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METHODOLOGY FOR MANAGING THE COMPETITIVENESS OF THE REGIONAL AGRICULTURAL SECTOR UNDER CONDITIONS OF SYSTEMIC TRANSFORMATIONS

METODOLOGIA PARA GERENCIAR A COMPETITIVIDADE DO SETOR AGRÍCOLA REGIONAL EM CONDIÇÕES DE TRANSFORMAÇÕES SISTÊMICAS

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Abstract
The purpose of the study is to develop and test a methodology for assessing the competitiveness of the regional agricultural sector and rural areas, taking into account the digitalization factor under conditions of systemic economic transformations. The study employs comparative analysis, an index-based approach, and the method of normalized coefficients. An algorithm for comprehensive competitiveness assessment has been developed, including the calculation of partial, composite, and integral indices based on a set of economic, production, socio-demographic, and digital indicators. The methodology was tested using the example of five leading regions of the Russian Federation in terms of agricultural output. It has been established that the competitiveness of the regional agro-industrial complex is determined not only by financial and economic performance and resource productivity, but also by the level of digital development of the territory. Differentiation of regions according to the integral competitiveness index was identified, which made it possible to determine their strengths and weaknesses across key development factors. It is demonstrated that digitalization acts as a system-forming factor in

Resumo
O objetivo do estudo é desenvolver e testar uma metodologia para avaliar a competitividade do setor agrícola regional e das áreas rurais, levando em consideração o fator digitalização em condições de transformações econômicas sistêmicas. O estudo emprega análise comparativa, uma abordagem baseada em índices e o método de coeficientes normalizados. Foi desenvolvido um algoritmo para avaliação abrangente da competitividade, incluindo o cálculo de índices parciais, compostos e integrais com base em um conjunto de indicadores econômicos, produtivos, sociodemográficos e digitais. A metodologia foi testada usando o exemplo de cinco regiões líderes da Federação Russa em termos de produção agrícola. Foi estabelecido que a competitividade do complexo agroindustrial regional é determinada não apenas pelo desempenho financeiro e econômico e pela produtividade dos recursos, mas também pelo nível de desenvolvimento digital do território. Foi identificada a diferenciação das regiões de acordo com o índice de competitividade integral, o que permitiu determinar seus pontos fortes e fracos em fatores-chave de desenvolvimento. É demonstrado que a

enhancing the efficiency of agricultural production. The proposed methodology expands existing approaches to assessing the competitiveness of regional agriculture by incorporating digital development indicators. The findings may be used in the formulation of regional strategies for the development of the agro-industrial complex and for ensuring food security.

Keywords: Competitiveness. Regional Agro-Industrial Complex. Digital Transformation. Competitive Advantage. Development Strategy.

digitalização atua como um fator formador de sistemas no aumento da eficiência da produção agrícola. A metodologia proposta amplia as abordagens existentes para avaliar a competitividade da agricultura regional, incorporando indicadores de desenvolvimento digital. As conclusões podem ser utilizadas na formulação de estratégias regionais para o desenvolvimento do complexo agroindustrial e para garantir a segurança alimentar.

Palavras-chave: *Competitividade. Complexo Agroindustrial Regional. Transformação Digital. Vantagem Competitiva. Estratégia de Desenvolvimento.*

1 INTRODUCTION

Under conditions of globalization and rapid technological development, regions face challenges related to maintaining and strengthening their competitive advantages. Digital transformation is becoming a crucial factor determining the economic and social development of both urban and rural territories in the regions of Russia. However, the implementation of digital initiatives requires a well-considered approach that takes into account the specific characteristics of each region, its resources, and its potential capabilities.

At present, there is a significant gap between those Russian regions that actively implement digital technologies and those that remain on the periphery of this process. In urban areas, where the level of digitalization is generally higher, innovative industries are developing and the quality of life is improving, which, in turn, attracts investment and highly qualified personnel. At the same time, rural territories in Russia remain relatively isolated, experiencing difficulties in accessing modern technologies and services. This creates a risk of further deepening the socio-economic divide between urban and rural areas, thereby threatening Russia's food security.

Despite growing awareness of the importance of digital technologies, many regions lack a clear strategy for implementing digital solutions that would reflect their unique characteristics. This leads to fragmented efforts, inefficient use of resources, and ultimately, the absence of tangible effects from digital transformation. Therefore, there is

a need to develop a comprehensive approach to the digital transformation of Russian regions that would contribute to the creation of sustainable competitive advantages at both the regional and global levels.

Accordingly, the main research questions are as follows: what conditions and factors contribute to successful digital transformation of urban and rural territories; how digital technologies can be more effectively used to develop regional competitive advantages; and what measures are necessary to reduce disparities between urban and rural areas in the context of digitalization. Addressing these issues will not only enhance regional economic competitiveness but also positively affect social well-being and the quality of life of the population.

Currently, research on digitalization within the paradigm of regional competitiveness tends to focus on the region as a whole, without considering intra-regional differentiation of socio-economic processes between urban and rural areas. Meanwhile, digital transformation processes in rural territories of Russian regions are developing with considerable difficulty and lag significantly behind cities, particularly large agglomerations.

Emphasizing differences between urban and rural territories is therefore an essential aspect of studying digitalization and regional competitiveness. The digital divide between urban and rural areas represents a serious problem, as the accessibility and quality of digital technologies differ substantially across these territorial units. This gap manifests itself in various forms, including access to the Internet, availability of digital infrastructure, opportunities for professional training, and the level of digital literacy among the population.

Research on digitalization that accounts for internal disparities between urban and rural areas makes it possible to develop more effective strategies aimed at increasing regional competitiveness. The key to successful digitalization of rural territories lies in an approach that considers the specific features of each region, thereby ensuring more balanced and even development of digital transformation processes within the regional economy.

Thus, under contemporary conditions, digitalization becomes a primary instrument for enhancing the competitiveness of rural territories and agriculture, including at the regional level. The use of digital technologies allows optimization of

production processes, improvement of access to information, and enhancement of the quality of life of rural residents.

The purpose of this article is to present a methodology for managing the competitiveness of the regional agricultural sector based on digitalization, as well as to analyze the impact of digital technologies on the economic performance of regional agriculture.

2 LITERATURE REVIEW

Currently, an active scientific school is being formed in Russia in the field of digitalization of rural territories and agriculture. This direction is based on global trends and international experience in this complex and contradictory process. Representatives of this field are developing methodologies for managing digital transformation in agriculture.

