

## Sustainable Development of Dairy Cattle Breeding in Different Regions of the Russian Federation

**Asiya K. Subaeva\***

Kazan Federal University

**Aydar A. Nurullin**

Kazan Federal University

**Vladimir T. Vodyannikov**

Russian state agrarian University-MTAA named after K. A. Timiryazev,

**Elena V. Khudyakova**

Russian state agrarian University-MTAA named after K. A. Timiryazev,

**Vladimir S. Sorokin**

Russian state agrarian University-MTAA named after K. A. Timiryazev,

### Abstract

Despite the goals and guidelines of the State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials and Foodstuffs, adopted by the Government of the Russian Federation, dairy cattle breeding continue to decline. This is largely the result of a long production cycle in the industry, the difficulties with obtaining loans, the underdevelopment of the material and technical base of livestock and fodder production. Consequently, the sustainability of milk production in most regions remains low, although there are certain differences. To substantiate effective ways to develop dairy cattle breeding and increase its sustainability, it is necessary to highlight these regional differences, to determine the indicators for assessing the level and dynamics of the sustainability of production. For this purpose, statistical methods such as the method of statistical summary and grouping, the comparison method, the correlation analysis method, the cluster analysis method were used. It is proposed to methodically separate two concepts - the stability of the state and the sustainability of development. The first of these is proposed to be estimated by such an indicator as the coefficient of variation, the second by indicators - using the Spearman coefficient or the correlation index. In this article, the indicator of the stability of the state by the main factor for dairy cattle breeding has been determined - the yield of fodder crops by regions of the Central Federal District. As a result of the grouping in terms of the coefficient of variation in yields of cereal crops, which are the basis of the ration diet, the following regularity was obtained for the regions of the Central Federal District: the higher the yield of grain crops (in the regions of the Central Black Earth Region), the higher the production risk and the lower the production stability. This fact can serve as a justification for the need for more active implementation of anti-risk adaptive measures in dairy cattle farming in these regions, and also as a basis for providing appropriate measures to state policies to stimulate the development of the industry.

**Keywords:** dairy cattle breeding; Fodder base of dairy cattle breeding; Sustainability of agricultural production; Stability of fodder production; Indicators of sustainability; Regional agriculture; Natural and climatic clusters.



CC BY: [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/)

### 1. Introduction

Over the years of reform, the decline in production in dairy cattle was the most significant of all branches of agriculture. This process continues today. At the same time, milk and dairy products, according to medical norms, should constitute one-third of the human diet. In addition, by 2050, experts predict a doubling of demand for food (Nechaev and Vasilyeva, 2010; Shatilova *et al.*, 2018; Zinchenko, 2016). At present, livestock farming is one of the most dynamically developing agrarian sub-sectors in developing countries. Its share in the GDP of agriculture is 33% and is growing rapidly due to population growth, urbanization and rising incomes in developing countries (Gareyev, 2010; Golubev and Yusupova, 2013).

The consumption of milk and dairy products per capita in Russia (239 kg) is 30-50% less than the level of the developed countries of Western Europe, 15-20% below the level of the EEU countries. According to the MilkNews Analytical Center in January-February 2017, Russia's imports of dry and condensed milk and cream increased by 38.7% compared to the same period in 2016 (mainly due to imports of dry skim milk (21%)). This state of affairs does not correspond to the State Program for the Development of Agriculture for 2013-2020, where one of the main goals is the goal of food import substitution, which is especially relevant in the context of economic sanctions. In particular, this program plans to increase the share of domestic milk and milk products to 80.6%. This issue is relevant to a greater or lesser extent for different regions of the Russian Federation. As a rule, these

are regions of the Non-Black Earth Region, where, due to natural and climatic factors, the yield of fodder crops is lower, which reduces the possibility of organizing a solid fodder base for dairy cattle and leads to a decrease in the efficiency of production.

## 2. Methods

Stability generally refers to the ability of the system to maintain the current state under the influence of external influences. In the general sense, the concept of "stability" implies the relative preservation of the equilibrium of the system under the influence of environmental conditions over a period of time. With regard to agricultural production, one can speak of the stability of the economic system, therefore, it is necessary to define the notion of "economic sustainability".

