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Optimization of the Proportions of Land, Capital and Labor in Agricultural Production in the Northern Regions of the Russian Federation

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Abstract. The article examines the dynamics of the proportions of land, capital and labor in the context of agricultural specialization in livestock farming in a technologically interconnected cycle of agricultural production in the Northern regions. It shows that in the economic activities of agricultural enterprises in the Arctic and the North, there is an intensification and expansion of livestock farming and a corresponding change in the composition and structure of the main production funds, but at the same time, attention to field production, in particular to improving the structure of sown areas, including fodder crops, is weakening. The article formulates proposals for improving the proportionality of the main factor components of agricultural production: land, capital and labor. One of the tools for regulating the proportionality of land, capital and labor can be the formation of motives for agricultural organizations to search for specializations leading to the rationalization of the proportionality of the main factors of production. Improvement of the state agro-industrial policy for the Northern regions in terms of rationalization of the proportions of land, capital and labor will increase the efficiency of state regulation of agricultural production development.

Keywords: Northern regions of the Russian Federation, specialization, proportionality of capital, labor and land in agriculture

Introduction

The expediency of in-depth development of optimal proportions between land, capital and labor, ensuring sustainable development of agriculture in the Northern regions, can be justified by a set of interrelated circumstances.

The first circumstance is that the ratio of the main factors of agricultural production directly and indirectly affects its efficiency and competitiveness.

The second circumstance is due to the need to ensure food security at the level of the constituent entities of the Russian Federation in connection with the introduction of economic sanc-

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tions by the United States, the EU countries and some other states against Russia, which is possible with an optimal combination of the main factors of production — land, capital and labor.

The third circumstance is determined by the need to develop the domestic market of agricultural products in order to resolve issues of import substitution, which is accompanied by a change in the combination of the main factors of production — land, capital and labor — and requires their optimal ratio.

In the current conditions, one of the key tools for stimulating the effective development of agriculture in the country and its regions is the establishment and maintenance of optimal proportions between the main factors of production — land, capital and labor, which makes the topic of this study relevant.

The objective of the article is to clarify and specify the proportions of land, capital and labor in the technologically interconnected cycle of agricultural production as applied to the conditions of the northern regions of the Russian Federation.

Research methodology

The methodological basis of the study was formed by general scientific methods, such as dialectical, induction, deduction; economic and mathematical methods; index and statistical methods. The empirical base of the study is represented by official statistical data of the territorial bodies of the Federal State Statistics Service for the northern regions of the Russian Federation.

In accordance with the methodological provisions on statistics, indicators of costs and resources of agriculture, hunting, fishing and fish farming are formed on the basis of statistical data of the Federal State Statistics Service. They characterize the volume, composition, directions of distribution and use of resources in the relevant economic organizations. The main initial indicators of agricultural resources are: land resources, indicators of reproduction of labor resources and the main production assets of agricultural entities. The methodology of our study of the rational proportions of development of the main factor components of agricultural production in the northern territories of the Russian Federation ¹ includes the aggregation of relevant indicators for typical territories and the use of economic-mathematical models based on the Cobb-Douglas formula.

Literature review

N.V. Pelikhov and E.I. Kushnikov [1] examine the well-known factors of production (capital, labor and land) in the context of innovative economy, identifying weaknesses and contradictions

¹ In accordance with Government Resolution No. 1946 of November 16, 2021 “On approval of the list of regions of the Far North and localities equated to regions of the Far North, in order to provide state guarantees and compensation for persons working and living in these regions and localities, recognizing certain acts of the Government of the Russian Federation as invalid and recognizing certain acts of the Council of Ministers of the USSR as not applicable on the territory of the Russian Federation”, the regions of the Far North include the Republic of Karelia, the Komi Republic, the Republic of Sakha (Yakutia), the Republic of Tyva, Kamchatka Krai, Krasnoyarsk Krai, Khabarovsk Krai, Arkhangelsk Oblast, Irkutsk Oblast, Magadan Oblast, Murmansk Oblast, Sakhalin Oblast, Nenets Autonomous Okrug, Chukotka Autonomous Okrug, Yamalo-Nenets Autonomous Okrug, Khanty-Mansi Autonomous Okrug – Yugra.

in their use. The authors conclude that the development of new institutional structures that accelerate the development and optimal use of existing factors of production in the interests of sustainable development is currently becoming relevant. Studying entrepreneurial abilities and information among the main factors of production, the authors analyze the possibilities of replacing them with intellectual potential.