The scientific school focusing on digital transformation of rural territories aims at integrating modern technologies into the agricultural sector and developing infrastructure. Particular attention is paid to the application of information technologies to increase agricultural production efficiency, optimize management processes, and improve the quality of life in rural areas.

One of the most recent works in this area is the collective monograph “Digital Technologies in Agriculture,” prepared by researchers of the Russian State Agrarian University – Moscow Timiryazev Agricultural Academy [1]. A key idea of the monograph is the emphasis on digital technologies as a fundamental factor in enhancing the competitiveness and efficiency of agriculture. It examines various aspects of information system applications, including data analytics for managerial decision-making, automated production management systems, and modern communication tools to improve coordination among participants of the agro-industrial complex.

One of the central conclusions is the need to create a unified information infrastructure capable of integrating data and processes, thereby ensuring a higher level of management and control throughout the entire cycle from production to distribution. The importance of training and educating personnel capable of effectively working with new technologies and adapting them to real agricultural conditions is also emphasized.

The authors highlight that successful digitalization of agriculture can significantly increase productivity and sectoral sustainability, contributing to both environmental and economic resilience. They strongly recommend greater attention to the integration of digital technologies into the agro-industrial complex, engagement of all key stakeholders, and provision of access to necessary resources and information.

In A.K. Subaeva's monograph "Technical and Technological Modernization of Agriculture in the Context of the Digital Economy" [2], key aspects of modernization of the agricultural sector are examined against the background of digitalization and the pursuit of food security.

Subaeva identifies several directions and problems related to technical modernization in the digital economy. Particular attention is paid to identifying patterns and trends in the agricultural machinery market, as well as to the levels of digital technology implementation – from governmental decisions to local initiatives of agro-industrial enterprises.

The main conclusions emphasize the need to develop a conceptual model for introducing new technologies that considers existing constraints and barriers. These barriers may be financial, organizational, or related to insufficient workforce preparedness and general inertia in adopting innovations within the agricultural sector. It is determined that modernization can only succeed under a comprehensive approach that includes both technical and informational support, as well as active participation of all agribusiness stakeholders. The monograph also stresses the importance of cooperation among science, business, and government in implementing breakthrough innovation strategies and high technologies.

The monograph by M.A. Zhukova and A.V. Ulezko, "Prospects for Digital Transformation of Agriculture" [3], explores key aspects and processes associated with the introduction of digital technologies into the agricultural sector. The authors emphasize that the digital economy represents not merely a set of high technologies, but a new quality of economic relations, requiring reconsideration of traditional approaches to agricultural management.

The main conclusions underline the importance of institutional conditions for successful digital transformation. The authors analyze factors that either facilitate or hinder digital development, including infrastructure development, technology

accessibility, availability of qualified personnel, and financial resources. The monograph also examines the state of informatization in Russian agriculture, analyzing current trends and challenges faced by agricultural producers.

One of the central ideas is the need to establish a digital platform for the agro-food complex that would integrate various aspects of sectoral activity and ensure interaction among market participants. The authors argue that without such a platform, effective data integration and operational efficiency are difficult to achieve.

While digitalization of agricultural production has been studied extensively at the national level, certain aspects of digital transformation at the regional level remain insufficiently explored. For a country such as Russia, the regional dimension of agricultural production is particularly significant. Regions of the Russian Federation differ considerably in climatic, financial, labor, and other production conditions. Digital technologies, including big data applications, can help Russian regions identify the most advantageous agricultural specialization. Under conditions of strong territorial differentiation, the development and implementation of effective organizational and economic mechanisms for managing agricultural specialization of economic regions and constituent entities of the Russian Federation become a priority for the further development of the national agro-industrial complex.

The implementation of regional agricultural digitalization projects should ensure [4, p. 8]:

– increased efficiency of agricultural land use;
– optimization of interaction processes with economic entities and interdepartmental coordination through electronic document management;
– reduction of paper-based workflow and shorter timelines for providing state support;
– training of specialists to work effectively with innovative digital technologies;
– monitoring of agricultural animal movement;
– increased transparency of veterinary and sanitary inspections and ensuring proper labeling and accounting;
– traceability of agricultural products during production, circulation, and transportation throughout the country;
– automation of production processes, reduction of labor costs, and minimization of

risks associated with imported software.

According to several authors [5], a key problem in the digital transformation of rural territories is insufficient attention to rural digital development within state policy. The lack of reliable statistics and data on rural digitalization prevents objective assessment of digital development levels. Consequently, the development of methodologies for assessing rural digitalization in Russian regions is constrained by the insufficient formation of an adequate statistical base.

Based on the above, it is evident that digital transformation is becoming a key factor in the competitiveness of rural territories and agriculture in Russian regions. Significant contributions to the methodology for assessing regional agricultural competitiveness have been made by Borel A.N. [6], Dorzhieva E.V., Dugina E.L. [7, 8], Martynov K.P. [9], Pechertseva O.N. [10, 11], and Khuazheva A.Sh. [12], among others. However, the digital paradigm necessitates consideration of digital competitiveness within the methodology for assessing and managing the competitiveness of the agro-industrial complex, including at the regional level. The degree of digitalization of the agricultural sector is becoming a crucial factor ensuring competitive development of regional agro-industrial systems. Accordingly, further development of the methodology for managing regional agro-industrial competitiveness will be shaped by digitalization and the recognition of this factor as a key competitiveness criterion within the emerging sixth technological paradigm.

The conducted research demonstrates that the competitiveness of regional agriculture depends on numerous factors and conditions. In addition to the quality and price of agro-food products and the achieved level of sectoral digitalization, competitiveness is influenced by labor force reproduction in rural areas, availability of skilled and able-bodied personnel, price disparity between agriculture and industry, development of production infrastructure, labor productivity, access of agricultural producers to markets, and other factors.

3 METHODS

The author's conceptual framework for studying the competitiveness of regional agriculture is based on a consistent analysis not only of the efficiency level of agricultural production in the region and its competitive positions in agro-food markets, but also of the economic conditions of operation and the level of digitalization of economic entities within the regional agricultural sector, which stimulate the formation of competitive agricultural producers in the region.

In this context, the competitiveness of regional agriculture is understood as the aggregate of the most significant advantages of regional agricultural production over other territories, ensured through the digitalization of economic processes, a high level of socio-economic development, and favorable economic conditions for agricultural functioning within the region.

