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Spatial and Sectoral Development of the Region Based on the Development of Agro-Industrial Territorial and Supply Chain Management in Economic Systems

L.E. Krasilnikova[*1],

[1] FSBEI HE "Perm State Agro-Technological University named after Academician D.N. Pryanishnikov", Perm, Russia

Abstract. Nowadays there is an urgent need for accelerated development of agricultural industry in Russia. The solution of agro-industrial complex management tasks puts forward the problem of agricultural production reserve growth determination in each of the regions of Russia as one of the most urgent ones. The purpose of the study is to develop evaluation methodology and evaluate agro-industrial territorial-economic systems that have a significant production potential of agricultural sectors in the regions of the Russian Federation. The author justifies the choice of indicators and evaluation criteria. The study was based on economic and mathematical modeling of empirical spatial data, calculated on the basis of official statistical information within the Russian Federation regions. The study made it possible to identify the factors that directly determine the production volumes in agriculture, suggest the use of high quality scenario models to describe this influence, prove that the economics of the regions under review did not reach saturation with agricultural products and there are significant reserves for their further progressive development. The developed scenarios and forecast estimates are effective tools to analyze the development of agricultural sectors, and can also be used as management tools that allow to assess the efficiency of available resource use in agriculture of each of the considered agro-industrial territorial-economic systems. The results of the study have scientific and practical significance. They can be used in research and monitoring of agricultural development in the regions, determining the resource requirements necessary for the development of agricultural industries, the development of sectoral and integrated projects and agriculture development programs.

Keywords: scenario analysis, branches of agriculture, agro-industrial territorial-economic systems, supply chain management, forecast, resulting indicator.

1. Introduction

In modern conditions, the tasks of food security provision in the Russian Federation, the import substitution of the main types of agricultural products, raw materials and foodstuffs, and the sustainable development of rural areas require a qualitative improvement of the established management system. The scientific literature devoted to this issue, offers various approaches, which, in our opinion, are narrowly disciplined as a rule [1, 2, 12]. In this regard, there is a need to develop an integrated methodological approach, which is based on strategic measures, taking into account the mechanism of their implementation [14]. Successful implementation of this approach cannot be achieved without the development of an institutional environment that ensures effective intrasectoral, intersectoral integration and production specialization of agro-industrial territorial-economic systems (hereinafter - ATES) in the regions of the Russian Federation. The ATES is an intraregional territorial system that unites rural territories, the evolution of the institutional environment and the peculiarities of the agroindustrial activity that formed the historically established local structure and the specificity of reproduction processes.

During the 90-ies of the XX-th century with the elimination of the planned economy the market system of organizational and economic relations was developed in the Russian agro-industrial complex (AIC), characterized by increasing integration processes in the world economy and related trends of main indicator reduction (acreage, livestock of

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agricultural animals, milk production and milk-containing products, etc.), the reduction of land reclamation activities, mass bankruptcy and, thus, the liquidation of agricultural enterprises, the decrease of population life level and quality in non-urban territories [3,4].

In the 2000-ies, the state prioritized the development of the agro-industrial complex and the regulation of agricultural product markets, which led to some positive results. Thus, the implementation of national projects in the agricultural sector has provided some success in the poultry and pig breeding industries [5,6]. In 2017, the supply of agricultural products abroad exceeded $ 20.0 billion [8]. In terms of wheat exports, the country occupied the leading position in the world. But at the same time, the enthusiasm for the export of grain reduces the volume of fodder production, which leads to the decrease of cattle meat and milk production [9].

At the same time, the attitude to the agro-industrial sector as a secondary sector of the economy, the lack of well-developed theoretical and methodological approaches, not always justified enthusiasm for institutional changes and foreign experience copying without taking into account local specifics reduce the effectiveness of managing the development of agro-industrial territorial-economic systems [14,15,16, 17.18].

The acuteness of the indicated problem is aggravated by modern economic realities and the resulting discrepancy between the institutional environment and the implemented management solutions [11,12,13]. Therefore, we need both new managerial decisions, as well as updated criteria, and parameters of agro-industrial complex development at various territorial levels and in the sectoral context.

2. Research Method

The relevance of the methodological base study to manage the development of agro-industrial territorial-economic systems in modern conditions within the framework of the Russian Federation state policy implementation for food security and import substitution is determined by the need to develop appropriate strategic trends, improve intra-industrial and inter-industrial relations based on intra-regional municipal integration.

Based on the strategic approach to the region development as a whole, and individual territories, in particular, enshrined in the law of June 28, 2014 No. 172-FL "On Strategic Planning in the Russian Federation", we propose the following methodology to assess the development of ATES (Figure 1).