L.N. Ivanikhina and A.A. Ivanikhin [2] note that resources in production should be in organic unity, and only a rational and balanced combination of resources, as a rule, ensures sustainable proportional development of agricultural production.

T.G. Gurnovich, A.S. Bezlepko and R.A. Kuznetsov [3] draw attention to the fact that the agricultural machinery park in the regions is steadily declining. In agricultural enterprises, each machine purchased today accounts for almost four decommissioned ones. At the same time, the preservation of sowing areas is a serious and urgent task.

M.U. Elipkhanov, Z.P. Okazova, O.I. Vlasova [4] emphasize that agriculture is part of the resource cycle of soil and climatic resources, which predetermines both the production cycle and the supply cycle of agricultural raw materials. The unevenness of the production and supply cycle of agricultural raw materials makes it difficult to establish rational proportions between land, capital and labor.

R.F. Gataullin and R.M. Sagatgareev [5, p. 215] note that the weak base of material and technical resources of agriculture in the regions of the North and the Arctic causes a decline in the technical level of agricultural production, a reduction in the potential for using labor and land resources, a decrease in the quality of agricultural activities, veterinary services for livestock and poultry.

P.S. Pozubenkov and E.I. Pozubenkova [6] emphasize that land requires the correct combination with other factor components of agricultural production. However, during the years of market reforms, the main attention was focused on the problem of land ownership, while issues related to the rational and efficient use of agricultural land were not properly formulated.

I.V. Izmalkova and S.A. Izmalkov [7] note that, unlike numerous means of production, the qualitative characteristics of land improve when used correctly, while other means of production (buildings, machinery, equipment) wear out.

K.Kh. Ibragimov [8] emphasizes that modern agriculture involves the use of means of production that are extremely dangerous to human health, therefore, issues of spatial organization of its branches should become a priority in the land and agricultural legislation of Russia.

A.A. Shamin and A.E. Shamin [9] believe that entrepreneurial ability should be considered as one of the most important factors in agricultural production along with land, capital and labor.

O.V. Kosenchuk [10] argues that, under any circumstances, the formation and use of labor resources is a leading factor in the multifunctional development of agriculture.

A.M. Zigangirova [11] states that the wages of rural workers lag far behind the wages of workers in other sectors of the economy.

In the Republic of Sakha (Yakutia), methodological guidelines have been adopted for rationalizing the combination of land, capital and labor in agriculture [12].

D.P. Suarta, M.Ts. Uedastra and others determined the influence of production factors (land and capital) on the production of cayenne pepper. Empirical data are summarized using the Cobb-Douglas production function. The results of the study show that land area and capital volumes together have a significant impact on cayenne pepper production. At the same time, the authors note that additional capital is used inappropriately. The proportions of land and capital are partially rational, the production elasticity of land and capital is in the range from 0 to 1 [13].

Thus, the literature devotes considerable attention to the proportionality of land, capital and labor. It is recognized that strengthening the economic system of the agro-industrial complex depends significantly on the level of rationality of the combination of land, capital and labor used in agriculture. With the destruction of optimal relationships between land, capital and labor, the economic ties between production and consumption are also broken, and the economic and social efficiency of agriculture is reduced. However, the issues of proportionality of land, capital and labor in agriculture are considered fragmentarily, not comprehensively, especially with regard to the northern and Arctic regions.

Results and discussion

The main components of agricultural production are the land used in it, capital resources, and the workers employed in it.

When talking about the farming system, we are primarily referring to the proportionality of land, capital, and labor. The need to measure the main factors of production in different units makes it difficult to formalize the processes of optimizing their proportions.

A rational farming system is the core of the organizational and economic plan of any enterprise. According to historical data, in 1914, most large landowners' farms had an organizational and economic plan.

Let us analyze the proportions between land, capital, and labor in the northern regions of the Russian Federation (Table 1).

Table 1

Number of employees, area under agricultural crops, volume of fixed assets in agriculture, forestry, hunting, fishing, fish farming in the northern regions of the Russian Federation in 2022

Northern regions	Fixed assets, million rubles	Cultivated areas, thousand hectares	Average annual number of employees, thousand people.
Arkhangelsk Oblast (excluding Nenets Autonomous Okrug) ²	47 398	61.3	23.3
Nenets Autonomous Okrug ³	3 913	0.1	1.1

² Statistical yearbook of the Arkhangelsk Oblast excluding the Nenets Autonomous Okrug: stat. collection / Arkhangelskstat, 2023. URL: <https://29.rosstat.gov.ru/?ysclid=lwum9ym42z742453173> (accessed 25 May 2024).

