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Article

Spatial development of agricultural production in Russia: The comparative advantages approach

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Abstract: The territorial planning approach to allocating productive forces is based on the fact that territories have competitive advantages in producing specific products. However, in agriculture, the advantages principle cannot be used to shape the allocation patterns, due to a variety of intervening factors, such as the climatic and environmental conditions for agricultural production and the quality of land and availability of water. In the case of Russia, one of the most diverse countries in terms of the territorial disparities in agricultural production, this study examines the location and development patterns of the agricultural sector. The study identifies the competitive advantages of territories by comparing localization of agricultural production, production costs, performance, and profitability of agricultural producers, as well as prices of agricultural products in 78 different administrative regions in Russia. The study reveals which regions have more advantageous conditions for over-concentrating energy capacities, labor resources, fixed capital, and investments. However, at a certain point, over-concentrated production forces can lead to a deterioration in the performance of farmers due to an increase in capital intensity. Therefore, countries with significant regional differences in agricultural production should adjust their spatial development patterns according to the parameters of territories' comparative advantages.

Keywords: agricultural sector; comparative advantage; competitive advantage; resource allocation; territorial planning

1. Introduction

It is generally accepted that economic agents, when allocating resources to a certain territory and selecting a location for the concentration of production factors, are primarily guided by the desire to maximize profits (Blaug, 1997). Consequently, the territorial planning approach for allocating productive forces is based on the fact that some territories have competitive advantages in producing certain goods. In line with the Ricardian theory of comparative advantage (Ricardo, 1817), these territories produce and export goods that are relatively inexpensive for them, and import those that are less expensive elsewhere.

In agriculture, the comparative advantage approach to allocating resources cannot be applied without restriction to shaping the spatial development of the sector. Historically, the distribution of production in agriculture has been determined by Smith's concept of absolute advantages of territory (Smith, 1776), rather than by comparative advantages. Absolute advantages include favorable natural and climatic conditions, abundance and ease of access to raw materials, and quality of agricultural land (Dornbusch et al., 1997). However, according to Bernhofer (2005), each region has comparative advantages when compared to other types of products, rather than

absolute advantages. Porter (2008) argued that these advantages are strategically important for business development. Following the principle of comparative advantage, farmers benefit from producing those agricultural goods for which the yields are higher, costs lower, producer profits greater, and selling prices lower. In general, the strategic advantages of the agricultural sector relate to the ability of farmers in different regions to produce certain types of products with relatively higher competitive advantages (Giuca et al., 2022).

Regarding the prerequisites for optimal placement of productive forces in agriculture, the comparative advantages of territories are typically studied within environmental dimensions (climate change (Svetlov et al., 2019); biological and climatic parameters of ecosystems (Suvorov and Stancu, 2021; Vinnichek and Ivanov, 2011)), as well as economic dimensions (volume of output (Bogoviz et al., 2016); export sales (Maslova et al., 2019); level of price protection for producers (Fukasaku, 1992; Serova, 2022); logistics (Gao et al., 2019; Silaeva, 2023)). In addition to the climatic and environmental conditions for agricultural production, a number of factors, such as the quality of land (Erokhin et al., 2021), the availability of water (D'Odorico et al., 2020), and the density of rural population (Kuznetsova, 2022) can distort the balance of comparative advantages between individual territories. These factors can also be linked to issues related to self-sufficiency in food self-sufficiency and food security (Erokhin et al., 2022).

The more diverse the natural and economic conditions of agricultural production, the more factors need to be considered in order to determine the optimal parameters for the spatial distribution of productive forces. This is especially relevant for large developing countries, like Russia (Erokhin et al., 2020), China (Liu et al., 2020), Kazakhstan (Nurlanova et al., 2018), or Brazil (Ferreira, 2013), which have stark differences in natural and climate zones combined with regional economic imbalances. In addition, developing countries face a crucial need to shift their development priorities away from purely economic factors when deploying productive forces in agriculture and towards social issues, such as combating poverty in rural areas and ensuring physical availability and economic access to food for all citizens, as part of efforts to ensure food security (Akbari et al., 2022; Brucker et al., 2022; Nicholson et al., 2021). For example, the Food Security Doctrine of the Russian Federation (President of the Russian Federation, 2020) aims to increase both food output and consumption, and agricultural product output, in order to create a balance between supply and demand. This approach is assumed to allow citizens to gain adequate physical and economic access to staples at a level that meets reasonable consumption standards.

