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The state of dairy cattle breeding and clustering of municipal entities of the Krasnoyarsk Territory by the level of industry development

A A Gorodov^{1,2}, M A Fedorova³ and O Yu Gavrilo³

¹ Siberian federal university, 79, Svobodny ave., Krasnoyarsk, 660041, Russia

² Reshetnev Siberian state university of science and technology, 31, Krasnoyarsky Rabochy ave., Krasnoyarsk, 660037, Russia

³ Krasnoyarsk state agrarian university, 90, Mira str., Krasnoyarsk, 660049, Russia

E-mail: marina-grande@yandex.ru

Abstract. The concept of sustainable agriculture is one of the directions of the state's national security strategy, which is determined by economic, social, environmental and political factors. Sustainable development of the region directly affects the sustainable development of the state, and sustainable development of the region; in its turn it directly depends on the sustainable development of individual industries, among which dairy cattle breeding is the leading one. The total milk production in Russia as a whole in farms of all categories reached a record high of 31.5 million tons (+2.5% in the country and +2.6% in the Krasnoyarsk Territory). However, the annual milk consumption per capita in 2017 in the Russian Federation was 233 kg, in the Krasnoyarsk Territory it was a little less than this Russian indicator (231 kg, which is 71% lower than 325 kg which is the standard recommended by the Ministry of Health of the Russian Federation), which indicates a low level of milk self-sufficiency. The level of the country's milk production development is determined by the production state in its regions, which in turn depends on their territorial location, climatic conditions, natural-historical features of the territories, etc. Since a large number of enterprises is involved in milk production in the region, production should be considered in the context of municipal districts, which makes it possible to identify the most promising clusters from the standpoint of the production potential formation of the dairy cattle breeding industry in the Krasnoyarsk Territory.

1. Introduction

The concept of sustainable agriculture is one of the directions of the state's national security strategy, which is determined by economic, social, environmental and political factors. Sustainable development of the region directly affects the sustainable development of the state, and sustainable development of the region in its turn directly depends on the sustainable development of individual industries, among which dairy cattle breeding is the leading one.

The purpose of the study is to analyse the current state of dairy cattle breeding development in Russia and in Krasnoyarsk Territory; and to cluster the municipal subjects of the Krasnoyarsk Territory by the level of the industry development.



Research objectives are as follows: to identify trends in the development of the dairy cattle breeding industry, to determine the level of milk self-sufficiency in the Krasnoyarsk Territory, and to cluster the municipal entities of the Krasnoyarsk Territory by the level of the industry development.

2. Research methods

In the course of the study, a monographic, retrospective method and a method of cluster analysis were applied.

Milk and dairy production varies in different countries. It is influenced by a number of factors, the leading ones of which are soil and climatic conditions, national feeding habits, as well as population income levels. According to IDF (International Dairy Federation), in 2017 the world production of all types of milk increased by 2.5% and amounted to 849 million tons, including the world production of cow’s milk which increased by 2.2% (696 million tons) [1]. The highest gains in the production of cow’s milk are shown by the countries of Central and North America, Eurasia, and Australia. The top milk producers annually include such leading countries as the EU, the USA, India, China, Brazil, Russia, New Zealand and Pakistan.

Dairy cattle in Russia is the leading and most complex and problematic sub-branch of animal husbandry. The current state of dairy production in the Russian Federation is clearly demonstrated by the indicators presented in table 1.

Table 1. Dynamics of milk production in Russia. ^a

Region	Years					% of 2018 to 2014
	2014	2015	2016	2017	2018 ^b	
<i>Milk production in farms of all categories, thousand tons</i>						
Russian Federation	30790.9	30796.9	30758.5	31183.5	31564.1	102.5
Krasnoyarsk Territory	724.5	739.8	733.5	749.4	743.4	102.6
<i>Production of commercial milk, thousand tons</i>						
Russian Federation	19695.1	20097.3	20616.4	21384.2	22079.1	112.1
Krasnoyarsk Territory	460.9	474.2	470.6	483.5	482.8	104.8
<i>The share of marketable milk in total production, %</i>						
Russian Federation	63.9	65.3	67.0	68.6	69.9	-
Krasnoyarsk Territory	63.6	64.1	64.2	64.5	64.9	-
<i>The number of cows in farms of all categories at the end of the year, heads</i>						
Russian Federation	8530.8	8408.1	8263.7	8226.0	8159	95.6
Krasnoyarsk Territory	168.6	170.6	169.1	170.6	167.5	99.3
<i>Milk productivity of cows (in farms of all categories), kg / year</i>						
Russian Federation	4021.0	4134.0	4218.0	4368.0	4516.6	112.3
Krasnoyarsk Territory	4446.0	4603.0	4578.0	4709.0	4708.6	105.9

