Modern state of the production organization of beef cattle breeding in the Russian Federation

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Abstract. The paper presents the analysis of existing technologies, technological processes and technological equipment, as well as the state of the organization of production of beef breeding in Russia. The adoption of the program “Development of beef breeding in Russia” allowed significant expansion of the production of beef by raising specialized beef cattle not only for the southern and southeastern regions of our country, but also in the rest of Russia. Nowadays, the geography of beef breeding has expanded significantly: it is being actively implemented in six of the eight federal districts. Thus in 2018, 74 constituent entities of the Russian Federation were selected for priority support of livestock breeding. The authors note that the successful economic development of the industry is primarily determined by the engineering and technical level and the technical and economic base of agricultural production, as well as the power availability and the degree of mechanization of production processes in general.

However, during the period of economic reforms in Russia, there was a sharp drop in the level of comprehensive mechanization of beef farms. Thus, today the provision of machinery and equipment in this industry does not exceed 65% of the standards. It is necessary to note that the problem with special-purpose machinery and equipment for industrial technologies of fattening beef is one of the reasons for the technical and technological backwardness of this industry.

During the design, construction and operation of feeding enterprises, it is obligatory to carry out a technical and economic analysis of various options for industrial feeding of livestock, since modern realities require producers to solve many important issues, such as qualitative definition of territories for the production of beef cattle in the Russian Federation.

1. Introduction
In the last decade of the 20th century, crucial structural changes occurred in the livestock industry in Russia. These changes were reasoned by the negative consequences of a sharp transition of the economy to market relations, which were expressed, first of all, in the decrease in the number of cattle in public sector farms, a gradual slowdown in the influence of intensive factors on the growth rate of livestock production.

Thus in 1990, the livestock industry in Russia amounted 57 million head of cattle. Among it 1.3 million was beef cattle. Annual beef production was 4.3 million tones, which was 29.2 kg per capita.

During the years of pseudo reforms, the domestic agro-industrial complex was practically destroyed, and cattle breeding became its most unsuccessful industry.
In just a few decades after the demonstration of 1990, the total number of cattle decreased to 18.1 million, including breeding stock of specialized beef cattle at agricultural enterprises up to 350 thousand heads. Per capita beef production was 14.1 kg. At the end of 2018, Russia's self-sufficiency in beef was just over 78%. However, this relatively high indicator did not reflect the actual situation in the industry, since its growth was primarily associated with the decrease in beef consumption and, as a consequence, with a drop in imports, while the volume of domestic production was still at a rather low level.

If we consider only agricultural enterprises and peasant farms, excluding households, then self-sufficiency in 2018 was 60.5%, while according to experts in 2018 medium and large producers of Russian beef did not provide even 40% of the total market offers.

2. Materials and methods.

Households remain the main producers of beef in the Russian Federation for a long period of time. However, in 2014-2018 their production decreased by 200.1 thousand tons or 11.2% (Table 1).

Agricultural enterprises comprise only a third of the country's beef production. The reason is that livestock meat production is actually a by-product from dairy farming. The main beef production technology in Russia is based on the fattening of dairy cattle with low productivity and, as a result, high production costs, while in global practice industrial technologies are used for fattening dairy-meat and meat cattle, which allows foreign producers to obtain high quality marbled beef with a lower cost. However, over the past five years, due to various measures of state support, the volume of beef production in all categories of farms has grown by 62.4 thousand tons, or by 6.7% [1-2].

Table 1. Production of butcher cattle in live weight, thousand tons

| Years | Farms of all categories | Including Agricultural organizations | Peasant households and individual entrepreneurs | Households of the population |
|-------|-------------------------|--------------------------------------|-----------------------------------------------|------------------------------|
|       | thousand tons            | Share in total volume, %             | thousand tons                                  | Share in total volume, %     |
| 2014  | 2854.9                  | 929.8                                | 32.6                                          | 212.2                        |
| 2015  | 2820.1                  | 905.8                                | 32.1                                          | 233.3                        |
| 2016  | 2777.2                  | 927.5                                | 33.4                                          | 239.3                        |
| 2017  | 2738.1                  | 941.1                                | 34.4                                          | 258.7                        |
| 2018  | 2798.4                  | 992.2                                | 35.5                                          | 284.4                        |

Another trend typical of modern beef production in the last decade is the increased interest in this production of peasant (farmer) households and individual entrepreneurs.

