

## Modeling of Structural and Institutional Factors of Development in Regions Unfavorable for Agriculture

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### Abstract

The paper aims to assess the influence of structural and institutional factors on agricultural development in the regions where rural areas are qualified as unfavorable for agriculture by the government of the Russian Federation. The discussed factors particularly include rural unemployment, sectoral structure of the regional economy and agriculture, and forms of ownership of food producers. The proxy used as a gauge of regional agricultural development level is the output per person employed in the sector of "agriculture, hunting and forestry" as it is defined for statistical purposes. The application of economic and mathematical methods of analysis helped to create a set of regression models, which showed several distinctive geographical groups among the unfavorable regions. Each group of regions calls for specific individual strategies of transition to sustainable development of the disadvantaged agricultural territories.

**Keywords:** Institutional capital; Agriculture; Economic and mathematical simulation; Territory.



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### 1. Introduction

The territory of the Russian Federation is vastly varied in its natural, climate and economic environment underlying the economy, and the differences involved produce particularly visible impact on the living standards and income levels of population in rural areas. As a result, there are certain regions where unfavorable agricultural conditions, primarily the lacking natural capital, have led to a considerable gap in the levels of wellbeing between the rural and urban populations. The need to mitigate this gap means the need for focused state support in such regions, which led to the statutory introduction of the concept of unfavorable territories for agriculture ([Federal Law No, 2006](#)) and the government-approved list of regions where such territories prevailed ([Orders of the Government of the Russian Federation, 2017](#)) (these regions will be hereinafter referred to as unfavorable). Measures of state support for unfavorable regions should take into account the impact of individual factors contributing toward better living standards in such regions. This paper focuses specifically on structural and economic factors.

The sustainable development approach relates to the possibility of compensating for the lacking natural capital by building up the tangible, human and institutional capital subject to environmental constraints. This concept and mathematical modeling can be used to identify factors enabling the most efficient use of available resources in unfavorable regions with a view to solving local problems of raising income levels in rural areas and, at the same time, their respective contribution toward national food production.

### 2. Materials and Methods

The information base of the research comprises statistical and calculated indicators proposed by the authors and characterizing the sectoral and institutional structure of agriculture, the employment vs unemployment ratio among rural populations, the share of agriculture in regional economies, and the efficiency of agricultural enterprises ([Russian regions. Socioeconomic indicators, 2017](#)). Table 1 lays out some of the selected and calculated indicators.

The theoretical base of the research is the concept of sustainable development ([Bobylev and Khodzhaev, 2004](#)); ([Heal, 1998](#)); ([Frisvold and Kuhn, 1999](#)); theoretical references of state governance and agricultural strategic management ([Mantino, 2010](#)); ([Markova and Dankova, 2014](#)); ([Kuznetsova, 2016](#)); ([Vasilchenko, 2018](#)), and the

modeling of interaction of factors behind the development of unfavorable regions (Blinova *et al.*, 2015), (Blinova *et al.*, 2015); (Zinchenko *et al.*, 2013).

The empirical part of the research aims to identify indicators and evaluate how they are linked to the level of social and economic development in the regions with unfavorable agricultural conditions and rural territories. The criteria to qualify a region as unfavorable are defined by the Russian Government (Regulation No. 51 of the Government of the Russian Federation, 2015) and relate primarily to the regions with prevalent forest and mountainous areas. The list also includes northern subpolar regions with developed resource industries, particularly, oil and gas production, where agriculture is maintained to sustain local traditions. The latter include the Republic of Komi, the Nenets Autonomous District, the Yamalo-Nenets Autonomous District, the Khanty-Mansi Autonomous District - Yugra, the Sakha Republic (Yakutiya), the Sakhalin region.

**Table-1.** Socioeconomic indicators of agricultural sector in federal districts and individual federal subjects included in the list of territories unfavorable for agriculture in 2016

