Milk production dynamics in the Russian Federation: causes and consequences

V V Nosov¹, N M Suray¹, O A Mamaev³, O V Chemisenko³, P A Panov³ and M G Pokidov⁴

¹ Department of Economics and Management, K.G. Razumovsky Moscow State University of Technologies and Management, 73 Zemlyanoy val, Moscow 109004, Russian Federation
² Siberian Cossack Institute of technology and management, K.G. Razumovsky Moscow State University of Technologies and Management, 73 Zemlyanoy val, Moscow 109004, Russian Federation
³ Department of Technology and Industry, K.G. Razumovsky Moscow State University of Technologies and Management, 73 Zemlyanoy val, Moscow 109004, Russian Federation
⁴ Lipetsk Cossack Institute of Technology and Management, K.G. Razumovsky Moscow State University of technologies and management, 73 Zemlyanoy val, Moscow 109004, Russia

E-mail: novla@list.ru

Abstract. The article analyzes milk production in the Russian Federation from 1950 to 2019. Within the period under review, we can distinguish the following changing patterns of the indicator: from 1950 to 1990 the average annual absolute growth rate was 0.84 million tons, between 1991 and 2004 there has been an average annual loss of 1.43 million tons, and since 2005 there has been no growth in milk production. The article explains the reasons for the dynamics of the indicator and suggests measures meant to encourage the growth of milk production and achievement of the Food Security Doctrine in the area of rational consumption rates for milk and dairy products that meet modern requirements on healthy nutrition.

1. Introduction
Milk and dairy products are a unique and valuable protein source, demand for which grows every year with the increasing world population. Many countries experience milk shortage, which has a negative impact on morbidity and mortality rates, limits the cognitive development of a person and prevents human capital accumulation [1-6]. Milk is used in the production of various food products, pharmaceuticals and non-food items.

In the Russian Federation, milk and dairy products are included in the Food Security Doctrine list and are of paramount importance for the population’s food ration [7].

The purpose of this paper is to distinguish historical stages of milk production in the Russian Federation, analyze the dynamics and identify the causes of the situation at every historical stage.
2. Methods and materials
Availability of statistical data sources is important for time-series construction. In the research, we used data provided by the Federal State Statistics Service of the Russian Federation, International Dairy Federation (IDF) and the Food and Agriculture Organization of the United Nations (FAO).

When considering milk production, a problem arises with a comparison of indicators. The main reason for inconsistent data is territorial incompatibility resulting from the dissolution of the Soviet Union and lack of information for several years. The first issue was solved by using RSFSR information for 1950-1990, which is roughly comparable to modern Russia data. The second issue was solved by calculation of missing time series values based on the statistical digest ‘National Economy of the USSR’ and adjustment of milk production figures according to the RSFSR average share of milk production [8]. To characterize the dynamics of the indicator, we used absolute growth and average absolute growth rates. We also used the method of chain substitutions to determine the impact of factors on changes in output indicators. Table and graphic method were also used in the study [9].

3. Results and discussion
Based on the official sources and results of comparison of time-series levels, we constructed time-series of milk production in Russian households of all categories over the period from 1950 to 2019. The results are presented in figure 1.

![Figure 1. Milk production and cow numbers in each household category of the Russian Federation.](image_url)

Table 1 shows the directions of changes in dynamics of the milk production indicator.

| Development period, year | Directions | Absolute growth, million tons | Average absolute growth, million tons | Growth rate, % | Average annual growth, % |
|--------------------------|------------|-------------------------------|---------------------------------------|---------------|-------------------------|

Table 1. Development of milk production in the Russian Federation.
In RSFSR from 1950 to 1990, the dominant livestock types were dairy and dual-purpose (milk and meat) breeds. Only 5% of cattle were beef animals, 50% - milk breeds and 45% - dual-purpose animals. Soviet cattle breeding developed extensively through an increase in the number of cattle, which did not require serious investments and had low productivity due to poor mechanization and automation of production. Nevertheless, the absolute growth rate of milk production was 34.3 million tons, including 11 million tons through herd expansion and 23 million tons through growth in production.

In 1991 the Russian Federation declared independence and initiated radical political and economic transitions that affected all sectors, including agriculture. Market transformations in the agricultural sector negatively affected the state of dairy cattle breeding.

