

# SUSTAINABLE DEVELOPMENT OF TERRITORIES, BRANCHES, AND PRODUCTION COMPLEXES

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## THE IMPACT OF THE LIVESTOCK INDUSTRY ON THE ECOLOGICAL DEVELOPMENT OF RURAL AREAS



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*The relevance of the sustainable development agenda of the Russian Federation and its territories remains at the present time, even taking into account the difficult external economic and geopolitical situation in the world. The relatively recent changes in Russian legislation are characterized by the fact that now not only the country as a whole is considered in the sustainable development paradigm, but also rural areas, which should also follow the path of the sustainable development. In this regard, the article defines the constituent entities of the Russian Federation according to a certain range of indicators, where the trends of the sustainable rural development are manifested. Our method of two-stage analysis allows first assessing the development of one of the agricultural branches – regional animal husbandry, and then determining its impact on the sustainable development of rural areas. To do this, we introduce several special coefficients that make it possible to summarize*

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*the data set in a regional context and identify current trends. As a result, the paper concludes that the sustainable development of rural areas is influenced by a number of factors, among which are: the composition and quantity of feed consumed by cattle, the number of heads in the herd, state support for agricultural producers from budgets of different levels. Theoretically, the article has elements of scientific novelty and is distinguished by the fact that, along with the economic and social components, it allows taking into account the equally important environmental component of the triad of the sustainable development. In practical terms, the article may be useful to the authorities of the constituent entities of the Russian Federation responsible for achieving the targets for sustainable rural development, as it identifies current trends and identifies factors affecting the development of both the industry and the territory, which contributes to the adoption of scientifically sound management decisions.*

*Agriculture, regional animal husbandry, government support, net financial result, efficiency coefficient, cattle, profitability of goods sold.*

### **Introduction**

The understanding of the concept of sustainable development that has formed within the global community, characterized fundamentally by the unity of its three components (economic, social, and environmental), their interdependence and mutual influence, is associated not only with the balanced development of all its components in the current period but also with shaping the future socio-ecological-economic potential of a territory, considering the perpetual improvement of the population's quality of life. This understanding of the concept follows from the very term "sustainable development" as reflected in the report "Our Common Future" by the World Commission on Environment and Development<sup>1</sup>, as well as from numerous

publications available in scientific and specialized literature (Kozlov et al., 2024; Kalitseva, Charaeva, 2023; Akim, 2023; Alferova, 2023; Erokhina, 2022; Amirova et al., 2022; Bolshakov, Shamaeva, 2017).

The Russian Federation has ratified several international conventions and protocols<sup>2</sup> and has legally formalized its own regulatory documents in this sphere<sup>3</sup>. Thus, it has not only joined global trends in sustainable development but has also assumed certain limitations and obligations to comply with and implement the prescribed regulations.

Federal Law 160-FZ adopted last year (dated June 22, 2024) introduced the term "sustainable development of rural territories" into legal discourse through Article 4.1. This term is to be understood as a quantitative increase in specific economic and social indicators. In

<sup>1</sup> Our Common Future: Report of the World Commission on Environment and Development. United Nations General Assembly. 1987. Available at: <https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html> (accessed: 27.08.2025).

<sup>2</sup> On the Adoption of the Paris Agreement: RF Government Resolution 1228, dated September 21, 2019. Available at: <https://www.garant.ru/products/ipo/prime/doc/72661694/?ysclid=m1zeo8dzm0623948623> (accessed: 27.08.2025); On the Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change: Federal Law 128-FZ, dated November 4, 2004. Available at: <http://www.kremlin.ru/acts/bank/21599> (accessed: 27.08.2025); On the Ratification of the United Nations Framework Convention on Climate Change: Federal Law 34-FZ, dated November 4, 1994. Available at: <https://clck.ru/36vPKw> (accessed: 27.08.2025).

<sup>3</sup> On Certain Measures to Improve the Energy and Environmental Efficiency of the Russian Economy: Presidential Decree 889, dated June 4, 2008. Available at: <http://www.kremlin.ru/acts/bank/27565> (accessed: 27.08.2025); Strategy for the Socio-Economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050: RF Government Resolution 3052-r, dated October 29, 2021. Available at: <https://clck.ru/36vPQZ> (accessed: 27.08.2025).

particular, the law mentions “increasing the volume of agricultural production” (economic component) and “achieving full employment of the rural population” (social component)<sup>4</sup>. That is, sustainable development of rural territories is defined without fully accounting for another, no less important component – the environmental one. It should be noted here: the legally presented definition refers to only one component of the natural environment – “rational use and protection of lands”; other environmental objects are not specified.