Before the adoption of the program “Development of beef breeding in Russia”, beef production by raising specialized beef was typical only for the southern and southeastern regions of our country. Nowadays, the geography of beef breeding has expanded significantly: it is being actively implemented in six of the eight federal districts. Thus in 2018, 74 constituent entities of the Russian Federation were selected for priority state support of livestock breeding.

Due to the realization of this program aimed at the implementation of large investment projects and the creation of highly productive herds for which in 2017-2018 allocated 78 billion rubles in 2018, the livestock of specialized beef cows in farms of all categories amounted to more than 970 thousand heads. Thereby the increase in the livestock over the year was about 5.6%. The largest breeding stock of specialized beef in agricultural enterprises and peasant farming is concentrated in the Southern Federal District (287 thousand heads), in the Central Federal District (240 thousand heads), as well as in Volga and Siberian federal districts (167 and 120 thousand heads, respectively).

In total, according to the results of 2018, in agricultural organizations, peasant farmings, including individual entrepreneurs, the number of cattle of specialized beef breeds amounted to more than 2.26 million animals, which was 8.4% more than in 2017. The leading regions in 2018 were Bryansk and
Oryol regions, where the increase in specialized meat stock amounted to 33.7 and 31.8 thousand heads, followed by 19.1 and 15.5 thousand heads in Tula and Kaluga regions, respectively, and the Smolensk region closed the top five, here the increase was 12.7 thousand heads.

Speaking about the prospects of the industry, both in the region and in the country as a whole, it is planned to increase the number of specialized beef up to 2.4 million heads using state support within the framework of a single subsidy [3-5].

The basis for the industrial fattening of beef is currently feedlots. They are widely used in the USA and Canada, as well as in some EU countries [6-8].

Feedlot is the free keeping of animals in farmyards in open areas. As a rule, this method prevails on yards with more than a thousand heads for fattening. It is a production with a complex of equipment, machinery and structures for storing and preparing feed, keeping and feeding animals, concentrated on large areas.

Feedlots are classified according to the following criteria:
1. by the number of livestock simultaneously fattening;
2. by the type of organizational and legal form;
3. by the way of keeping livestock.
4. by the way of organizing purchases, fattening and sale of livestock.
5. by the length of stay of fattening cattle.

Feedlots differ significantly from each other in terms of: the degree of service and work, the system of purchasing and selling livestock, the method of manure removal and many others, features, indicators and characteristics.

The advantage of a feedlot is that it can be built in 1-2 months, including not only projecting and fencing of livestock yards, but also a solid foundation, construction of feed trays, group drinking systems, construction of a reception area for livestock, assembly and installation of a feed preparation shop and construction of feed storage facilities.

However, all the types of feedlots have both advantages and disadvantages. Thus, one of the disadvantages of open housing remains the inability to control the external environment. Therefore, in the cold season, the increase in feed consumption is observed, and in the hot period, on the contrary, there is a decrease in appetite.

Ultimately, the feedlot should provide maximum efficiency from it, high mechanization of technological processes, with minimal labor costs, centralization of management processes, closed machine routes and a rational choice of equipment in terms of capacity for all technological processes.

However, during the period of economic reforms in Russia, there was a sharp drop in the level of complex mechanization of farms in the sectors of dairy and beef cattle breeding. Thus, today the provision of machinery and equipment in these industries does not exceed 60-65% of the standards. It is necessary to note that the problem with specialized machinery and equipment for industrial technologies for fattening beef is one of the reasons for the technical and technological backwardness of this industry.