The sequence of actions provides for procedures based on systematized basic parameters of ATES development in the following areas: food security and sustainable rural development.

- 1. Collection and processing of source statistics. Formation of information by criteria, selection and justification of indicators. Formation of information by criteria, selection and justification of indicators.
- 2. Transformation of data, which describe the development of ATES.

- 3. Scoring of the results obtained by indicators
- 4. Calculation of the final integral and total indicators

- 5. Consideration of theoretical and practical results arising from the analysis and the possibilities of their use, the development of ATES strategies
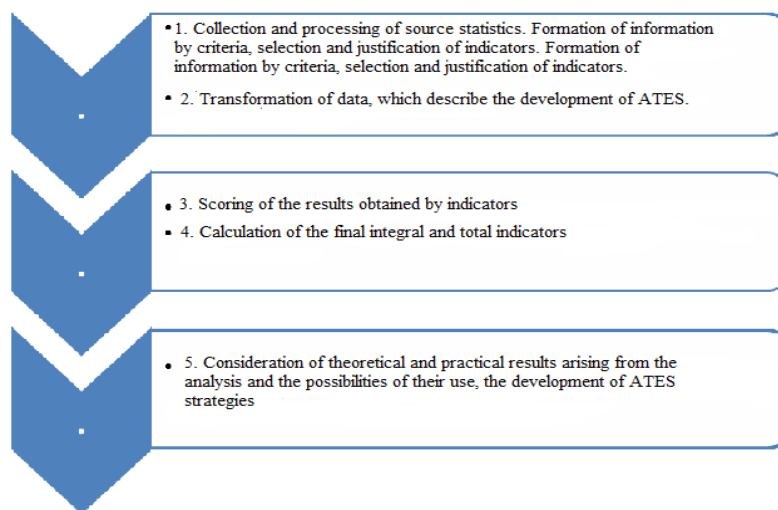
Figure 1 - ATES development evaluation methodology

At the first stage, they perform the collection and processing of statistical data on selected rural areas. During the determination of the general summary, all the objects under study (municipal areas) are divided into homogeneous typical groups (ATES) (by territorial criterion). They determine the criteria for ATES development evaluation, as well as the indicators reflecting these processes. The following blocks of indicators are proposed for the study:

1. Sustainable rural development;

2. Food security (including import substitution).

Blocks are selected for ATES specifically, in terms of value for agro-industrial activities. The indicators of these blocks can be changed and expanded in the process of regional and inter-municipal administration improvement. Indicators are selected for each block and presented in Table 1.

Table 1. Blocks and indicators of ATES development

Block	Indicators	Measurement un.
1. Sustainable rural development	The length of local public roads owned by municipalities at the end of the year (with hard surface).	Km
	Current (operational) costs for environmental protection, including the payment for environmental protection services.	thous. rub.
	Average number of workers of the in agrarian and industrial complex.	men
	Average monthly wage for the workers of agrarian and industrial complex.	rub.
2. Food Security (including import substitution)	Agricultural products (in actual prices).	thous. rub.
	Agricultural production index (in comparable prices);	as the percentage of the previous year, percent

* The table was compiled by the author based on his own research.

At the second stage of the methodology, the average dynamics indicators for the study period, the level of ATES development, as well as the total APEC indicators are calculated. The level of ATES development is calculated by the following formula:

$$U_{атэс} = \sum \frac{Срд}{Ср} \qquad \text{, where} \qquad (1)$$

$U_{атэс}$ – ATES development level,

Срд – average dynamics of the indicator,

Ср – average level of the indicator.

At the third stage, the scoring is made in accordance with the obtained values and the scale for each ATES (Table 2).

Table 2. ATES criteria and indicators: Rating Scale

Indicators	Indicator value (meas. un.)	Rating scale from 0 to 10 with the increment of 2,5 (meas. un.)
The length of local public roads owned by municipalities at the end of the year (with hard surface).	(km) from 0 to 1000	(km) 2,5: to 300 5: from 300 to 400 7,5: from 400 to 5000 10: above 5000
Average number of workers of the in agrarian and industrial complex.	(men) from 0 to 2200	(men) 2,5: to 100, 5: from 100 to 500, 7,5: from 500 to 1000, 10: above 1000)
Average monthly wage for the workers of agrarian and industrial complex.	(rub.) from 0 to 23 000	(rub.) 2,5: to 5000, 5: from 5000 to 10000, 7,5: from 10000 to 15000, 10: above 15000
Current (operational) costs on environmental protection, including the payment for environmental protection services.	(thous. rub.) from 0 to 400 000	(thous. rub.) 2,5: to 1000, 5: from 1000 to 10000, 7,5: from 10 000 to 20000, 10: above 20000
Agricultural output (at actual prices).	(thous. rub.) from 0 to 5 800 000	(thous. rub.) 2,5: to 100000, 5: from 100000 to 500000, 7,5: from 500000 to 1000000, 10: above 1000000
Agricultural production index (in comparable prices).	as the percentage of the previous year, from 90 to 105	(as the percentage of the previous year) 2,5: to 90, 5: from 90 to 100, 7,5: from 100 to 105, 10: above 105