With this shift in emphasis from economic efficiency to food security, the allocation of resources in agriculture becomes more significant. This approach considers not only the interests of the agricultural industry, but also the needs of society as a whole. Of course, natural factors and the advantages of certain territories in producing certain goods cannot be ignored. Climatic and environmental conditions play a crucial role in determining where productive forces should be located in agriculture (Zaruk et al., 2022). There is no doubt that rent factors remain a significant determinant in allocating agricultural resources and strategically developing the agricultural sector. However, the availability-accessibility balance can only be

maintained by strengthening the specialization of advantageous areas in food and agricultural product production and raw material supply.

In order to maximize the potential of agricultural producers, it is essential to align natural conditions with biological requirements and specific crop and livestock cultivation practices (Altukhov, 2023). Various authors, including Bespakhotny (2019), Yan et al. (2021), and Pellegrina (2022), have pointed out that the agricultural capacity of territories with a favorable combination of natural and economic factors is not sufficient to meet the complex challenges of achieving food security targets for all. Therefore, it is crucial to use all competitive advantages, including those of territories with less favorable agricultural production conditions (Migunov and Syutkina, 2022). In this regard, the study aims to identify opportunities for improving the efficiency of the spatial distribution of productive forces by optimizing the use of comparative advantages in certain territories for producing specific agricultural products. The study aims to analyze the effectiveness of resource allocation in strategic development of the agriculture sector across 78 Russian administrative regions, compare the comparative advantages of these regions in supporting growth in the agriculture sector, and make recommendations for optimizing the spatial allocation of resources at the territorial level and utilizing the agricultural potential of these regions.

2. Materials and methods

The research process includes two stages. The first stage is to assess the availability of resources for the development of the agricultural sector. The second stage is to evaluate the comparative advantages of various regions in terms of their product competitiveness.

2.1. Stage 1

Studying the structure of resources in the agricultural sector involves assessing the proportion of agricultural production compared to the market demand for products, both raw materials and finished goods, as well as ensuring the conditions for the strategic development of agricultural production. In addition, the efficiency of resource utilization and the capital intensity of the products produced are evaluated. At this stage, the distribution of agricultural resources within the territories is revealed, taking into account natural and economic factors that influence agriculture. The results of the distribution correlate with the demand structure in the food market and the conditions for strategic development within the agricultural sector. The ratio of gross output to population is an indicator of self-sufficiency in domestic food markets for key food products within each territory.

The indicator of cadastral value per hectare of agricultural land is used to analyze the natural and economic conditions for agricultural activity on different territories. To assess the impact of regional factors on the physical and economic viability of agricultural products, the country's administrative regions have been divided into five categories based on the cadastral values of one hectare of farmland. This approach allows for a more accurate comparison between territories with different biological and economic potential and levels of agricultural development (**Table 1** and **Figure 1**).

Table 1. Categories of administrative regions of Russia by the cadastral value of agricultural land.

Categories	Cadastral value, %[1]	Regions
Category 1: Low	27	Amur, Buryatia, Chukotka, Kalmykia, Kamchatka, Khakasia, Kirov, Komi, Murmansk, Perm, Sakha Yakutia, Sakhalin, Tomsk, Tyumen[2], Tyva, Zabaikalsk
Category 2: Below average	77	Altay Krai, Altay Republic, Arkhangelsk[3], Astrakhan, Irkutsk, Karelia, Kemerovo, Kostroma, Krasnoyarsk, Magadan, Novgorod, Novosibisk, Pskov, Samara, Sverdlovsk
Category 3: Average	111	Chechnya, Cheryabinsk, Kaluga, Khabarovsk, Kurgan, Primorye, Saratov, Smolensk, Tatarstan, Tver, Udmurtia, Ulyanovsk, Vladimir, Volgograd, Vologda
Category 4: Above average	147	Bakhkortostan, Bryansk, Chuvashia, Dagestan, Ingushetia, Ivanovo, Jewish Autonomous Republic, Kabardino-Balkaria, Mari El, Mordovia, Nizhny Novgorod, Omsk, Orenburg, Penza, Ryazan, Tambov, Tula, Yaroslavl
Category 5: High	302	Adygeya, Belgorod, Crimea[4], Kaliningrad, Karachaevo-Cherkessia, Krasnodar, Kursk, Leningrad, Lipetsk, Moscow Oblast, North Osetia Alania, Orel, Rostov, Stavropol, Voronezh