³ Statistical yearbook of the Nenets Autonomous Okrug: stat. collection / Arkhangelskstat, 2023. URL: <https://29.rosstat.gov.ru/?ysclid=lwum9ym42z742453173> (accessed 25 May 2024).

Komi Republic ⁴	28 623	31.8	15.9
Republic of Karelia ⁵	26 046	23.8	12.0
Murmansk Oblast ⁶	95 537	5.1	9.6
Khanty-Mansi Autonomous Okrug ⁷	8 925	7.6	13.0
Yamalo-Nenets Autonomous Okrug ⁸	11 464	0.1	5.3
Republic of Sakha (Yakutia) ⁹	23 765	49.3	28.6
Republic of Tyva ¹⁰	7 600	57.5	8.1
Krasnoyarsk Krai ¹¹	118 628	1527.1	89.4
Kamchatka Krai ¹²	103 321	20.9	19.4
Khabarovsk Krai ¹³	55 322	57.9	26.6
Irkutsk Oblast ¹⁴	93 390	704.2	70.0
Magadan Oblast ¹⁵	8 938	7.5	2.4
Chukotka Autonomous Okrug ¹⁶	1 882	0.01	1.5
Sakhalin Oblast ¹⁷	24 250	35.4	14.9
Regions of the North, total	659 002	2 589.6	341.1
Russia as a whole ¹⁸	8 502 698	82 290	4 466

As Table 1 shows, in 2022, there is a wide range of employment, arable land, and the volume of fixed assets in the northern regions of the Russian Federation. The Krasnoyarsk Krai leads with 89.4 thousand employees. Irkutsk Oblast is in the second place with 70.0 thousand employees. The Republic of Sakha (Yakutia) is in the third place with 28.4 thousand employees. In general, in the northern regions of the Russian Federation, the correlation coefficient between fixed production assets and sown areas is low -0.632 . The correlation coefficient between the number of

⁴ Statistical yearbook of the Komi Republic: stat. collection / Komistat, 2023. URL: <https://11.rosstat.gov.ru/statistical-compilation/document/67052> (accessed 25 May 2024).

⁵ Statistical yearbook of the Republic of Karelia: stat. collection / Kareliastat, 2023. URL: <https://10.rosstat.gov.ru/folder/43510> (accessed 25 May 2024).

⁶ Statistical yearbook of the Murmansk Oblast: stat. collection / Murmanskstat, 2023. URL: <https://51.rosstat.gov.ru/folder/36664/document/36692> (accessed 25 May 2024).

⁷ Statistical yearbook of the Khanty-Mansi Autonomous Okrug – Yugra in 2 parts. Part II: stat. collection / Tyumenstat, 2023. URL: <https://72.rosstat.gov.ru/ofpublic/document/72219> (accessed 25 May 2024).

⁸ Statistical yearbook of the Yamalo-Nenets Autonomous Okrug in 2 parts. Part II: stat. collection / Tyumenstat, 2023. URL: <https://72.rosstat.gov.ru/ofpublic/document/72222> (accessed 25 May 2024).

⁹ Statistical Yearbook of the Republic of Sakha (Yakutia): stat. collection / Yakutstat, 2023. URL: <https://14.rosstat.gov.ru/folder/39429> (accessed 25 May 2024).

¹⁰ Statistical yearbook of the Republic of Tyva: stat. collection / Krasnoyarskstat, 2023. URL: <https://24.rosstat.gov.ru/folder/30015> (accessed 25 May 2024).

¹¹ Statistical yearbook of the Krasnoyarsk Krai: stat. collection / Krasnoyarskstat, 2023. URL: <https://24.rosstat.gov.ru/folder/30015> (accessed 25 May 2024).

¹² Statistical yearbook of the Kamchatka Krai: stat. collection / Kamchatskstat, 2023. URL: https://41.rosstat.gov.ru/official_publications (accessed 25 May 2024).

¹³ Statistical yearbook of the Khabarovsk Krai: stat. collection / Khabarovskstat, 2023. URL: <https://27.rosstat.gov.ru/folder/66945> (accessed 25 May 2024).