Federal districts and regions	Agricultural output per person employed, thousand rubles	Rural unemployment, %	Share of agricultural sector in regional economy on average for 2014-2015, %*	Agricultural output per 1 ruble of fixed capital, rub./rub.	Profitability of crop farming, %	Profitability of animal farming, %
<b>RUSSIAN FEDERATION</b>	<b>1,000.7</b>	<b>8</b>	<b>5.01</b>	<b>0.86</b>	<b>30.3</b>	<b>9.8</b>
<b>Central Federal District</b>	<b>1,361.4</b>	<b>5.6</b>	<b>3.51</b>	<b>0.98</b>	<b>31.9</b>	<b>12.4</b>
Vladimir region	956.9	7.4	6.50	1.03	0.5	6
<b>Northwest Federal District</b>	<b>780.0</b>	<b>7.9</b>	<b>2.55</b>	<b>1.22</b>	<b>-4.8</b>	<b>11.1</b>
Republic of Karelia	332.2	11.4	3.56	2.74	-	-12.9
<b>Southern Federal District</b>	<b>1,079.1</b>	<b>7.8</b>	<b>11.85</b>	<b>0.67</b>	<b>38.2</b>	<b>7.3</b>
Volgograd region	923.7	9.6	11.82	0.63	46.4	5.5
<b>North Caucasus Federal District</b>	<b>622.6</b>	<b>13</b>	<b>14.83</b>	<b>0.78</b>	<b>33.4</b>	<b>12.5</b>
Republic of Dagestan	444.2	11.1	14.97	0.87	5.5	7.6
<b>Volga Federal District</b>	<b>1,010.0</b>	<b>5.7</b>	<b>7.41</b>	<b>0.78</b>	<b>21.8</b>	<b>7.3</b>
Perm territory	674.5	8.7	2.60	0.74	-6.1	4.2
<b>Urals Federal District</b>	<b>1,102.0</b>	<b>7.3</b>	<b>2.21</b>	<b>1.00</b>	<b>8.3</b>	<b>6.9</b>
Yamalo-Nenets Autonomous District	300.8	5.5	0.10	2.93	-56.2	-64.4
<b>Siberia Federal District</b>	<b>906.0</b>	<b>10.4</b>	<b>6.11</b>	<b>0.89</b>	<b>19.8</b>	<b>9.8</b>
Transbaikal territory	458.5	17	5.60	1.95	-4.9	-24.8
<b>Far East Federal District</b>	<b>728.7</b>	<b>9.5</b>	<b>3.35</b>	<b>0.98</b>	<b>16</b>	<b>-13.5</b>
Primorsky territory	445.0	9.4	4.88	1.67	1.2	-17.9

\*Weight of agriculture, hunting and forestry in gross regional product, on average for 2014-2015, %

Sources: calculations based on (Federal Law No. 264-FZ, 2006), pp.146-147, 537-538, 567-568, 808-811.

The proxy of a region's overall level of economic development in this paper is the per capita GRP (Calculated indicator showing the weight of 'agriculture, hunting and forestry' as an activity in gross value added generated in the federal subject.). Most of the unfavorable regions are considerably lagging behind by this indicator compared to the national or federal district averages. Traditional agricultural regions have relatively low per capita GRP levels compared to the federal district average, combined with relatively high scores by the weight of agriculture, hunting and forestry in the respective GRP. The implication of such combination of structural factors is the relatively scarce potential of the regional budget in providing support for agricultural production, maintaining educational institutions for training talent, and developing social infrastructure (Vasilchenko, 2018).

The quality of life of rural population in this paper is assessed based on the regional proportions of rural population and rural unemployment published by the Russian Federal State Statistics Service (Rosstat). The levels of

these indicators in unfavorable regions are significantly higher compared to the respective federal district averages, which is clearly observed in all federal districts (Table 1).

The proposed *assessment of comparative efficiency of application of tangible capital* is based on the calculated ratio of agricultural output across all categories of farms per 1 thousand rubles of fixed capital. This indicator shows considerable variation region by region depending on the sectoral makeup of production. The profitability indicators of crop farming and animal farming in unfavorable regions are significantly lower compared to the national or federal district averages (see Table 1).

We propose the following calculated indicators for describing the *sectoral and institutional structure of agriculture* in "unfavorable" regions: the share of animal farming in gross agricultural output and the share of agricultural entities and farms including sole entrepreneurs in gross agricultural output. There is considerable variation in the levels of the said indicators in neighboring regions, reflecting individual aspects and potential directions of structural shifts in agricultural production in each region based on institutional capital.

The whole combination of the discussed indicators shows the potential of improving the agricultural production stability by relying on tangible, human and institutional capital to compensate for the lacking natural capital in unfavorable regions. All selected indicators provide comparability among various regions considerably varying in terms of area, agricultural land fertility and rural population numbers.