Notes: [1] ratio of the category-average cadastral value of 1 hectare of agricultural land to the Russia's average cadastral value; [2] including the Khanty-Mansi and the Yamal-Nenets autonomous districts; [3] including the Nenets Autonomous District; [4] The Crimea Republic is included in the study due to its current position as a territory under de-facto Russia's control. Source: authors' development based on Federal Service of State Statistics of the Russian Federation [Rosstat] (2024).

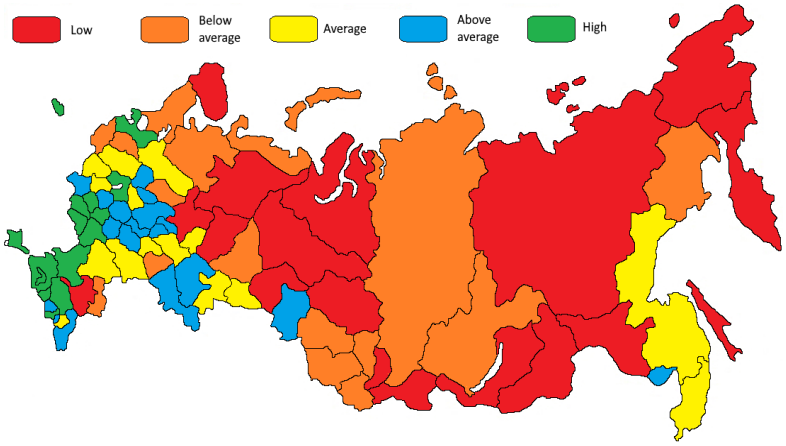

Figure 1. Location of Russia's regions by categories.

Source: authors' development.

2.2. Stage 2

At Stage 2, the authors assess the comparative advantages of different territories in terms of their ability to compete in certain aspects. The study uses the Balassa (1963) method, which compares indicators for one company with those of another company. This stage involves two types of indicators: those related to the physical availability of food and agricultural products on the domestic market (productivity, cost, and profitability), and those related to economic accessibility to staples for domestic consumers (consumer protection and household purchasing power).

To assess the physical availability and economic accessibility of food and agricultural products, the ratio between production and consumption of basic products and rational consumption standards per capita is used. This ratio indicates the level of self-sufficiency for meeting national norms for specific products in the region (Samygin et al., 2019). The Food Security Doctrine of Russia (President of the Russian Federation, 2020) defines self-sufficiency thresholds and security standards for six categories of staples. This study compares the advantages of different territories in producing grains, potatoes, vegetables, meat, dairy products, and eggs based on these

criteria.

To assess specialization, the authors use a localization indicator. This indicator characterizes the ratio between the share of output in a particular region and the overall share of that output in the country, expressed as a percentage. If this indicator is greater than 100%, then there is specialization in producing a given product in a given region. Conversely, if this indicator is less than 100%, then the region does not have specialization in producing that product (Samygin and Kudryavtsev, 2018).

To assess the competitive advantages of territories in terms of food security, the authors compare the level of various indicators (such as localization, as a criterion for specialization, productivity, cost, profitability, and selling price) relative to each other. This analysis is based on the assumption that the right specialization is the result of a region's comparative advantage in these dimensions of product competitiveness. In the process of comparing the strengths of different regions, it can be seen that the level of certain indicators achieved by groups of regions correlates with the average level in the country.

This comparison clearly shows, on the one hand, the specialization of a region in specific products and, on the other hand, the alignment of this specialization with identified competitive strengths. A territory has an advantage in producing a particular product if the indicator value is greater than 100%. This indicates that the territory produces more of this product than the national average. If the value is below 100%, then there is a disadvantage. This means that the territory does not produce enough of the product compared to the average for the whole country. This comparison clearly demonstrates, on the one hand, a specialization of a particular region in a specific product and, on the other hand, how this specialization aligns with the identified strengths.

