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Use of Grain Silage in Feeding Cattle Growing Stock

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Abstract

The article presents the study results on using grain silage in the feeding ration of replacement heifers. Instead of corn silage, the experimental group of heifers was fed with vetch-barley grain silage in the amount of 3.6 kg per head per day. In the experimental groups of young cattle, the increase in live weight (average daily, absolute, relative) was studied, and the economic efficiency of using grain silage in the diets of heifers was also determined. The study results showed that the absolute gain in the groups of experimental calves was 62.1±2.1 kg, which was higher by 14.6% or 7.9±0.4 kg ($p<0.05$) than the total gain of the control group, where this indicator was 54.2±1.9 kg. The relative gain of the experimental group was 70.8±1.7%. The relative increase in growing stock from the control group was 61.4±1.5%, which turned out to be 15.31% lower than in the control group ($p<0.01$). The average daily gains in the experimental group were 690.0±32.1 g, which slightly exceeded the indicator of the control group by 14.6% or 87.8±3.1 g. In the experimental group, the profit was higher by 5924.0 rubles than in control, which ensured an economic effect per head in this group in the amount of 1184.8 rubles.

Keywords: Grain silage, Cattle, Growing stock, Growth

Introduction

The modern period of cattle breeding development indicates certain requirements for feeding calves starting from their first days of life. A well-designed feeding scheme assumes getting a highly productive, healthy animal. The intensive development of the livestock industry requires the improvement of rearing technologies for growing stock, where the main role is played by the issues of feeding (Ushakov, 2008; Humer & Zebeli, 2017; Martin *et al*., 2017; Schild *et al*., 2020).

Before getting high-quality products, proper animal development should be provided. One of the most important steps in this process is getting healthy calves and proper raising conditions.

Along the process of raising young cattle, it is necessary to solve several problems. The first is to obtain highly productive cows with good health, fully developed with a strong constitution from replacement heifers. The second is to grow high-quality steers from pedigree calf bulls. The third is the fattening of growing stock to obtain high-class beef (Yakimenko, 2004; McMillan *et al*., 2018; Zubova *et al*., 2019; Genís *et al*., 2021).

When organizing the correct process of growing stock rearing, it is first necessary to consider the specifics of the periods of its development. In the first months of life, calves are distinguished by the highest intensity of their growth. At this time, an organism adapts to the external conditions of the environment, especially in the first days of life. Thus, there is the formation of ruminal digestion. The viability of calves is significantly influenced by the conditions of feeding and housing and age and associated morphological and physiological characteristics (Blom *et al*., 2020; Ferreira *et al*., 2020; Aragona *et al*., 2021; Salami *et al*., 2021).

Literature Review

An increase in production output and an improvement in products' quality in cattle breeding are possible by optimizing feeding rations in terms of the standardized nutrient content and ensuring the full value of animal feeding. In the diets of cattle, there is often an insufficient amount of protein. The lack of protein ranges from 10 to 20%, which leads to a decrease in the animal productive qualities from 20 to 40% (Yakimenko, 2004).

Ragimov (2010) conducted research to study male calves' feeding types and their effect on productive performance. In the 1st experimental group, the silage-hay type of feeding was used; the diet consisted of concentrated feed (16%), hay (34%), and corn silage (52%). The silage-concentrate type was in the 2nd experimental group (26% concentrated, 24% roughage, and 51% succulent feed). The silage-concentrate type was used in the 3rd experimental group (36% concentrated, 21% roughage, and 46% succulent feed). The analysis of the experimental results showed that the 2nd and 3rd groups' animals surpassed their analogs from the first group in terms of live weight gain by 4.0 and 7.5%, respectively. The meat yield from the carcasses of male calves of the second group was 0.9 and 1.4% higher than from the carcasses of the first and third groups. The data obtained indicate better growth energy with an increase in the concentrated feed proportion in the diet.

The plant feeds with a high nutrient content cannot optimize diets for essential nutrients, particularly minerals and protein (Abramkova, 2012).

