

Dairy Cattle Breeding Effectiveness Analysis under the Conditions of Import Substitution

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ABSTRACT

The relevance of the research problem is inspired by the strategic importance of dairy farming to the national economy, which is especially evident in the context of the EU economic sanctions against the Russian Federation and carrying out the import substitution policy. First and foremost, this policy applies to food commodities, including milk. The goal of the article is to study statistical productivity analysis of dairy cattle breeding as one of the major indicators to show its effectiveness (Privolzhsky Federal district in Russia is taken as the example). The main methods, used to study this problem are the index method, time series analysis, and correlation and regression analysis. As the study result there were identified the factors affecting the dairy cattle productivity, the prognosis and the conclusion about the positive aspects in solving problems of import substitution in the field of milk production. The article can be useful to regional governments in the development and adjustment programs for socio-economic development of subjects dealing with agriculture in the Volga Federal district of Russia.

KEYWORDS

Agriculture, dairy cattle, livestock productivity, efficiency, the substitution

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Introduction

Introduce the Problem

Due to the difficult political situation in the world, the sanctions imposed against the Russian Federation, one of the main directions to ensure food security is the cattle development, contributing to the increase in domestic

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products production. It is the strategic importance of dairy farming to the national economy is led to the topic relevance for this study.

Currently, food security is a situation in which every citizen is guaranteed physical and economic availability to buy sufficient quantities of quality, nutritious and safe health food.

To provide the population with adequate quality food is able only one of the most important sectors of agriculture – cattle breeding. It provides consumer goods industry and food processing with necessary raw material for the production food and consumer goods, and population is made provision with natural high protein diet foods. At all times, agriculture was a key sector of the economy. It is now.

Currently in our country there are programs to develop the main types of agricultural products and milk in particular. All measures are aimed not only to maintain financial sustainability of agricultural production, but also to improve the competitiveness of Russian products on the domestic and foreign markets, the agriculture modernization. In addition, the government sets the task to improve the rural resident's life quality, because agriculture is not only economic sector but also the habitat for a large part of the population and their work place.

One among such programs is the State target subprogram, "Milk and dairy products production Development for 2015 - 2020", is developed in accordance with the Russian Federation President's instructions and due to the initiative of the Milk Producers National Union. Its aim is the highest possible approximation to the values of the target indicators in Food Security Doctrine of the Russian Federation in the sphere of dairy farming production, as well as ensuring integrated and balanced dairy industry development and improving the milk production and processing efficiency.

Cattle breeding industry is specific. Compared to the crop it is less dependent on weather conditions, due to which it has less seasonality and allows to use resources a more evenly and efficiently. This also contributes to technical progress: automate feeding, milking, cleaning animal waste. Importantly, the cattle productivity largely depends on the personnel qualification, animal housing conditions and proper feeding. Thus, the livestock products are a result of two processes: the natural animal life and the production process.

Literature review

Dairy cattle traditionally occupies a central place in agricultural science. However, the statistical evaluation issues of the industry were considered by a limited number of scientists.

We can highlight the work of such researchers as E.S. Rybakova (2005) and L.V. Ruchinskaya (2013). In their dissertations they gave a complex statistical evaluation of major livestock products production and also carried out a detailed analysis on milk and dairy products market in the Russian Federation.

In particular, the authors describe in detail the statistics for the major milk countries producer, identify the advantages and disadvantages of domestic dairy cattle breeding compared to the US, make the main indicators forecast in animal husbandry.



I.V. Bezlepkina et al., (2005) developed an econometric model of specialized dairy farms in the Moscow region. The model is used to analyze the role of subsidies to agricultural producers in the profit distribution.

A number of authors have conducted studies on prices and cost of livestock products (Ollinger, 2011). In the writings of these scholars we can mention such statistical and mathematical methods, the analysis of asymmetry, factor analysis model, eliminating errors and others.