Based on the conducted analysis of theoretical and methodological approaches to the study of competitiveness, as well as the specific features of agricultural production, an algorithm for assessing the competitiveness of regional agriculture was developed. The algorithm consists of three stages:

– selection of a group of regions for analysis;

– calculation of partial indicators, composite indices, and an integral index according to the author's methodology;

– interpretation of the obtained results (Table 1).

Table 1

Algorithm for Comprehensive Assessment of the Competitiveness of the Regional Agricultural Sector, Including Digitalization Indicators

№	Stage Description	Sequence of Actions
1.	Selection of a group of regions based on specific criteria (specialization, territorial, natural-climatic, etc.) and analysis of the current state of agricultural production in these regions.	At this stage, regions are grouped (by federal districts, economic regions, etc.), and a general assessment is conducted according to the following indicators: gross agricultural output, level of digitalization of production processes, financial condition of the agricultural sector, specific features of crop and livestock production, etc.
2.	Calculation of indicators characterizing individual aspects of agricultural development and enabling quantitative assessment of regional agricultural	At this stage, partial indicators, composite indices, and the integral competitiveness index are calculated for all evaluated regions. Based on the results, key conclusions are drawn and a set of

	competitiveness based on a comprehensive approach.	measures (strategies, concepts, roadmaps) is developed to enhance the competitiveness of the regional agricultural sector, taking into account identified strengths and weaknesses.
3.	Interpretation of the results of the competitiveness analysis and formulation of conclusions.	At this stage, partial indicators, composite indices, and the integral competitiveness index are interpreted, and final conclusions are formulated.
4.	Development of recommendations and proposals for further development of rural territories and regional agriculture based on the current competitiveness assessment.	A set of measures (strategies, concepts, roadmaps) aimed at increasing the competitiveness of the regional agricultural sector is developed based on identified strengths and weaknesses.

Source: author's development

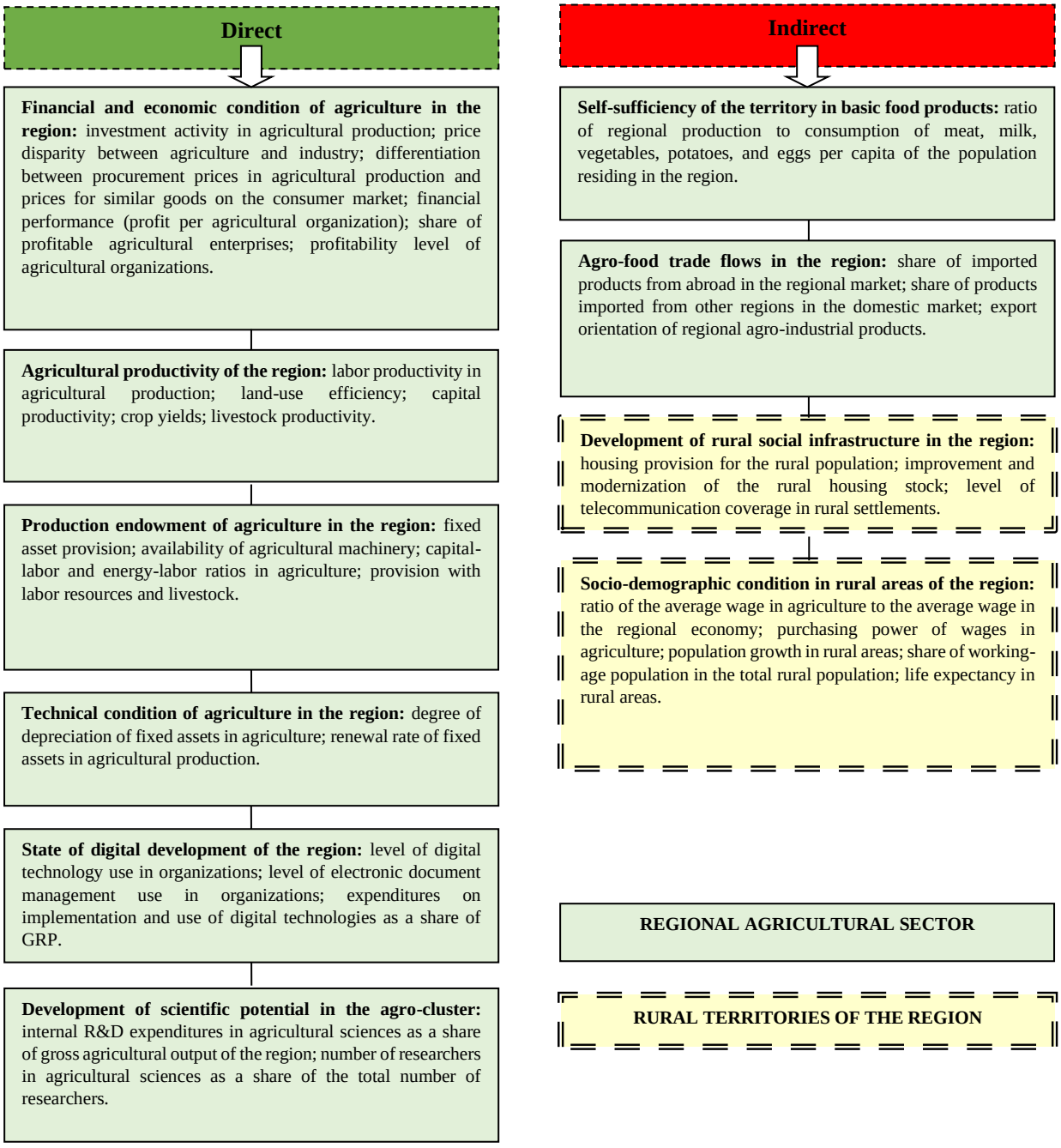
To compile a ranking of the competitiveness of the regional agricultural sector, we propose the use of the index method, which allows grouping partial competitiveness indicators and identifying factors that either constrain or stimulate effective agricultural development.

In order to determine the components of the indices reflecting the level of development and competitiveness of agricultural production in a region, it is first necessary to define a set of indicators that will be taken into account in assessing regional agricultural competitiveness. An important condition for constructing an index that most accurately reflects the competitiveness of agriculture in a given region is the selection of adequate indicators. These indicators should comprehensively reflect competitiveness criteria and key competitive advantages, assess the progressiveness of the sectoral structure, and be statistically available and objective.