2.3. Data

The database "Comparative Advantages of the Territories of the Russian Federation in the Agricultural Sector" (Samygin et al., 2023) was used as the source of data for this study. This database contains the main indicators for each territory of Russia, averaged over the period 2017–2020. These indicators were analyzed to assess the consistency of agricultural production in the territories with respect to specialization and competitive advantage, which contributes to the physical availability and economic accessibility of staples on the market. The database includes a set of indicators that describe the comparative advantages of the administrative regions of Russia in terms of production location, self-sufficiency, availability of food and agricultural products in the physical sense, their economic availability, productivity, costs, profitability for producers, protection of consumers, and the income of the population under different natural and economic conditions.

3. Results

3.1. Stage 1: Spatial distribution of resources involved in agricultural production

Stage 1 involved exploring the spatial distribution patterns of major categories of

natural, capital, and labour resources across the five categories of territories (**Table 2**).

Table 2. Allocation of resources by categories of territories, percentage of the total.

Parameters	Categories of territories				
	I	**II**	**III**	**IV**	**V**
Agricultural land	14	20	22	22	22
Livestock	15	19	20	28	19
Power generation facilities	8	6	21	20	34
Production costs	7	14	21	22	36
Agricultural enterprises and farmers	9	18	23	26	24
Agricultural workers	8	15	21	25	28
Fixed assets	9	15	19	20	35
Fixed capital expenditures	5	10	19	22	44
Government support	8	12	21	24	35

Source: authors' development based on (Rosstat, 2024).

It has been revealed that agricultural land is distributed approximately equally among territories 2–5. Category 1 territories are located mostly in areas with less favorable climatic conditions for agricultural production. This results in a lower level of land development and a lower economic attractiveness for agricultural producers. The population of agricultural animals is also distributed approximately evenly throughout the country, with a slight predominance in territories 4, where the largest livestock complexes are located that supply meat, milk, and other livestock products to urban areas in the most densely populated parts of Russia. Consequently, economic factors are more significant than natural ones in determining the spatial distribution of livestock production forces. In contrast, climate and soil quality are crucial in determining spatial developments in crop production.

The allocation of other resources in the study is heavily influenced by natural factors. For example, territories classified as Category 5 account for 35% of the total power generation capacity compared to only 8% in territories classified as Category 1. There are also significant differences in the supply of labor and capital between these two groups, i.e., the spatial availability of agricultural resources increases with improved natural and climatic conditions for agricultural production.

Thus, in areas with more favorable climates (categories 3–5), the income from renting out agricultural land depends on both natural and economic factors. However, in areas with less favorable climates (categories 1–2), the income primarily depends on natural factors. Category 5 territories, in comparison to Category 1 territories, have significant advantages in terms of several development indicators. These include the use of capital, labor, and land; the level of investment; government support; and the economic access to food and agricultural products (**Table 3**).

Table 3. Parameters of strategic development of the agricultural sector by categories of territories.

Parameters	Categories of territories				
	I	II	III	IV	V
Capital/area ratio, thousand RUB / hectare	29.1	32.2	32.9	35.8	65.3
Capital/labor ratio, thousand RUB / worker	10.4	10.6	10.8	11.2	14.1
Energy/area ratio, horse power / hectare	0.4	0.5	0.6	0.6	1.0
Fixed capital expenditures, thousand RUB / hectare	1.1	1.3	1.9	2.3	5.3
Government support, thousand RUB / hectare	0.7	0.7	1.1	1.3	1.9
The ratio of wages in the agricultural sector to the territory average, %	60.0	69.0	69.0	72.0	87.0
Producer price index in agriculture, %	102.0	100.0	99.0	99.0	96.0
The ratio of the territory-average prices for basic products to the national average (geometric average)	118.0	100.0	95.0	88.0	95.0

Source: authors' development based on (Rosstat, 2024)

Along with resources, territories with better natural conditions for agriculture produce a larger proportion of the total output (**Table 4**). As the value of agricultural land increases, the amount of output produced per unit of input used in production or consumption also increases. In territories 4 and 5, the ratio of output to population is greater than 100, suggesting an oversupply on the domestic market. However, in territories 1 and 2, there is a lack of self-sufficiency with regard to food and agricultural products.