* The table was compiled by the author based on his own research

During the fourth stage, they calculated the total score for all indicators, for which the 10-point scale is used.

During the fifth stage of our methodology application, the practical results obtained allow us to develop the strategic trends for the development of ATES.

The proposed approach to agro-industrial territorial and economic system level evaluation differs from those previously used according to the following parameters:

- complexity - includes the criteria for various development parameters: food security, import substitution, sustainable development of rural areas, which allows a more optimal and adaptive response to economic condition changes;

- indicators, parameters and criteria for ATES development can be easily adjusted by changing the production and economic disposition of the regional AIC;

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- a single scale of delimitation allows the method for any regions and territories, to form a package of relevant agrarian policy measures on its basis.

3. Research Tests Results

In accordance with the proposed methodology, we estimated the level of ATES development in the Perm Territory during 2011-2017.

The total number of studied objects of each typical group (ATES) was the combination of 28 rural areas. They determined the criteria for assessing the development of ATES, as well as the indicators reflecting these processes over 6 years.

4. Limited Time Interval

The time period is limited by:

1) the year 2011, since this is the last year before the accession of the Russian Federation to the WTO and the onset of new economic conditions;

2) the year 2017 since this is the last year of the Rosstat indicators.

The analysis of the achieved level of agro-industrial activity efficiency, the dynamics of the agro-industrial complex development indicators in the Russian Federation on the average, the factors and climatic peculiarities allowed us to offer the scores for specific ATES of the Perm Territory taken for their development assessment procedures.

Based on the calculated total scores for all indicators, the results were obtained and shown in table 3.

Table 3 - The scale of the predicted values for ATES development in the Perm region

Levels / Value	Depressive level	Problematic level	Stable level	Leading level
Unified scale	Up to 18,0	from 18 to 25,0	from 25 to 30,0	above 30,0
ATES Development Level Indicator	16,88	19,38	27,92; 26,97	33,75
ATES of the Perm Region	Northeast ATES	Northwest ATES	Western ATES; South ATES	The ATES of Perm agglomeration (central)

The results of the assessment by the proposed methodology allowed us to determine the development levels of ATES in the Perm Territory.

Depressive level. This category includes the territory of the Northeast ATES.

Problematic level. This category includes the territory of the North-West ATES.

Stable level. This category includes the territories of Western and Southern ATES.

Leading level. This category includes the ATES territory of the Perm agglomeration.

All studied ATES of the Perm Territory showed a different level of development over the studied period. This is explained by the fact that in 2012-2017, the most significant indicator for the development of the economy by the volume of agricultural production did not show a stable positive trend in all studied ATES of the Perm Territory.

Thus, the South ATES, Western ATES and the ATES of Perm agglomeration, demonstrate the success of

program implementation for agro-industrial activity and sustainable development support for rural areas against the background of the food embargo imposed by the Russian Federation on a number of countries. These are the positive aspects of modern economic conditions and starting opportunities to increase the efficiency of agricultural production not only of the country as a whole, but also of such a difficult region for agricultural activity as the Perm Territory.

At the same time, negative trends in the agro-industrial complex of the Northeastern and North-Western ATES persist for 25 years, as well as the negative trends of the Komi-Perm Autonomous District separation as an independent subject of the Russian Federation.

Multidirectional tendencies at this stage can be traced across all municipalities that make up specific ATES and confirm that the differentiation of territories according to the proposed approach is objective, allows us to identify the territories and industry leaders most optimally to which incentives for agrarian production of state support should be directed in all variations. Besides, the differentiation of territories is in demand as a frame-forming linking position of regional strategies for agro-industrial complex development and the sustainable development of rural territories [7].

The obtained results reflect the dynamics of ATES development for the analyzed period, as well as the established reproduction processes of the agro-industrial complex in these territories.

The diversity of threats and opportunities, ATES potentials and development risks significantly increase the importance of monitoring and forecasting tools that ensure coordination of the state and regional agrarian policy and the agrarian business, to which we also include the rural population involved in agricultural activities in the form of private farms. Without the smooth running and improvement of such tools, the end-to-end consistency in agro-industrial complex management, including the implementation of strategies and targeted programs, will be substantially limited and not comprehensive, and the mechanism of adaptation and institutional support will not be complete.