The system of key indicators of regional agricultural competitiveness proposed in this study consists of indirect indicators – which do not directly influence competitiveness (or influence it insignificantly) but signal its changes – and direct indicators – which exert a direct impact on competitiveness. The system includes the following indicators (Figure 2).

Figure 1

Indicators for Assessing the Competitiveness of the Regional Agricultural Sector and Rural Territories



Source: author's development

Thus, the proposed model for assessing the competitiveness of the regional agricultural sector takes into account the most significant indicators of regional agricultural competitiveness under contemporary economic conditions, including such a

key factor as the achieved level of digital development of the region.

After calculating each competitiveness indicator (Figure 2), a system of analytical tables is formed for the group of evaluated regions. The partial indicators are then aggregated using the method of normalized coefficients. The essence of the normalization method consists in converting indicators measured in different units (kilograms, percentages, etc.) into values ranging from 0 to 1 (where 0 corresponds to the worst result and 1 to the best result).

If a higher value of the indicator corresponds to a better result (i.e., the region should increase this indicator), the following formula is applied:

$$\overline{X} = \frac{X_{ij} - X_{min\,i}}{X_{max\,i} - X_{min\,i}} \qquad (1)$$

where:

X_{ij} - is the value of the i-th indicator for the j-th region,

$X_{min\,i}$ - is the minimum value of the i-th indicator among the analyzed regions,

X_{max} - is the maximum value of the i-th indicator among the analyzed regions.

If a lower value of the indicator corresponds to a better result, the following formula is used:

$$\overline{X} = 1 - \frac{X_{ij} - X_{min\,i}}{X_{max\,i} - X_{min\,i}} \qquad (2)$$

After calculating all partial indicators and composite indices, and taking into account the weight coefficients determined by the authors, the integral competitiveness index of the region is calculated as follows:

$$IK_i = 0{,}12I_{FESi} + 0{,}13I_{PRi} + 0{,}1I_{OPi} + 0{,}1I_{TPi} + 0{,}03I_{SDSi} + 0{,}05I_{RSIi} + 0{,}09I_{SPPi} + 0{,}1I_{TSi} + 0{,}18I_{DDRi} + 0{,}1I_{RNPi} \qquad (3)$$

where:

IK_i - integral competitiveness index of agriculture in the i-th region; — index of financial and economic condition of agriculture in the i-th region;

I_{PR_i}— productivity index in agriculture of the i-th region;

I_{OP_i}— index of agricultural production equipment and resources in the i-th region;

I_{TP_i}— index of agro-food commodity flows in the i-th region;

I_{SDS_i}— index of socio-demographic conditions in rural areas of the i-th region;

I_{RSI_i}— index of rural social infrastructure development in the i-th region;

I_{SPP_i}— index of self-sufficiency in basic food products in the i-th region;

I_{TS_i}— index of technical condition of agriculture in the i-th region;

I_{DDR_i}— index of digital development of the i-th region;

I_{RNP_i}— index of development of the scientific research potential in agriculture in the i-th region.

Considering that each of the ten composite indices, including the integral index, ranges from 0 to 1, four competitiveness groups are distinguished (Table 2).

Table 2

Classification of Regions by Level of Agricultural and Rural Competitiveness

Group No.	Group Name	Competitiveness Index Range
I	Highly Competitive	0,75-1,00
II	Above-Average Competitive	0,50-0,74
III	Moderately Competitive	0,25-0,49
IV	Low Competitive	0,00-0,24

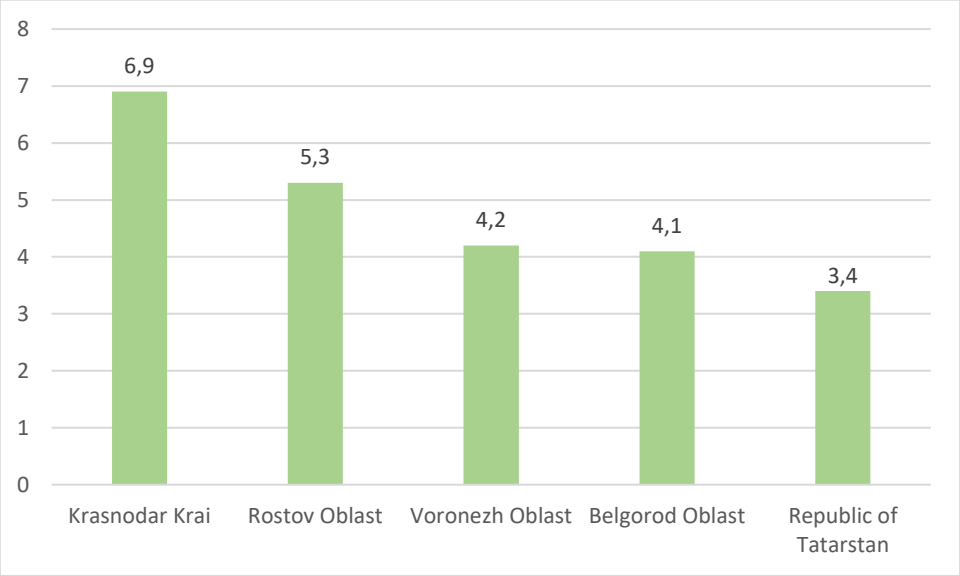
Thus, the developed methodology for assessing the competitiveness of the regional agricultural sector enables a comprehensive analysis of the competitive status of the regional agricultural industry and makes it possible to identify factors constraining the growth of competitiveness in agricultural production and rural territories. The results obtained using the author's methodology may be applied in the development of practical recommendations aimed at enhancing agricultural competitiveness in the regions of the country, including in the strategic planning of regional agro-industrial development.

4 RESULTS AND DISCUSSION

As part of the study, the competitiveness of the agricultural sector of the economy was assessed for five leading regions of Russia in terms of agricultural output in 2023: Krasnodar Krai (1st place – 6.9% of national output in 2023), Rostov Oblast (2nd – 5.3%), Voronezh Oblast (3rd – 4.2%), Belgorod Oblast (4th – 4.1%), and the Republic of Tatarstan (5th – 3.4%) (Figure 3). In total, these regions accounted for 24% of Russia's gross agricultural output in 2023. Thus, these regions form the core of Russia's agro-industrial complex, providing one quarter of the country's total agricultural production.