Table 4. Gross agricultural output by categories of territories.

Parameters	Categories of territories				
	I	II	III	IV	V
Share in gross agricultural output, %	7	14	21	21	37
Gross output per hectare, agricultural land, million RUB/hectare	20.7	25.5	32.2	34.2	59.2
Share in output, plant production, %	5	12	21	20	42
Output (plant production) per hectare of crops, million RUB/hectare	7.7	11.8	16.5	16.3	35.4
Share in output, livestock sector, %	9	16	21	23	31
Output (livestock sector) per cattle, million RUB/hectare	80.4	117.1	136.4	144.8	216.0
Share in Russia's total population, %	13	20	23	19	25
Ratio of gross output to population, %	54	70	91	111	148
Gross output per unit of power, million RUB/horse power	48.9	48.6	55.6	62.2	70.1
Output-population ratio, million RUB per capita	862.2	906.1	993.9	1049.1	1290.1
Output-income ratio, per capita income, thousand RUB/RUB	621.1	887.9	1261.7	1820.8	1828.6
Output-assets ratio, unit of fixed assets, RUB/RUB	0.753	0.801	0.954	0.971	0.993
Output-investment ratio, unit of fixed capital expenditures, RUB/RUB	20.0	19.2	15.8	13.8	11.6

Source: authors' development based on (Rosstat, 2024)

The study reveals significant differences in spatial development between territories in terms of gross output per unit of energy capacity, fixed assets, labor resources, and the income of the population. However, there is a reverse trend with regard to gross output per investment in fixed assets. There is an oversupply of labor in territories 4 and 5, while there is a shortage of labor in territories 1 and 2.

The assessment of intensity-related parameters (inputs of cost, capital, and investment per unit of output) reveals no significant differences between regions (**Figure 2**).

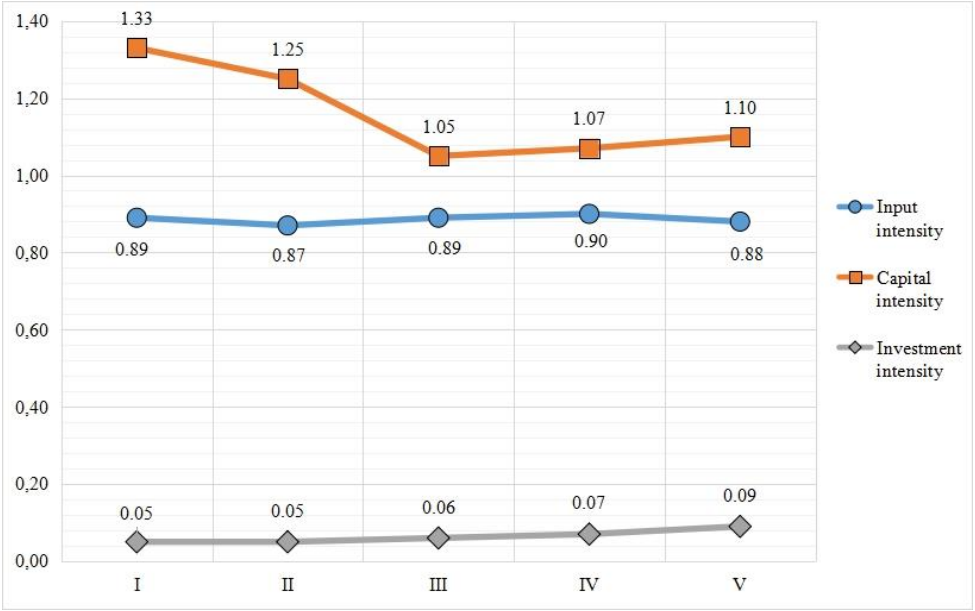

Figure 2. Performance parameters of agricultural producers by categories of territories, RUB/RUB.

Source: authors' development based on Rosstat (2024).