Features of dairy cattle breeding in the Russian Federation and prospects of its development from the point of view as import substitution is discussed by P.D. Kosinski & A.G. Chuprakov (2014), L.A. Kormushkina & N.N. Semenova (2015), Guskova, Salimova, & Krakovskaya (2015) and others. The main aim of these studies was the dependence analysis of the Russian Federation on staple foods (including dairy) from imports, ensuring country food security in terms of the European Union sanctions.

Problems in statistical analysis of agricultural markets are dedicated in many domestic and foreign scientists-economists work. In our opinion, there is a certain lack of studies on complex statistical description of the state dairy cattle breeding in the Russian Federation. Our study aims to fill this gap partially.

Such research can be developed in two aspects: 1) to examine selected conditional indicators in the dairy cattle breeding sphere; 2) to examine the industry position in some Federal districts and regions of Russia. If the first aspect is researched and developed by many scientists, than the second aspect has extremely small research base. Perhaps it was not absolutely necessary. However, introducing the import substitution policy in the Russian Federation, the question, if some areas are ready to provide the population with its own agricultural products, rises.

The scientific works analysis allowed us to conclude that, despite the high development of themes in modern economic literature, insufficient attention is paid to the problems of complex statistical analysis on the milk and dairy products at Russian market that determined the nature of our study.

Aim of the study/stating the purpose

The purpose of this study is a complex statistical study on dairy cattle productivity.

Based on the goal the following objectives were set up:

1. To characterize the object of the study;
2. To establish the effective factor indicators system for the study;
3. To analyze the structure of gross production and its dynamics;
4. To conduct correlation and regression analysis of cows productivity;
5. To perform a multivariate analysis of constituent entities in the Volga Federal district in conditions affecting productivity.

The object of the study includes the 14 regions of the Volga Federal district in Russia as a combination of milk producers in all farms categories.

The subject of research is a quantitative characterization of the dairy cattle performance indicators.

Materials and Methods

Research methods

The methodological framework of the study combines the methods of comparative, dynamic, correlation and regression, index analysis, non-parametric, graphical, tabular, and other scientific methods.

Analysis of the dynamics and dairy cattle indicators structure was conducted using the index method, Ryabtsev's index, and methods of time series analysis.

The dependence of the gross milk yield (GY) from the number of cows (N) and their productivity, i.e. milk yield from one cow (Y) can be represented in the form of multiplicative models:

$$GY = Y * N.$$

Index-number of these factors is in the same dependency:

$$IGY = IG * IN$$

Conventional signs: IGY – the index of the gross milk yield; IG – index productivity; IN – the index of the livestock.

Absolute change in gross milk yield by factors of growth of productivity and the number of livestock was calculated by the method of relative differences.

Absolute change in milk yield due to changes in the number of cows:

$$\Delta GY (N) = GY_0 * (IN - 1).$$

Absolute change in gross milk yield due to changes in milk yield from one cow (productivity):

$$\Delta GY (Y) = GY_0 * IN * (IY - 1).$$

Thus, the total change is calculated as the sum of the influence between two indicators:

$$\Delta GY = \Delta GY (N) + \Delta GY (Y).$$

Study of factors affecting the cow's productivity was conducted using correlation and regression analysis, building regression models.

Multivariate group of Volga Federal district regions by the integrated assessment of livestock productivity is performed by a nonparametric method "Pattern".

The experimental base of the research

The study is based on official statistical data. Source: unified interdepartmental statistical information system, Federal state statistics service (Rosstat), the Ministry of agriculture of the Russian Federation, the national Union of milk producers. The work was also used computer technology, in particular, the software package Statistica 10.0.

The information required is contained in such regulatory documents of the Federal level as the "State program of agriculture development and regulation of agricultural products markets, raw materials and food for 2013-2020", the State target program "Development of milk and dairy products production for 2015 - 2020".