Sustainability of the economy is its ability to perform its functions and maintain the basic parameters within the established norms for all types of external and internal influences (Prischepa *et al.*, 2016).

There are external and internal factors of sustainability. To internal it is possible to carry: system of conducting of plant growing of animal industries and other branches, the organization of manufacture, the organization, standardization and a payment, planning, coordination of work of structural divisions of the enterprise, the control of performance of works, regulation of deviation of manufacture from prospective parameters. External factors include: market conditions, inflation and unemployment, fiscal and budgetary policies, welfare of citizens, activity of state regulation of the industry. Due to its risky nature, agriculture must be withdrawn from the market with the help of appropriate state policy. To improve sustainability, public policies should be conducted at the federal, regional and local levels.

The stability of agricultural production was studied by such well-known scientists as V.T.

Vodyannikov, V.I. Veklenko, I.B. Zagaytov, A.P. Zinchenko, A.V. Kolesnikov, V.I. Nechaev and others (Kristensen *et al.*, 2011; Zagoruiko, 2014; Zimin and Solopova, 2004).

An important methodological task is the task of measuring the sustainability of agricultural production. As a measure of sustain ability in science, it is roposed to use several indicators.

First, as a measure of stability, it is proposed to use the Spearman (or Pearson) coefficient. This coefficient can be used as a coefficient of stability of growth ( $K_p$ ). It is calculated by the formula 1:

$$K_p = 1 - \frac{6 \cdot \sum_{i=1}^n d_i^2}{n(n^2-1)}, \quad (1)$$

where  $d_i$  is the difference between the  $i$ -th ranking value of the dynamics series and the  $i$ -th rank of the number of years in the series,  $n$  is the number of observations.

This coefficient varies in the interval  $[-1; +1]$ . The closer the value to unity, the higher the stability of a number of dynamics and the less risk. With a coefficient close to  $-1$ , there is a steady decline.

If it is necessary to assess the risk of changes, the correlation index ( $r$ ) (formula 2) is also used:

$$r = 1 - \sqrt{\frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{\sum_{i=1}^n (y_i - \bar{y})^2}} \quad (2)$$

where  $y_i$  is the  $i$ -th value of the dynamic series,  $\hat{y}_i$  is the  $i$ -th trend value of the dynamic series;  $\bar{y}$  is the average of a number of dynamics.

This indicator measures the share of change in the factor and the share of the residual variation (there is an existing one besides the variation determined by the trend). Residual variation, as is known, is determined by random factors, related to the trend, factors. The closer this index is to 1, the higher the influence of random factors and the less risk of change, but at the same time - the greater the risk of random factors (Zagaytov and Kozlobaeva, 2008).

Stability of the trend is measured by the coefficient of trend stability -  $K_T$ . It is measured by the ratio of the average increment of the indicator, measured by the coefficients of the regression equation, to the mean square deviation (formula 3):

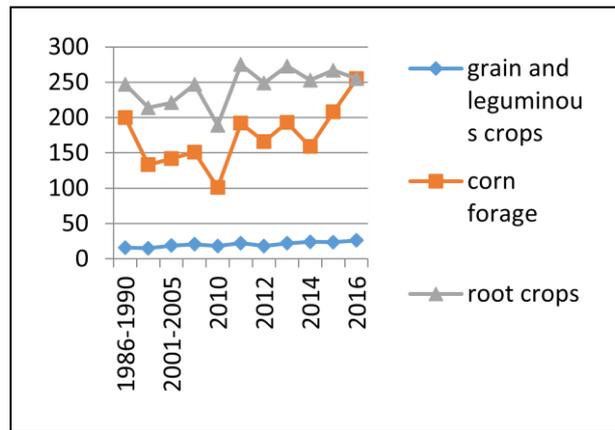
$$K_T = \frac{b}{\sigma}, \quad (3)$$

where  $b$  is the coefficient of the linear regression equation for the variable  $x$  (linear regression  $y = a + bx$ );  $\sigma$  is the standard deviation.

If the average increment is greater than one ( $\frac{dy}{dx} > 1$ ), then the series levels grow faster than the oscillations. The higher the  $K_T$ , the lower the risk of trend dynamics. If  $K_T < 1$ , then it means that the trend indicators are insignificant and there is practically no trend (a regular change in the indicator), that is, the higher the risk of trend dynamics. This is typical for the linear trend, but there are also indicators for the exponential and parabola.

