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ANIMAL HUSBANDRY

Beef Production Efficiency Gains through Commercial Herd Crossbreeding

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Abstract—The objective of the work was to study the beef production efficiency through intensive rearing and fattening of Simmental and crossbred bull calves. The bull calves were divided into three groups of 15 animals each in order to carry out the survey. The first (control) group involved purebred Simmental bull calves. The second group consisted of young stock produced via crossbreeding Simmental cows with German Simmental beef bulls. The third group was formed from crosses of Simmental cows with Charolais bulls. The animals of the second and third groups were characterized by lower feed costs per 1 kg liveweight gain, comprising 8.5 and 8.1 EFU, respectively, while the feed utilization efficiency for the bull calves of the first group comprised 8.7 EFU. These factors affected the profitability of beef production. Thus, the level of profitability of rearing the Charolais crosses reached 20.7%, which was 6.8 and 3% higher than that in the bull calves of groups one and two, respectively. Fattening to the age of 18 months contributed to a significant increase in the carcass fat mass. Therefore, the protein-to-fat ratio comprised 1 : 084, 1 : 0.75, and 1 : 068 for the groups in ascending order of their numbers. Under intensive rearing and fattening systems, Simmental bull calves of group one gained the target beef quality up to the age of 15 months. The practice of fattening the crossbred bull calves of groups two and three up to the age of 18 months has proved that their meat gains the target protein-to-fat ratio, while the meat of bull calves of the maternal breed should be considered over-fat beef, since the fat content exceeds the standard recommendations. The intensive system of rearing and fattening the Simmental bull calves up to the age of 15 months and the Simmental crosses with the German Simmental beef breed and the Charolais breed up to the age of 18 months can ensure the production of heavy carcasses with the target quality beef.

Keywords: Simmental breed, Charolais breed, commercial bull crossbreeding, beef production, economic efficiency

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INTRODUCTION

Meat and meat products represent the largest domestic food-market segment in terms of size and density. Its key role is determined by both the production volume along with the meat consumption and the importance of meat in human nutrition as the primary food sources of animal protein [1, 2]. In the contemporary operating environment, the low economic efficiency in beef production, compared to the other animal industries, most often relates to the feed costs per unit of production. Thus, the datasets of a number of researchers indicate that if the feed costs per 1 kg food substances for beef production are equal to 100%, the costs for the synthesized nutrients of the same amount required to produce milk, eggs, pork, and poultry meat usually make up 12, 26, 29, and 36%, respectively [3]. In addition, relatively low economic efficiency of beef production is associated with imperfection in economic and production relationships between the farms specialized in beef cattle production on the one hand and the enterprises for beef processing, packaging, and distribution on the other hand. Thus, beef livestock production in most of the farms is unprofitable, while the Moscow meat processing and packaging plants make approximately 100% profit on certain types of products [4].

The economic efficiency of beef production may be increased due to the labor productivity improvement based on the high-intensity technologies for rearing and fattening the cattle young stock, reducing the costs per unit of production, cutting irrational spending, and product quality upgrading. The latter is most preferable, since the high-quality beef produced at practically similar feed and labor costs is associated with the new attributes related to consumer purchase preferences influencing the higher disposal costs,

which allows this product to compete successfully on the market, increasing its market share.

Global experience shows that meeting the demand for beef is impossible without developing the specialized beef livestock. The proportion of the beef animals in the total cattle livestock population in the countries with well-developed animal industries is in the range of 40 to 85% [5]. Increasing the beef-livestock population size in Russia, which comprises 2.26 million animals, is possible not only by selectively breeding the specialized beef breeds for purebred stocks [6]. The perspective way is industrial-scale crossing of the dairy and dairy-beef cows with bulls of specialized beef breeds in order to produce crossbred progeny exhibiting more energy resources for higher growth rates, earlier puberty, and better beef quality characteristics when compared to that for the maternal breed animals [7]. Simmental cattle are widely used in industrial-scale crossing with Hereford, Limousin, Charolais, Aberdeen-Angus, and other beef breeds [8–11].