^a according to the data of [3, 4, 5]

^b according to preliminary estimates of Soyuzmoloko company

Analysis of the data in table 1 for the period under review indicates that the total milk production in Russia in all categories of farms as a whole reached a record of 31.5 million tons (+ 2.5% in the country and + 2.6% in the Krasnoyarsk Territory). At the same time, the scale of production of marketable milk as a key indicator of dairy cattle breeding development and the basic resource for the dairy processing industry in the whole country increased by 12.1%. The annual decline in the livestock of cows occurred primarily due to the replacement of low-producing dairy breeds with breeding ones, which will increase milk production by one head. So, the annual growth of milk yield per cow in the reporting year was: 12.3% in the Russian Federation and 5.9% in the Krasnoyarsk Territory.

The strategic benchmark for the production size in the dairy industry is the annual volume of milk production per capita. In foreign countries, the annual milk production per capita is much higher. So in 2017, this figure in New Zealand was 420 kg, in Australia - 390 kg, in the USA - 289 kg, in the EU - 283 kg, in Canada - 250 kg [2]. The lowest volume of raw milk production per capita among the main

producing countries in 2017 was in China (25 kg). In Russia, the value of this indicator was 211 kg, while the country ranks 8th among the world leaders in milk production.

It should be noted that milk and dairy products, as a primary element of the diet, are included in the list of products falling under the Doctrine of Food Security of the Russian Federation, as a basic component of ensuring the national security of the country. However, with a significant scale of production potential, unstable rates of innovative technologies and highly productive dairy breeds of cows, as well as insufficient state support measures ensure that the availability of milk and its products remain low and significantly dependent on imports.

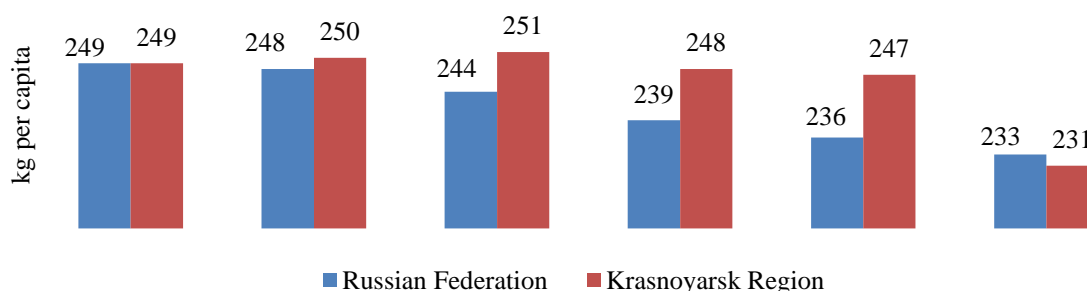


Figure 1. Dynamics of milk and dairy consumption per capita in the Russian Federation and the Krasnoyarsk Territory [3, 4, 5].

In our opinion, the analysis of the data presented in figure 1 indicates the unfavourable dynamics in the area under study and determines the need for scientifically based measures aimed at eliminating destructive phenomena in the growth of dairy production. The annual consumption of milk per capita in 2017 in the Russian Federation was 233 kg, in the Krasnoyarsk Territory it was a little less than this Russian indicator (231 kg), which is 71% lower than the standard (325 kg) recommended by the Russian Federation (RF) Ministry of Health (since August 19, 2016). The dynamics of milk and dairy product consumption per capita is greatly influenced by the decrease in the level of general resources of milk and dairy products and the rise in consumer prices in the context of a decline in real disposable incomes of the population.

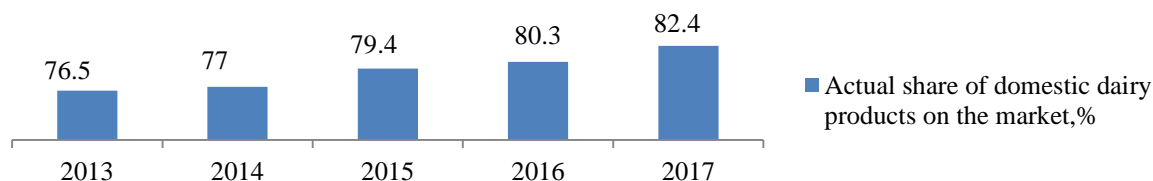


Figure 2. The level of self-sufficiency of the Russian Federation [5].

In the domestic market of milk and dairy product supply, a positive trend of growth in the level of self-sufficiency has been noted. So, in 2017, the actual share of domestic dairy products was 82.4%, which is higher than the value achieved in previous years, but lower than the figure established by the Doctrine of Food Security (by 7.6 %).