However, it is not only land but the environment as a whole that is significantly impacted by agriculture, particularly one of its sub-sectors – animal husbandry, including negative impacts. According to some expert estimates, methane (CH<sub>4</sub>) emissions into the planet’s atmosphere from cattle alone account for about 15%, with two-thirds of this attributed to cows. The peculiarity of this gas is that, compared to carbon dioxide (CO<sub>2</sub>), it heats the Earth dozens of times faster and retains heat for a longer period, which ultimately leads to the greenhouse effect, exacerbates the environmental problem of global warming, and consequently does not contribute to the sustainable development of a territory.

Certain Western European countries are seriously concerned about this problem and, in order to resolve it, are proposing rather radical measures: some – introducing a tax on methane emissions from livestock (for example, Denmark has already calculated a tax rate for cows and pigs); others – culling dairy cows (for instance, Irish authorities plan to eliminate 200 thousand out of 1.6 million head; similar actions are being

considered by the authorities of France and the Netherlands).

According to official data from the Federal State Statistics Service of the Russian Federation (Rosstat)<sup>5</sup>, in 2023, Russia had 17.1 million head of cattle, of which 7.5 million were cows (~44%). On average, a single animal “produces” about 100 kg of methane per year – illustrating the scale of the problem both globally (with about 1.8 billion head worldwide) and for individual countries (for example, in Brazil, according to a 2021 industrial cattle farming portal, the number of cows and bulls exceeded the country’s human population).

According to the Food and Agriculture Organization of the United Nations (FAO), in rankings of countries engaged in agricultural production, Russia is frequently positioned among the leading nations. However, our country’s leading positions are noted in sub-sectors of crop farming associated with harvesting specific crops: wheat, rye, barley, and buckwheat. Furthermore, it should be noted that compared to animal husbandry, crop farming in recent years has shown a net financial result that is 30% higher, and profitability ratios that are 3–4 times greater (for instance, in 2022, the profitability of sold products in animal husbandry was 11.5%, while in crop farming it was 34.9%; in 2021, the profitability in animal husbandry was 12.6%, compared to 48.5% in crop farming).

In light of this, as well as considering recent amendments to Russian legislation and the intentions of some states regarding tax initiatives and livestock culling, there is a need to conduct a sectoral analysis of the sustainable development of Russia’s rural territories based on regional animal husbandry (cattle farming).

<sup>4</sup> On Amending Article 19 of the Federal Law “On Peasant (Farm) Enterprises” and the Federal Law “On the Development of Agriculture”: Federal Law 160-FZ, dated June 22, 2024. Available at: <https://docs.cntd.ru/document/1306440348?section=text> (accessed: 27.08.2025).

<sup>5</sup> Agriculture in Russia. 2023. Information by Constituent Entities of the Russian Federation: Appendix to the Collection. Available at: <https://rosstat.gov.ru/folder/210/document/13226> (accessed: 27.08.2025).

### Literature review

If we employ the conceptual framework of regression analysis, then in the article by A.Kh. Blieva, sustainable territorial development is considered as the independent variable (regressor) that influences the dependent variable (regressand) – the agricultural economy. This formulation of the question is scientifically interesting because, firstly, it a priori defines a unidirectional causal relationship, and secondly, it contrasts with the now common viewpoint where sustainable development is considered the regressand, not the other way around. As a result, the author concludes that sustainable development of rural territories is an “important factor for the agricultural economy and the agro-industrial complex” (Blieva, 2023). In another article examining various problems of rural territories, the author analyzes the three components of sustainable development (social, economic, and environmental) in blocks and concludes that state support is needed for “innovative transformations” in the form of innovative programs, as well as “the introduction of new agricultural technologies that will increase its productivity while reducing negative environmental consequences from economic activity” (Bratarchuk, 2022). In the article by S.A. Andryushchenko and M.Ya. Vasilchenko, strategies for the development of dairy cattle farming in various constituent entities of the Russian Federation are substantiated. Based on a performed critical analysis of theoretical and methodological approaches to addressing issues of spatial organization in the livestock sector, the authors, from a methodological standpoint and in accordance with the postulates of sustainable development, conclude that it is advisable to improve the location of livestock production facilities (Andryushchenko, Vasilchenko, 2023). Another article is also devoted to issues of location and efficient functioning of livestock

sectors: its authors examine specific factors that can increase productivity in agriculture (Gubanova et al., 2023). The emphasis here is on the inherent features and regional differences of the Russian federal subjects.