¹⁴ Statistical yearbook of the Irkutsk Oblast: stat. collection / Irkutskstat, 2023. URL: <https://38.rosstat.gov.ru/folder/35281> (accessed 25 May 2024).

¹⁵ Statistical yearbook of the Magadan Oblast: stat. collection / Khabarovskstat, 2023. URL: <https://27.rosstat.gov.ru/folder/66943> (accessed 25 May 2024).

¹⁶ Statistical yearbook of the Chukotka Autonomous Okrug: stat. collection / Khabarovskstat, 2023. URL: <https://27.rosstat.gov.ru/folder/66945> (accessed 25 May 2024).

¹⁷ Statistical yearbook of the Sakhalin Oblast: stat. collection / Sakhalinstat, 2023. URL: <https://65.rosstat.gov.ru/publications> (accessed 25 May 2024).

¹⁸ Russian statistical yearbook: stat. collection / Rosstat, 2023. URL: <https://rosstat.gov.ru/folder/210/document/12994> (accessed 20 April 2024).

employees and the volume of fixed production assets is 0.743. The number of employees is positively correlated with sown areas, with the correlation coefficient of 0.931.

The regions that include the Arctic and border the Arctic Ocean have specific characteristics in terms of the combination of land, capital and labor. There is a wide range of employees, agricultural land and fixed production assets. The Republic of Sakha (Yakutia) ranks first with 28.6 thousand employees. Second place is occupied by the Arkhangelsk Oblast with 23.3 thousand employees. The Khanty-Mansi Autonomous Okrug ranks third with 13.0 thousand people employed.

In the regions included in or directly adjacent to the Arctic zone (Arkhangelsk Oblast, Nenets Autonomous Okrug, Komi Republic, Republic of Karelia, Murmansk Oblast, Yamalo-Nenets Autonomous Okrug, Sakha Republic (Yakutia), Chukotka Autonomous Okrug), the correlation coefficient between the number of employees and the area under cultivation is high — 0.90. The correlation coefficient between the number of employees and the volume of fixed assets is 0.28. The correlation coefficient between the area under cultivation and fixed assets is 0.13.

The Arctic and Northern regions have specific features in the structure of cultivated agricultural land. Let us show these features (Table 2).

Table 2

Proportions between cultivated land and land under fodder crops in the Northern and Arctic regions in 2022

Northern and Arctic regions	Agri-cultural land, %	Including			
		cultivated lands, %	hayfields, pastures, %	perennial plantings, thousand	fallow lands, thous. ha, %
Arkhangelsk Oblast (including Nenets AO) ¹⁹	100	43.7	54.7	1.3	0.3
Komi Republic ²⁰	100	25.1	73.3	1.6	-
Republic of Karelia ²¹	100	47.3	49.0	3.7	-
Murmansk Oblast ²²	100	77.2	11.4	11.4	-
Khanty-Mansi AO ²³	100	2.0	96.1	1.5	0.4
Yamalo-Nenets AO ²⁴	100	0.5	99.4	0.1	-
Republic of Sakha (Yakutia) ²⁵	100	10.6	87.9	0.1	1.4

¹⁹ Report. The state and protection of the environment of the Arkhangelsk Oblast for 2022. Arkhangelsk / Center for Nature Management and Environmental Protection, 2023, p. 109. URL: <https://office.dvinaland.ru/docs/pub/a3a8be11d6a25abd27d0d313c824d65c/default/?&> (accessed 24 November 2024).

²⁰ State report. On the state of the environment of the Komi Republic in 2022: state report / Ministry of Natural Resources of the Komi Republic. Syktyvkar, 2023, p. 36. URL: <https://mpr.rkomi.ru/dokumenty/gosudarstvennyy-doklad-o-sostoyanii-okrujayushchey-sredy-respubliki-komi> (accessed 24 November 2024).

²¹ State report. On the state of the environment of the Republic of Karelia in 2022 / Ministry of Natural Resources and Environment of the Republic of Karelia. Petrozavodsk, 2023, p. 54. URL: <https://www.ecology.gov.karelia.ru/> (accessed 24 November 2024).

²² Agriculture of the Murmansk Oblast. URL: <http://www.agrien.ru/reg/мурманская.html> (accessed 24 November 2024).

²³ Agriculture of the Khanty-Mansi Autonomous Okrug. URL: <http://www.agrien.ru/reg/> (accessed 24 November 2024).

²⁴ Agriculture of the Yamalo-Nenets Autonomous Okrug. URL: <http://www.agrien.ru/reg/янао.html> (accessed 24 November 2024).

