Russian beef sector: economic analysis and forecast

O V Kostenko

1Federal State Budgetary Educational Institution of Higher Education "Vyatka State Agrotechnological University," 610017, Kirov, Russia

E-mail: kostenko_ov@vgsha.info

Abstract. The article presents research results on the Russian beef production sector. As in the rest of the world, beef in the Russian market is losing the competition to pork and poultry. Beef is the most resource-intensive type of meat in terms of feed consumption and land requirements. The industry has a longer herd reproduction period and return on investment. The Russian beef market is in a long-term decline. Domestic production is declining, and imports have been declining since 2015. The level of consumer prices for beef is 1.5-2 times higher than the price for pork and poultry. According to the study results, several key factors in the industry's recovery from the crisis were identified. It is necessary to radically increase the share of beef obtained from beef cattle. This will allow obtaining better quality meat and reducing its cost. Now the share is about 20%, while in the world, beef cattle account for 40%. The construction of food chains in beef cattle is different from other agricultural sectors. The model of a combination of vertical integration (holdings) and cooperation with small independent producers is effective. The formation of such networks can be accelerated by creating and stimulating regional clusters. Russian beef has significant competitive advantages in foreign markets. In Russia, the use of steroids, growth hormones, and feed additives that stimulate the muscle mass of livestock is prohibited. Russian government programs have proven their effectiveness in other agricultural sectors. In this case, resources are needed to support clusters and cooperation in meat food chains.

1. Introduction
Food security is one of the main issues of global development and the subject of numerous scientific studies. Moreover, achieving food security through sustainable food systems is central to the Sustainable Development Goals [1].

Since the 1970s, developed countries have significantly increased the production of agricultural raw materials and food, primarily due to investment and technological innovation [2]. Decades later, developing countries are industrializing, including adopting new agricultural technologies and integrating into global food supply chains [3].

Despite the significant increase in agricultural production globally, the problem of sustainable food supply remains relevant for many countries. A review of the sources showed that research on this problem covered a wide range of problems and solving methods. The agricultural policy affects the food security of the country and the world [4]. Trade openness has a positive and significant impact on food security [5], and its impact on improving dietary diversity and nutrition quality has been proven. The digital revolution has become a powerful new driver for the development of agri-food systems [6].

After decades of decline, Russian agriculture is demonstrating sustainable development [7]. The starting point is considered the Priority National Project "Development of the Agricultural Sector,"
which the Government of the Russian Federation initiated in 2006. The Food Security Doctrine of the Russian Federation was adopted in 2010. State subsidies have become one of the primary sources of investment in the technological renewal of many agricultural sectors. The fall in the ruble exchange rate after the economic crises of 2008 and 2014 and the food embargo of 2014 significantly contributed to the protection and recovery of the domestic food market.

At the stage of growth, large-scale structural changes are taking place in agriculture in Russia. The concentration of agricultural land and agricultural business as the economy grows is a global trend. According to [8], 1% of the largest farms in the world (more than 50 hectares of cultivated land) manage more than 70% of agricultural land. In a number of countries, agricultural holdings hold a significant share in food production. In Hungary, in 2000-2010, the specialization of agricultural holdings increased significantly, and regions of stable poultry farming and grape growing were formed [9]. The restoration of agriculture in the northern grain provinces of Kazakhstan was due to investments and management of integrated holdings [10].

In Russia, agricultural holdings continue to increase their share in comparison with independent agricultural producers. In many ways, this is facilitated by state policy. An increasing part of the subsidies is received by some of the largest agricultural companies and holdings [11]. According to [12], about 100 agricultural holdings can be attributed to large-scale business entities. They comprise about 3% of state agricultural organizations, while their share in the proceeds is about 37%.

The main growth factors in the Russian meat industry are the transfer of innovative technologies, entry into global value chains, investments in technological renewal, and the construction of new high-tech livestock facilities. For example, in pig farming, the degree of borrowing innovations by large holdings is 100% for machinery and equipment [13]. The most common equipment is Big Dutchman (Germany) and Roxell (Belgium). In addition, Russian producers massively use breeds of farm animals of foreign selection, import feed additives, and veterinary drugs. Many researchers in Russia pay attention to the fact that the dependence of domestic livestock production on global foreign companies is approaching a critical level.