Natural disparities among Russian regions in the spatial distribution of production forces have minimal impact on the intensity of agricultural output. Moreover, investment concentration in fixed assets per unit of production increases as the cadastral value of agricultural land increases. It appears that the shift of production factors to more competitive territories 4 and 5 (in accordance with the principle of competitive advantage) can disrupt the pattern of competitiveness, increasing production costs in formerly competitive regions and thus reducing economic access to food and agricultural products in domestic markets.

3.2. Stage 2: Comparative advantages of territories in the development of agricultural production

The results obtained in Stage 2 are category-level indicators that are correlated with national average values for the same parameters. These comparative values are expressed as a percentage of the national average and indicate whether a territory has a competitive advantage for producing certain agricultural products.

The advantages of the grain and bread industry derive from the natural and economic factors of a given area. As these factors improve, the level of specialization also increases. However, only Category 5 territories fully specialize in grain production, with a self-sufficiency ratio that is almost six times greater than in Category 1 territories (**Table 5**). The parameters of self-sufficiency, economic accessibility, localization, and productivity all follow a similar trend, which is not always consistent with trends in cost, profitability, or consumer protection. Only in Category 5 territories, agricultural output is balanced with per capita consumption.

Table 5. Comparative advantages of Russia's territories in physical availability and economic accessibility of basic agricultural products, %.

Products/categories	Parameters							
	SS[1]	EA[2]	L[3]	Prod[4]	C[5]	Prof[6]	CP[7]	PP[8]
Grain/bread								
Category I: Low	44	98	40	71	96	107	106	102
Category II: Below average	59	99	75	64	109	110	112	94
Category III: Average	100	97	83	82	96	109	100	95
Category IV: Above average	149	100	86	84	102	105	108	106
Category V: High	260	105	142	161	94	94	94	103
Potatoes								
Category I: Low	64	87	112	85	82	82	100	106
Category II: Below average	87	103	123	96	108	100	108	102
Category III: Average	87	101	118	99	89	100	89	99
Category IV: Above average	168	115	129	110	103	102	102	95
Category V: High	124	98	62	99	111	106	104	98
Vegetables								
Category I: Low	45	85	61	109	111	100	111	103
Category II: Below average	128	94	86	128	105	79	134	96
Category III: Average	101	103	108	108	101	83	122	97
Category IV: Above average	145	112	108	108	101	83	122	97
Category V: High	119	109	104	78	99	155	64	101
Meat, beef and pork								
Category I: Low	62	100	149	74	76	94	89	116
Category II: Below average	83	101	112	85	103	102	103	104
Category III: Average	67	97	91	125	95	103	95	96
Category IV: Above average	143	95	100	112	108	125	98	92
Category V: High	200	107	83	136	103	99	98	93
Milk and dairy products								
Category I: Low	80	96	138	71	99	98	99	116
Category II: Below average	87	105	122	84	106	103	103	102
Category III: Average	106	99	122	96	101	100	101	94
Category IV: Above average	125	100	116	74	96	99	98	95
Category V: High	110	100	68	110	99	103	96	93
Eggs								
Category I: Low	57	91	134	103	98	100	98	116
Category II: Below average	104	100	126	104	108	100	109	107
Category III: Average	90	106	106	105	95	96	99	96
Category IV: Above average	143	96	101	96	105	101	104	88
Category V: High	130	107	80	93	96	102	94	93

Notes: [1] self-sufficiency, dietary intake criteria; [2] economic accessibility; [3] localization; [4] productivity of crops/animals; [5] cost; [6] profitability of agricultural producers; [7] consumer protection; [8] purchasing power of people's income. Source: authors' development based on Rosstat (2024).

All categories of territories except Category 5 have comparative advantages for potato cultivation. The level of specialization in potato farming is not closely linked to the natural and economic conditions of agricultural production, but it does perfectly reflect the trends of self-sufficiency and economic accessibility. At the same time, there is no clear connection between the level of specialization and the comparative advantages, as the quality of agricultural land improves. Category 4 territories achieve a balance between potato production and per capita consumption.

In the vegetable sector, there is a balance between self-sufficiency, economic accessibility, and specialization. Factors such as productivity, costs, profitability, and consumer protection play little role in determining the specialization of regions in vegetable production. This balance is observed in regions with average and above-average agricultural land quality.