### 3. Results and Discussion

The economic modeling of the factors behind the development of unfavorable regions as part of the research was coupled with mathematical modeling. A correlation matrix was built in Microsoft Office Excel for all readings of all indicators across 36 regions, which confirmed the independence of the selected variables. A regression model was built to assess the importance of structural and institutional factors for the development of agriculture in the disadvantaged regions.

The calculated indicator of agricultural output per person employed in the sector was used as the function (Y). This indicator reflects the influence of labor productivity in the sector on the growth of rural incomes, which corresponds with the laws qualifying Russian regions unfavorable for agriculture ([Regulation No. 51 of the Government of the Russian Federation, 2015](#)).

In solving the model, a hypothesis was verified as to the uneven profile of regional rural areas qualified as unfavorable for agriculture, as well as the presence of several types of regions. The first model was calculated for all 36 regions including 16 regions of the European Russia, 14 regions of the Eastern part and six regions with developed mining industry; its coefficient of determination R<sup>2</sup> stood at 0.41, which pointed at low reliability of the model. The second model was derived by excluding the data on the six northern regions, and the coefficient of determination R<sup>2</sup> rose to 0.70, which implied medium reliability of the model and a distinct status of the northern region group:

$$Y = 973,6 - 2,43X_1 - 21,7 X_2 + 13,2 X_3 + 83,3 X_4 + 8,74 X_5 - 4,0 X_6 - 0,8 X_7; \quad R^2 = 0,70 \quad (1)$$

where

X<sub>1</sub> was the proportion of rural population in the region, %;

X<sub>2</sub> was the level of rural unemployment, %;

X<sub>3</sub> was the weight of agriculture in the GRP, %;

X<sub>4</sub> was the yield on fixed capital, rub./rub.;

X<sub>5</sub> was the share of agricultural entities and farms in agricultural output, %;

X<sub>6</sub> was the share of animal farming in gross agricultural output, %;

X<sub>7</sub> was the gross regional product per capita, thousand rub.

The profitability indicators are very meaningful in understanding the reasons behind the lack of resources for developing unfavorable regions but they should be better discussed separately and excluded from the model.

A separate model was calculated for the factors of development of unfavorable regions in the European Russia:

$$Y_a = 798,4 + 14,1X_1 - 33,0X_2 - 8,0 X_3 + 0,3 X_4 + 27,2X_5 - 17,4X_6 - 2,1X_7; \quad R^2 = 0,93 \quad (2)$$

The coefficient of determination R<sup>2</sup> in model (2) turned out to be very high at 0.93, which means this model can be used with sound precision to forecast the influence of structural and institutional factors on the economic development of agriculture in disadvantaged regions in the European Russia; similar regions of Siberia and the Russian Far East should be discussed separately.

A comparison of the parameters of models (1) and (2) shows that the structural and institutional factors have considerable influence over the level of development of unfavorable regions. In both cases, the variables corresponding to the share of agricultural entities and farms in gross agricultural output (X<sub>5</sub>) and the yield on fixed capital in the sector (X<sub>4</sub>) have positive coefficients, which indicates that, with growing share of large and medium producers, the yield on capital and labor productivity in agriculture are also rising in unfavorable regions. This result has important pragmatic implications and confirms the need to intensify efforts in institutional transformations and transition from large market-oriented household husbandries toward farms equipped with contemporary machines and tools ([Shabanov, 2018](#)).

Both models show negative coefficients with the variable of rural unemployment (X<sub>2</sub>), which implies a stable negative relation between the share of the unemployed in the total rural population and labor productivity in agriculture. This shows that all efforts to expand employment in agriculture also have positive impact on the sector.

Also negative are the coefficients with the share of animal farming in the overall agricultural output (X<sub>6</sub>); combined with low profitability in the sector (Table 1), this means additional support is required specifically for innovation-led development of animal farming.

The variable describing the weight of agriculture in the GRP for the region (X3) appears with positive or negative coefficients in different models, which implies the regional economic structure may have different impact on the development of agriculture for different groups of regions.

## 4. Conclusion

The conducted study has confirmed the hypothesis that the level of development in the regions with prevalent unfavorable areas for agriculture is better where structural and institutional factors are more active, apart from the buildup of tangible and human capital. A potential application of regression models is also shown in calculations of the impact of individual structural and institutional factors, such as fostering the replacement of traditional household husbandries by farms equipped with modern fixed capital. The influence of efforts to expand rural employment on labor productivity in agricultural production in unfavorable regions is also demonstrated.