It is impossible not to note the importance of monitoring for the implementation of forecasting development.

Naturally, the development of a specific ATES depends not so much on the level of forecasting, but on the complex of factors and the existing structure of the production system, the characteristics of which reflect stability and adaptation to changes in environmental conditions.

They propose scenario conditions for management system improvement of the agroindustrial complex and rural areas, which make it possible to give predictive estimates of development using the example of the Perm Territory by 2030. The period up to 2030 corresponds to the terms of measures on agro-industrial complex competitiveness increase in the framework of the strategy for the socio-economic development of Russia until 2030. Forecast data are calculated on the basis of trend extrapolation.

4.1. Scenario 1

The first scenario assumes the preservation of state policies focused on food security provision, the import substitution of the main types of agricultural products and foodstuffs, as well as on the sustainable development of rural areas. The tasks of own agricultural product competitiveness increase during the implementation of this scenario necessitate the large-scale use of innovative production and processing technologies, orient the industry to the intensification of production processes.

At this scenario, the key function of state and municipal government is the greatest possible support for farmers in all aspects of socio-economic development. They provide for the priority of agrarian policy, the empowerment of the relevant governing bodies, the regulation of agricultural product exports. On this basis, a promising trend for management improvement is the increase of intra-industrial and inter-industrial cooperation, including the form of ATES inter-municipal government bodies. Putting into practice the management of these structures should proceed in the context of strategic and programmatic trend implementation for the development of the agro-industrial complex of the Russian Federation and the regions. The probability

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of such condition development is taken by us as 0.65 and is based on the analysis of modern condition and trend factors in the socio-economic development of the country and regions.

Since this scenario is very fruitful for ATES at the leading and sustainable levels of development, taking these scenario conditions, we can assume not only the preservation of the main indicator dynamics in recent years, but also its growth. In ATES on the areas with a modern depressed and problematic level of development, the expected dynamics of indicators will also demonstrate positive dynamics, which will ensure the transition of ATES to the corresponding matrix quadrants (Table 4).

Table 4 – ATES development forecast for the Perm region according to the first scenario

ATES	Length of public roads of local importance, km		Current expenses for environmental protection, thousand rubles		Agricultural products, thousand rubles		Agricultural production index, %		The average number of employees in the agro-industrial complex, pers.		Average monthly wage of workers in agroindustrial complex, rub.	
	2017	Predicted value by 2030	2017	Predicted value by 2030	2017	Predicted value by 2030	2017 and 2016	Predicted value by 2030 and 2017	2017	Predicted value by 2030	2017	Predicted value by 2030
ATES of Perm agglomeration	1489	3374	391036	628695	9938026	9992496	102	123	2971	6077	15592	22608
Northwest ATES	1181	1622	241	241	2343039	2732627	99	117	1433	1433	9718	16520
Western ATES	1718	3052	46841	68907	5714335	8423092	82	147	3403	3403	13444	21511
Northeast ATES	1382	2139	143483	186998	1846075	1846075	91	100	1242	1242	9296	13014
South ATES	5677	11463	505984	887399	16869282	22051182	102	131	8289	8289	10796	21484

4.2. Scenario 2

The second scenario allows for the restoration of the liberal course on the integration of domestic agriculture in the global space, the improvement of market mechanisms and free competition with imported goods.

Significant investments are needed from foreign and Russian investors for the effective development of the agro-industrial complex under this scenario with the emphasis on the development of new markets, the formation of large agroholdings and the consolidation of resource potential. Thus, the decisive role will be played by foreign capital and technological dependence, as well as by the professional level of participants in reproduction processes. The probability of such condition development is taken by us as 0.35 and is also based on the results of the study.

Due to not the most favorable conditions for agricultural activities and trends in the development of the economy of the Perm region under this scenario, the prospects for inter-municipal cooperation are reduced. Besides, the competitiveness of local agricultural producers is rapidly falling.

Thus, the ATES of Perm agglomeration, concentrating processing enterprises (using also imported raw materials) and suburban farms, is likely to retain its strategic position.

Western ATES will reduce the main indicators of development, but will maintain its position. At the same time, the rest of the ATES may move to the level of territories with depressed and problematic level of development (Table 5).