Milk production dynamics of 1990-2004 can be explained by the lack of producers’ interest in the production of milk, which was caused by the disparity in prices for agricultural and industrial products. Price disparity resulted in deterioration of cattle breeding infrastructure. Lack of investments to cattle breeding development affected production capacities; animals were kept huddled in dirty conditions, fed nutrient-deficient fodder. At the same time, there was a reduction in selective breeding capabilities.

Under the circumstances, a large part of agricultural organizations and peasant farm enterprises reoriented from milk production towards more profitable plant cultivation. Therefore, the number of dairy breeds reduced drastically, which led to a decrease in milk production of 26.8 million tons.

After the 1998 crisis, due to investments in Russian agriculture, dairy production intensified, resulting in milk production increasing by 6.0 million tons. Overall, over the period from 1991 to 2004, dairy production decreased by 20.8 million tons. The average annual decrease in milk production was 3.4%.

The decline in milk production has been overcome in 2006 as a result of changes to the economic policy of the Russian Federation. The "Agriculture Development" national project adopted in 2005 and transformed into the "State program for agriculture development and regulation of agricultural products, raw materials and food markets" in 2008, marked a new phase in state policy. Activities of the 2013-2020 program were adapted to the conditions of Russian membership in WTO. The Federal law on Agriculture Development adopted in 2006 has fundamentally changed the state agriculture support mechanism. Funds were supposed to be allocated from the federal budget if regional budgets would cofund these expenses. This required the adoption of regional development programs. Another positive step has become the adoption of the Food Security Doctrine in 2010. The Doctrine stated that the production of milk and dairy products in the country should provide 90% of its needs.

One of the support measures for agricultural producers is subsidies from federal and regional budgets for improving productivity in dairy production (per litre of milk) through higher productivity of cows and preservations of livestock. In 2017 changes were made to the state program: the use of a multiplying coefficient was proposed for allocation of funds for subjects of the Russian Federation with average milk productivity of 5000 kg and higher. The government also makes extensive use of preferential investment loans for the development of dairy cattle breeding. In 2019 about 6.9 billion rubles was allocated for this purpose.

Despite measures taken there was a continued decline in cow numbers: from 2006 to 2019 it reduced by 14.9% and led to a decrease in milk production by 4.5 million tons. However, this decrease was offset by the increase in cow productivity, which resulted in milk production increasing by the same 4.5 million tons. Thus, we can see that milk production did not change in 2019 compared to 2006.

The "Agriculture Development" national project contributed to the appearance of individual dairy farms that had high productivity rates. However, the average productivity level of milk cattle is still below the world level due to the underdevelopment of genetics in Russia and a high wear rate of farms' equipment. As a result, the increasing trend of milk yield only compensated the milk production losses caused by the reduction in cow numbers.
The need to introduce intensive technologies to cattle breeding and the existing credit policy requires additional costs, which leads to costs and prices of raw milk increasing. The Order of the Ministry of Agriculture of the Russian Federation of 27 June 2018 № 251 introduced mandatory supporting veterinary e-documents "Mercury VSD". Figure 2 shows the average data on milk cost structure in 2005 and 2019.

Costs per 1 kg of raw milk vary significantly because of changes in fodder prices: fodder is often bought abroad, and the price depends on the ruble exchange rates. The salary indicator increased as well, which is related to the goal of achieving a 90% ratio between salaries in agriculture and the national average taking as a basis the value stated in the Industrial Agricultural Sector Agreement of the Russian Federation for 2018-2020 [10].

The increase in milk production costs has been accompanied by an increase in prices. In total from 2005 to 2019, the average annual increase in the price of raw milk was about 2 rubles per 1 litre per year. Nevertheless, the cost of raw milk was growing at a higher rate than wholesale prices, reducing the profitability of milk production. Such a situation exists not only in the Russian Federation but also in developing countries [11].

There are more than 21 thousand dairy plants in the Russian milk industry and related sectors. The industry employs over 1.4 million workers, which is about 2% of the working population. Today Russia has over 20 thousand raw milk producers, more than 900 processors and over 200 of service companies. Dairy products account for 15% of retail turnover. At present, Russian milk plants are running at 60-70% capacity, therefore, the low number of dairy plants is not a limiting factor for milk production.

Milk pricing is greatly influenced by scarce dairy production resources. Experts have estimated that to meet the demand for milk, Russia has to produce 50 million tons of it per year. This results in competition in the dairy market and the subsequent increase in milk prices. Dairy processing plants have greater production resources for milk production and run at less than 50% capacity; therefore, there are enough reserves for milk production.

