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ECONOMIC AND MATHEMATICAL RESEARCH OF THE RURAL TERRITORIES DEVELOPMENT IN RUSSIA

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Abstract

In the article the works of Russian and international scientists devoted to the solution of problems of the countryside territories development are being analyzed. The conducted research made it possible to identify the main trends in development of Russia's rural areas and in the leading countries of the world as well. The article analyzes the prevailing support level needed for Russia's rural development. Also it presents the dynamism of main indicators of Russia's countryside evolution. The authors identify regions of Russia with low and high rates of rural evolvement. Influencing factors are being revealed. The study offers a mathematical model for the rural areas advance in both medium- and long-term perspectives. The authors make a forecast for Russia's rural areas progress until 2050. The article concludes that it is necessary to concentrate processing industries in rural areas, as well as to create new jobs, to reduce people outflow from rural areas, and to stimulate the development of efficient production in the agricultural sector of the Russian economy.

Key words**:** *rural areas, economic development, agriculture, land use, agricultural economics, institutional reform*

INTRODUCTION

Russia's land area is the largest in the world. The total area of the country is more than 17 million square kilometers, including agricultural land of 191.3 million hectares [12]. The great length of the country and its size predetermined the specifics of the rural areas progress. The current state of the Russian economy and its level also affects the rural advance dynamics. Throughout the history of the Russian state, the government has paid special attention to the well-being of the countryside. Rural territories are the basic units of the agrarian segment of the country's economy, its central link. The extent to which rural areas are developed depends on the overall degree of agriculture. As a rule, the higher the scale of economy, the higher the scale of the countryside progress. In most countries of the world, including Russia, the problem of sustainable progress of the countryside is given the highest priority. This, first of all, is due to the fact that in rural areas there live a significant number of Russia's residents - about 38 million people. It is more than 25% of the country's total population. 6.2 million people are directly employed in agricultural production [12]. Various programs are being developed and adopted for the rural areas at all the levels including federal, regional and local. In rural areas, the production capacities of agriculture are concentrated, as well as large processing industries in many countries of the world. Another task of the countryside is the provision of manpower for agricultural production. Another equally important problem in the development of areas under study is the maintenance and development of the existing ecological systems. The changes taking place in Russia's economy are due to the natural processes of the world economy development, primarily the cyclical development [9, 14], as well as factors related to political processes. They pointed out the

importance of the problem being studied, both for the Russian economy and for the world economy.

MATERIALS AND METHODS

The conceptual basis of the study is the work of prominent scientists of Russian and international science [1-10, 13-15, 18, 20]. The study uses elements of the theory of spatial development, the theory of effective development, mathematical modeling of socio-economic processes, probability theory. The main research methods in the economic part are the abstract-logical method, computational-constructive, graphic, monographic, economic-statistical methods.

In the mathematical part of the study, when constructing the economic-mathematical model and calculating the predicted values of the studied indicators, we applied mathematical methods of modelling and forecasting, such as the method of growth curve models, a graphical method for selecting a regression equation describing a model based on empirical data, estimating the accuracy of the forecast by correlation and regression analysis. The relationship between the empirical items in the study was checked for linear or nonlinear dependencies (polynomial, exponential, logarithmic, hyperbolic). Choice of the approximating function was determined by the highest correlation index, and accuracy of prediction was determined by the smallest approximation error. To eliminate the error from the point estimate of the forecast of the calculated indicators we used the confidence interval.

RESULTS AND DISCUSSIONS

The twenty-first century world economy shows a tendency of slowdown in the pace of its development [19], which was especially evident during the periods of the world economic crises of 1998 and 2008. Analysis of the leading foreign countries development in the agrarian sector made it possible to identify a number of basic trends. Thus, studies [2, 5, 13] stress the importance of accelerated development of the countryside on the basis of small family farms formation (USA, England, France). Many countries (China, Brazil, India) give preference to the development of large-scale industries and, at the expense of this, stimulating the rural areas growth [4, 20]. In many developing countries (Africa, Southeast Asia), preference is given to the rural areas progress through cooperation and the division of labor [1, 3, 7, 8]. In Russia, the progress of the countryside has its own specifics, due to the specifics of the country's general political and economic development [15].