Special attention to issues of managerial activity in the context of sustainable development of rural territories is given in an article where the authors analyze the planning system, management processes, interaction schemes, etc., which ultimately allows for the development of a “model for managing the sustainable development of a region’s rural territory” (Soldatov et al., 2022). In another article also considering management processes, state regulation of agriculture and its sub-sectors is linked to the implementation of various functions, among which are highlighted “creating and ensuring sustainable development of rural territories <...>; solving specific environmental tasks” (UTerritoryntseva, 2023). In a collective monograph (Khagurov, 2020), using rural districts of the Krasnodar Territory as an example, the main factors influencing the stability of living systems are examined. In a similar vein, the article by A.I. Surov and co-authors analyzes the problem of mismatch between the available cattle population and harvested pasture fodder in the Stavropol Territory. Within the scientific approach to sustainable development, conservation, and reproduction of natural ecosystem potential, the researchers conclude on the necessity for rational use and restoration of natural environment elements (Surov et al., 2024).

The literature review, including the aforementioned works as well as some other scientific publications on the research topic (Uskova, 2009; Popova et al., 2020; Solopov et al., 2022; Sergienko, 2023; Sashkova, Erokhin, 2024; Bovkun-Saass, 2025; Yurkova et al., 2020), allows for several conclusions. On one hand, there is an insufficient number of publications assessing

the impact of agricultural activities, broken down by various sub-sectors of the regional economy (including animal husbandry), on the environment and the sustainable development of rural territories; the patterns and factors shaping current development trends for both the industry and the territory are not defined. On the other hand, it is precisely their consideration that becomes unquestionably necessary, as it is directly linked to the formation of sustainable development of the rural territory. Furthermore, it can be noted that current publications are characterized by insufficient elaboration of issues such as the location of various branches and sub-branches of animal husbandry at the regional level; comprehensive consideration of endogenous and exogenous conditions and factors influencing their location and, consequently, the sustainable development of Russia's agricultural territories. All of this underscores the relevance of the article's topic and defines the practical significance of the conducted research.

### Research objective and methodology

The objective of the research is to determine current trends and the degree of influence of the animal husbandry sector on the environmental

component of a region in the context of sustainable development of Russia's rural territories, through conducting a territorial-sectoral analysis of the constituent entities of the Russian Federation. The authors' focus is primarily on the economic-environmental aspects of sustainable development of the country's rural territories.

The research methodology comprises several stages. At the first stage, based on official data from the Federal State Statistics Service (Rosstat), initial data for the years 2015, 2018, 2019, 2020, 2021, and 2022 (this is the time interval available in domestic statistics) are collected for all 85 constituent entities of the Russian Federation according to the following indicators.

1. "Cattle population" (CP). This indicator is fundamental, as it accounts for all cattle (in all categories of farms: agricultural organizations, peasant (farmer) households, and households) within each region, belonging to the category of ruminant animals that produce methane, which negatively affects the environment, and is perceived as a factor in the territory's sustainable development. Overall, Russia exhibits a downward trend in the values of this indicator (*Fig. 1*).