Table 5 – The forecast of ATES development in the Perm region under the second scenario

ATES	Length of public roads of local importance, km		Current expenses for environmental protection, thousand rubles		Agricultural products, thousand rubles		Agricultural production index, %		The average number of employees in the agro-industrial complex, pers.		Average monthly wage of workers in agroindustrial complex, rub.	
	2017	Predicted value by 2030	2017	Predicted value by 2030	2017	Predicted value by 2030	2017 to 2016	Predicted value of 2030 by 2017	2017	Predicted value by 2030	2017	Predicted value by 2030
ATES of Perm agglomeration	1489	1489	391036	391036	9938026	9938026	102	100	2971	2971	15592	15592
Northwest ATES	1181	1181	241	241	2343039	2085306	99	91	1433	1275	9718	12000
Western ATES	1718	1718	46841	46841	5714335	5085758	82	92	3403	3028	13444	12000
Northeast ATES	1382	1382	143483	143483	1846075	1643007	91	89	1242	1105	9296	12000
South ATES	5677	5677	505984	505984	16869282	15013661	102	94	8289	7377	10796	12000

We have evaluated the proposed ATES development scenarios of the Perm Territory based on the analysis of the forecast values for key socio-economic indicators and the assumption that the probability of the first scenario is 0.65; the second option is 0.35 by applying quantitative probability estimates. In this case, each variant (scenario) — the pessimistic, the most likely and the optimistic — has the probabilities of their implementation. The assessment was made using the scale from -10 to 10 points, depending on possible deviations of the predicted indicators (table 6).

Table 6 - The assessment of the proposed ATES development scenarios for the Perm Territory by 2030

ATES of Perm Region	Scenario 1 (probability - 0,65)	Scenario 2 (probability - 0,35)
ATES of Perm agglomeration	8	6
Western ATES	6	5
South ATES	6	5
Northwest ATES	5	3
Northeast ATES	5	3
Scenario Evaluation	19,5	7,7
	More favorable	Less favorable

The evaluation of the proposed scenarios was made according to the following formula:

$$Oc = \sum Pi * Aj \quad \text{, where} \qquad (2)$$

Oc - scenario evaluation;

Pi – probability of scenario condition development i;

Aj – the score of the scenario impact on the development of the object under study j.

In this case, the possible error of the presented forecast estimates is the following:

- a limited number of indicators that meet the criteria for food security, import substitution, sustainable rural development at the level of municipal statistics;

- modern conditions of economic uncertainty;

- the initial data errors, which may be related to the inaccuracy of economic measurements and the quality of the information provided by the municipal management bodies. In particular, the relative data underlying the calculation of the initial statistical indicators in accordance with the methodology of Rosstat (agricultural production index); the sample surveys of household farms and households.

The assessment of the proposed ATES development scenarios for the Perm Territory by 2030 showed that the regions with a polysystem territorial-economic system and risky farming are more prone to the option of the agro-industrial complex development while preserving state policies aimed at food security provision, the import substitution of basic types of agricultural products and food, as well as at sustainable rural development.

5. Conclusion

In terms of scientific and practical recommendations for the systematization of methodological support,

they proposed the toolkit to assess the development of ATES. The evaluation results on the example of the Perm region confirmed the objectivity of the proposed approach and allowed them to be divided into levels: depressive, problematic, stable and leading. The differentiation of territories according to the proposed approach makes it possible to allocate territories and industry-leaders optimally to which the means of state support should be concentrated and directed stimulating agricultural production. Besides, the differentiation is claimed as a frame-forming and connecting position of regional strategies for the development of the agro-industrial complex and sustainable rural development;

- they proposed scenario conditions to improve the mechanism for the adaptation and institutional support management to develop ATES, allowing the provision of forward-looking estimates of development using the example of the Perm Territory by 2030. The implementation of measures for the creation and development of ATES that are fully developed and recommended for practical application will allow to maintain the positive dynamics of the main indicators of the agro-industrial complex in recent years and to ensure its growth under a more favorable scenario. Thus, in the ATES of the Perm agglomeration, the increase of agricultural production index by 2030 will be 23.45%. Under a less favorable scenario, ATES strategic position of the Perm agglomeration is expected to remain. At that, they predict the decline of competitiveness and the transition to the level of territories with depressed and problematic level of development in the rest ATES of the region. In particular, the index of agricultural production in such ATES will decrease from 6 to 11% BY 2030.

Thus, it is substantiated that the variant of the agro-industrial complex development with the preservation of state policy oriented towards food security, import substitution of the main types of agricultural products and food, as well as sustainable development of rural area is more favorable.

The practical value of the result is the ability of the scientific community and government agencies to claim it during the development of the agrarian policy strategic positions of the country and regions, as well as its use by higher educational institutions for educational course development related to the rural economy management.

Acknowledgments

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