An economic analysis showed the existence of several geographical groups among the unfavorable regions. Regression model solutions for various combinations of the groups confirmed the differentiation of unfavorable regions in three groups: namely, the European Russia, the Eastern part (Urals, Siberia, the Far East), and northern subpolar regions with developed mining industry. Each group of regions calls for specific individual strategies of transition to sustainable development of rural territories unfavorable for agriculture, with the aim to improve rural employment and income levels.

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## References

- Blinova, T., Markov, V. and Rusanovskiy, V. (2015). Youth Unemployment in Russia: Models of Interregional Differentiation. *Regional Formation and development studies*. 1((15)): 7-17.
- Bobylev, S. N. and Khodzhaev, A. S. (2004). *Ekonomika prirodopol'zovaniya [Economics of Natural Resource Management]*. INFRA-M: Moscow. 501.
- Federal Law No, -. F. (2006). On agricultural development. Available: [www.consultant.ru](http://www.consultant.ru)
- Frisvold, G. and Kuhn, B. (1999). *Global environmental change and agriculture. Assessing the impacts*. Cheltenham, UK: Edward Elgar Publishing.
- Heal, G. (1998). *Valuing the future. Economic theory and sustainability*. Columbia University Press: New York.
- Kuznetsova, O. V. (2016). *Sovremenniy etap regional'noi politiki v Rossii v kontekste zarubezhnogo opyta [Current Regional Policies in Russia against the Background of International Practice]. Problemy regional'nogo razvitiya Rossii. Russkoe geograficheskoe obshchestvo. Ser. "Voprosy geografii" [Issues of Regional Development of Russia. Russian Geographical Society. Problems of Geography Series], Moscow, Izdatel'skii dom Kodeks. Kodeks Publishing House. 134-50.*
- Mantino, F. (2010). *Sel'skoe razvitie v Evrope. Politika, instituty i deistvuyushchie litsa na mestakh s 1970-kh godov do nashikh dnei [Rural Development in Europe. Local Policies, Institutions and Actors since the 1970s till Present]. Monograph. FAO Investment Centre; translated from Italian. Business Media: Rome. 272.*
- Markova, A. L. and Dankova, L. V. (2014). Formy i sposoby gosudarstvennogo regulirovaniya ustoichivogo razvitiya sel'skikh territorii [Forms and Ways of State Regulation of Sustainable Development in Rural Territories]. *Vestnik Voronezhskogo gosudarstvennogo agrarnogo universiteta [Bulletin of the Voronezh State Agricultural University. 228-36.*
- Orders of the Government of the Russian Federation, N.-R. (2017). List of entities of the Russian Federation classified as unfavorable for agricultural production. Available: [www.consultant.ru](http://www.consultant.ru)
- Regulation No. 51 of the Government of the Russian Federation (2015). On establishing criteria for qualifying territories as unfavorable for agricultural production. Available: [www.consultant.ru](http://www.consultant.ru)
- Russian regions. Socioeconomic indicators (2017). *Statistical book. Russian Federal State Statistics Service (Rosstat)*. Moscow. 1402.
- Shabanov, V. L. (2018). Transformatsiya LPKh kak istochnika zanyatosti i dokhodov sel'skogo naseleniya [Transformation of Household Subsistence Husbandries as a Source of Employment and Income of Rural Population], *Ekonomika sel'skogo khozyaistva Rossii [Economics of Russian Agriculture]. 7: 79-84.*
- Vasilchenko, M. Y. (2018). Dinamika proizvodstva zhivotnovodcheskoi produktsii v regionakh, neblagopriyatnykh dlya vedeniya sel'skokhozyaistvennogo proizvodstva [Trends of Animal Farming Production in Regions Unfavorable for Agricultural Production]. *Regional'nye agrosistemy: ekonomika i sotsiologiya [Regional Agricultural Systems: Economics and Sociology]. Yearbook, 1. Available: <http://www.iagpran.ru/datas/users/f09df00b3875bc0aa742e4b3cbf5cc37.pdf>*
- Zinchenko, A., Ukolova, A. and Demichev, V. (2013). Sravnitel'naya otsenka regionov Rossii s neblagopriyatnymi usloviyami vedeniya sel'skogo khozyaistva [Comparative Assessment of Russian Regions with Unfavorable Conditions for Agriculture]. *Ekonomika sel'skogo khozyaistva Rossii [Economics of Russian Agriculture]. 2: 20–26.*