For the effective mechanization of technological processes at the enterprises engaged in cattle feeding, the same groups of technical means as in dairy farming are used. The exception is the enterprises engaged in feeding specialized livestock on industrial basis. At these enterprises, in conjunction with general-purpose machinery, special equipment is additionally used (a splitting machine, a fixing machine, work site fencing, a self-feeder for long-stemmed feed, a self-feeder for concentrated feed, a self-feeder for green feed).

Nowadays, only a few large producers have modern specific technological equipment for the care of beef and not for all positions, since a number of positions of this equipment are not produced in Russia or its produced is limited. The reason for this is that many existing feedlot enterprises use a traditional, ineffective and labor- and energy-intensive technology of keeping animals in stout buildings.

A distinctive feature of modern livestock feeding technologies should be a high degree of their adaptation to regional conditions, depending on the availability of fodder, labor, energy and other resources with the maximum use of the biological potential of animals.

The basic element of such technologies, which can significantly reduce direct costs in the production of beef, is the milking of calves during spring round calving, in which cattle are in the pasture from early
spring to late autumn, consuming feed from pastures with a minimum consumption of concentrated feed. Thereby the producers significantly reduce the cost of feed, as well as material and labor resources. The actively introduced technology of “cow-calf” production in beef breeding provides more thorough analysis and control of production, increased use of artificial insemination, synchronized hunting of animals and the possibility to raise standard calves, taking into account the requirements of feeding enterprises, as well as improving the quality of feed and reducing the death of calves.

The main advantage of this technology is that it allows reducing labor costs associated with the most labor-intensive process - raising young animals, which up to 6-8 months are with the cow, receives milk and gradually switches to the consumption of grass feed. During the weaning from the mother, the calf reaches a weight of up to 200 kg, which allows organizing growing and fattening up to a weight of 450-500 kg by 16-18 months. This technology allows the full use of forage lands and does not require stout buildings in the winter for keeping animals, which, due to their breed qualities and simplicity, can easily tolerate low temperatures, in case of organizing sufficient feeding with roughage and drinking water.

In this case, the cleaning and transportation of manure is carried out mechanically or hydraulically. From mechanical means, circular and reciprocating scraper conveyors, scraper units and bulldozers are used. The hydraulic power systems used on livestock fattening farms are gravity, forced and combined.

At domestic enterprises engaged in fattening livestock, they following machinery units are widely used: TSN160A, TSN-160B, TSN-ZB, TR-5, TSN-2B manure conveyors, longitudinal scraper units USF-170A or US-F250A complete with transverse US-10, US-12 and USP-12, longitudinal scraper conveyors TS-ShR complete with transverse TS1PP, scraper units US-12 complete with transverse USP-12, transfer augers TSHN-10. Loading of liquid and semi-liquid manure is carried out by fecal pumps or NZHN-200, PNZh-250 into spreaders and surface application machines RZHT-8, MZHT-10.

The pacing factor for the successful development of beef breeding is the level of feeding that ensures the effective use of the genetic potential of animals. The fodder base in beef breeding should be based on fodder of its own production, through the intensification of pasture farming. The mechanization of technological processes provides the necessary conditions for keeping animals while minimizing the labor costs of service personnel.

The choice of the optimal economically justified options for the mechanization and automation of farms, the most effective complexes of machines and equipment, as well as the maximum load of mechanization means is extremely important.

The complex of machinery units for the mechanization of the main technological processes and operations in the production of beef using the technology of beef breeding consists of machinery and equipment for the mechanization of watering animals with water heating in winter, storage, unloading, transportation, grinding, mixing and distribution of rough, green and concentrated feed, specialized equipment for keeping and serving animals in stall and pasture periods.

During the choice of technical means for feed distribution, it is necessary to take into account the implementation of the main operation in combination with auxiliary processes, such as the transportation of feed from storage sites, preparation of feed mixtures, dosing and removing feed residues from feeders with the possibility to create a single flow technological line with automatic control. Technical means for manure removal from premises, transportation and storage are primarily determined by the technology to obtain it, i.e. the ways of keeping animals.