The main objective of the Russia's rural areas development is to create comfortable conditions for agricultural activities, reduce the outflow of rural population from rural areas, develop engineering, production and social infrastructure in rural areas, increase rural incomes and longevity, and stimulate rural business activity on the basis of the peasant farms progress.

Total amount of funds allocated for the countryside development of Russia in 2015 amounted to 540.91 million US dollars (Fig. 1), while the increase in resources allocated for the same goal by 2020 which is twice as much as before (to 1,157.06 mln US dollars). In the structure of funds, the largest share is taken by the regional budgets, their share varies from 43 to 53 percent.

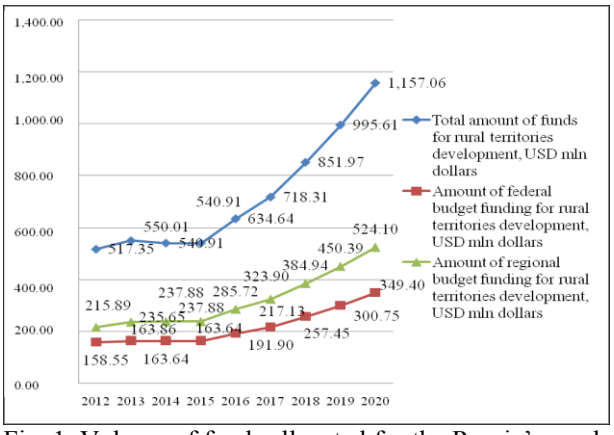

Fig. 1. Volume of funds allocated for the Russia's rural areas development, US $ million, calculated by the authors on the data basis [16]

In the structure of allocated funds for the Russia's rural areas (Fig. 2), the largest share is taken by measures to improve the living

conditions of more than 46% and the extension of a network of highways about 22 percent. Other equally important areas of spending are financing for further gasification, water supply, building of rural schools.

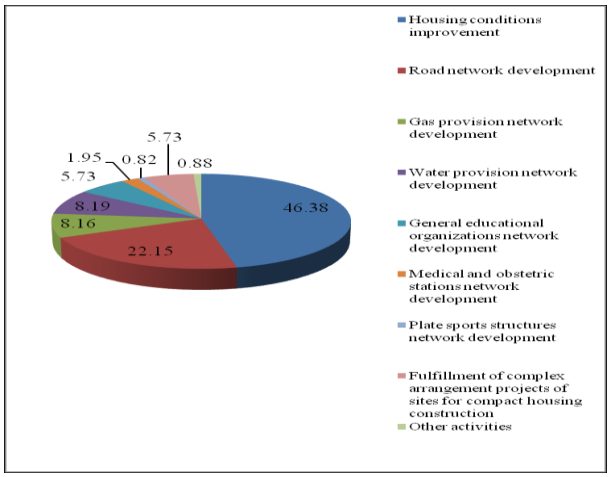

Fig. 2. Structure of the funds for Russia's rural areas in 2015, %, calculated by the authors on the data basis [11]

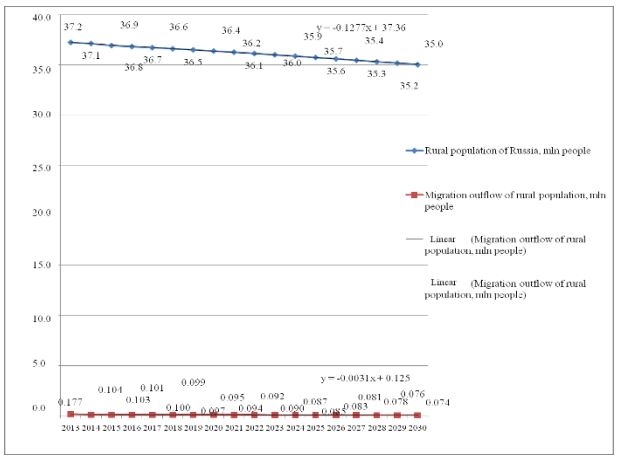

Fig. 3. Number of people and migration outflow out of rural areas in Russia in 2013-2030, mln people, calculated by the authors on the data basis [17]