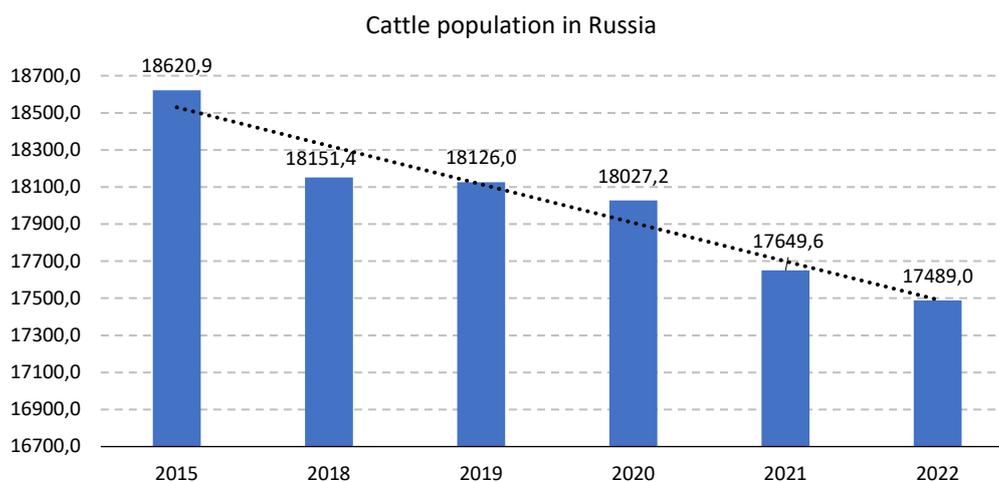


Figure 1. Dynamics of changes in the cattle population in the Russian Federation for the period 2015–2022, thousand head

Source: Rosstat data.

2. “Feed consumption per conventional head of cattle”<sup>6</sup>. This indicator is necessary in the analysis because: 1) it reflects a moderate positive correlation with milk yield per cow (an additional calculation of the linear Pearson correlation coefficient demonstrated the closeness of the relationship between the variables:  $r = 0.37$ ), meaning the amount of feed can influence livestock productivity (the study did not account for various additives and supplements that increase animal productivity); 2) it is one of the indicators of efficiency in animal husbandry, as, being an expense item in the accounting balance, it directly affects the financial and economic indicators of economic entities, and thus generally reflects the economic efficiency of the sector in the region – the less spent on feed procurement without decreasing milk yields, the higher the efficiency; 3) it is used in calculating the coefficient of animal husbandry efficiency in the region (coefficient  $C_{\text{ahe}} = \text{“cattle population”} / \text{“feed consumption per conventional head of cattle”}$ ; this coefficient is calculated by analogy with the production efficiency indicator in economics, which determines maximum results with minimal costs; the coefficient is calculated for each federal subject); 4) the calculated coefficient is used in subsequent stages for the overall assessment of sustainable development of rural territories.

3. “Net financial result (profit minus loss) of organizations” ( $N_{\text{fr}}$ ), reflecting the economic viability of this type of activity.

4. “Profitability of sold goods, products (works, services) of organizations” ( $P_{\text{sg}}$ ), reflecting the economic efficiency of this type of activity.

The last two indicators are the key financial and economic metrics for organizations operating in animal husbandry. Their values can fundamentally influence

the indicators of sustainable development in rural territories.

In the second stage, the time series for all indicators are normalized for each constituent entity of the Russian Federation by calculating the arithmetic mean for the analyzed period.

In the third stage, the regional animal husbandry efficiency coefficient ( $C_{\text{ahe}}$ ) is calculated for each entity by dividing the average values: “cattle population” / “fodder consumption per standard cattle unit”.

In the fourth stage, the value and contribution of each constituent entity of the Russian Federation to the development of animal husbandry in Russia is determined. This is done by calculating the specific weight of the regional animal husbandry efficiency coefficient relative to the animal husbandry efficiency coefficient for the Russian Federation as a whole.

In the fifth stage, a statistical summary of the calculated regional animal husbandry efficiency coefficients is compiled and compared with the financial and economic indicators of organizations (the arithmetic mean of the time series in each region). For the final summary, the data array is grouped according to the indicator of the specific weight of the regional efficiency coefficient, considering the following ranges of variability:

1) 0.00–0.99% – constituent entities of the Russian Federation with an insignificant share of agriculture in the regional economy ( $C_{\text{ahe}}$  – low);

2) 1.00–1.99% – constituent entities of the Russian Federation with a significant share of agriculture in the regional economy ( $C_{\text{ahe}}$  – medium);

3) 2.00% and above – constituent entities of the Russian Federation with a high share of agriculture in the regional economy ( $C_{\text{ahe}}$  – high).

<sup>6</sup> Exactly corresponds to the indicators calculated by national statistics (Agriculture in Russia. 2023: Statistical Collection. Rosstat. Moscow, 2023. P. 71; Table 4.12).