Apart from the standard general farm equipment supplied for dairy and fattening cattle farms, beef cattle breeding technology requires additional special equipment for keeping animals in the grazing period, this equipment is for fences installing, fencing special working areas for veterinary and sanitary services for animals, etc. In winter, stall equipment is required for keeping cows with dairy calves in loose housing, fencing for the organization of feeding and rest areas in forage yards, self-feeders for rough, green and concentrated feed if separate feeding is organized, drinkers with heated water, grinders-distributors used to make a necessary amount of litter.

The use of automation systems can be minimal. These are local systems installed on operating machines, such as feed mixers. It is necessary to use automated animal identification systems in order to computerize breeding records of animals, control the technological parameters of raising and fattening animals, resource consumption and documentation reporting.
The parameters of the set of machines must correspond to the best domestic and foreign counterparts, take into account the peculiarities of the regions of beef producers using beef breeding technologies and ensure a significant reduction in labor costs, fuel and energy resources per unit of production in comparison with traditional technologies.

A promising direction is the creation of block-modular technical means. It is necessary to implement a set of machines based on the MES-06 energy module, consisting of machines and equipment for the mechanization of the processes of preparation and distribution of rough, stalked, concentrated feed, watering animals with high-quality water during the pasture period, loading and transport operations, equipment for veterinary and sanitary processing of premises and animals, lumber production necessary for the repair of the production base and other equipment.

An energy module with a set of machines allows mechanizing all the technological operations for animals’ servicing and keeping. All the machines can have the modification of trailed machines for tractors of 0.6-0.9 class. The use of this set with a class 0.6 energy tool is the most effective on farms with a livestock of 200 to 600 beef cows.

The achievement of the planned high performance indicators is ensured by the introduction of modern machine technologies. The basic energy source of technological units is an agricultural tractor. For farms with a livestock of 50-400 cows, the sets of machines, aggregated with tractors class of 0.6-0.9 are required, for farms with 400-600 cows the class of 0.9-1.4 is necessary and for farms with more than 600 cows the class of 1.4 is required respectively. This will ensure a more efficient performance of technological operations for keeping and servicing animals with optimal consumption of energy and resources.

According to the structure of mechanized work in the technology of beef production in beef breeding, a set of machines must provide a comprehensive mechanization of technological operations using technical means with parameters corresponding to the best domestic and foreign level. It is necessary to take into account that the consumers of the technology are both large specialized farms, in which the number of beef cows exceeds 600 heads, and farms and peasant farms with less than 200 beef cows.

Voronezh region is one of the most dynamically developing regions of the Central Federal District in the field of beef breeding. Thus, in 2019, there were 55.1 thousand heads in the region, and the dynamics of the annual growth of livestock was 21.4%. The volume of beef produced in 2018 in the region was 98.9 thousand tons, or 19.9% of all beef produced in the Central Federal District [8-11].

**Table 2.** Specialized beef cattle at the enterprises of the Voronezh region in 2015-2019

| Groups of specialized beef cattle | 2015 heads | %    | 2016 heads | %    | 2017 heads | %    | 2018 heads | %    | 2019 heads | %    |
|----------------------------------|------------|------|------------|------|------------|------|------------|------|------------|------|
| cows (except for fattening cows) | 29195      | 39.71| 30322      | 37.84| 31501      | 39.02| 32452      | 39.12| 30356      | 37.25|
| young animals up to 8 months     | 9299       | 12.65| 15464      | 19.30| 12616      | 15.63| 11364      | 13.70| 10971      | 13.46|
| animals for growing and fattening| 35020      | 47.64| 34339      | 42.86| 36612      | 45.35| 39146      | 47.19| 40166      | 49.29|
| (meat productivity)              | Total      | 73514| 100.0      | 80125| 100.0      | 80729| 100.0      | 82962| 100.0      | 81493| 100.0  |

Analyzing the dynamics of the number of specialized beef cattle at the enterprises of Voronezh region over the past five years, we should note the following structural changes. Thus, due to the state program to support beef cattle breeding, as well as the support of regional authorities, the total livestock of animals at the enterprises of the region increased by 7979 heads or 10.8%.