The current systems for assessment and classification of animals and their carcasses cannot contribute to stimulating the growth of beef production, since the beef quality evaluation is based on the subjective principles stipulating the use of visual and organoleptic methods. Thus, the parameter for fat deposition is considered basic and it cannot meet the current demands of consumers [12]. In order to stimulate the production of beef and improve its quality, new criteria for live-animal and carcass evaluation closely approximating the international standards have been developed [13].

The objective of the survey was to study the beef production efficiency through intensive rearing and fattening of Simmental and crossbred bull calves.

EXPERIMENTAL

The survey was carried out at the Tula Research Institute of Agriculture (Branch of Nemchinovka Federal Research Center). In order to conduct the survey, the bull calves were allocated into three groups of 15 animals each. The groups were designed with the pair-analog method including origin, age, and weight at birth. The first (control) group involved purebred Simmental bull calves. The second (experimental) group consisted of the youngstock produced through crossing the Simmental cows with the German Simmental beef bulls. The crosses of the Simmental cows with the Charolais bulls were included into the third (experimental) group. Selecting the breeds used in the survey was based on the relevance of studying at the Animal Husbandry Department, Tula Research Institute of Agriculture, since there was a need to build a commercial beef cattle herd with the available Simmental dairy-beef cattle livestock of the maternal pedigree.

The youngstock in all of the groups were reared from birth to 18 months under similar feeding and keeping conditions. From birth to weaning at 7 months of age, the calves were reared under the beef cattle management. The systems of keeping the cow and calf together indoors up to the second half of May and outdoor grazing up to October were used. After weaning, the youngstock were switched to stall keeping. Animal feeding was intensive. The feeding ration was estimated according to the standard recommendations developed by the All-Russia Research Institute for Animal Husbandry in order to reach 1000–1100 g average daily weight gain and 550–600 kg liveweight at the age of 18 months. The records of feed intake were performed every week with measuring the weights of given feeds and their residuals. The bull-calf liveweight gain was managed with weighing the animals at monthly intervals.

Slaughtering the animals for control purposes were carried out at the Tula meat processing and packaging plant. Thus, a bull calf of each group was slaughtered at birth. At the ages of 6, 12, and 15 months, three animals of each group were slaughtered. At the age of 18 months, five animals of each group were slaughtered. The preslaughter liveweight, the fresh carcass weight, the visceral fat weight, and the slaughter weight and yield were determined. The bull-calf carcasses were evaluated by the muscular system development and the fat deposition degree.

Efficiency of rearing and fattening the cattle youngstock was estimated based on the data on feed costs, production costs, wages and salaries, and total cash income provided by marketing the live animals for meat. The animal marketing cost was calculated with the data on liveweight, fresh carcass weight, muscular system development, and fat deposition. In order to assess the economic efficiency of youngstock rearing and fattening, we carried out calculations of feed costs per unit of liveweight gain, net income by the difference between the animal rearing cost and the revenue provided by marketing this animal for meat, and beef production profitability.

RESULTS AND DISCUSSION

Rearing the youngstock under the production technology for beef calves suckled from their cows and high levels of feeding could ensure the intensive growth of bull calves in all of the groups. The Charolais crosses at the ages of 12, 15, and 18 months gained the highest liveweight comprising 431.9, 523.4, and 620.6 kg, respectively, which were 7.8, 7.5, and 10.2% higher than that in their purebred Simmental peers. Differences in the value of this parameter between the bull-calves of groups one and two in all of the age periods were insignificant. The absolute liveweight gain from birth to 18 months of age in the young stock of group three comprised 768.8 kg, which was 32.4 and

56.4 kg greater than that in the bull calves of groups two and one, respectively.

Crossing with Charolais cattle had a positive effect on the postslaughter characteristics of the crosses. It was ascertained that the fresh carcass weights of the animals of group three at the ages of 12, 15, and 18 months comprised 240.0, 303.6, and 355.4 kg, respectively, which were 24.9, 39.2, and 50.8 kg more than that in their peers of the maternal breed ($P < 0.01 - P < 0.001$). The bull calves of group two had an intermediate position in the fresh carcass weight.

