is only possible if the changing trend for the two leading factors is maintained. This, in turn, requires the solution of the above problems. This model allows not only to identify growth potential for the resultant indicator but also to make forecasts of it.

References

1. Aganbegyan AG, Porfir'ev BN. Zameshchenie importa prodovol'stviya i razvitie «zelenoi» agroekonomiki kak strategicheskie otvety na antirossiiskie sektoral'nye sanktsii [Substibution of Food Imports and Development of Green Agricultural Economy as Strategic Responses to Anti-Russian Sectoral Sactions] Ekonomika sel'skokhozyaistvennykh i pererabatyvayushchikh predpriyatii. 2015;2.
2. Akhmetov VYa, Gataullin RF, Galikeev RN. Problemy i perspektivy organizatsii regional'nogo agropromyshlennogo nauchno-proizvodstvennogo klastera v Respublike Bashkortostan [Problems and Prospects of Organization of Regional Agricultural Research and Manufacturing Cluster in the Republic of Bashkortostan]. Ekonomika: vchera, segodnya, zavtra. 2017;7(5A):27–44.
3. Berezhnaya EV, Berezhnoi VI. Matematicheskie metody modelirovaniya ekonomicheskikh sistem [Mathematical Modelling Methods for Economic Systems]. Moscow. Finansy i Statistika Publ., 2006; 432 pp.
4. Blinova TV, Bylina SG. Stsenarnyi prognoz chislennosti sel'skogo naseleniya Rossii na srednesrochnuyu perspektivu [Scenario Forecast of Rural Population in Russia in the Mid-Term Horizon]. Ekonomika Regiona. 2014;4: 298–308.
5. Garipov FN, Gizatullin KhN, Garipova ZF. Osnovnye napravleniya preodoleniya vyzovov XXI veka v agrosfere [The Main Vectors of Overcoming the Challenges of the 21st Century in Agriculture] Ekonomika regiona. 2016;12(1): 105–116.
6. Gorbatkov SA, Polupanov DV, Farkhieva SA, Korotneva MV. Ekonometrika [Econometrics]. Ufa, RITs BashGU Publ. 2012;204 pp.
7. Gorbunov VK, Derevenskii VG. Proizvodstvennye funktsii malogo predprinimatel'stva regionov Rossii. O metode "prostranstvennoi regressii" [Production Functions of Regional Small Business in Russia. On the "spatial regression" method]. Vestnik of Moscow University, 2015;1: 94–109.
8. Gorbunov VK. L'vov A.G. Effektivnye proizvodstvennye fondy i proizvodstvennye funktsii malogo predprinimatel'stva [Effective Production Assets and Production Functions of Small Business]. Ekonomika regiona, 2018;14(2): 502–515.
9. Gromyko LG. Teoriya statistiki: praktikum. [The Theory of Statistics. Workshop] Moscow, INFRA-M Publ., 2003; 160 pp.
10. Denisov VI. Motivatsionnye mekhanizmy i predposylki rosta sel'skokhozyaistvennogo proizvodstva v Rossii [Incentives Mechanisms and Prerequisites of Growth of Agricultural Output in Russia]. Ekonomika i matematicheskie metody, 2017;53(2): 66–76.
11. Denisov VI. Neispol'zuemye vozmozhnosti gosudarstvennoi podderzhki agrarnogo truda v Rossii [Unused Opportunities of Government Support of Agricultural Labor in Russia]. Ekonomika regiona, 2018;14(3):1003–1013.
12. Zadumkin KA, Anishchenko AN, Vakhrusheva VV, Konovalova NYu. Povyshenie effektivnosti proizvodstva moloka na osnove sovershenstvovaniya regional'noi sistemy kormoproizvodstva [Improving the Performance of Milk Production through Improving the Regional System of Forage Production]. Ekonomicheskie i Sotsial'nye Peremeny: Fakty, Tendentsii, Prognoz. 2017;10(6): 170–191.
13. Kuzin AA, Medvedeva NA, Zadumkin KA, Vakhrusheva VV. Stsenarii razvitiya molochnoi promyshlennosti Rossii [Scenarios of Development of the Russian Dairy Industry]. Ekonomicheskie i Sotsial'nye Peremeny: Fakty, Tendentsii, Prognoz. 2018;11(6): 73–88.
14. Neganova VP, Dudnik AV. Sovershenstvovanie gosudarstvennoi podderzhki APK regiona [Improvement of Government Support