Figure 3

The five largest agricultural-producing regions in Russia in 2023, as a percentage of total national output



A comparative analysis of the competitiveness of the selected regions begins with the financial and economic condition index (the initial data for the calculation are presented in Table 3).

Table 3

Calculation of the Financial and Economic Condition Index for the Agricultural Sector of the Regions under Study (2023)

Region	Investment activity (fixed capital investment in agriculture per 1 ha of agricultural land), thousand RUB	Price disparity between agriculture and industry	Profitability of sales in livestock production, %	Profitability of sales in crop production, %	Share of loss-making organizations, %	Financial and economic condition index
Belgorod Oblast	8,837	1,097	28,9	36	11,9	0,967
Voronezh Oblast	8,469	0,964	26,1	43,2	15,2	0,714
Krasnodar Krai	8,210	1,038	22,9	31,1	23,5	0,606
Rostov Oblast	2,149	1,035	20,1	19,8	19,4	0,409
Republic of Tatarstan	6,127	0,974	4,6	-3,7	24,7	0,134

Source: authors' calculations based on Federal State Statistics Service of Russia (Rosstat), https://rosstat.gov.ru

Based on the data in Table 3, several key features can be identified that support conclusions about the competitiveness of the regions under study. First, attention should be paid to investment activity, measured as fixed capital investment in agriculture per 1 hectare of agricultural land. Belgorod Oblast ranks first (8.837 thousand RUB), indicating a high level of investment in the agricultural sector. The lowest level of investment is observed in Rostov Oblast (2.149 thousand RUB), which may indicate insufficient interest in modernization and development of agriculture in this region.

Price disparity between agriculture and industry also varies across the regions and may affect production profitability. A high disparity in Krasnodar Krai (1.038) and the minimum value in Voronezh Oblast (0.964) may play a significant role in shaping competitive advantages for agricultural producers.

Profitability of sales in livestock and crop production is another important indicator of economic condition. Belgorod Oblast demonstrates high values in both livestock production (28.9%) and crop production (36.0%), confirming its strong

economic position. In contrast, the Republic of Tatarstan shows negative profitability in crop production (−3.7%), which is a concerning signal.

The share of loss-making organizations is also relevant: high values in the Republic of Tatarstan (24.7%) and Krasnodar Krai (23.5%) suggest possible structural and financial problems. At the same time, Belgorod Oblast has the lowest loss-making share (11.9%), which may indicate a more stable financial situation.

On the basis of these indicators, the financial and economic condition index was calculated for each region. The highest index in 2023 is observed in Belgorod Oblast (0.967), indicating significant achievements in the agricultural sector and overall financial stability. Conversely, the Republic of Tatarstan has the lowest index (0.134), reflecting certain problems in the regional agricultural economy compared to other regions (low sales profitability, high share of loss-making organizations, and a noticeable price disparity, with industrial prices increasing faster than agricultural prices).

The comparative analysis suggests that Belgorod and Voronezh oblasts demonstrate the best financial and economic performance in the group, making them more attractive for investment and more successful in agricultural production. At the same time, the Republic of Tatarstan and Rostov Oblast require increased attention from state to specific financial and economic indicators in order to enhance competitiveness in the future.

One of the most significant groups of competitiveness indicators for the regional agricultural sector is the set of resource productivity indicators in agricultural production (labor, land, and capital). Productivity reflects the efficiency of using labor, financial, and land resources: the higher it is, the more effectively production processes are organized.

Table 4 presents the productivity index indicators of the agricultural sector for the regions under study (2023).

Table 4

Calculation of the Agricultural Sector Productivity Index for the Regions under Study (2023)

Region	Labor productivity by gross output (net profit), thousand RUB per employee	Gross output (net profit) per 1 ha of agricultural land	Capital productivity (RUB of gross output per 1 RUB of fixed assets)	Crop yield, index value	Animal productivity, index value	Productivity index
Rostov Oblast	2064 (70,6)	53,3 (1,8)	1,89	1,000	1,000	0,612
Belgorod Oblast	3763 (771,6)	164,4 (33,7)	1,27	0,291	0,000	0,503
Voronezh Oblast	2829 (386,6)	87,5 (11,9)	1,19	0,433	0,634	0,401
Krasnodar Krai	2445 (245,9)	124,3 (12,5)	1,08	0,161	0,866	0,359
Republic of Tatarstan	2118 (14,7)	63,9 (0,4)	1,09	0,000	0,856	0,185

Source: authors' calculations based on Federal State Statistics Service of Russia (Rosstat), https://rosstat.gov.ru

An analysis of Table 4 allows the following generalized conclusions regarding the agricultural sector productivity index in 2023.

Rostov Oblast demonstrates strong results across most indicators. Labor productivity by gross output is 2064 thousand RUB per employee, indicating efficient labor utilization. Gross output per hectare is 53.3 thousand RUB, and capital productivity equals 1.89, suggesting a high return on investment. The index values for crop yield and animal productivity are the highest in the group, reflecting a strong competitive advantage.

Belgorod Oblast shows mixed productivity results. Labor productivity is the highest among the regions (3763 thousand RUB per employee), indicating high efficiency of labor resources. Gross output per hectare (164.4 thousand RUB) is also the highest. However, the low crop yield index (0.291) and the weakest animal productivity index indicate substantial problems in agricultural production. The overall productivity index is 0.503, the second-highest after Rostov Oblast.

Voronezh Oblast occupies an intermediate position: labor productivity is 2829 thousand RUB per employee (386.6 thousand RUB net profit per employee), and gross

output per hectare is 87.5 thousand RUB (11.9 thousand RUB net profit per hectare). Capital productivity (1.19) is lower than in Rostov (1.89) and Belgorod (1.27). The crop yield index equals 0.433, indicating certain difficulties, while animal productivity is relatively high (0.634). The overall productivity index (0.401) suggests a need for improvement.

Krasnodar Krai shows relatively low resource-use efficiency: labor productivity is 2445 thousand RUB and gross output per hectare is 124.3 thousand RUB. Capital productivity is 1.08, the lowest in the group. The crop yield index is very low (0.161), but animal productivity is high (0.866), which partially offsets the negative effect of low yields. The productivity index is 0.359.