To the researched population includes the enterprises and private farms of the population, belonging to the following groups of Russian Classification of Economic Activities (RCEA):



”Section A. Agriculture, forestry, hunting, fisheries. Code 01.41 Dairy cattle rising, raw milk production”.

This group includes:

- cultivation and breeding of dairy cattle;
- pedigree dairy cattle breeding;
- raw cow and raw milk production of other cattle (buffaloes, yaks).

More detailed coding of economic units: ”01.41.1 Breeding dairy cattle; 01.41.11 Breeding dairy cattle, except for breeding; 01.41.12 Breeding dairy cattle; 01.41.2 Raw cow milk and raw milk Production; 01.41.29 Raw milk Production of other cattle (buffaloes, yaks)”.

The stages of the research

At the first phase of research, there were formulated its main goals and objectives, identified the object and subject of the research, the analysis methods.

At the second stage the study object characteristic there was formulated a system of indicators for statistical analysis.

At the third stage the analysis of the indicators, characterizing the state of dairy cattle breeding, was made, tendencies, changes regularities in the industry and factors influencing the change in the effective index were identified.

The last stage was done in the interpretation of the results and identifies areas of promising research in this area.

Results

Volga Federal district is one of the leading in the country in terms of industrial development. At the same time, it is also one of the main agricultural regions in the country. In the district concentrated the largest share in the number of cows was 26%.

Within the Volga Federal district in proportion of the cow’s number is leading the Republic of Bashkortostan and Tatarstan, the Orenburg and Saratov region that accounted for more than half of the total number of cows (57%).

Specific indicator in the statistics of livestock breeding is the cow’s number per 100 hectare of cultivated area. It allows taking into account the territorial dimensions of the subjects. The highest density in 2014 was in the Chuvash Republic – 17 cows per 100 hectare of cultivated area. The values close to the largest, also observed in the republics of Bashkortostan and Mari El Republic - 14 cows. The lowest density observed in the Samara region – about 5 cows. The calculated coefficient of variation for this indicator stood at 39.6%, which indicates the uneven distribution of livestock by regions of the Volga Federal district.

Volga Federal district ranks first not only in cows but also in terms of gross milk yield (about 30% of whole milk production in the country). If in 2005 the largest share of milk production accounted for private farms of the population and accounted for 54%, in 2014 the share of this category of producers has decreased; at the same time increased the proportion of milk production in agricultural organizations. It became dominant in the structure - 49% (table 1).

Table 1. Dynamics of milk production structure in the Volga Federal district by types of farms in 2005 and 2014.

Farms Categories	Share of milk production %		Share Change	
	2005 год	2014 год	percentage points %	%
Agricultural organization	42,4	48,5	6,1	14,3
Households	54,2	45,2	-8,9	-16,4
Peasant farm enterprise	3,4	6,2	2,8	82,7
Total	100,0	100,0	-	-

Source: Regions of Russia. Socio-economic indicators (2015)

Share in total milk production of farms is minimal, while in 2014 it increased by 83% (compared to 2005).

Within the district there are marked as identical and significant differences in the structure of milk production by types of farms. For example, in the Kirov region almost all the milk produced by agricultural enterprises (about 90%). The major share of milk production in the Saratov region provides households (78%).

The study showed that over the study period for the Federal circuit, as in the whole of Russia, marked decrease in total milk yield. Dynamics within the Volga Federal district have been mixed. Only three regions of the district provided a positive increase in milk production: Republic of Tatarstan, the Udmurt Republic and the Orenburg region. In other subjects of the Russian Federation recorded a decrease in gross yield. The most significant decrease in absolute terms in the Republic of Bashkortostan is more than 300 thousand tons. In relative terms, the largest decline in milk production in the Penza region – more than 30 %.

The gross milk yield depends on the number of cows and their productivity. It should be borne in mind that the calculations for the individual data of each subject and summary data for the Federal circuit in General give different results, so we used the two-factor and three-factor multiplicative and additive index models.