Dairy production exhibits strong seasonality. The period of peak production of milk for processing is May-June, the period of minimum production - October-December. Milk price fluctuations are related
to the seasonality of production: minimum prices occur in June-August, maximum - in December-February. Seasonal fluctuations in dairy production are common for all countries; however, they are considerably lower in Europe: the seasonal coefficient is 0.82 there [12].

The problem of the seasonality of dairy production in Russia can still be solved: for example, in the Leningrad region, Moscow region and Krasnodar region, the seasonal ratio is higher than 0.8.

Another issue that needs to be solved is the markup on milk and dairy products in shops. Table 1 represents the data on milk products prices (average data for Russia) in distribution networks and wholesale prices charged by suppliers over the period from 2017 to 2019.

Table 2. Average data on milk wholesales prices and network prices.

| Product             | Average wholesale price charged by suppliers, rubles/kg | Average price in a distribution network, rubles/kg | Average markup, % |
|---------------------|--------------------------------------------------------|---------------------------------------------------|-------------------|
|                     | 2017 | 2019 | 2017 | 2019 | 2017 | 2019 |
| Pasteurized milk    | 37.5 | 37.9 | 51.9 | 53.1 | 38.4 | 40.14 |
| Butter              | 311.5 | 320.7 | 501.3 | 534.8 | 60.9 | 66.71 |
| Hard cheeses        | 335.2 | 305.5 | 471.8 | 479.4 | 40.7 | 56.98 |
| Sour cream          | 122.3 | 127.9 | 188.9 | 196.9 | 54.4 | 53.9 |

The table shows that the markup can be 66% of the wholesale price, which is lower than the markup of the retail price; nevertheless, such a situation is hardly fair. The fact is that dairy products sales are dropping, affecting cheese sales. Even when wholesale prices of cheese have declined in 2019, retail prices still rose. Thus, supply chain coordination becomes vital to achieve the all level consensus, in which different members along a supply chain can respond to market requirements in proper ways [13-14].

This leads to the absence of demand and a reduction in trade turnover. The reason for the declining demand for dairy products is low purchasing power. The previous year's residues are much higher than the last year's.

Due to the absence of demand for dairy products, especially for the ones with long sell-by dates, the price has to be lowered, sometimes even lower than the cost level, which results in financial and interest losses.

This situation forces producers to switch to dairy products with short production and expiration dates, even though the market size is limited, the potential is exhausted, and competition is large. Another option for producers is to produce products with non-dairy supplements. Thus, production of cheese analogues and spreads has been growing recently. Palm oil and non-milk fats are the main substitutes for butterfat.

A decrease in interest for dairy products is caused by the distrust of their quality, which is impossible to test without buying and trying the product. Distrust of information on the label and fear of products with GMO are also present. The once growing interest in flavoured yoghurts is now decreasing as well due to the fact that the product is not a novelty anymore and because the yoghurt ingredients such as nature-identical flavourings, colourings and stabilizers have become common knowledge. It is not entirely known of these additives are safe, which is actively supported by mass media adding to the distrust of products. All this is accompanied by the reduction in purchasing power. Milk prices have converged between Europe and Russia, but population incomes leave much to be desired.

In accordance with the Order of the Ministry of Health of the Russian Federation of 10 August 2016 № 614 "On approval of recommendations on rational norms of food consumption that meet contemporary requirements for healthy nutrition", the rational consumption rate of milk and dairy products (in terms of milk) per person per year is 325 kg. According to the Food Security Doctrine, the self-sufficiency level for milk and dairy products (in terms of milk) should be no less than 90%, but it was 82.4% at the yearend. The commercial milk self-sufficiency indicator was 66%. In 2019, the
consumption of milk and dairy products was 234 kg per person, which is 72% of the norms set by the Ministry of Health.

Today we can identify the following priorities of the Russian milk industry:

- to increase the output of raw milk while maintaining the quality level;
- to reach 90% self-sufficiency;
- to improve the competitiveness of domestic dairy products.