Meanwhile, in Russia, as in many leading foreign countries [3; 5], there is a movement of people away from rural areas (Fig. 3). This is probably the most important reason for the need for a radical change in approaches to Russia's rural growth. In the adopted «Strategy for Development of Rural Territories of the Russian Federation for the period up to 2030» [17], the outflow parameters of the population from rural areas have been determined (Fig. 3). These measures allow to concentrate a large part of the country's human resources of about 35 million people in the countryside and significantly reduce the rural population outflow.

Table 1 presents main indicators of the areas under study development, the criterion indicators are the housing commissioning, general education organizations, medical and obstetric stations, gas networks and water pipes. In the Russian Federation, despite the reduction in the funding of some programs, the financing of rural development has remained virtually unchanged. That allowed to save volumes of housing commissioning in rural areas and other key areas of further progress of rural areas.

The conducted research has allowed to allocate regions of Russia with low and high rates of development of non-urban territories (Fig. 4).

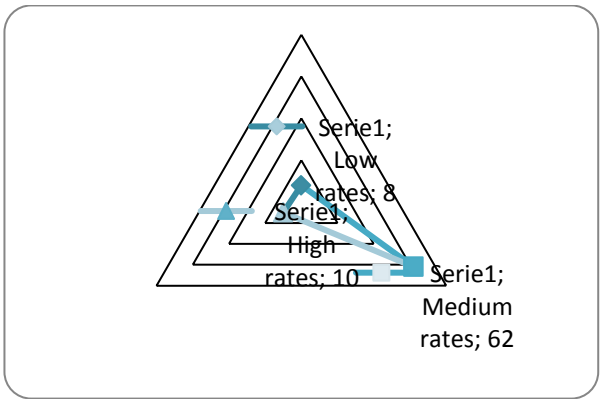

Fig. 4. Number of Russia's regions in terms of the countryside territories progress rate, units, calculated by the authors on the data basis [12]

Table 1. Main indicators of countryside development in Russia in 2010-2015

Indicators	2010	2011	2012	2013	2014	2015
Housing commissioning for citizens residing in rural areas, thousand m2	1,267.33	1,289.89	1,343.21	1,260.89	1,298.68	709.78
Including those for young families and young professionals	633.37	616.12	681.75	611.08	645.53	453.57
Commissioning of general education organizations, thousand student places	4.59	4.81	4.1	5.7	5.16	2.82
Commissioning of medical and obstetric stations, units	43	94	115	175	174	146
Commissioning of gas distribution networks, thousand km	5.16	4.44	4.22	3.83	3.07	1.84
Commissioning of local water supply, thousand km	2.87	2.21	2.31	1.98	2.37	1.24

Source: Compiled by the authors on the basis of data [11].

There are 10 regions with high rates of the rural progress, among them are the Belgorod Region, the Krasnodar Krai, the Lipetsk Region, the Republic of Tatarstan, and the Saratov Region.

The regions with low rates of development are 8 in number. Among which the authors single out the Jewish Autonomous Region, the Karachaevo-Cherkess Republic and the Sakhalin Region.

The remaining regions of Russia are included in the group with an average level of development, which does not mean the prosperity of these regions in the rural development and the creation of good conditions for the effective management of modern agriculture.

Our research has allowed us to identify the main factors affecting the level of the countryside elaboration in Russia's regions. First of all, they are: the rate of agriculture progress, natural and climatic conditions, the rate of concentration of the rural population, traditions and created social and living conditions in the countryside.

In the study, based on actual data, we calculate and justify the forecast of main indicators affecting rural development in Russia up to the years of 2020, 2030 and 2050.

The projections, due to the nature of the empirical data relationship ambiguities, checked linear and nonlinear function (polynomial, exponential, logarithmic, a hyperbolic).