for Regional Agricultural Sector]. Ekonomika regiona. 2018;14(2): 651–662.
15. Pappe YaSh, Antonenko NS, Polzikov DA. Prodovol'stvennaya bezopasnost' Rossii: sovremennyi podkhod [Russia's Food Security: Modern Approach]. Problemy prognozirovaniya. 2017;3: 62–74.
16. Rodionova EV. Integratsionnye protsessy v myasoproduktovom podkomplekse APK Rossii: rezul'taty, osobennosti, napravleniya razvitiya [Integration Processes in the Meat Subsector of the Russian Agricultural Industry: Results, Special Characteristics, Vectors of Development]. Ekonomicheskie i Sotsial'nye Peremeny: Fakty, Tendentsii, Prognoz. 2018;11(2): 144–159.
17. Rossiya v tsifrakh. 2018: krat. stat. sb. [Russia in Numbers. 2018: Short Statistical Compilation]. Moscow, Rosstat Publ. 2018; 522 pp.
18. Rossiya i strany mira. 2018: statisticheskii sbornik [Russia and the World. 2018: Statistical Compilaiton]. Moscow, Rosstat Publ. 2018; 375 pp.
19. Savitskaya GV. Ekonomicheskii analiz. [Economy Study]. Moscow, Novoe Znanie Publ., 2003; 640 pp.
20. Sagatgareev RM. Mekhanizm razrabotki i realizatsii strategii povysheniya dokhodov sel'skogo naseleniya [The Mechanism of Development and Implementation of the Strategy to Increase Incomes of Rural Population]. Ekonomika: vchera, segodnya, zavtra, 2017;7(5A): 90–100.
21. Samygin DYu, Baryshnikov NG, Mizyurkina LA. Proektnaya model' razvitiya agrarnoi ekonomiki: prodovol'stvennyi aspekt [Design Model of Development of Agrarian Economy: Food Aspect]. Ekonomika regiona, 2017;13(2): 591–603.
22. Skvortsov EA, Skvortsova EG, Sandu ES, Iovlev GA. Perekhod sel'skogo khozyaistva k tsifrovym, intellektual'nym i robotizirovannym tekhnologiyam [Transition of Agriculture to Digital, Intellectual and Robotic Rechnologies]. Ekonomika regiona. 2018;14(4):1014–1028.
23. The Strategy of Sustainable Development of Rural Areas of the Russian Federation through to 2030: approved by the Executive Order of the Government of the Russian Federation No. 151-p, dated February 2, 2015. URL: http://www.consultant.ru/document/cons_doc_LAW_174933.
24. Suvorov NV. Aktual'nye napravleniya i problemy sovershenstvovaniya model'nogo instrumentariya makroekonomicheskogo analiza [Current Vectors and Problems of Improvement of Modelling Tools in Macroeconomic Analysis]. Problemy prognozirovaniya. 2005;5: 25–29.
25. Suvorov NV. Verifikatsiya ekonometricheskoi modeli s uchetom apriornykh ogranichenii na strukturnye parametry [Verification of the Econometric Model in View of A Priori Restrictions on Structural Parameters]. Voprosy statistiki, 2016;11:53—66.
26. Suvorov NV. Razvitie metodov issledovaniya statisticheskikh zavisimostei: regressionnye modeli s peremennymi strukturnymi parametrami [Development of Research Methods for Statistical Dependencies: Regression Models with Variable Structural Parameters]. Voprosy statistiki. 2018;6: 3—15.
27. Cherednichenko OA, Dovgot'ko NA, Yashalova NN. Ustoichivoe razvitie agroprodovol'stvennogo sektora: rossiiskie prioritety i napravleniya adaptatsii Povestki dnya–2030 [Sustainable Development of the Agri-Food Sector: Russian Priorities and Lines of Adaptation of the Agenda 2030]. Ekonomicheskie i Sotsial'nye Peremeny: Fakty, Tendentsii, Prognoz. 2018;11(6): 89–108.
28. Cobb CW, Douglas PH. A Theory of Production. Supplement, Papers and Proceedings of the Fortieth Annual Meeting of the American Economic Association. The American Economic Review. 1928; 18(1): 139–165.
29. Osokina NV, Kazantseva EG. Strengthening of the Economic Power of the Dominating Entities in the Food Industry. Foods and Raw Materials. 2016; 4(2): 190–200.
30. El-Kader, S. M. A., & Al-Dahr, M. H. S. (2018). Inflammatory cytokines and immune system response weight reduction in obese patients with type 2 diabete, mellitus. *European Journal of General Medicine*, *15*(1).
31. Özer G, Ergün U, İnan LE. Headache in Multiple Sclerosis From a Different Perspective: A Prospective Study. J Clin Exp Invest. 2018;9(1):9-13. https://doi.org/10.5799/jcei.413052.
32. Akkuzova, A., Mankeyev, Z., Akkuzov, A., Kaiyrbekova, U., & Baiymbetova, R. (2018). Some features of the meaning “literary text” in the pragmalinguistic aspect. *Opción*, *34*(85-2), 20-34.