The calculation results showed that, in General, in the Volga Federal district the gross milk yield decreased in the reporting year by 5.1% or 508, 8 thousand tons (table 2).

Table 2. Factor analysis of the gross milk yield in the regions of the Volga Federal district for the period 2005-2014

Region	Indices, %			Absolute increase of the gross yield, thousand tons		
	Productivity	Livestock	Gross milk yield	Due to the influence of		Total
				Changes in productivity	Changes in livestock	
Republic of Bashkortostan	131,0	65,0	85,1	419,4	-729,8	-310,4



The Republic of Mari El	137,9	56,5	77,9	53,8	-109,5	-55,7
The Republic of Mordovia	156,3	63,6	99,4	147,2	-149,8	-2,6
The Republic of Tatarstan	142,1	79,2	112,6	511,8	-318,9	192,9
Udmurtia	149,9	76,7	115	241,1	-146,8	94,3
Chuvash Republic	143,6	67,5	96,9	127,9	-141,2	-13,3
Perm Region	142,2	63,2	89,9	140,2	-193,3	-53,1
Kirov Region	157,3	57,3	90,1	197,3	-257,0	-59,7
Nizhny Novgorod Region	144,6	66,7	96,4	191,1	-214,3	-23,2
OrenburgRegion	164,3	65,8	108,1	317,3	-256,2	61,1
PenzaRegion	134,2	48,3	64,8	83,2	-260,3	-177,1
SamaraRegion	145,3	66,7	96,9	135,5	-149,2	-13,7
SaratovRegion	114,6	77,9	89,3	99,0	-192,6	-93,6
UlyanovskRegion	137	59,1	81,0	62,8	-117,5	-54,7
Total:	159,0	59,7	94,9	2727,6	-3236,4	-508,8

Source: Regions of Russia. Socio-economic indicators (2015)

Thus by increasing the productivity of cows in each region the gross milk yield of the district increased by 2727, 6 thousand tons. Due to the growth in the share of livestock in the regions with high productivity, due to positive structural changes, there were produced additional 23, 5 thousand tons of milk. However, the decline in the total number of cows was quite substantial and led to the decrease in the gross yield on 3259, 9 thousand tons.

In General, over the period there was seen a steady trend to increased productivity - milk production from one cow (table 3). The result of smoothing we received trend model in which productivity depends on the time factor t:

$$Y=150,34 t + 2959,8, \text{ where } t \text{ is the time factor.}$$

Table 3. The dynamics of cows productivity in the Volga Federal district for the period 2005-2014

Date	Milk yield from a cow, kg	Absolute GGain		Growth Rate, %	
		Chain	Base	Chain	Base
2005	3 151	-	0	-	0,00
2006	3 482	331	331	10,50	10,50
2007	3 658	176	507	5,06	16,09
2008	2 850	-808	-301	-22,09	-9,56
2009	3 468	618	317	21,68	10,05
2010	4 085	617	934	17,79	29,63
2011	4 198	113	1 047	2,77	33,22
2012	4 267	69	1 116	1,64	35,41
2013	4 268	1	1 117	0,02	35,44
2014	4 441	173	1 290	4,03	40,90

Source: Regions of Russia. Socio-economic indicators (2015)

Thus, the cow's productivity in the Volga Federal district on average every year increases by 150, 34 pounds. Based on the trend model there was constructed point and interval forecasts for 2015 and 2016. The calculations

showed that with 95% probability we can expect that the level of cows productivity in the Volga Federal district in 2015 will be between 3949,8 to 5277,5 kg of milk from one cow, and in 2016 from 4100,2 to 5427,9 kg. In fact, in 2015 the milk yield from one cow, compared with 2014 increased 4632 kg, which corresponds to the interval forecast, is slightly higher than the point. Also in the last 2 years the decline in the cow population has slowed somewhat.