Non-zero linear autocorrelation coefficients indicated a nonlinear trend. The choice of the approximation function determined by the highest index of correlation, forecast accuracy - the smallest approximation error. Since any forecast is based on a limited number of raw data obtained curve does not display all the events and trends, and describes a number of mid-level movement dynamics. So, any forecast seems to be approximate.

Therefore, to eliminate the error, we moved from the point estimate of the forecast to the interval one, and indicated the so-called confidence interval.

Table 2 presents the forecast for the Russia's rural development up to 2050 which was calculated using mathematical prediction methods.

To check the series for the presence of a nonlinear trend, linear autocorrelation coefficients were calculated for a time series consisting of logarithms of the original levels. Non-zero values of autocorrelation coefficients indicated a non-linear trend for all indicators, therefore, to predict the values of the selected indicators, we used:

Exponential regression $Y_t = Y_0 \cdot EXP(k;t)$ (1),

Indicative regression $Y_t = a \cdot b^t$ (2),

Logarithmic regression $Y_t = a + b \cdot \ln(t)$ (3).

The choice of the approximating function was determined by the highest correlation index and the smallest approximation error for time series smoothed by the moving average method. The coefficients of regression equations were selected by the method of least squares.

As an interval estimate with reliability $\alpha = 0{,}05$, a confidence interval was:

$$\hat{Y}_{t+p} = \overline{Y}_{t+p} \pm \delta \quad (4),$$

where: $\hat{Y}_{t+p}$ - interval value of forecasting characteristic in (t+p) period ,

$\overline{Y}_{t+p}$ - pointwise value of forecasting characteristic (forecast) in (t+p) period,

$\delta = t_\alpha \cdot \sigma$ (5)

probable error of forecast,

$t_\alpha = t_\alpha(\alpha;k)$ (6)

tabulated point of Student criterion.

Quality of the forecast is determined by its accuracy (%), equal to the difference of 100% and possible forecast error, (%). In this case, the forecast error in general is understood as the difference between the actual and predicted values of the studied quantity.

Table 2. Forecast of Russia's Rural Areas Development

Factor	Model	Forecast 2020	2030 Confidence interval (if $\alpha = 0.05$)	2050	Forecast evaluation: Approximation error, (MAPE, %)	Forecast evaluation: Forecast error, (ME)
Rural population, mln people	$y_t = EXP(3.6648 - 0.0033 \cdot t)$ (exponential)	36.55 (36.00; 37.11)	35.37 (34.81; 35.92)	33.11 (32.55; 33.67)	0.52	-0.022
Land area (farming area), mln hectares	$y_t = 221.1854 \cdot 0.9997^t$ (indicative)	219.8 (219.7; 219.9)	219.1 (219.04; 219.23)	217.8 (217.73; 217.92)	0.02	-0.003
Average yearly number of people involved in rural activities, (farming, hunting, forestry), thousand people	$y_t = 8,439.72 - 770.72 \cdot \ln t$ (logarithmic)	6,125.81 (5,829.54; 6,422.08)	5,832.65 (5,536.38; 6,128.92)	5,457.91 (5,161.64; 5,754.17)	1.59	-0.00005
Ratio of people involved in rural activities to total number of people, %	$y_t = 13.1102 - 1.3987 \cdot \ln t$ (logarithmic)	8.9 (8.41; 9.30)	8.3 (7.86; 8.75)	7.6 (7.17; 8.05)	1.58	-0.00002
Commissioning of general education organizations, thousand student places	$y_t = 48.2655 - 11.0961 \cdot \ln t$ (levelled logarithmic)	15.02 (11.1; 18.95)	10.53 (6.6; 14.45)	4.86 (0.93; 8.78)	5.98	-0.0008

Source: Compiled by the authors on the basis of data [12].