The level of the country’s milk production development is determined by the state of production in its regions, which in its turn depends on their territorial location, climatic conditions, natural-historical features of the territories, etc.

Identification of leaders and outsiders can be carried out by comparing the values of individual indicators. Since a large number of enterprises in the region produce milk, production should be considered in the context of municipal districts. The ability to determine the direction of production on the basis of economic characteristics is provided by multidimensional statistical methods, in particular by cluster analysis [6].

In Russia, economic clusters are organized for the joint solution of scientific, technical, commercial, and social problems of interest to a group of organizations [7]. Thus, it is necessary to identify the most promising clusters from the standpoint of the formation of the production potential of the dairy cattle breeding industry in the Krasnoyarsk Territory.

It should be noted that the production potential or production capacity of an enterprise (or an individual industry) refers to its capabilities, expressed in terms of production in natural terms, which depend on both the quantity, quality and ratio of resources, and the level of their return [8] based on criterion indicators of industry development.

The study included 29 municipal districts of the five administrative zones of the Krasnoyarsk Territory engaged in milk production to some extent. Thus, the source data matrix (x) has the dimension $n*m$ or $29*13$ (n is the number of objects of observation, m is the number of elementary analytical features).

For processing and analysing statistical information, STATISTICA computer-aided computing system was selected; with its help data standardization was carried out in order to convert existing data to a more accessible form, which is dictated by the presence of data from different types of scales and values (i.e., centners, rubles, etc.) in the initial matrix. It should be noted that STATISTICA system assigns the cluster number automatically and is not its rating, i.e. ordinal index reflecting the significance of the cluster.

The classification results are presented in figure 3 and table 2, which allow us to distinguish four clusters.

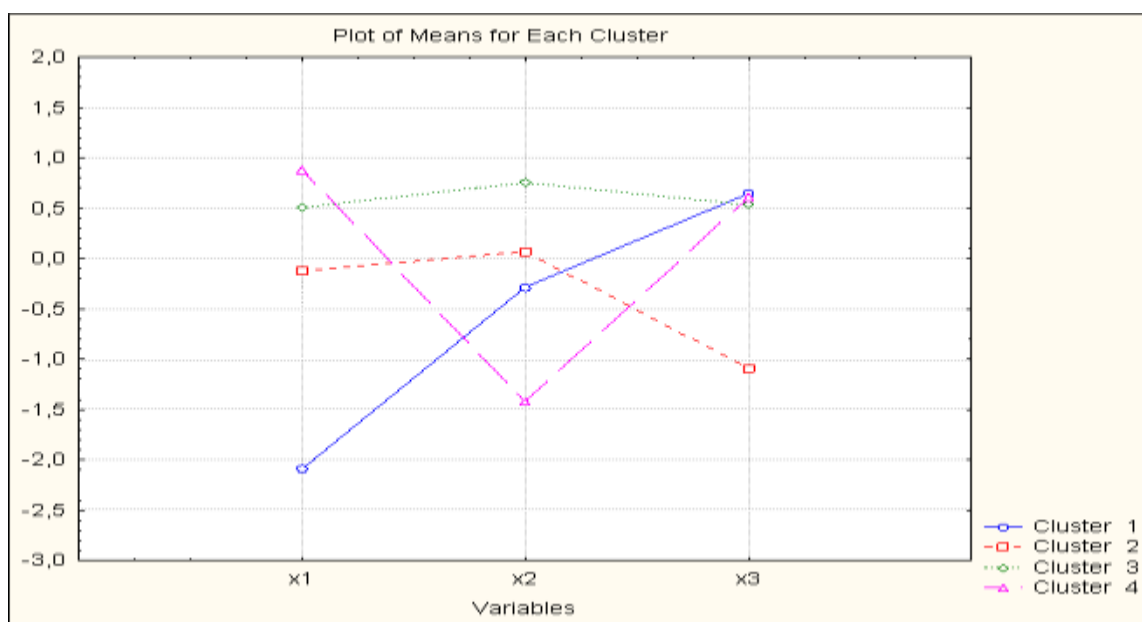


Figure 3. Classification of factors by clusters.

Figure 3 shows three clusters, and the influence of factors on the distribution of clusters. It can be concluded that F1 has the greatest influence on the formation of clusters, and F3 has the least impact on this process. Also we shall note that the first cluster is somewhat different in the location and length of the distance.

The correctness and reliability of the partitioning is confirmed by a comparative analysis of intercluster and intracluster distances. Since the distance of individual observations is less than the distance between the centres of other clusters, it can be assumed that the separation of clusters has passed clearly and inter-group differences are maximized.

Table 2. Belonging to clusters of the Krasnoyarsk Territory areas.