The nutrient costs per unit of weight gain are considered one of the most important indicators for economic efficiency of animal rearing and fattening. It is associated with the fact that a substantial share of costs in terms of value for rearing and fattening the cattle youngstock is attributed to feed portion. The data represented in Fig. 1 show that the feed costs per 1 kg liveweight gain in the animals of all of the groups tended to increase with increasing age. Thus, if the feed costs per 1 kg weight gain for bull calves from birth to weaning at the age of 7 months made up 4.4–4.5 EFU, their values for the period from 9 to 12 months of age and at the end of the experimental period comprised 8.0–9.0 EFU and 13.1–16.4 EFU, respectively. This is caused by the age-related metabolic changes in the animal body and the intensified body fat deposition, which are usually followed by increase in the calorie content per unit of gain. Significant feed costs per unit of gain (15.07–16.34 EFU) were recorded in the animals at the age from 7 to 9 months, which coincided with the event of weaning the bull calves from their mothers, causing the effect of weaning-induced stress.

The weaning induced stress caused significant decreases in the average daily gains and the bull-calf liveweight losses. Thus, if the average daily weight gains per month before weaning the youngstock from their mothers were rather high (950–1202 g), the first-month postweaning values decreased up to 236, 173, and 40 g for the animals of the groups in ascending order of their numbers, respectively. The postweaning liveweight losses per month in the animals of groups one, two, and three made up 20.9, 24.7, and 32.8 kg, respectively. A significant decrease in the postweaning growth rates of bull calves is apparently associated with the impact of the stress concentration factors. They caused the manifestation of psychosocial stress induced by weaning the bull calves from their mothers, which usually requires significant energy expenditures of the body. In addition, the liveweight losses may be caused by changes in feeding patterns and, subsequently, the long-term alteration in both the animal gastrointestinal function, because of transition from the milk-grass-based diets in a grazing period to the concentrate-silage-hay diets in a housing period, and the gastrointestinal tract microbial communities, which is observed in research papers [14, 15]. The youngstock in this period were also affected by the

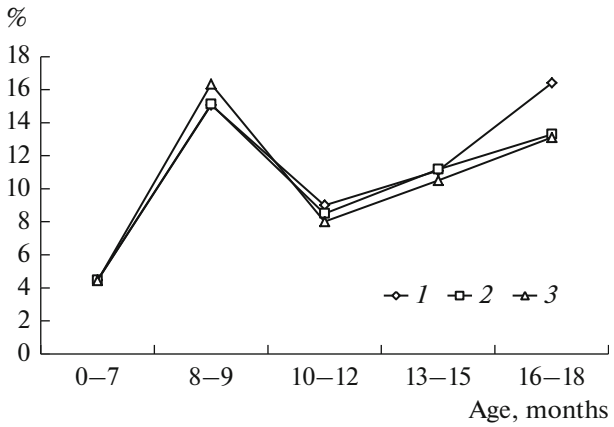

Fig. 1. Feed costs per 1 kg liveweight gain, EFU.

technological stress associated with the animal's transition from year-ground grazing management to the stall housing system with limited movements, which is usually followed by hypodynamia.

A relatively high energy of growth of the crossbred bull calves in groups two and three could contribute to reducing the feed costs per unit of liveweight gain. The feed costs per unit of weight gain in the bull calves of the maternal breed over the complete experimental period made up 8.7 EFU, while the feed costs comprised 8.5 and 8.1 EFU for the crosses in groups two and three, respectively. Relatively low feed costs of gain in calves of the maternal breed are apparently associated with higher rates of fat accumulation in their bodies, especially with the large visceral fat deposits. The crosses of groups two and three inherited the paternal-breed biological properties to develop the active tissues at low fat accumulation.

The increased age-related feed costs per unit of experimental youngstock liveweight gain affected the cost price per 1 centner of weight gain, which consequently had an effect on the beef production profitability. The value for recoupment of costs was highest in the Charolais cross group (20.7%), while the values for that among their peers of groups one and two comprised 13.9 and 17.7%, respectively (Fig. 2).