At the final (sixth) stage, the sustainability of rural territory development is determined. For this purpose, two coefficients are calculated, demonstrating the degree of participation of regional economic entities in environmental restoration and the expenses they incurred to compensate for negative impact on the regional ecosystem: 1) the coefficient reflecting “current expenditures on atmospheric air protection and climate change prevention” per “head of cattle” in the region ( $C_{aap}$ ); 2) the coefficient reflecting “investments in fixed capital aimed at atmospheric air protection”, also per “head of cattle” in the region ( $C_{ifc}$ ). The development of rural territories can be considered sustainable if each coefficient has a value above 1.00. The source data for the calculation correspond to the following time interval (according to available Rosstat data): 2015, 2017, 2019, 2021. The calculation of the aforementioned coefficients is based on the arithmetic mean value.

## Research results

Following the sequential implementation of the stages described above, three groups of regions were formed based on the established criteria. The group with a high share of agriculture in regional development includes 17 constituent entities of the Russian Federation (*Tab. 1*).

This group of regions is characterized by rather ambiguous results. Thus, despite similarly high animal husbandry efficiency coefficients, the average values of the “net financial result (profit minus loss) of organizations” indicator differ substantially between the entities. For example, within the same group, one can find both regions ranked in the top-10 with the highest values in Russia (Republic of Tatarstan, Voronezh Region, Novosibirsk Region, and Krasnodar Territory – the latter also having the highest profitability in Russia and being in the top-10 regions for this indicator) and the most loss-making regions, which are in the bottom-10 in Russia (Orenburg Region,

**Table 1. Russian regions with a high share of animal husbandry in the Regional economy**

No.	RF constituent entity	$C_{ahe}$		$N_{fr}$ million rubles	$P_{sg}$ %
		coefficient value	% relative to the RF		
1	Republic of Dagestan	37.64	5.98	28.83	5.63.
2	Republic of Bashkortostan	26.98.	4.28	1034.5	7.98.
3	Republic of Tatarstan	26.70	4.24	4594.83	9.07
4	Trans-Baikal Territory	21.32	3.38	5.83	-9.52
5	Orenburg Region	20.86	3.31	-225.5	1.75
6	Rostov Region	20.46	3.25	-15197.7	1.73
7	Altai Territory	19.07	3.03	2982.5	15.52
8	Krasnodar Territory	17.04	2.71	6802.83	21
9	Voronezh Region	16.98	2.70	6206.333	16.75
10	Republic of Buryatia	16.41	2.61	376.17	16
11	Republic of Kalmykia	16.00	2.54	77	-0.13
12	Bryansk Region	15.37	2.44	-830.5	6
13	Stavropol Region	14.24	2.26	2357.17	12.48
14	Saratov Region	14.16	2.25	824	11.45
15	Volgograd Region	13.98	2.22	762.67	11.43
16	Novosibirsk Region	12.77	2.03	4535.833	14.82
17	Republic of Tyva	12.61	2.00	-1.66667	-9.3

Source: Rosstat data.

Rostov Region, Bryansk Region). Furthermore, two other regions should be noted – Trans-Baikal Territory and the Republic of Kalmykia – where the net financial result is positive, while profitability is negative.

The second group includes 19 RF constituent entities. Overall, they are also characterized by multifaceted results, but more smoothed out (Tab. 2,  $C_{ahe}$  – medium).

Attention is drawn to four RF constituent entities (Belgorod Region, Kursk Region, Leningrad Region, and Republic of Mordovia), which have the highest financial and economic indicators in Russia: they are in the top-10 regions of the country (an exception: Leningrad Region is not in the top-10 for the “profitability” indicator, but its profitability is almost twice the average value for the group).

The next group of RF constituent entities is characterized by an insignificant share of agriculture in the regional economy –  $C_{ahe} < 1\%$

(the remaining 49 RF constituent entities, not presented in Tables 1 and 2). However, even here, the group’s multifaceted nature is observed: regions with the lowest values for the net result and profitability (Sakhalin Region, Murmansk Region, Khanty-Mansi Autonomous Area, Yamal-Nenets Autonomous Area, etc.) coexist with regions that, on the contrary, possess the highest values in Russia for financial and economic indicators (Lipetsk Region, Pskov Region, Oryol Region, Ryazan Region, Republic of Mari El, and Republic of Crimea).

The obtained results reveal the following trends.