The Republic of Tatarstan has the lowest values among the analyzed regions: labor productivity is 2118 thousand RUB, gross output per hectare is 63.9 thousand RUB, and capital productivity is 1.09. The crop yield index is zero, although the region ranks third in animal productivity. The overall productivity index equals 0.185, indicating an extremely low level of resource-use efficiency.

Overall, the analysis shows that Rostov Oblast demonstrates the best results due to the highest capital productivity and balanced indicator values. At the same time, Belgorod Oblast combines high labor productivity with problems in crop yield and animal productivity. The other regions show notable deviations in efficiency, which may require targeted measures by regional authorities to improve the situation in the agricultural sector.

Indicators of production endowment essentially reflect the concentration of agricultural resources within a region, which affects territorial competitiveness, since the concentration of production resources is a significant competitiveness factor at all levels of the economic system. Table 5 presents the production endowment index indicators of the agricultural sector for the regions under study (2023).

Table 5

Calculation of the Agricultural Sector Production Endowment Index for the Regions under Study (2023)

Region	Fixed asset provision (value of agricultural fixed assets per 1 ha), thousand RUB	Capital-labor ratio (value of agricultural fixed assets per employee), thousand RUB	Machinery provision (tractors, combines), index value*	Energy provision (horsepower per employee) **	Labor provision (employees per 1 ha)	Livestock provision (cattle, pigs, sheep and goats), head per 1,000 ha	Production endowment index
Belgorod Oblast	130,1	2978,5	0,000	56,4	44	2424	0,620
Krasnodar Krai	115,2	2264,3	0,500	96,2	51	293	0,584
Voronezh Oblast	73,2	2367,1	0,500	94,0	31	639	0,413
Republic of Tatarstan	59,0	1952,0	0,334	104,1	30	362	0,319
Rostov Oblast	28,2	1092,9	0,000	136,8	26	213	0,167

Source: Federal State Statistics Service of Russia (Rosstat), https://rosstat.gov.ru.
* data for 2021; ** data for 2022.

Based on Table 5, several important conclusions can be drawn regarding the production endowment indicators of the agricultural sector in the studied regions in 2023. Belgorod Oblast ranks first in fixed asset provision (130.1 thousand RUB per hectare), reflecting a strong investment base. Krasnodar Krai and Voronezh Oblast also show relatively high values (115.2 and 73.2 thousand RUB), while the Republic of Tatarstan (59.0 thousand RUB) and Rostov Oblast (28.2 thousand RUB) demonstrate much lower levels.

The capital-labor ratio is also highest in Belgorod Oblast (2978.5 thousand RUB per employee). Voronezh Oblast and Krasnodar Krai follow (2367.1 and 2264.3), whereas the Republic of Tatarstan and Rostov Oblast have substantially lower values.

Machinery provision, expressed as an index value, is critically important. Belgorod and Rostov oblasts have an index of 0.000, indicating the weakest provision with agricultural machinery, suggesting a need to strengthen the technical base.

With respect to energy provision, the highest value is observed in Rostov Oblast (136.8 hp per employee), representing a competitive advantage in machinery utilization.

The lowest value is in Belgorod Oblast (56.4 hp per employee).

Labor provision indicates the number of employees per hectare: Rostov Oblast has the lowest value (26), potentially reflecting labor shortages, while Krasnodar Krai has the highest value (51).

Livestock provision varies significantly: Belgorod Oblast has the highest concentration (2424 head per 1,000 ha), indicating a well-developed livestock sector. Voronezh Oblast and the Republic of Tatarstan show lower values (639 and 362), while Krasnodar Krai and Rostov Oblast lag behind (293 and 213).

Regarding the production endowment index, Belgorod Oblast again demonstrates the best result (0.620), indicating a high level of mechanization and resource endowment. Krasnodar Krai follows (0.584), and Voronezh Oblast has 0.413. The Republic of Tatarstan and Rostov Oblast show much lower indices, emphasizing the need for substantial investment to increase production endowment.

In general, Belgorod Oblast stands out most clearly in terms of production endowment, followed by Krasnodar Krai and Voronezh Oblast. The Republic of Tatarstan and Rostov Oblast require serious transformations and improvements to reach competitive positions in production endowment and mechanization (with the exception of energy provision, where these regions are leaders).

A key competitiveness factor in agro-industrial production under the development of the sixth technological paradigm is the level of digitalization. Therefore, the methodology for assessing and managing competitiveness was supplemented with indicators of regional digital development. Digitalization is a system-forming factor for the competitiveness of regional industries due to the introduction of artificial intelligence, the Internet of Things, and big data analytics, which can dramatically increase production efficiency not only through greater automation and robotization, but also through the use of digital technologies in forecasting, planning, and control.

Accordingly, a key group of indicators within the proposed competitiveness assessment methodology is the level of regional digital development. Table 6 presents the digital development index indicators for the studied regions (2023).

Table 6

Calculation of the Digital Development Index for the Regions under Study (2023)

Region	Use of digital technologies in organizations, % of total	Expenditure on implementation and use of digital technologies as a share of GRP, %	Use of electronic document management in organizations, % of total	Digital development index
Belgorod Oblast	20,8	1,07	61,7	0,725
Voronezh Oblast	19,8	0,93	60,0	0,470
Republic of Tatarstan	18,6	1,73	53,7	0,455
Rostov Oblast	18,7	0,94	57,0	0,228
Krasnodar Krai	18,6	0,96	49,1	0,012

Source: authors' calculations based on Federal State Statistics Service of Russia (Rosstat), https://rosstat.gov.ru

Based on Table 6, several conclusions can be made regarding the state of digital transformation in the studied regions in 2023. Belgorod Oblast occupies the leading position across all indicators related to digital technology use: 20.8% of organizations use digital technologies, exceeding the values of the other regions. Notably, expenditures on digital technologies amount to 1.07% of gross regional product (GRP), indicating active investment in digital infrastructure and technologies. The use of electronic document management is also the highest (61.7%), implying an established document workflow system that can increase the efficiency of agro-industrial enterprises. The digital development index equals 0.725, making Belgorod Oblast the most successful region in digital transformation within the group.

Voronezh Oblast ranks second, with 19.8% of organizations using digital technologies. Although expenditures on digitalization are 0.93% of GRP, electronic document management reaches 60.0%. Nevertheless, the digital development index is 0.470, suggesting the need for further improvements.