Absolute, relative and comparative indicators are used to analyze the accuracy of quantitative forecasts. These are of practical significance for the research:

$$ME = \frac{\sum_{t=1}^{n}(Y_t - \overline{Y_t})}{n} \quad (7),$$

$$\sigma = MSE = \sqrt{\frac{\sum_{t=1}^{n}(Y_t - \overline{Y_t})^2}{n}} \quad (8),$$

$$MAPE = \frac{1}{n} \cdot \sum_{t=1}^{n} \frac{\left|Y_t - \overline{Y_t}\right|}{Y_t} \cdot 100\% \quad (9).$$

If $0 < MAPE(\%) < 10$ - high forecast accuracy and model can be used for forecasting.

The work of many scientists in Russia and abroad are dedicated to the study of rural development.

The conceptual basis and the main goal of the studies on this scientific problem is the theoretical justification and use of the identified and developed directions in practice for the effective exploitation of rural territories.

Thus, having analyzed a large number of scientific works on this topic, it is necessary to highlight the study of Bruce L. Gardner[5]. In his opinion, the main feature of effective progress of territories in the rural areas is the need of establishing a relationship between the level of agricultural production and the creation of an appropriate infrastructure in the countryside, ensuring the necessary growth of production and contributing to the flow of population to the countryside.

According to M. Banse and S. Tangermann [2], when determining the directions for further development of these territories, special attention should be paid to technological factors, the ability to modernize production processes, social, engineering and production infrastructure. An important aspect of the issue is the ability of the government to support the countryside, by providing targeted support to agricultural producers, as well as channeling available financial resources for improving social facilities, reducing differences in living conditions between the village and urban areas.

In Russia, a group of scientists under the academic supervision of A.V. Glotko [6] proposed a scientific hypothesis that the identification and solution of methodological and theoretical issues which affect the effective extension of rural areas develops the system of principles, models and directions for improving economically feasible, socially desirable and environmentally sound management impacts on rural areas. It is made with the purpose of their comprehensive development and implementation of a system of measures aimed at improving both the level and the quality of the village population life.

In research by a group of scientists guided by A.Y. Trotskovsky [18], the rural areas extension is considered in conjunction with the patterns of the settlement system, and primarily urban resettlement. The most important role in ensuring the countryside progress belongs to the regions, which should not only react to the proposals of enterprises, but should themselves organize the economic

process, producing integrated urban and rural environments, and individual areas specially designed for commercial activities.

In the scientific works of I.N. Merenkova and V.N. Pertsev et al. [10] the most interesting idea is the approach to the research of the rural development basing on the definition of the main contradictions, laws and principles of moving forward, definition of a system of criteria and indicators, substantiation of signs and assumptions. These indicators include production and economic and financial factors characterizing the development and level of sustainability of reproductive processes in agriculture, as well as socio-demographic indicators that determine the quality of village population life, and the state of rural social and engineering infrastructures, indicators reflecting changes in ecosystems of the territory. Also, there are indicators reflecting the degree of interaction between the government and local authorities.

CONCLUSIONS

Rural territories represented by land resources are the basis of the agricultural production process, and the territories themselves are home for a significant part of the population. Throughout the world, the evolvement of rural territories is paid a great attention. The level of the peasant areas and the effectiveness of their use, both from the social-economic and environmental sides, shows the level of the country's economy and its agricultural segment.

The research conducted by the authors made it possible to identify the existence of significant problems in Russia's village. These problems in Russia's economy require an early solution, since the existing level of the countryside, contributes only to reducing the outflow of the population from the village and into towns, and its stabilization, which, in our view, is clearly not enough.

The forecast for the extension of non-urban areas in Russia, using mathematical modelling and forecasting methods with a high degree of reliability, presented in this article, indicates that the trend continues for a further reduction in the number of the village population, agricultural land area and other indicators.

In Russia, as the economic and mathematical study shows, rural development should be based on the concentration of production in the countryside, and on the transfer of large processing industries to production sites. In those regions of Russia, where agriculture is of secondary importance (due to the specific nature-climatic conditions) it is advisable to develop small-scale family farms in villages.

For the effective rural development in Russia's economy, we consider it necessary to increase the amount of financial resources directed to the qualitative growth of the engineering, industrial and social infrastructure of peasant areas, to increase the level of incomes of the country population, and improve the life quality in the countryside.

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