1. A positive net financial result (profit minus loss) coincides with negative profitability of sold products. This first trend is characteristic of a specific group of regions, which includes 10 RF constituent entities: Trans-Baikal Territory, Kamchatka Territory, republics of Kalmykia, Sakha (Yakutia), Alania, Karelia, Arkhangelsk

**Table 2. Russian regions with a significant share of animal husbandry in the regional economy**

No.	RF constituent entity	$C_{ahe}$		$N_{fr}$	$P_{sg}$
		coefficient value	% relative to the total	million rubles	%
18	Astrakhan Region	12.46	1.98	38.17	4.17
19	Belgorod Region	11.15	1.77	26582.12	21.1
20	Irkutsk Region	11.01	1.75	2571.67	9.63
21	Omsk Region	10.88	1.73	2205	11.08
22	Krasnoyarsk Territory	9.62	1.53	3797.5	10.43
23	Republic of Altai	9.09	1.44	-8.33	-5.78
24	Udmurt Republic	8.76	1.39	2729.83	8.8
25	Sverdlovsk Region	8.70	1.38	3802.167	6.3
26	Republic of Sakha (Yakutia)	8.51	1.35	17.67	-32.53
27	Tyumen Region without AA	8.45	1.34	3068.17	11
28	Kabardino-Balkarian Republic	8.42	1.34	80.33	9.93
29	Chechen Republic	8.27	1.31	-16	-28.4
30	Nizhny Novgorod Region	7.83	1.24	2261.667	8.47
31	Republic of Mordovia	7.82	1.24	7474.33	20.02
32	Chelyabinsk Region	7.74	1.23	1453.83	5.05
33	Kursk Region	7.38	1.17	7001.67	27.63
34	Perm Territory	7.08	1.12	1862.5	4.73
35	Leningrad Region	7.06	1.12	6697.167	10.32
36	Chuvash Republic	6.44	1.02	-887.333	9

Source: Rosstat data.

Region, city of Moscow, Nenets and Chukotka autonomous areas.

Negative profitability is possible, at least in two cases: a) profit is insufficiently high due to a limitation in the profit margin itself (e.g., when market conditions and other circumstances do not allow for increasing prices of sold products), and b) an increase in the cost of production occurs in certain regions, which is confirmed by aggregated data for Russia as a whole when considering the cost structure for production and sales of products (Fig. 2).

This situation is quite challenging from a practical standpoint, as this type of activity is economically loss-making. Consequently, livestock farms cannot independently improve the level of social well-being of their workers, which directly depends on the economic performance of this industry. Theoretically, one might consider abandoning unprofitable livestock farming in such a region. However, the Food Security Doctrine of the Russian Federation does not allow for such speculative decisions. Therefore, authorities (both federal and regional) must make decisions based not on the economic outcome, but on the principle that ensures the fulfillment of the state's strategic objectives. This trend reveals territories with

unstable development, even without analyzing its third component – the ecological one. In this case, state support for the industry at the federal level is required to ensure minimum allowable indicator values.

2. A negative net financial result (profit minus loss) coincides with negative profitability of sold products. This second trend is characteristic of a group of regions which includes 13 RF constituent entities: republics of Tyva, Altai, Chechen, Karachay-Cherkess, Samara, Sakhalin, Magadan, Murmansk regions, Primorye and Khabarovsk territories, Khanty-Mansi Autonomous Area (KhMAA), Yamal-Nenets Autonomous Area (YNAA), and the Jewish Autonomous Region. The reasons for obtaining negative values in financial and economic indicators are typical for all regions (see the first and third trends). However, their parameters are significantly influenced by natural and climatic conditions, production and consumption volumes, the composition and nomenclature of the cost structure, and other circumstances reflecting the specifics of regional development and the particularities of livestock farming in different RF constituent entities. From a socio-ecological-economic point of view, this situation leads to conclusions