In parallel with the institutional and technological changes, there are large-scale changes in Russia's territorial distribution of agricultural sectors. The authors' studies based on the example of pig and poultry meat production [14, 15] revealed some distinct trends. At the industry's growth stage, the industry's production capacity and output are localized in a relatively small number of regions (10-15 territories), where the output exceeds domestic needs by several times. This is followed by changes in the agricultural specialization of the Russian regions (by narrow sectors). For example, in the Tambov Region, the production of eggs has been curtailed, but pork and poultry production has increased significantly. As result, an increasing share of agricultural raw materials and food is traded not locally but in interregional markets.

By 2021, the key indicators for the country's domestic food supply exceeded the established thresholds for most types of products. There is solid and steady growth in several agricultural sectors. There are some results of Russia's agrarian economic policy in the meat sector:

- pig farming has restored the "pre-reform" (1990) volumes of pork production by 2017. Industry growth continues. The national market is close to saturation [14]. Pork exports in 2020 reached a point at which it begins to have a severe impact on the industry;
- poultry meat production increased by more than 3 times over the same period. Enterprises are increasing the volume of exports [15] to China, Vietnam, and other countries. The product range includes both traditional types (drumsticks, wings) and specific products (e.g., chicken feet);
- beef production failed to reach 1990 volumes. The output of cattle meat in 2019 was only 37.5% compared to the level of 1990. However, in the aggregate of all types of meat, the domestic market is fully provided with its own products. The production of livestock for slaughter has reached the "pre-reform" level and continues to grow (Fig. 1).
Meat consumption per capita increased to 77 kg in 2020, with an average per capita consumption of 73 kg (norms set by the Ministry of Health of Russia). At the same time, the share of beef continues to fall steadily.

The decline in beef consumption, the increase in pork and poultry consumption is a global trend, including that characteristic of developed countries [16]. Thus, in the United States, the share of beef in meat consumption decreased from 48% to 32% from 1976 to 1988 [17].

The reason for these changes was the successful technological innovations in pig and poultry farming. Currently, beef is one of the most resource-intensive types of meat in feed consumption, land requirements, and livestock maintenance costs [16]. The consumption of cereal equivalents (CE) in terms of carcass weight is 19.8. Pork and poultry are more efficient, reflecting lower CE ratios of 8.5 and 4.7, respectively. The demand for land for beef production is 20.9 m² per kilogram of meat per year. This is twice as much as the demand for pork (8.9 m²). This explains that beef prices are significantly higher than pork and poultry prices (FAO, Food Outlook, November 2018). In developed countries, beef is classified as a premium type of meat (EEC. Review of the cattle meat market of the member states of the Eurasian Economic Union for 2013-2017. Moscow, 2018).

However, as the population's income increases, the demand for and consumption of beef increases. This is especially true in developing countries. A review of multi-country studies [18] showed that state agricultural programs affected animal food consumption, and most strongly in low-income countries. For example, in China, beef in the meat balance increased from 2.5% in 1978 to 8.3% in 2009 [19]. Over the next 10 years, beef consumption increased by more than 1.5 times [20]. It is noted that this was due to the rapid growth of household incomes and the unprecedented expansion of the middle class in China. The researchers obtained empirical data showing that the elasticity of beef consumption was 0.169 for the low-income group and increased to 0.671 for the high-income group.

These factors and trends have a diametrically opposite impact on the future development of the industry. On the one hand, beef production is a more complex and less attractive business than pig and poultry farming. This industry has a higher resource intensity of the product, a longer reproduction period of the herd and a payback period of investment. Therefore, the prices for beef are usually higher than the prices for other types of meat.

On the other hand, the demand for beef will increase as the income of the population increases. Russia's state programs for the development of agriculture have shown high efficiency in other sectors. Therefore, targeted support for beef cattle breeding can become the next stage of agricultural policy. Also, keep in mind that other meats cannot wholly replace beef in the diet.

The objective of the study is an economic analysis of the beef industry in Russia, a forecast of opportunities and prospects for development.
2. Materials and methods
The theory of regional economics, a systematic approach in economics, methods of agrarian economics, a review of scientific literature, economic and statistical analysis were used as a theoretical basis for the study.