## 3. Results

A stable feed reserve of cattle is the basis for the sustainable development of dairy cattle breeding, obtaining stably high milk yields. Highly productive livestock is particularly sensitive to changes in feeding conditions. Stability of feed-production is determined, first of all, by natural and climatic conditions. The data in Figure 1 show that the yield of different forage crops in the Russian Federation varies considerably over the years, that is, it is unstable.

**Figure-1.** Dynamics of yield of fodder crops in the Russian Federation, q / ha

The stability of feed production is also affected by factors of intensification of production, among which the main place is occupied by such factors as the amount of fertilizers applied and the level of technical equipment of production. A great importance for the health and productivity of animals has a temperature regime and microclimate. Over the years of reforms, the amount of mineral fertilizers applied decreased on average in the country from 78 kg / ha (1990) to 13 kg / ha (2016). Differences in the intensity of business management affect the number of unprofitable agricultural enterprises in the regions of the Russian Federation. In regions located in the southern part of the Central Federal District - the Central Black Earth Region, which is characterized by a warmer climate, the share of unprofitable organizations is lower.

In different regions of the Russian Federation, the production of stable forage crops is different. Analysis by regions of the CFD of the stability of the production of cereals, which are the basis of the feed ration of livestock, according to the coefficient of variation (Table 1) showed that this indicator is higher in areas with high yields of grain crops, usually in the areas of the Central Black Earth Region.

Table-1. Stability of the indicator "productivity of cereals and leguminous crops, c / ha" in the regions of the Central Federal District

District, Region	Years							Average yield over a period of q / ha	Mean square deviation, q / ha	Coefficient of variation
	2005	2010	2011	2012	2013	2014	2015			
Central Federal District	22,6	17,5	24,3	25,9	30,4	34,8	31,2	26,7	5,9	22,1
Regions:										
Belgorod	28,8	18,8	33,0	34,2	37,5	44,5	39,7	33,8	8,3	24,6
Bryansk	17,6	16,3	20,0	22,8	24,1	28,8	29,7	22,8	5,2	22,8
Vladimir	18,2	16,4	19,5	22,1	17,2	23,2	24,7	20,2	3,2	15,8
Voronezh	21,5	14,0	24,6	25,0	27,3	32,4	30,0	25,0	6,0	24,0
Ivanovo	13,2	18,0	16,8	20,0	16,6	21,3	22,6	18,4	3,2	17,4
Kaluga	16,0	19,4	19,6	21,5	16,2	21,3	25,4	19,9	3,3	16,6
Kostroma	9,7	12,1	14,4	13,5	11,2	16,0	15,5	13,2	2,3	17,4
Kursk	24,4	19,0	29,1	30,9	36,3	43,3	34,0	31,0	8,0	25,8
Lipetsk	33,2	19,6	26,3	26,2	33,8	34,4	30,4	29,1	5,4	18,6
Moscow	19,2	21,6	23,9	25,8	23,7	28,1	31,3	24,8	4,0	16,1
Orel	24,0	21,6	22,4	27,2	32,6	39,8	30,4	28,3	6,5	23,0
Ryazan	20,1	15,6	19,3	21,3	25,9	29,8	30,2	23,2	5,6	24,1
Smolensk	13,9	12,2	19,3	18,4	16,6	21,4	22,2	17,7	3,7	20,9
Tambov	20,4	13,8	22,5	21,6	30,9	31,7	32,0	24,7	7,0	28,3
Tverskaya	11,1	11,1	13,4	13,4	13,1	16,4	16,7	13,6	2,2	16,2
Tula	18,6	18,1	18,5	24,8	28,9	31,2	27,9	24,0	5,6	23,3
Yaroslavl	11,6	13,7	16,2	17,3	13,5	20,7	20,8	16,3	3,6	22,1

According to Table. 1, an analytic grouping of regions by the coefficient of variation was carried out (Table 2).