Since the feed costs per unit of bull-calf liveweight gain were the least in the period from birth to 7 months of age, nevertheless, the beef production profitability at 6-month-old calf slaughter was negative, comprising –7.6 and –10.5%, respectively; i.e., rearing the youngstock up to the age of 6 months is unprofitable. It is contrary to some extent to the concept of increase in profitability at reduction in costs per unit of weight gain. However, it should be noted that a disposal cost of 6-month-old-calf carcasses is significantly lower than that for the 15–18-month-old-animal carcasses. Beef production profitability tended to increase with increasing the age of the bull calves. Profitability reached the highest level with disposal of 15-month-

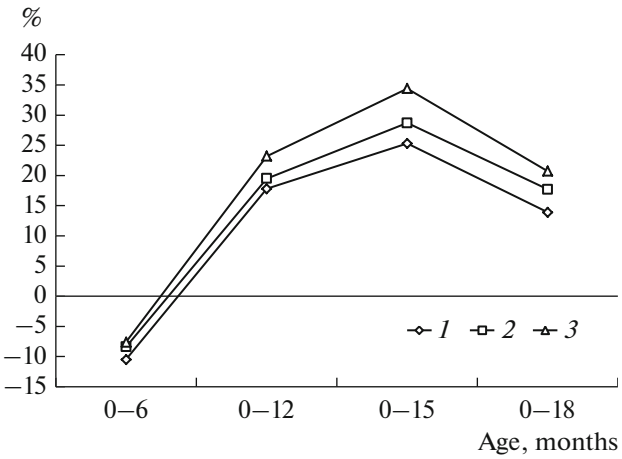

Fig. 2. Age dynamics and beef-production profitability level.

old young stock. At the end of the experimental period, the value of this parameter for the bull calves of the maternal breed decreased up to 13.9%, while the values for the crosses of groups two and three decreased up to 17.7 and 20.5%, respectively, which can be caused by significant feed costs because of a faster rate of body fat deposition.

The beef finishing system is of great importance in the meat industry. The finished beef is assessed by characteristics in the protein-to-fat ratio considered optimal at the 1 : 0.70–75 level. The ratios between protein and fat absolute masses in the carcasses of 15-month-old bull calves of group one and the crosses of groups two and three were 1 : 0.74 and 1 : 0.57, respectively. The data provided herein show that the bull calves of the maternal breed could reach the optimal ratio between protein and fat in the carcasses up to the age of 15 months. The parameter value for the crosses at that age in groups two and three was 0.13–0.16 units lower than that for the optimal ratio.

Fattening up to the age of 18 months contributed to significant increase of the fat mass in the bull-calf carcasses. Therefore, the protein-to-fat ratios for the groups in ascending order of their numbers made up 1 : 0.84, 1 : 0.75, and 1 : 0.68, respectively. The analysis of the data indicating the end of the fattening process showed that under the intensive system of rearing and fattening, the Simmental bull calves reached the target quality of beef up to the age of 15 months. The beef of the crossbred bull calves of groups two and three at the finishing age of 18 months is characterized by the optimal ratio between protein and fat, while the beef of the bull calves of the maternal breed should be considered over-fat, since the fat amount is considerable.

CONCLUSIONS

Therefore, the intensive rearing and fattening system for the Simmental bull calves and the Simmental crosses with the German Simmental beef and Charolais breeds to the ages of 15 and 18 months, respectively, can ensure the production of heavy carcasses with the target quality beef. Moreover, it contributes to the relatively low feed costs per unit of liveweight gain and increases in profitability of young-stock rearing.

The intensive system of rearing and fattening the Simmental × Charolais crosses was most profitable due to their greatest capabilities for accelerated and long-term growth without excessive fat deposition at lower feed costs of weight gain.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interests. The authors declare that they have no conflict of interests.

Statement on welfare of animals. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. The article does not concern any researches using animals as objects.

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