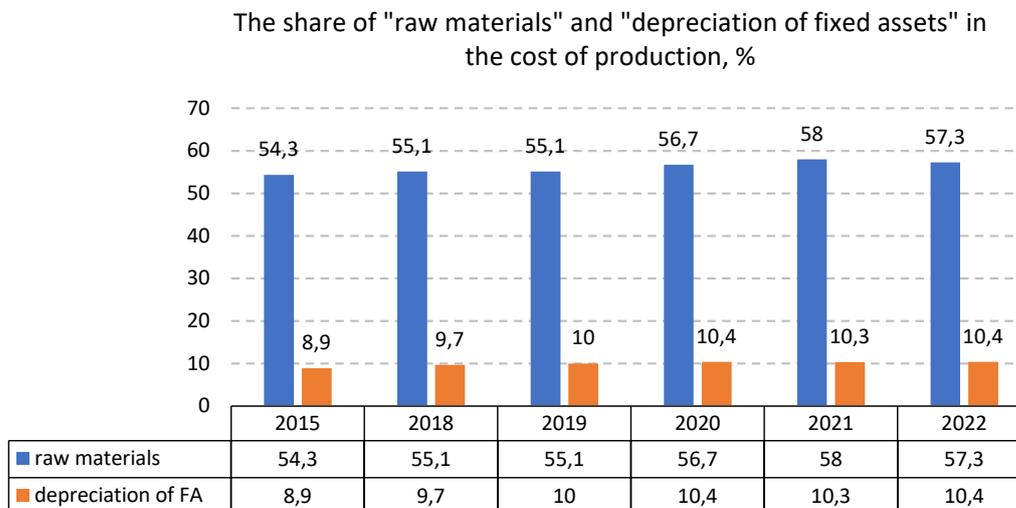


Figure 2. Dynamics of changes in the share of individual components in the cost structure, %

Source: Rosstat data.

similar to those from the analysis of the first trend – regions within this group should be considered as having unstable development. As in the previous case, state support for the industry is required, but this time from both federal and regional authorities.

3. A negative net financial result (profit minus loss) coincides with positive profitability of sold products. This trend is characteristic of a group of regions which includes six RF constituent entities: Orenburg, Bryansk, Rostov, Kaluga regions, Chuvash Republic, Republic of Adygea. In this study, the average value over a series of years was calculated (a mathematical mean). Therefore, the obtained result does not mean that every year ended with a negative balance and that agricultural organizations were loss-making annually. For example, the Bryansk Region showed a negative financial result in 2015 and 2018, which in absolute terms “outweighed” the positive financial result for all subsequent years – from 2019 to 2021. However, this means (this is the trend) that, depending on external and other factors, agricultural producers in certain regions of the country periodically face the problem of generating profit in the current year, and their further “survival” depends either on previously formed reserves and accumulated resources (material, financial, etc.), the so-called “safety cushion”, or on state support in the form of various subsidies, grants, and other payments from budgets of different levels. That is, positive profitability (the average value over

a series of years) makes the development of agriculture (livestock farming in particular) in such regions relatively promising in the future. But in the present – due to the negative net financial result – they should be considered as rural territories with conditionally stable development. In this case, the actions of regional authorities to support agricultural producers may be of a sporadic nature.

4. A positive net financial result (profit minus loss) coincides with positive profitability of sold products. The fourth trend is characteristic of all remaining regions not listed in points 1–3, with the exception of the city of Saint Petersburg, for which data on cattle population were unavailable. While such a situation raises no doubts from a socio-economic point of view, it becomes ambiguous when considering the environmental component – an integral part of the triad of sustainable development of rural territories. For instance, in the Republic of Tatarstan and the Novgorod Region, with the same profitability (9%) and different net financial results (in Tatarstan it is 12.25 times larger), the negative environmental impact (methane emissions) also differs: in Tatarstan, the average for the analyzed years was 979.47 thousand head, while in the Novgorod Region it was 29.91 thousand head. Consequently, the negative environmental impact in Tatarstan is 32.75 times greater. This raises the question: which region, then, should be considered a region with sustainable development?

Aggregated data for the four trends discussed above are presented in *Table 3*.

**Table 3. General characteristics of sustainable development trends in Russian rural territories**

Trend	$N_{fr}$	$P_{sg}$	Development characteristic	Number of RF constituent entities
first	positive	negative	unsustainable	10
second	negative	negative	unsustainable	13
third	negative	positive	conditionally sustainable	6
fourth	positive	positive	conditionally sustainable	55

Source: own compilation.

## Discussion

To answer the question posed, it is necessary to proceed to the implementation of the sixth stage. The calculation of the corresponding coefficients ( $C_{aap}$  and  $C_{ifc}$ ) was carried out for the RF constituent entities with a significant (“high” and “medium”) share of agriculture (livestock farming) in the regional economy. The results of the calculations are presented in *Table 4*.