Republic of Tyva ²⁶	100	6.0	90.8	0.02	3.18
Krasnoyarsk Krai ²⁷	100	57.7	39.2	0.7	2.8
Kamchatka Krai ²⁸	100	13.5	85.1	1.1	0.3
Khabarovsk Krai ²⁹	100	14.8	82.7	2.5	3.8
Irkutsk Oblast ³⁰	100	62.0	36.8	0.1	0.1
Magadan Oblast ³¹	100	19.6	75.1	-	2.4
Chukotka AO ³²	100	1.2	98.8	-	-
Sakhalin Oblast ³³	100	28.0	34.8	32.8	4.4
Russia ³⁴	100	60.5	37.1	0.9	1.5

As Table 2 shows, the northern and Arctic regions have agricultural lands, which are predominantly made up of pastures and hayfields (69.9% of the total area of agricultural land). On the contrary, in Russia as a whole, cultivated land predominates in the composition of agricultural land (60.5%).

In the structure of agricultural lands of the Russian Federation in 2022, cultivated land predominates, accounting for 58.9% of all agricultural land, with hayfields accounting for a significantly smaller share (9.4%) and pastures accounting for 28.9% of all agricultural land.

Let us consider the structure of agricultural lands in the Russian Federation and in the regions of the European North: the Republic of Karelia, Arkhangelsk Oblast, Murmansk Oblast, Komi Republic for 2017, 2020 and 2022 in % of the total (Table 3).

Table 3

Structure of agricultural land in the Russian Federation and in the regions of the European North: Republic of Karelia, Arkhangelsk Oblast, Murmansk Oblast, Komi Republic for 2017, 2020 and 2022 in % of the total³⁵

Year	Agricultural lands	Including			
		cultivated lands	perennial plantings	hayfields	pastures
Murmansk Oblast, Arkhangelsk Oblast, Republic of Karelia, Republic of Komi					
2017	100	36.6	2.0	45.6	15.8
2020	100	35.9	1.7	45.6	15.8
2022	100	37.3	1.8	45.6	15.3
Russian Federation					

²⁵ State report on the state and protection of the environment of the Republic of Sakha (Yakutia) in 2022 / Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia). Yakutsk, 2023, p. 35. URL: <https://minpriroda.sakha.gov.ru/doklady-o-sostojanii-okruzhajushej-sredy> (accessed 24 November 2024).

²⁶ Agriculture of the Republic of Tyva. URL: <http://www.agrien.ru/reg/тыва.html> (accessed 24 November 2024).

²⁷ Agriculture of the Krasnoyarsk Krai. URL: <http://www.agrien.ru/reg/краснояр.html> (accessed 24 November 2024).

²⁸ Agriculture of the Kamchatka Krai. URL: <http://www.agrien.ru/reg/камчатский.html> (accessed 24 November 2024).

²⁹ Agriculture of the Khabarovsk Krai. URL: <http://www.agrien.ru/хабаровский.html> (accessed 24 November 2024).

³⁰ Agriculture of the Irkutsk Oblast. URL: <http://www.agrien.ru/> (accessed 24 November 2024).

³¹ Agriculture of the Magadan Oblast. URL: <http://www.agrien.ru/> (accessed 24 November 2024).

³² Agriculture of the Chukotka Autonomous Okrug. URL: <http://www.agrien.ru/reg/> (accessed 24 November 2024).

³³ Report on the state and protection of the environment of the Sakhalin Oblast in 2022 / Ministry of Ecology and Sustainable Development of the Sakhalin Oblast. Yuzhno-Sakhalinsk, 2023. URL: <https://ecology.sakhalin.gov.ru/ministerstvo/doklady-ob-jekologicheskoy-situacii/791-doklad-o-sostojanii-i-ob-ohrane-okruzhajushej-sredy-v-sahalinskoj-oblasti-v-2022godu.html> (accessed 24 November 2024).

³⁴ Agriculture in Russia: stat. collection / Rosstat, 2023. URL: <https://rosstat.gov.ru/folder/210/document/13226> (accessed 24 November 2024).

³⁵ Authors' calculations based on data from the Federal State Statistics Service of Russia. URL: <https://rosstat.gov.ru/> (accessed 04 January 2024); Agricultural land area by regions of Russia. URL: https://ruxpert.ru/Статистика:Площадь_сельхозугодий_по_регионам_России#Регионы (accessed 24 November 2024).