**Table-2.** Grouping of the regions of the Central Federal District of the Russian Federation in terms of the degree of stability of yields of cereals and leguminous crops, q / ha

Groups and intervals by coefficient of variation, V	The average variation coefficient (V) by group	Regions of Central Federal District
From 0,158 to 0,200 (7 townships)	0,169	Lipetsk, Ivanovo, Kostroma, Tver, Moscow, Kaluga, Vladimir
From 0,201 to 0,243 (7 townships)	0,229	Ryazan, Voronezh, Tula, Orel, Bryansk, Yaroslavl, Smolensk
More 0,244 (3 townships)	0,262	Tambov, Kursk, Belgorod

Source: compiled by the authors according to the Federal State Statistics Service of the Russian Federation

The smallest variation of this indicator is mainly in the regions of the Non-Black Earth Region. Calculation of the relationship between the coefficient of variation, reflecting the stability of production, and the average yield showed a fairly close relationship between these factors, the correlation coefficient was 0.55. This analysis shows that the most high-intensity production is less stable and more risky.

To analyze the dependence of the stability of agricultural production on natural and climatic factors (air temperature, precipitation amount, type and texture of soil), a cluster of regions with the help of the software complex Deductor Studio was singled out as an example of one of the typical representatives of the northern part of the Central Federal District - Tver Oblast. In particular, the Kohonen map algorithm was used. The results of the cluster analysis are given in Table. 3.

**Table-3.** Cluster groups of regions of the Tver region depending on natural and climatic conditions

Group 1	Bezhetsky, Konakovsky, Penovsky, Selizharovsky
Group 2	Andreapolsky, Vesegonsky, Kalyazinsky, Kimry Krasnokholmsky, Kuvshinsky, Lesnoy, Molokovsky, Sandovsky, Sonkovsky, Spirovsky, Torzhoki
Group 3	Vyshnevolotsky, Zharkovsky, Zapadnodvinsky, Likhoslavl, Maksatikhinsky, Rameshkovsky, Staritsky, Toropetsky
Group 4	Bologovsky, Ostashkovsky, Firovsky,
Group 5	Belsky, Zubtsovsky, Kalininsky, Kashinsky, Kesovogorsky, Nelidovsky, Oleninsky, Rzhevsky

The analysis of the stability of several factor and effective indicators of the development of dairy cattle breeding was carried out for selected cluster groups: gross output of crop production, as this industry is the supplier of feed for livestock raising and is most susceptible to the influence of natural and climatic conditions, thousand rubles; the yield of cereals and leguminous crops, which are the basis of the feed ration of livestock; the yield of perennial grasses for hay, this indicator is included for a comparative analysis of its variability with the fluctuating yield of cereals and leguminous crops; produced milk, t (Table 4).

**Table-4.** Calculation of the degree of stability of the main indicators of the development of feed production and dairy cattle breeding in the cluster groups of the districts of the Tver region for 2008-2015.

Cluster Group	Indicators	Average by years	Mean square deviation, $\delta$	Percentage of variations, %
1	Gross production of plant growing, thousand rubles.	1284063,0	360024,3	28,0
	Yield of grain and leguminous crops, q / ha	20,4	4,8	23,5
	Yield of perennial grasses for hay, q / ha	15,6	2,0	12,6
	Produced milk, t	38624,1	3627,4	9,4
2	Gross production of plant growing, thousand rubles.	2085548,0	437595,3	21,0
	Yield of grain and leguminous crops, q / ha	11,9	1,3	10,6
	Yield of perennial grasses for hay, q / ha	16,2	0,6	3,4
	Produced milk, t	49257,5	8476,7	17,2
3	Gross production of plant growing, thousand rubles.	1328669,0	471956,0	35,5

	Yield of grain and leguminous crops, q / ha	11,3	1,1	9,5
	Yield of perennial grasses for hay, q / ha	12,2	1,1	8,8
	Produced milk, t	26786,2	9150,3	34,2
4	Gross production of plant growing, thousand rubles.	279537,9	65253,0	23,3
	Yield of grain and leguminous crops, q / ha	5,4	1,8	33,6
	Yield of perennial grasses for hay, q / ha	11,4	1,2	10,2
	Produced milk, t	5432,6	2819,8	51,9
5	Gross production of plant growing, thousand rubles.	2655871,0	561720,7	21,2
	Yield of grain and leguminous crops, q / ha	16,7	3,3	20,0
	Yield of perennial grasses for hay, q / ha	15,1	0,5	3,1
	Produced milk, t	42380,5	9777,1	23,1