The analysis of the number of beef cattle kept at 67 agricultural enterprises in 25 districts of Voronezh region in 2015-2019 showed that in more than 85% of enterprises there were farms with a livestock of 50 to 400 beef cows, while 50% of all enterprises had no more than 100 cows (Table 3). Thus, the standard-size range of farms, taking into account the rational use of mechanization means of
technological processes, can have the following optimal gradation: farms with up to 200 cows; farms with 200 to 600 cows; farms with over 600 cows.

Today, the farms with a livestock of 50-400 beef cows are the most promising and most widely used in agricultural enterprises of the region. The maximum use of pastures and animal feeding can significantly reduce production costs and allow producing cost-effective beef.

Table 3. Typical range of farms depending on the number of beef cows in the farms of Voronezh region for 2015-2019

| Average number of beef cows per farm, head | 2015 | 2016 | 2017 | 2018 | 2019 |
|------------------------------------------|------|------|------|------|------|
| Up to 50                                 | 10   | 15   | 22   | 18   | 18   |
| 51-100                                   | 13   | 11   | 15   | 14   | 15   |
| 101-200                                  | 12   | 15   | 11   | 16   | 14   |
| 201-400                                  | 4    | 8    | 13   | 11   | 10   |
| 401-600                                  | 4    | 3    | 4.92 | 2    | 2    |
| 601-800                                  | 1    | 1.64 | 0    | 0    | 0    |
| 801-1000                                 | 1    | 1.64 | 2    | 1    | 2    |
| 1001-1200                                | 1    | 1.64 | 1    | 1.49 | 1    |
| 1201-1400                                | 1    | 1.64 | 1    | 1.49 | 0    |
| Over 1400                                | 5    | 8.20 | 5    | 7.46 | 5    |
| Total                                    | 53   | 61   | 67   | 69   | 67   |

Talking about the dynamics of the breeding stock of beef cattle in the region we should admit that it has undergone a significant change over the past five years. Thus, the number of agricultural enterprises, raising beef cattle increased by more than 25%. The main change affected the group of enterprises with a livestock of up to 50 heads, so during the study period their number increased by 80% and became 26.87% of all enterprises engaged in breeding beef cattle.
The main beef producer using innovation-oriented methods in the industry in Voronezh region is LLC Zarechnoye. LLC Zarechnoye is the second largest Russian producer of meat from specialized beef cattle breeds after Miratorg. By the beginning of 2019, the total livestock of LLC Zarechnoye was 70 thousand animals (including 24 thousand heads of breeder herd), taking into account the capacities of “Stevenson-Sputnik” breeding farm acquired in 2018. The enterprise is implementing its project on 12 farms, the total area of which is more than 100 thousand hectares. It also has its own meat processing plant with a capacity of up to 150 tons of meat products per day or up to 40 thousand tons per year. The company produces marbled beef from Aberdeen-Angus breed and beef from meat and meat-dairy breeds.

3. Conclusion
Nowadays the regions do not pose the challenge to transfer all beef production at agricultural enterprises to an industrial basis in the shortest possible time through the creation of large complexes. This is a long-term process that requires large investments and material resources.

The existing livestock farms at enterprises can produce a significant amount of products for a long time. Therefore, it is advisable to maximize mechanization, use the possibilities of reconstruction of existing buildings in order to fully intensify these farms and introduce elements of industrial technology on them.

Over the previous 20 years, about 80% of the operated equipment has already reached the standard operation life and needs to be replaced. This is one of the reasons for energy-intensive, economically ineffective and unprofitable production. To the greatest extent, this had the impact on the beef production industry and namely specialized beef cattle breeding.

The efficiency of beef production largely depends on the choice of the most economical methods, mechanization means and automation of production processes on farms, the quality of projects for the construction of new and reconstruction of existing farms, the use of rational forms of labor organization, as well as the introduction of advanced experience and scientific and technological progress.

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