2017	100	59.3	2.2	9.5	28.9
2022	100	58.9	2.2	9.4	28.9

As can be seen from Table 3, the structure of agricultural land in the north-western regions of the Russian Federation has remained stable for many years. In 2022, hayfields predominate in the structure of agricultural land in the regions, accounting for 45.6% of all agricultural land, followed by pastures, accounting for 15.3%. Cultivated land accounts for a significantly smaller share — 37.3% of all agricultural land.

Let us consider the indices of crop and livestock production in the northern and Arctic regions.

Table 4

*Indices of agricultural production of all categories of farms (in comparable prices, as a percentage of the previous year) for 2021 and 2022 in the Northern and Arctic regions*³⁶

Northern regions	Agriculture, total		Including			
			Crop production		Animal farming	
	2021	2022	2021	2022	2021	2022
Arkhangelsk Oblast (excluding Nenets Autonomous Okrug)	97.9	97.0	98.0	95.5	97.7	98.8
Nenets Autonomous Okrug	125.6	95.9	96.4	105.3	130.4	94.4
Komi Republic	97.7	97.5	93.7	95.9	99.6	98.2
Republic of Karelia	91.6	104.7	89.7	107.0	93.5	102.4
Murmansk Oblast	106.5	89.6	132.3	94.3	94.5	86.1
Khanty-Mansi Autonomous Okrug	85.8	88.1	81.8	97.6	91.8	79.3
Yamalo-Nenets Autonomous Okrug	119.5	96.5	94.5	101.7	120.3	96.4
Republic of Sakha (Yakutia)	98.9	101.4	93.3	107.1	101.5	99.1
Republic of Tyva	102.1	96.3	105.8	86.1	101.3	98.3
Krasnoyarsk Krai	86.2	93.9	81.9	99.4	89.8	88.4
Kamchatka Krai	104.0	99.9	105.6	99.4	102.8	100.3
Khabarovsk Krai	98.5	85.9	101.9	90.1	95.7	82.2
Irkutsk Oblast	99.4	93.9	101.7	91.1	94.9	100.0
Magadan Oblast	94.1	107.7	97.0	113.5	90.4	97.6
Chukotka Autonomous Okrug	98.4	106.0	95.4	103.3	99.4	107.0
Sakhalin Oblast	100.4	101.8	97.1	104.3	104.6	98.5
Arctic and Northern regions, total	98.1	97.4	96.7	99.0	99.1	96.3
Russia as a whole ³⁷	99.3	111.3	117.6	101.9	101.9	104.4

As Table 4 shows, there is a tendency towards specialization in livestock farming in the regions of the North and the Arctic. This trend is especially evident in the Republic of Tyva and the Arkhangelsk Oblast.

The focus on livestock farming has the downside of reducing the area under crops. Let us show the impact of livestock farming on crop farming using the example of the dynamics of cultivated areas in the Komi Republic for 1970–2022 (Table 4).

³⁶ Agricultural production indices in farms of all categories / Bulletin "Agricultural production in the regions of the Far North and equated localities in 2022". URL: <https://rosstat.gov.ru/compendium/document/13277> (accessed 24 November 2024).

³⁷ Agriculture in Russia: stat. collection / Rosstat, 2023. URL: <https://rosstat.gov.ru/folder/210/document/13226> (accessed 24 November 2024).

Table 5

Agricultural cultivated areas (in farms of all categories) for 1970–2022 in the Komi Republic, thousand hectares³⁸

Year	Total area under cultivation	Grain crops	Potatoes	Field vegetables ³⁹	Fodder crops	Including perennial grasses (area mowed in previous years and unprotected crops in the current year)	Annual grasses (including silage crops)	Area of fallow land
1970	84.0	9.6	12.7	1.3	60.4	22.4	37.7	
1980	93.7	1.0	12.8	1.2	78.7	37.7	39.8	1.3
1990	100.5	0.6	12.1	1.0	86.8	44.8	41.0	1.3
2000	80.0	0.5	12.2	1.1	66.1	50.4	15.6	2.5
2010	39.5	0	6.5	0.6	32.3	28.0	4.3	1.8
2015	38.5	0	4.9	0.6	33.0	27.3	5.7	0.1
2018	39.5	0	3.8	0.6	32.8	27.0	5.8	0.1
2019	37.1	0	3.5	0.5	33.0	27.0	6.0	0.0
2020	34.9	0	3.2	0.5	31.1	25.9	5.3	0.1
2021	32.4	0	2.8	0.5	29.1	24.0	5.1	0.1
2022	31.8	0	2.9	0.5	28.4	22.4	6.0	0.0

As Table 5 shows, while the total cultivation area in the Komi Republic was 84.0 thousand hectares in 1970, then in 2022, it was 31.8 thousand hectares, i.e. decreased by 2.6 times. The area under fodder crops decreased, but slightly less — by 2.1 times. Grain crops ceased entirely.