In the meat industry, trends in terms of self-sufficiency, economic accessibility, and specialization coincide. At the same time, there are opposite trends in productivity, costs, profitability, and consumer protection. Paradoxically, a strong specialization in Category 1 territories for the production of meat products does not lead to any related comparative advantages. On the other hand, stronger comparative advantages in territories 3–5 do not lead to higher levels of specialization, and only territories 5 manage to balance domestic production and meat consumption. The discrepancy between specialization and advantages is correlated with the finding that the spatial distribution of livestock production is more influenced by economic factors than natural factors, as observed in Stage 1.

A similar discrepancy can be observed between advantages and specialization in the dairy sector. All territories except for Category 5 specialize in producing milk and dairy products, but the level of specialization does not always correspond to productivity. In territories 1 and 4, which have strong specialization in dairy production, high productivity is not always achieved, and productivity is often below the national average. Similarly, in territories 1–4 which specialize in the production of eggs, the level of specialization is inversely related to natural and economic conditions (it increases as the quality of agricultural land decreases). Even though these territories have a distinct specialization, they do not always reach the self-sufficiency or economic accessibility thresholds that Category 5 meets. On the other hand, Category 5 territories demonstrate the highest level of productivity, despite their weakest specialization when it comes to producing milk and dairy products.

4. Discussion

To summarize the results, several points can be made to discuss the potential contribution of the study to the literature.

First, in the most general sense, differences in the comparative advantages of individual territories in agriculture can be seen to stem from differences in spatial rent (Czyzewski and Matuszczak, 2016). This conclusion is consistent with Ricardo's theory of land rent, which essentially states that differences in rent (in the current study, cadastral value) between territories arise due to differences in costs on different plots of land in terms of fertility (Wickstrom, 2024). According to Ricardo (1817), rent is formed on the best land available for cultivation, relative to the worst land plots.

Indeed, the results of the study show that in territories with a higher population density (the European part of Russia and the southern territories of the Far East), a lack of agricultural resources necessitates the use of land with lower quality parameters (areas of lower fertility, according to Ricardo). As shown by Sieber (1870) in one of the interpretations of Ricardo's theory of land rent, higher-quality land plots are introduced into agricultural production earlier than other plots (the spatial dimension of comparative advantage), while with additional investment in land cultivation, rent also increases (the economic dimension of comparative advantage).

Second, rent can be seen not just as a technical issue concerning the distribution of income between the tenant and landowner, but also as a source of competitive advantage for territories and a tool for redistributing public wealth (Dubyansky, 2020). Many scholars, including Kuzmenkova (2013), Dolgushkin (2015), and Borodin (2021), agree that, in the agricultural sector, the government should adjust the spatial distribution of market-based competitive advantages in order to mitigate extreme differences between territories and balance economic performance with social development objectives.

Third, in accordance with Giza et al. (2021), Bai et al. (2022), and Karahasan and Pinar (2023), the study assumes that the spatial availability of agricultural resources increases with improved natural and climatic conditions for agricultural production. Based on the above interpretation of Ricardo's theory of land rent, one can assume that rent arises in territories with relatively more fertile land (categories 3–5) due to the fact that food shortages lead farmers to cultivate less fertile areas. As a result, the prices of agricultural products should be high enough to cover the cost of producing crops on the least fertile land (Dubyansky, 2020). Previous studies have not clearly revealed the relationship between natural factors of production and prices (Radulescu et al., 2022; Chang and Fang, 2022; Li, 2023). However, it is observed that both producer price indices and average prices of various types of raw materials and food products are lower in areas with better natural and economic conditions for agriculture.

Fourth, the revealed inverse relationship between specialization and natural competitive advantages supports the conclusion that the connection between specialization and natural strengths is different in the crop and livestock industries (Subić et al., 2020; Yang et al., 2022; Zhao and Xiong, 2022). In the crop sector, there is a direct relationship between the level of specialization and improvements in competitive advantages. That is, as the competitive advantages improve, the level of specialization increases. However, as shown by de Raymond (2013), Li et al. (2017), Erokhin et al. (2021), and Singbo et al. (2021), among others, over-specialization in crop production can be ineffective. Many crops cannot be grown in the same place annually due to biological conditions. Instead, they need to be rotated through different land plots in order to maintain soil fertility and prevent pests and diseases from becoming resistant to treatment (Stupen et al., 2020). The natural fragmentation of land masses, their heterogeneity in terms of soil composition, productivity, and other characteristics, requires a variety of uses for these lands. This leads to the need for a diverse range of crops to be maintained in circulation simultaneously. Therefore, for a territory which specializes in crop production, it is challenging to reach a level of specialization where the economy of scale can be maximized (Kim et al., 2012).