Also, the economic analysis using a modified location quotient [21] was applied to study territorial placement and agricultural localization processes.

The data used in the calculations were taken from the official website of the Federal State Statistics Service of the Russian Federation (https://rosstat.gov.ru/). Additionally, data from the Federal Center for the Development of Agricultural Products Export (Ministry of Agriculture of the Russian Federation, https://specagro.ru/analytics) and the Expert and Analytical Center for Agribusiness "AB-Center" (https://ab-centre.ru/) were used.

3. Results
A model of analysis from the theory of strategic management was used to analyze the economic characteristics of the cattle meat industry [22]. The model assumes several standard areas of analytical research in the industry.

In 2020, the size of the Russian beef market (domestic production plus export) was the minimum for the last 20 years and was 1,944 thousand tons (the Expert and Analytical Center of Agribusiness AB-Center). In 2001-2010, the market volume was relatively stable (the maximum in 2008 was 2,741 thousand tons), after which the stage of decline began (Fig. 2) with an average annual rate of decline of 2-3%.

![Fig. 2. Beef market in Russia: average annual growth rates, %.

Since 2015, beef imports have been significantly reduced. In 2020, only 333 thousand tons were imported, the share of imported market resources decreased to 16% (the maximum was 36% in 2008) (Fig. 3).

![Fig. 3. The share of beef imports in the domestic market, %.

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However, to a greater extent, the decline is due to other reasons. In line with global trends, the preferences of Russians are shifting in favor of pork and poultry. As a result, beef average per capita consumption decreased by almost 1.5 times: from 19.2 kg in 2008 to 13.2 kg in 2020 (AB-Center).

The structure of the industry's producers has changed dramatically over the past 30 years (Fig. 4). In the last year of the "Soviet period," agricultural organizations produced the main share of beef (87%). By 2005, production in this segment "collapsed" by almost 6 times. Households became the main producer of beef (61% in 2005), increasing output by almost 2 times. During this period, farming was born, its share reached 3% by 2005. The gradual decline in beef production continued for the next 15 years (2005-2019).

![Fig. 4. Cattle slaughter weight produced in Russia: output by producer types, thousand tons.](image)

Changes in the structure of beef producers for 2005-2019 are shown in Table 1. There has been a symmetrical redistribution of shares between farmers and households. Farmers have increased beef production by more than 3 times. Households have reduced their share but still produce more than half of the beef volume. The total production of the industry's products during this period fell by 10%.

| Producer types          | Percentage structure | Change over the period |
|-------------------------|----------------------|------------------------|
|                         | 2005  | 2019  |                |
| Farmers                 | 2.8   | 10.6  | + 7.8           |
| Householders            | 61.0  | 53.1  | - 7.9           |
| Agricultural organizations | 36.2  | 36.3  | + 0.1           |
| Total                   | 100.0 | 100.0 | -                |

Beef prices in the domestic market are a consequence of the downturn and many other industry problems (Fig. 5). As a result, beef has become almost the most expensive type of meat in the domestic market of Russia; its prices have increased by 6.8 times. Only lamb is more expensive, but it is more of niche meat. For comparison, pork prices increased by 4.6 times, prices for poultry meat – by 3 times. Moreover, the accelerated development of pig and poultry farming, the increase in the efficiency of these industries, and the domestic market saturation have led to the fact that prices for these types of meat have hardly increased in the last six years. Nevertheless, beef prices continue to rise.
Fig. 5. Average consumer prices for meat by type in Russia, RUB/kg.

Despite the higher prices, beef production is the least profitable industry (Fig. 6, according to the FSBI Center for Agroanalytics).

Fig. 6. Profitability of meat production (excluding industrial processing, excluding subsidies), %

Similar data is provided by the Eurasian Economic Commission (EEC. Review of the cattle meat market of the member states of the Eurasian Economic Union for 2013-2017. Moscow, 2018). In 2016, the loss rate of beef production in Russia was -31.3%, in Belarus -36.7%, and only in Kazakhstan, the business was profitable (27.5%).

4. Discussions

So, beef loses competition to substitute products for pork and poultry meat. Success in the above cases is based on the following key success factors.