Regarding the proportions of cultivated land and pastures in the structure of agricultural land, the situation that developed in the Republic of Tyva between 1953 and 2024 is noteworthy (Table 5) [14, Mongush B.S.; 15, Sambuu A.D., Dabiev D.F., Ayunova O.D. et al.; 16, Kovaleva K.P.].

Table 6

Year	Agricultural land, total, thousand ha	Including	
		pastures	cultivated lands
1953	5 622	968	100
1960	4 489	2 652	387
1970	4 623	3 060	470
1980	4 627	4 024	494
1990	3 975	3 434	434
2001	3 901	3 463	237
2015	2 657	2 405	136
2016	2 657	2 405	135
2019	3 200	2 653	135
2020	3 833	3 416	191
2023	2 654	2 402	135
2024	3 824	3 412	195
Correlation coefficient of cultivated lands and pastures indicators — 0.613782			

³⁸ Cultivation areas of agricultural crops. 2023. <https://11.rosstat.gov.ru/agriculture?ysclid=m3x68rg168890294144> (accessed 25 November 2024).

³⁹ Since 2000 — including areas under vegetables in protected soil in households.

As Table 6 shows, the area of agricultural lands in the Republic of Tuva decreased from 5,623 thousand hectares in 1953 to 3,824 thousand hectares in 2024. Uneven dynamics were observed in the area of cultivated lands. Since 1953, the area of cultivated lands increased from 100 hectares in 1953 to 494 thousand hectares in 1980. However, it then decreased to 135 thousand hectares in 2023. In 2024, the area increased to 195 thousand hectares. This gives rise to the hypothesis that if cultivated land increases, pastures decrease, and vice versa. However, the correlation coefficient refutes this hypothesis. Cultivated lands and pastures increase and decrease mainly in the same direction. The correlation coefficient between the areas of cultivated lands and pastures in the Republic of Tuva for 1953–2024 is 0.613782.

The emphasis on livestock farming in the development of agricultural organizations is not an unambiguously positive phenomenon. On the one hand, the vector for the preferential development of livestock farming leads to the strengthening of the market positions of agricultural enterprises in the Arctic and northern regions. On the other hand, with a decreasing amount of cultivated land used, the efficiency of using labor and capital resources, all other things being equal, decreases, environmental risks increase, and the potential for growth in pasture areas decreases.

Let us consider the issue of staffing ratios in the number of people employed in agriculture using the example of the Komi Republic. The Komi Republic occupies a middle position in terms of the number of people employed in agriculture and can therefore serve as a benchmark for these ratios.

In the most favorable years for agriculture in the region (1960–1980), the average annual growth rate of gross agricultural output was 4.3%, and labor productivity in the public sector was 4.4%. In 1980, 39,601 people were employed in agriculture and forestry⁴⁰. By the mid-1980s, about 2,300 qualified specialists were trained annually. Per 1,000 agricultural workers, the annual training by profession was as follows: 228 tractor drivers, 215 car drivers, and 60 livestock breeders. Agricultural enterprises trained workers in 20 professions, mainly narrow-profile ones that did not require long-term training. They trained 1.9 times more workers than vocational and technical schools. In 1985–1990, 4.3 thousand skilled workers were trained in full-time vocational and technical educational institutions. In 1981–1985, secondary schools provided an additional 11.2% of the demand for livestock workers, 17.6% for tractor drivers, and 4.5% for car drivers. Every year, more than 500 graduates of rural secondary schools were employed in agricultural enterprises [17, Terentyev V.V.].

At the end of the 20th — beginning of the 21st centuries, the situation changed. The average annual number of people employed in agriculture in the Komi Republic for 1990–2020 decreased by 10 times [18, Shcherbakova A.S.]. The average annual number of people employed in

⁴⁰ The Komi Republic is 85 years old (historical and statistical collection). Syktyvkar, Territorial body of the Federal State Statistics Service for the Komi Republic. 2006. Pp. 53–54.

agriculture in the Komi Republic in 2019 was 7.6 thousand people, in 2023 — 7.3 thousand people⁴¹. Thus, from 2019 to 2023, the number of agricultural workers decreased by 3.9%.