Fifth, in contrast to the crop sector, in the livestock industry, specialization is

more influenced by economic factors than natural ones. In line with the previous findings of Yan et al. (2021), Zhao and Xiong (2022), and Yang et al. (2022), this study shows that economic factors are more significant than natural factors in determining the spatial distribution of livestock production forces. As previously demonstrated by Constantin et al. (2021) and Gine et al. (2022), as the total inputs increase, the return on agricultural resources decreases. In accordance with the principle of marginal cost efficiency (Marshall, 1890), a production unit may need to modernize at a certain point in order to increase the effectiveness of additional investments in fixed assets.

5. Conclusion

5.1. Summary of findings

- Differences in the comparative advantages of territories in the agricultural production stem from differences in the qualitative parameters of land (spatial rent) measured by cadastral value of agricultural land.
- Spatial availability of agricultural resources increases with improved natural and climatic conditions for agricultural production.
- In crop production, specialization depends more on natural factors, while in animal husbandry, economic factors have a stronger influence on the distribution of resources.
- Effectiveness of new fixed asset investments tends to decrease as the natural and economic factors of agricultural production improve, and the market becomes saturated with labor resources.
- Despite the differences in natural and economic conditions between territories, the value of current costs per unit of output remains relatively stable, while the amount of investment per unit of output continues to increase

5.2. Policy implications

In Russia, spatial development of agriculture is challenged by the discrepancy between distinct specialization in a territory for producing a particular product and the relative advantages of other territories. Territories 1–3 are losing to territories 4–5 based on criteria such as yield, productivity, costs, profitability, and consumer protection. The paradox lies in the fact that in lower competitive territories 1–3, a significant proportion of production is directed towards products that are not only more expensive for consumers, but also less profitable for producers. This mismatch between specialization and advantages erodes the competitiveness of territories in agricultural production, and degrades the diversification of the agricultural sector. To improve the spatial pattern of development in the agricultural sector, the government should encourage farmers to utilize competitive advantages that help balance the parameters of physical availability and economic accessibility of staple foods as key indicators of food security. Further investments in territories 3–5, without taking into account their competitive advantages, will not only increase the physical supply of products, but also increase their prices and, consequently, decrease the economic affordability of food and agricultural products for domestic consumers.

5.3. Current limitations and future research

This study has several limitations, the removal of which opens up potential areas for research in the field of assessing the impact of the competitive advantages of individual territories on shaping the spatial development patterns in agriculture.

Using only one parameter of cadastral value as a basis for determining differences between territories may limit the applicability of the approach. Instead, a composite index could be used. It may include several indicators, such as the structure of the land fund in the territory, the proportion of arable land in the total land area, soil composition, land availability per capita, average yield, and land use structure by type of farm. Using a composite index as a comparative advantage parameter will allow for a more accurate reflection of various aspects of advantages, including land quality and land use characteristics, in a particular territory.

Similar to the main parameter of comparative advantage used in this study, it is necessary to expand the set of parameters to assess economic, social, and environmental aspects of advantages. Thus, economic parameters may include transaction costs (access to local or national markets), wages for agricultural workers, taxes, and agricultural credits. Social parameters could include the level of income in rural areas and the level of education among rural residents. Environmental dimension can be assessed through indicators such as soil pollution, soil erosion, and the availability of programs for restoring soil fertility in the region.

Allocating resources between territories based on their natural and economic conditions requires a study of the impact of comparative advantages on a territory's food self-sufficiency and food security parameters. In this study, the authors assess only the indicators of self-sufficiency of territories in producing certain types of agricultural products and the economic accessibility of food, but the food security agenda is much broader than just self-sufficiency. Future studies should consider indicators such as the stability of food supply and food safety when assessing the competitive advantages of different territories.

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