The obtained results allow for another significant conclusion. In certain constituent entities of the Russian Federation (Krasnoyarsk Territory, Sverdlovsk, Tyumen, Chelyabinsk,

Irkutsk, Omsk regions, etc.), where the animal husbandry efficiency coefficient meets the “high” or “medium” criteria, the sustainable development of rural territories depends to a considerable extent on the level of industrial production development in that entity: the higher it is, the more sustainable the development of rural territories in this region will be, since revenues from industry can compensate for the negative environmental impact caused by animal husbandry. This pattern should be taken into account when implementing regional sustainable development policies.

**Table 4. Russian regions with sustainable / unsustainable development of rural territories**

No.	RF constituent entity	$C_{aap}$	$C_{ifc}$	$C_{ahe}$	Development of rural territories
1	Republic of Dagestan	0.05	no data	high	unsustainable
2	Republic of Bashkortostan	1.46	1.34	high	sustainable
3	Republic of Tatarstan	3.51	1.67	high	sustainable
4	Altai Territory	0.60	0.06	high	unsustainable
5	Krasnodar Territory	1.45	1.16	high	sustainable
6	Voronezh Region	1.30	0.17	high	unsustainable
7	Republic of Buryatia	1.19	0.15	high	unsustainable
8	Stavropol Region	1.19	0.52	high	unsustainable
9	Saratov Region	2.28	1.22	high	sustainable
10	Volgograd Region	11.06	3.45	high	sustainable
11	Novosibirsk Region	1.49	0.27	high	unsustainable
12	Astrakhan Region	1.68	0.09	medium	unsustainable
13	Belgorod Region	6.62	2.20	medium	sustainable
14	Irkutsk Region	10.90	10.63	medium	sustainable
15	Omsk Region	4.06	5.35	medium	sustainable
16	Krasnoyarsk Region	13.12	33.08	medium	sustainable
17	Udmurt Republic	0.62	0.08	medium	unsustainable
18	Sverdlovsk Region	18.97	10.23	medium	sustainable
19	Tyumen Region without AA	1.33	3.40	medium	sustainable
20	Kabardino-Balkarian Republic	0.10	no data	medium	unsustainable
21	Nizhny Novgorod Region	2.76	0.90	medium	unsustainable
22	Republic of Mordovia	0.51	0.12	medium	unsustainable
23	Chelyabinsk Region	18.64	18.74	medium	sustainable
24	Kursk Region	0.82	0.05	medium	unsustainable
25	Perm Territory	8.08	0.61	medium	unsustainable
26	Leningrad Region	7.93	13.41	medium	sustainable

Source: Rosstat data.

## Conclusion

Currently, experts propose several ways to solve the problem of methane emissions from ruminants. Some advocate for changing the type of feed and diet by including various additives that would reduce CH<sub>4</sub> emissions. Others propose breeding a special type of cattle with lower atmospheric “exhaust”. Yet others suggest somehow collecting the gas produced by each animal and using it purposefully. There are other methods as well. However, none of them has so far led to significant success or proven its effectiveness for widespread long-term application.

At the same time, attention should be paid to significant factors that substantially influence the sustainable development of rural territories and must be considered both for forming sustainable development trends and for making relevant management decisions by authorities:

1) not only the composition but also the quantity of consumed feed and various additives in the animals’ diet; more progressive (advanced, innovative) nutrition for cattle should contribute to solving a dual task: on the one hand, reducing the cost of livestock rearing due to a smaller volume of feed in the diet (the economic component of sustainable development), and on the other hand, reducing

methane emissions by including appropriate components in the diet (the ecological component of sustainable development). Thus, this factor directly links the economic and ecological components of sustainable development;

2) the number of cattle heads, as it is decreasing worldwide for various reasons: in the USA, the number decreased by 3% in 2022; in France, by 2.7%; globally, by ~50 million head; in Russia, the number was 18.6209 million head in 2015 and 17.6496 million head in 2022; therefore, considering this global trend, it can be stated that the economic component directly influences the ecological component of sustainable development; at the same time, the overall reduction in the number of cattle should be ensured by their productivity (for example, according to Rosstat, the level of self-sufficiency in basic food products in Russia is quite high; in particular, for meat, it was 101.8% in 2022);

3) state support for agricultural producers from budgets of different levels; according to domestic statistics, state expenditures on agriculture increase product profitability by an average of 4–5% (in animal husbandry), which undoubtedly positively affects the economic, ecological, and social components of the triad of sustainable development of rural territories.

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