Despite a sharp reduction in the number of people employed in agriculture in the Komi Republic (which is increasingly concentrated in cities), there is a shortage of personnel. As of 1 April 2024, there was a shortage of 185 workers and specialists in agriculture. Mechanics, machine operators and machine milking operators were also in high demand⁴².

The obstacles to maintaining the number of workers in agriculture in line with the needs of farming are the low prestige of agricultural work, its seasonality, difficulties in finding a marriage partner, the low level of social infrastructure, and the narrow choice of professions and jobs.

The main institutions and processes for the reproduction of personnel for agriculture at the beginning of the 21st century, compared to the end of the 20th century, have been preserved and are not effective enough. These are educational institutions (universities, vocational educational institutions, schools, trainings at enterprises), state regulatory bodies, public organizations. It is important to adapt these institutions more actively and in a timely manner to the changing technological and social environment. Technologies in agriculture are being introduced and developed much faster than educational programs for agricultural workers are being updated. Graduates of educational institutions, as a rule, do not have relevant knowledge and skills for work; in fact, they need to be retrained. The stereotype that agriculture is a dusty, low-prestigious and low-paid job is outdated. In some cases, the average income of agricultural workers even exceeds the average income in other industries. Modern agricultural enterprises use combines worth 100 million rubles, quadcopters and digital technologies⁴³.

The experience of economic activity of agricultural enterprises in the Arctic and the North indicates the intensification and expansion of livestock farming, with corresponding changes in the composition and structure of fixed assets. The share of cultivated land in agricultural land is decreasing. Less attention is paid to the cultivation of arable land, in particular, to improving the structure of sown areas, including fodder crops. Accordingly, the number of agricultural workers is decreasing. Nevertheless, there is a shortage of workers in agriculture in the regions of the North and the Arctic.

Conclusions and recommendations

1. The efficiency of using the main factors of agricultural production — land, capital and labor — depends significantly on their combination. The combination of factors can be considered as a whole and separately by region with varying degrees of detail.

⁴¹ Komi Republic in figures. Short statistical collection / Komistat. Syktyvkar, p. 44.

⁴² Komi lacks agronomists and zootechnicians. URL: <https://www.bnkomi.ru/data/news/171196/?ysclid=lwq41jendx598589047/> (accessed 27 May 2024).

⁴³ German A. Farmers in IT: why there is a stable shortage of personnel in agriculture. URL: <https://www.forbes.ru/mneniya/486847-kolhozniki-v-it-pocemu-v-sel-skom-hozajstve-stabil-nyj-deficit-kadrov?ysclid=lwq4pyv4j9245599851> (accessed 28 May 2024).

2. Deviations from the average functional combinations of land, capital and labor in the region, territory and organization as a whole can be an important factor in reducing the efficiency of their use.

3. Optimization of factor components forms the basis for improving the links in two technological chains of agricultural production — “production – market” and “innovation – production”.

4. In order to maintain the growth trend of livestock farming, increase the number of livestock and improve its productivity in the regions of the North, it is important to ensure rational ratios of land, capital and labor, aimed at eliminating their inefficient use and reducing negative environmental consequences. It is important to stabilize the area of cultivated lands and then increase it.

5. In modern practices of ensuring rational combinations of land, capital and labor in the regions of the North and the Arctic, a wide range of relations, methods, and instruments of influence are used: burdens on owners, market transactions, indirect methods of infrastructure support, tax methods, financial incentives methods, regulatory methods, program-targeted methods, legal regulation, customs regulation.

It would be correct to say that the specific choice of relationships, methods, and directions of influence of regulatory bodies is determined by their effectiveness in solving urgent practical problems of reproduction [19, Terry L.A., Bruce Y.].

6. Identification of opportunities for improving the combinations of land, capital and labor in agricultural enterprises in the regions of the North is associated with the development of cooperation between enterprises and the entrepreneurial sector of the agro-industrial complex.

Prospects for research

A promising direction for the development of the topic of proportionality of land, capital and labor in agriculture in the northern regions of the Russian Federation is the quantitative determination of the contribution of these factors to production output and the development of measures for their optimization.

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T.A. Naydenova — original text writing, statistical data processing, revision and formatting.

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