No	District	Distance from observation to cluster center	Distance between cluster centers
<i>Cluster 1</i>			
1	Kansky	0.508995	K ₁ -K ₂ →1.533 K ₁ -K ₃ →1.617 K ₁ -K ₄ →1.839
2	Nazarovsky	0.609879	
3	Uzhur	0.612999	
4	Kuraginsky	0.599943	
<i>Cluster 2</i>			
5	Rybinsk	0.413678	K ₂ -K ₁ →2.351 K ₂ -K ₃ →1.079 K ₂ -K ₄ →1.424
6	Novoselovsky	0.323257	
7	Sharypovsky	0.586018	
8	B.Murtinsky	0.337634	
9	Yemelyanovsky	0.393091	
10	Mansky	0.931717	
11	Sukhobuzimsky	0.645096	
12	Krasnoturansky	0.847658	
13	Minusinsky	0.241508	
14	Shushensky	0.242669	
<i>Cluster 3</i>			
15	Abansky	0.322704	K ₃ -K ₁ →2.615 K ₃ -K ₂ →1.165 K ₃ -K ₄ →1.274
16	Dzerzhinsky	0.276290	
17	Ilan	0.261473	
18	N.Ingashsky	0.456645	
19	Sayan	0.551632	
20	Uyarsky	0.574603	
21	Balakhtinsky	0.498846	
22	Idrinsky	0.111833	
23	Yenisei	0.575518	
24	Kazachinsky	0.531049	
<i>Cluster 4</i>			
25	Irbeysky	0.584887	K ₄ -K ₁ →3.383 K ₄ -K ₂ →2.029 K ₄ -K ₃ →1.623
26	Bogotol	0.421148	
27	Tyuhetsky	0.703643	
28	Ermakovsky	0.952384	
29	Caratuzsky	0.489847	

In order to get a complete the “picture” of the resulting clusters it is necessary to analyse the average values of the initial indicators reflected in table 3, since it is this approach that will reflect the development of milk production in the selected clusters.

The data in table 3 indicate that the undoubted leaders are the areas included in the first two clusters, in particular, the first cluster included four advanced areas of the Krasnoyarsk Territory (Nazarovsky, Kansky, Uzhursky and Kuraginsky), which are the largest in milk production, which served as the basis for calling this cluster high level of development of dairy cattle breeding. All areas are distant from the centre of the cluster, which emphasizes an atypical approach to the formation of agricultural areas. Analysing the average values of selected indicators with average values along the edge and with values of similar parameters of other clusters, it can be noted that all indicators are exceeding the values, which once again proves the effective development of milk production in the cluster.

Table 3. Cluster baseline averages.

Indicators	Average in the territory	Clusters			
		1	2	3	4
x ₁ – gross milk production, tons	12482	50855	11514	3464	1759

x ₂ – cattle stock at the end of the year, heads	6981	28351	5762	2604	1077
x ₃ – livestock of cows, heads	2531	9409	2289	1029	515
x ₄ – average annual milk yield per a fodder cow, kg	4396	6178	5078	3818	2764
x ₅ – received calves from cows and heifers, heads	2915	11405	2602	1107	367
x ₆ – produced per capita, kg	481	1405	589	186	117
x ₇ – self-sufficiency of the population of the region with milk in relation to a scientifically based standard of consumption of dairy products, %	148	432	181	57	36
x ₈ – milk sales volume, tons	11564	46777	11297	2942	1169
x ₉ – death of cattle, heads	268	956	269	67	116
x ₁₀ – production costs for 1 ton of milk, rubles	19231	19431	21403	15966	21257
x ₁₁ – average selling price of 1 ton of milk, rubles	24603	27266	27823	22622	19997
x ₁₂ – profitability (with subsidies),%	33	43	33	48	-8
x ₁₃ – profit per 1 ton of milk, rubles	3911	6309	5005	5729	-3832

The second cluster includes ten districts. The values of the group of quantitative indicators of this cluster are close to the average values along the edge. It can be said that the areas of this cluster are potential territories for the development of the dairy cattle breeding industry.

The third and fourth clusters significantly lag behind the average regional values in terms of the indicator level. These clusters include areas, some of which are located in subtaiga and taiga zones, which are characterized by a low potential for the development of the industry, due to certain climatic and economic conditions, in particular the complexity of forming a food base that is the basis for the existence of dairy cattle breeding in general and particular. Accordingly, insufficient development of the industrial potential of the industry in the areas of these clusters leads to a low level of efficiency in the management of the industry.

3. Conclusions

The economic feasibility of creating specialized milk production clusters is due to the provision of innovative development opportunities, social importance, territorial dispersion, as well as the need to improve the competitiveness of the dairy cattle industry in general, and milk production, in particular, through the formation of the production potential of the industry.

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