The cow's productivity as an intensive factor increase in gross milk yield is of particular interest for the analysis. We see it as a productive indicator (Y). In an effort to increase productivity you must know the factors that influence it.

This issue helped to solve correlation and regression analysis. On the basis of a multi-step analysis of the 11 factors in the multiple regressions equation included 2 factors. The result is a model that demonstrated the direct dependence of the milk production from one cow from the square acreage of perennial grasses per 1 head of cattle and an inverse relationship from the share of unprofitable enterprises, operating in agriculture. The regression model has the form:

$$Y = 4880,989 - 38,178X_1 + 318,550X_2.$$

We'll interpret the model parameters. By increasing the share of unprofitable organizations functioning in agriculture (X1), 1% milk yield from one cow is reduced on average to 38 kg per year at average the impact of other factors

The increase in acreage of perennial grasses per head of cattle (x2) per hectare, and promotes the growth of milk yield from one cow on average 318 kg.

The coefficient of determination amounted to 81.7 %. This indicates the high quality of the constructed model.

At the final stage of the study using the method of "Pattern" is a grouping of constituent entities in the Volga Federal district for the multidimensional evaluation of conditions affecting the cow's productivity.

We have identified the factors characterizing the condition of the most high livestock productivity: X1 – fodder consumption per one conventional head of cattle, centners of feed units;

X2 – the acreage of and leguminous crops, thousand hectares per head;

X3 - the acreage of perennial grasses per hectare per head of the cows.

X4 – the share of unprofitable organizations functioning in agriculture, %;

X5 – investment in fixed capital per capita, rubles.

The most favorable conditions for high productivity of cows have developed in 6 regions of the Volga Federal district: the Kirov, Nizhny Novgorod, Saratov and Samara regions, the Republic of Udmurtia and the Republic of Tatarstan. Favorable conditions have 4 regions: the republics of Bashkortostan and Mari El Republic, Ulyanovsk and Orenburg regions. The least favourable are in the Republic of Mordovia, Perm region, Penza region and the Chuvash Republic), having the least favorable conditions for high productivity.

As a result of the statistical study there were revealed the following general tendencies of dairy cattle breeding development for the period 2005-2014: improving cow's productivity, however, a significant reduction in their numbers, had the greatest influence on the effective indicator - the gross milk yield.



Discussions

In the process of development methodological issues statistical study on agriculture the great importance were played by the domestic and foreign scholars as V.G. Mkhitaryan & L.V. Sweet (2013) and others.

Our study has its own specifics: it explores the status of dairy farming in a separate Federal entity, and as a methodology applied statistical methods.

The problem of import substitution in dairy products livestock is very acute. At this stage of domestic agriculture development it is unable to fully meet the needs of the population in Russia. However, this applies primarily to meat and a lesser extent to milk. According to experts, to achieve full import substitution is impossible not so much because of the capabilities of the manufacturers, but because of the lack of processing facilities.

The positive, which was disclosed in our study, was the increase of dairy cattle productivity. The extrapolation showed a continuation of this trend in the coming years. The negative point is a decrease in the total (gross) milk, which is caused by a significant reduction in the number of cattle.

With proper farming techniques, improved breeding, well thought-out investment policy Privolzhskiy Federal district has every reason to significantly improve the competitiveness, to provide import substitution and increase the volume of milk production. This is facilitated by good climatic conditions, transportation and financial factors.

Here the role of the State in managing the process of import substitution is very important. It can implement various options to support agricultural producers, including financial and technical. It is important to remember that the control process is only possible on the basis of reliable statistical information. Under these conditions, an important role has the applied statistical research.

Conclusion

Our statistical study has a practical significance, which is that the analysis can be used by the relevant authorities in the development and adjustment programs for socio-economic subject's development of the Volga Federal district.

This study can be extended in its spatial aspect, involving the geographic expansion. In each Federal district of Russia can have its own set of factors the productivity of livestock and the features of the dynamics and dairy production structure.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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