Organizations in the Republic of Tatarstan demonstrate a digital technology use level of 18.6%, accompanied by substantially higher expenditures (1.73% of GRP). This may indicate high digitalization costs that are not fully reflected in outcomes, since the digital development index is 0.455.

Rostov Oblast and Krasnodar Krai show similar patterns: the share of organizations using digital technologies is 18.7% and 18.6%, respectively, while expenditures and electronic document management are relatively low compared to other regions. Krasnodar Krai has the lowest digital development index (0.012), indicating low effectiveness of digital technology adoption and use in the regional economy.

After calculating all composite competitiveness indices using normalized coefficients (Formulas 1 and 2), aggregation is carried out and the integral index is formed according to Formula (3), taking into account weight coefficients determined by the expert method. The results of calculating all composite indices and the integral competitiveness index are presented in Table 7.

Table 7

Competitiveness Ranking of the Agricultural Sector of the Regions under Study (2023)

№	Region	IK_i	I_{FESi}	I_{PRi}	I_{OPi}	I_{TPi}	I_{SDSi}	I_{RSIi}	I_{SPPi}	I_{TS}	I_{DDRi}	I_{RNPi}
1	Belgorod Oblast	0,613	0,967	0,503	0,620	0,865	0,586	0,806	0,982	0,064	0,725	0,000
2	Voronezh Oblast	0,502	0,714	0,401	0,413	0,450	0,211	0,771	0,562	0,976	0,470	0,466
3	Republic of Tatarstan	0,397	0,134	0,185	0,319	0,628	0,393	0,914	0,296	0,965	0,455	0,244
4	Rostov Oblast	0,354	0,409	0,612	0,167	0,807	0,488	0,208	0,166	0,467	0,228	0,219
5	Krasnodar Krai	0,243	0,606	0,359	0,584	0,054	0,462	0,132	0,130	0,252	0,012	1,000

Source: authors' calculations based on Rosstat data, https://rosstat.gov.ru

Based on the results in Table 7, several key conclusions and patterns can be identified. The integral competitiveness index varies substantially across regions, indicating uneven development of the agricultural sector in different parts of the country. The highest values are observed in Belgorod Oblast (0.613), due to higher financial and economic performance, digital development, production endowment, and productivity compared to other regions included in the study.

Second place is held by Voronezh Oblast (0.502). Although its composite indices are lower than those of Belgorod Oblast, the region shows a relatively balanced integral competitiveness level.

The Republic of Tatarstan ranks third (0.397), indicating certain difficulties. Low

values of the financial and economic condition and productivity indices suggest the need for structural changes and investment to increase competitiveness.

Rostov Oblast and Krasnodar Krai have the lowest ranking values (0.354 and 0.243, respectively). This may indicate serious challenges in these regions, including possible financing problems, inefficient resource use, and underdeveloped rural social infrastructure. Particularly notable are the low indices of commodity flows and agricultural science development in Krasnodar Krai, which may negatively affect the sustainable development of the agricultural sector.

Overall, the results show that improving agricultural competitiveness requires not only expanding production capacity and introducing new technologies, but also strengthening financial sustainability, rural social infrastructure, regional self-sufficiency, and other factors that significantly influence the overall effectiveness and development of the agricultural sector. In view of these aspects, regions should develop strategic plans aimed at addressing weak points and achieving more balanced development of the agricultural sector. In this regard, a competitiveness matrix was developed to identify priority areas for managing the competitiveness of rural territories and the agro-industrial complex in the studied regions (Table 8).

Table 8

Competitiveness Matrix of the Agricultural Sector of the Regions under Study (2023)

Region	Strengths	Weaknesses
Belgorod Oblast	(1) High financial and economic performance of the agricultural sector. (2) High self-sufficiency in basic food products. (3) Strong positions in external and internal agro-food markets. (4) High level of digitalization of regional enterprises. (5) Good production endowment.	(1) Low level of scientific potential development in agriculture. (2) Poor technical condition of agricultural production.
Voronezh Oblast	(1) Strong technical condition of agricultural production. (2) High level of rural social infrastructure development. (3) High financial and economic performance of the agricultural sector.	(1) Low level of socio-demographic conditions in rural areas.
Republic of Tatarstan	(1) Strong technical condition of agricultural production. (2) High level of rural social infrastructure development.	(1) Low financial and economic performance of the agricultural sector. (2) Low agricultural productivity. (3) Insufficient development of scientific potential in agricultural research. (4)

		Low self-sufficiency in basic food products.
Rostov Oblast	(1) Strong positions in external and internal agro-food markets.	(1) Low self-sufficiency in basic food products. (2) Low level of production endowment. (3) Low level of rural social infrastructure development. (4) Insufficient development of scientific potential in agricultural research. (5) Low level of regional digital development.
Krasnodar Krai	(1) High level of scientific potential development in agricultural research.	(1) Low level of regional digital development. (2) Weak positions in external and internal agro-food markets. (3) Low self-sufficiency in basic food products. (4) Low level of rural social infrastructure development.

Source: author's development

As a result of the comparative analysis of competitiveness across the five leading Russian regions (Krasnodar Krai, Rostov Oblast, Voronezh Oblast, Belgorod Oblast, and the Republic of Tatarstan) in agricultural production based on 2023 data, the findings indicate that Belgorod Oblast has the highest level of competitiveness among the regions considered. This is consistent with the conclusions of other authors, such as Dorzhieva E.V. and Pechertseva O.N., who emphasize the importance of financial and economic performance and investment activity as key factors determining agricultural success. High investment levels in Belgorod Oblast underscore the need for substantial capital investment to increase productivity and efficiency of the agricultural sector.

At the same time, while the integral competitiveness index for the Republic of Tatarstan is 0.397, the results regarding the stability of its financial performance support existing assumptions about its relatively low profitability compared to southern and chernozem regions of Russia, which possess strong structural competitive advantages in agricultural production.

In addition, the comparative productivity analysis reveals contradictions between high labor productivity in Belgorod Oblast and low crop yield and animal productivity indicators. This observation is consistent with the conclusions of Martynov K.M., who notes that regions with a strong agricultural sector may still face constraints that limit overall efficiency outcomes. It is also important to note that agricultural diversification, as in the case of Belgorod Oblast, may lead to production fragmentation, which, in turn, requires adjustments to resource management systems in regional agricultural production.