First, it is a drastic increase in beef production by farms specializing in beef cattle breeding. Traditionally in Russia, cattle of dairy and dairy-meat breeds were used. However, according to [23], the share of beef cattle breeding was negligible until 2008. Furthermore, according to various estimates, the proportion of beef from beef cattle breeds ranges from 15% [24] to 25% [23]. Thus, beef cattle account for 40% of the world’s cattle.

World practice shows that the separation of dairy and beef areas in cattle breeding directly affects business efficiency [25]. Technologies for feeding and keeping livestock differ significantly. In these sectors, different equipment is used; in beef cattle breeding, it is less complex. It is considered that beef cattle breeding is less labor-intensive. Lastly, meat from dairy cattle is very much inferior to beef cattle in terms of quality.

Since the beginning of systematic state support for agriculture in the late 2000s, several regions of Russia, in partnership with large companies, have initiated major projects for the development of beef cattle breeding. Miratorg, Russia’s largest agricultural holding, has been developing a project for the production of marbled beef in the Bryansk and Orel Regions since 2009 [23]. Bryansk Meat Company
LLC has invested more than $1 billion in the project. It is almost the largest company globally in terms of the concentration of breeding stock (cows and calves). The vertical integration chain includes all stages, from feed production to industrial meat processing. In the coming years, the company plans to develop horizontal integration with independent suppliers of young meat cattle for fattening. The company produced 150 thousand tons of marbled beef in 2019 and plans to export at least 25% of the products.

The Voronezh Region has been implementing a program to develop beef cattle breeding since 2013 [25]. In the region's territory, a meat cluster has been formed (the number of meat cattle is 100 thousand heads). The technological chain includes all stages: genetics (breeding plant and four breeding reproducers) – production (mothers-cows and calves up to 6 months) – fattening (feedlots, cattle up to one and a half years) – processing (meat processing complex) – sales. The Zarechnoye agricultural holding is a key enterprise of the cluster (50 thousand heads of beef cattle). The holding attracts farmers and small agricultural organizations to raise calves (about 250 producers).

Regional programs for the development of beef cattle breeding have been successful in the Republic of Altai and the Republic of Kalmykia. In these territories, the notable increase in beef was given by farms (increasing by 10 times over 2005-2020).

The following factors underlie the success of the cases given above. First, these are federal and regional programs to support beef cattle breeding. Secondly, these are business development models for beef production. Agricultural holdings can implement large projects and ensure their faster implementation and supply to large markets (the national market and foreign markets). The farmer model requires more time to implement, but is considered more sustainable, is applicable in marginal regions, and solves social problems. The product is delivered to local markets, and there are short food supply chains. Therefore, both models must ensure the growth of beef production in commodity farms.

The territorial location and degree of localization of cattle meat production change during this period. The modified location quotients method [21] is applied. The calculations are based on statistics on beef production only in commodity farms (agricultural organizations and farmers), excluding households (Fig. 7).

![Fig. 7. Russian regions: modified location quotients above 2.0 (cattle slaughter weight produced by agricultural organizations and farmers)](image)

As shown by the analysis, not many Russian regions specialize in cattle meat production (one-sixth). The sample includes the regions of the center of the European part of Russia, the Volga region, and the marginal regions of the North Caucasus and Siberia. Over the period of 2005-2019, the level of localization has increased, but in most regions, this is a moderate increase. In four regions, localization has increased dramatically. These are the regions whose cases are listed above. In the Bryansk and Orel Regions, feedlots are belonging to the Miratorg holding. Farmers’ support programs provided an increase in the Republic of Kalmykia and the Republic of Altai.
Second, the construction of food chains in beef cattle breeding is very different from other agricultural sectors. In countries with developed beef cattle breeding, production is divided into several highly specialized stages (genetics, breeding, fattening, slaughter, and processing) [26]. Therefore, the traditional closed-loop vertical integration model is ineffective, as is the case in pig and poultry farming.

The beef industry has many independent entities in the United States at several production stages [2]. As a result, cattle change hands at several points along the supply chain. The cattle are dispersed throughout the country at the cow-calf stage, as land and feed are needed. Seven hundred thousand families are engaged in this operation. In China [27], agri-food chains are dominated by small and medium-sized organizations, including cattle breeding.