The final indicator for the development of dairy cattle breeding is the sustainability of milk production. According to this indicator, the most stable is the first group, which includes the Konakovo district under consideration. However, this group has the least stable character of yield of cereals and leguminous crops and perennial grasses, and also - the gross output of plant growing, occupies 4-5 place. This fact indicates the holding of anti-risk measures in the farms of these areas. The farms of this group have the highest yield of grain and leguminous crops, which are the basis of the feeding area of cattle. The most stable was the second and fifth groups.

#### 4. Summary

The sustainability of dairy cattle and fodder production is now necessary to increase. It is necessary to distinguish the indicators often identified in the scientific literature - the stability of production, expressed in the stability (minimum of oscillation) of the indicators, and sustainable development - a concept often opposed to the sustainability of production. The sustainability of production can be measured by a variety of indicators, among which the most frequently used are the Spearman rank coefficient, the correlation index, the coefficient of variation. If the stability of production can be estimated with the help of the coefficient of variation, then the stability of development (or the stability of the trend) can be measured with the help of a rank coefficient or a correlation index. For different regions of the Russian Federation this issue is more or less acute. Studies carried out regarding the study of the stability of the main factor in the development of dairy cattle breeding - fodder production, have shown that in regions with the highest levels of fodder production, the sustainability of feed production is lower (Thornton, 2010).

Variation of the degree of stability is also observed at the level of a single region, which was investigated using the example of the districts of the Tver region. Areas located in relatively less favorable natural and climatic conditions are subject to a higher degree of influence of natural and climatic risks.

#### 5. Conclusions

Such clustering of districts is necessary to justify the necessity of carrying out anti-risk measures for dairy cattle breeding, which should be used most in areas with a high degree of risk. Among such measures, it is possible to apply fodder crop insurance, the application of appropriate equipment and technology, the introduction of the necessary amount of fertilizers for fodder crops, the timely conduct of veterinary measures, and others.

#### Acknowledgements

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

#### References

- Gareyev, I. T. (2010). *Risk management in machine-technological stations machine-technological station*. MTC. 6.
- Golubev, S. V. and Yusupova, G. L. (2013). Formation of the mechanism of management of industrial risk in agriculture using information technologies: monograph. ulyanovsk: USASA, formation of the mechanism of management of industrial risk in agriculture using information technologies: monograph. 258.
- Kristensen, T., Mogensen, L., Knudsen, M. T. and Hermansen, J. E. (2011). Effect of production system and farming strategy on greenhouse gas emissions from commercial dairy farms in a life cycle approach. *Livestock Science*, 140(1-3): 136-48.
- Nechaev, V. I. and Vasilyeva, N. K. (2010). Fetisov S.D. Assessment of the sustainability of the development of the agrarian sector. *The Economics of Agriculture in Russia*, 2: 52-62.

- Prischepa, I. M., Krasovskaya, I. A., Dudarev, A. N., Dorofeyenko, M. L. and Razboeva, G. V. (2016). The youth of the 21st century. *Education, Science, Innovations*.
- Shatilova, L. M., Borisova, V. V. and Kasatkina, O. A. (2018). Representation of the linguistic and cultural concept lie in the French and Russian language picture of the world. 34(85): 194-212.
- Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *philosophical transactions of the royal society of London b, biological sciences*. 365(1554): 2853-67.
- Zagaytov, I. B. and Kozlobaeva, E. A. (2008). *Stability of reproduction in the system of factors of increasing competitiveness*. Publishing house. OrelGau: Orel. 34-37.
- Zagoruiko, A. Y. (2014). Evaluation of production risks in the grain-derived subcomplex of the kurgan region agrarian bulletin of the urals. 72-75.
- Zimin, N. E. and Solopova, V. N. (2004). *Analysis and diagnostics of financial and economic activity of the enterprise*. Colossus: Moscow.
- Zinchenko, A. P. (2016). *Statistical study of the efficiency of livestock in Russia*. Publishing House of the Russian State Agrarian University MCXA: Moscow.