Digitalization data show that the level of digital technology adoption remains critically important for improving competitiveness. For example, Belgorod Oblast, where 20.8% of organizations have adopted digital technologies, also demonstrates the highest digital development index. However, regions with low digitalization levels, such as Krasnodar Krai, may be caught in a trap of low productivity and outdated management models.

In summary, the obtained results align with numerous previously published studies, confirming the value of the proposed model for managing agro-industrial competitiveness within the digital paradigm. Integrating these research findings into decision-making processes makes it possible not only to identify current trends, but also to formulate recommendations that account for the specific features of each region. This can improve the condition of the agricultural sector in individual regions and, more broadly, enhance the country's food security and economic sustainability.

5 CONCLUSIONS

In conclusion, the conducted study confirms the initially stated objective and tasks related to assessing the competitiveness of the agricultural sector in five key regions of Russia. The study sought to determine which factors influence the competitiveness of agricultural production and how the level of digitalization can serve as a criterion for evaluating the competitiveness and efficiency of regional agro-industrial systems.

The practical significance of this study lies in the development of a methodology that enables a comprehensive assessment of the competitiveness of the agricultural sector at the regional level, with particular emphasis on the impact of digitalization on production and economic processes in the industry. The proposed author's methodology will allow public authorities and businesses to formulate more precise strategies for enhancing agricultural competitiveness based on specific indicators and assessments.

Prospects for further research include expanding the database for analysis not only across federal districts but also at the level of municipalities. It would also be useful to further examine the influence of socio-demographic factors on the competitiveness of the regional agricultural sector and to assess the potential for implementing digital and innovative technologies in Russia's agro-industrial sector. Particular attention should be

given to cross-sectoral interactions between agriculture and other sectors of the economy, which would make it possible to form a more sustainable economic model at both the regional and national levels. Accordingly, this study opens up not only prospects for further theoretical research but also important directions for practical implementation within regional socio-economic development strategies. In addition, an important direction for further research may be the development of a predictive model of competitiveness of regional agro-industrial systems based on the proposed assessment methodology.

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REFERENCES

1. Khoruzhii, V. I., Ukolova, A. V., Demichev, V. V., Ul'iankin, A. E., Bykov, D. V., Nevzorov, A. S., Kozlov, K. A., Moloshnikova, A. D., & Grigorash, Z. A. (2024). Tsifrovye tekhnologii v sel'skom khoziaistve [Digital technologies in agriculture]. Moscow: Izdatel'stvo RGAU–MSKhA.

2. Subaeva, A. K. (2023). *Tekhnicheskaia i tekhnologicheskaia modernizatsiia sel'skogo khoziaistva v usloviiakh tsifrovoi ekonomiki* [Technical and technological modernization of agriculture in the context of the digital economy]. Kazan: Kazanskii gosudarstvennyi agrarnyi universitet.

3. Zhukova, M. A., & Ulez'ko, A. V. (2021). Perspektivy tsifrovoi transformatsii sel'skogo khoziaistva [Prospects for the digital transformation of agriculture]. Voronezh: Voronezhskii gosudarstvennyi agrarnyi universitet.

4. Shcherbakova, A. S., Ivanov, V. A., Mal'tseva, I. S., & Ozarovskaia, A. V. (2024). Tsifrovaia transformatsiia sel'skogo khoziaistva: Ot global'nogo do regional'nogo urovnia [Digital transformation of agriculture: From the global to the regional level]. Journal of Agriculture and Environment, 11(51). https://doi.org/10.60797/JAE.2024.51.10.

5. Bogdanova, E. N., Saburov, A. A., Minchuk, O. V., & Nikiforov, A. S. (2024). Tsifrovaia transformatsiia sel'skikh territorii v usloviiakh innovatsionnogo razvitiia

Zapadnogo sektora rossiiskoi Arktiki [Digital transformation of rural territories under innovative development of the western sector of the Russian Arctic]. Arktika i Sever, 57, 5–33.

6. Borel, A. N. (2014). Sushchnost' konkurentosposobnosti sel'skogo khoziaistva i formiruiushchie ee faktory [The essence of agricultural competitiveness and its determining factors]. Zhurnal mezhdunarodnogo prava i mezhdunarodnykh otnoshenii, 4(71), 64–70.

7. Dugina, E. L., Dorzhieva, E. V., & Bazarova, O. V. (2023). Model' otsenki konkurentosposobnosti regional'nogo sel'skogo khoziaistva [A model for assessing the competitiveness of regional agriculture]. Vestnik Udmurtskogo universiteta. Seriia Ekonomika i pravo, 33(1), 50–56. https://doi.org/10.35634/2412-9593-2023-33-1-50-56

8. Dugina, E. L., Bulatova, N. N., & Dorzhieva, E. V. (2025). Otsenka urovnia konkurentosposobnosti i napravlenii razvitiia sel'skogo khoziaistva v sub"ektakh RF Baikal'skogo regiona [Assessment of the competitiveness level and development directions of agriculture in the constituent entities of the Russian Federation of the Baikal region]. Ekonomika sel'skokhoziaistvennykh i pererabatyvaiushchikh predpriiatii, 2, 45–53. https://doi.org/10.31442/0235-2494-2025-0-2-45-53.

9. Martynov, K. P. (2013). Metodika otsenki ustoichivosti razvitiia regional'noi agrarnoi sfery [Methodology for assessing the sustainability of regional agricultural development]. Teoriia i praktika obshchestvennogo razvitiia, 8, 316–318.

10. Pechertseva, O. N. (2008). Otsenka konkurentosposobnosti sel'skogo khoziaistva v oblastiakh Ural'skogo federal'nogo okruga [Assessment of agricultural competitiveness in the regions of the Ural Federal District]. Agrarnyi vestnik Urala, 2(44), 52–54.

11. Pechertseva, O. N. (2010). Analiz tekushchei i perspektivnoi konkurentosposobnosti sel'skokhoziaistvennogo proizvodstva v Ural'skom federal'nom okruge [Analysis of current and prospective competitiveness of agricultural production in the Ural Federal District]. Ekonomika regiona, 1(21), 137–141.

12. Khuazheva, A. Sh. (2008). Uroven' ustoichivosti i konkurentosposobnosti regional'nykh agropromyshlennykh kompleksov (metodicheskie podkhody k ranzhirovaniiu) [The level of sustainability and competitiveness of regional agro-industrial complexes (Methodological approaches to ranking)]. Problemy prognozirovaniia, 4(109), 146–150.

Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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