4. Conclusion
To solve the accumulated problems, there is a need to analyze the situation and come up with a long-term strategy for the development of Russian milk sector that would allow normalizing the situation and providing the population with a sufficient amount of safe and quality dairy products. Under the program, there is a need to:

- realize the genetic potential and improve the legislative framework to develop domestic livestock breeding;
- increase the productivity of dairy cattle through the improvement of zoological hygiene and animal housing conditions and implementation of measures to improve herd reproduction and increase the utilization of artificial insemination;
- upgrade and rehabilitate the production facilities to increase the production output;
- improve fodder supply to develop high-producing livestock;
- increase incomes of milk producers through subsidizing commercial milk production, investment lending and short-term lending and refunding a part of capital costs for creation and modernization of objects of dairy breeding;
- support milk processors by refunding capital costs for creation and modernization of milk processing plants and by changing the credit policy on industry financing;
- increase accountability for violation of EEU technical regulations on dairy products labelling;
- reduce the impact of the seasonal factor on the dairy market conditions by using the mechanism of purchasing and commodity interventions on non-perishable dairy products;
- encourage consumption of milk and dairy products through the social catering system, food assistance programs, through the use of mass media and organization of various activities (expositions, fairs and conferences).

These issues can be solved only with the help of the government, which priority is aimed at providing the population with a sufficient amount of safe and quality dairy products.

References
[1] Victora C G, Adair L, Fall C, Hallal P C, Martorell R and Richter L 2008 Maternal and child undernutrition: consequences for adult health and human capital Lancet 371 340-57
[2] Dewey K G and Begum K 2011 Long-term consequences of stunting in early life Maternal & child nutrition 7 5-18
[3] Black R E, Victora C G, Walker S P, Bhutta Z A, Christian P de Onis M et al. 2013 Maternal and child undernutrition and overweight in low-income and middle-income countries Lancet 382 427-51
[4] Jin M and Iannotti L 2014 Livestock production, animal source food intake and young child growth: The role of gender for ensuring nutrition impacts Soc. Sci. Med. 105 16-21
[5] Mosites E M, Rabinowitz P M, Thumbi S M, Montgomery J M, Palmer G H, May S et al. 2015 The Relationship between Livestock Ownership and Child Stunting in Three Countries in Eastern Africa Using National Survey Data PLoS ONE 10 e0136686 DOI: https://doi.org/10.1371/journal.pone.0136686
[6] DeLay N, Thumbi S, Vanderford J et al. 2020 Linking calving intervals to milk production and
household nutrition in Kenya Food Sec. 12 309–25 DOI: https://doi.org/10.1007/s12571-019-01006-w

[7] Zhichkin K, Nosov V, Andreev V, Kotar O and Zhichkina L 2019 Damage modelling against non-targeted use of agricultural lands IOP Conf. Ser. Earth Environ. Sci. 341 012005 DOI:10.1088/1755-1315/341/1/01200500

[8] Chistik O, Nosov V, Tsypin A, Ivanov O and Permjakova T 2016 Research indicators of railway transport activity in time series Intern. J. Econ. Persp. 10 57-65

[9] Zhichkin K, Nosov V, Zhichkina L, Zhenzebir V and Sagina O 2020 Cadastral appraisal of lands: agricultural aspect IOP Conf. Ser. Earth Environ. Sci. 421 022066 DOI:10.1088/1755-1315/421/2/022066

[10] Frolova I, Nosov V, Zavyalova N, Dorofeev A, Vorozheykina T and Petrova L 2020 Labor opportunism as a blocking factor for the innovative development of industrial enterprises ESI 7 2228–42 DOI: https://doi.org/10.9770/jesi.2020.7.3(51)

[11] Sraïri M, Benyoucef M and Kraiem K 2013 The dairy chains in North Africa (Algeria, Morocco and Tunisia): from self-sufficiency options to food dependency? SpringerPlus 2 162 DOI: https://doi.org/10.1186/s40100-017-0085-x

[12] Madau F, Furesi R and Pulina P 2017 Technical efficiency and total factor productivity changes in European dairy farm sectors Agric Econ 5 17 DOI: https://doi.org/10.1186/s40100-017-0085-x

[13] Chopra S and Meindl P 2004 Supply chain management: strategy, planning, and operation (NJ: Pearson Prentice-Hall)

[14] Lemma H, Singh and Kaur N 2015 Determinants of supply chain coordination of milk and dairy industries in Ethiopia: a case of Addis Ababa and its surroundings SpringerPlus 4 498 DOI: https://doi.org/10.1186/s40064-015-1287-x