Similar trends are observed in beef cattle breeding in Russian practice. The Zarechnoye agricultural holding (Voronezh region) has created and united most of the links in the food chain (its genetic center, feedlot, and processing plant) but attracts farmers to raise calves. The company provides farmers with profitable sales of products; the state provides preferential loans according to the regional program. The Miratorg holding was forced to combine all the links of the food chain in 2011. However, the company is now changing its strategy and creating a contractual relationship with independent organizations.

By the way, a similar trend has emerged in the Russian sheep industry. Breeding centers of large companies distribute young stock on a contract basis to farms. Networks of feedlots and farms are being created. For example, one can note major investment projects of the companies Stavropolsky farmer, Khakasskaya baranina, Caucasus-Myaso.

Thus, in beef cattle breeding, the model of combining vertical integration (holdings) and cooperation with small independent companies is more effective. The National Union of Beef Producers [24] believes that beef production is definitely a profitable business under these conditions. Moreover, the high level of concentration of food production, according to [28], reduces food security and the sustainability of food systems. The author believes that under these conditions, the creation and stimulation of regional clusters can significantly accelerate the formation of networks of participants in the product chain in beef cattle breeding. This is confirmed, in particular, by the experience of the Voronezh Region and the Republic of Kalmykia.

Third, the development of the industry depends on the market demand for beef and an adequate marketing strategy of companies. According to the Federal Center for Export Development of Agricultural Products of the Ministry of Agriculture of Russia, global beef consumption grew by 0.4% annually over 2014-2020. In the coming years, demand is anticipated to rise, based on the trend of rising living standards in developing countries (e.g., China and Brazil). In addition, the demand for beef of meat breeds is growing in large cities.

Consumers' preferences regarding the types of beef are rapidly changing. In China, according to [19], beef consumption shifted from fresh meat to frozen meat and then from frozen meat to chilled meat. In large cities (Beijing and Shanghai), the share of chilled meat is already 30%, in small cities, only 10%. In rural areas, fresh steamed meat from farmers' markets is still preferred.

The structure of beef sales channels varies from country to country. In China [19], sales at farmers' markets continue to prevail. In Europe, 65% of beef is sold in supermarkets, 25% in meat chain stores, and the HoReCa segment (hotels and restaurants) accounts for 10%.

Foreign markets are of great interest, including for Russian companies. Several large companies currently export cattle meat, including Miratorg, Zarechnoye, and Orenbiv (data from the Federal Center for Export Development of Agricultural Products of the Ministry of Agriculture of Russia). The Bryansk Region accounts for 43% of beef exports 43% (2019).

Russian beef has two competitive advantages in foreign markets. First, in Russia, it is prohibited to use steroids, growth hormones, and feed additives that stimulate livestock mass growth in animal husbandry. Second, Russian companies have the opportunity to supply products at lower prices.
5. Conclusions
As in the rest of the world, beef in the Russian market is losing the competition to pork and poultry. Successful technological innovations in pork and poultry have made beef the most resource-intensive type of meat in feed consumption, land requirements, and livestock costs. As a result, the industry has a longer herd reproduction period and return on investment.

The Russian beef market is in a long-term decline. Domestic beef production has been steadily declining, and imports have been declining since 2015. Households still produce more than half of the beef, although their share has declined in favor of farmers. The level of consumer prices for beef is 1.5-2 times higher than the price of pork and poultry.

According to the results of the study, several key factors for the industry to emerge from recession and prolonged stagnation were identified:

- drastic increase in the share of beef obtained from beef cattle. This will allow obtaining better quality meat and reduce its cost. Now, this share is about 20%, in the world, beef cattle accounts for 40%;
- construction of food chains in beef cattle is different from other agricultural sectors. The model of a combination of vertical integration (holdings) and cooperation with small independent producers is effective. The formation of such networks can be significantly accelerated by creating and stimulating regional agro-clusters;
- Russian beef has significant competitive advantages in foreign markets. First, in Russia, the use of steroids, growth hormones, and feed additives that stimulate the growth of the muscle mass of livestock is prohibited. Second, Russian companies are competitive in terms of export prices.

State programs to support Russian agriculture have already proven their effectiveness in other sectors. In this case, resources are needed to support beef cattle breeding, including support for clusters and cooperation in meat food chains.

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