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Researchers Krasnoshchekova and Shishkin (2012), in turn, note that imbalance in diets in terms of minerals can significantly reduce the productivity of animals and contribute to the development of many diseases. Diets that are unbalanced in terms of the necessary nutrients significantly inhibit the growth rate of growing stock, reduce the feed consumption effectiveness, and increase the production cost (Azhmuldinov, 2009; Almaiman & Al Wutayd, 2019; Hanan *et al*., 2019).

Feed additives are used for various sex and age groups of animals to solve the problems of a weak feed base and feed saturation with necessary elements in animal husbandry. Ushakova (2008) conducted studies on the use of mineral supplements and revealed that an increase in the number of mineral elements in the diet, in particular zinc, copper, and cobalt, gives positive results. In comparison with the average recommended norms, with an increase in the proportion of mineral elements in the diets of young fattening cattle, a positive effect on the meat productivity indicators is found.

At the present stage of the livestock industry, the organization of full-fledged feeding of animals in the winter period is of particular relevance and practical importance (McMillan *et al*., 2018; Salami *et al*., 2021). Specific attention should be paid to feeding replacement heifers up to 6 months of age, particularly based on mono feed in their diets - grain silage (Kanani *et al*., 2019; Erickson *et al*., 2020; Mitchell & Heinrichs, 2020; Aragona *et al*., 2021).

Grain silage is a forage prepared from the vegetative part of grain fodder crops cultivated for forage purposes and harvested without threshing. Leguminous crops are also used in conjunction with grain fodder crops. Grain silage is well accessible for the rumen digestion of animals. The feed is well eaten by animals and is digested in the gastrointestinal tract, making it possible to reduce the supply of concentrated feed and reduce the cost of livestock products (Ushakov, 2008; Erickson *et al*., 2020; Piao *et al*., 2021).

Scientists have found that feeding cows with mixed silage instead of corn silage improved the digestibility of the main nutritional components of the diet. The digestibility of dry matter, organic matter, protein, and fat of the ration feed has significantly increased. There was also a significant decrease in the digestibility of fiber. It was also noted that the inclusion of combined grain silage in the diet of lactating cows instead of corn silage in nutritional value was accompanied by a decrease in the consumption of feed nutrients for a unit of dairy products (Erickson *et al*., 2020).

Fewer nutrients are lost during harvesting haylage compared to hay drying and ensiling freshly cut grasses. Grain silage is a new type of forage with a pH of 4.5-5.5. Therefore, to obtain good-quality grain silage, it is necessary to observe all technical operations when harvesting it strictly.

The technological process of preparing grain silage includes the following technological operations: mowing herbs, picking up dried green mass, crushing, loading into vehicles, transporting to a trench, loading into a trench, compacting the mass, sealing. The grass must be cut during the optimal growing season to obtain high-quality silage. The optimal timing is the onset and full budding of legumes, in cereals, the exit into the tube. At this time, they have a high energy nutritional value (10.5-10.8 MJ, or about 1.0 feed units in 1 kg of dry matter) and the full content of crude protein (18-23% in perennial legumes and 13 -18% in cereals), as well as the highest content of digestible nutrients (Kalashnikov *et al*., 2003; Yakimenko, 2004; Ragimov, 2010; Martin *et al*., 2017).

Special mowers are used for mowing grass. After mowing, the green mass is collected in rolls, dried for 1-2 days to reduce humidity in dry and hot weather to 70%, in moderate - up to 60%. Then the dried mass is picked up, crushed to particles 3-5 cm in size, and transported to storage sites. Trenches are used for laying grain. In buried trenches, the mass is unloaded directly from vehicles, and there it is leveled with a tractor. From the beginning to the end of filling the trench, it is necessary to carry out thorough, continuous compaction of the green mass. After filling, the trench is sealed using a polymer film, and it is covered with straw on top, with a layer of earth.

Thus, using haylage from a mixture of cereals - legumes or grain fodder crops will improve livestock supply with juicy fodder during the stall period. The use of haylage in the diet after the dairy period of young cattle contributes to an increase in production in live weight, an increase in the economic efficiency of the further development of dairy cattle breeding in the country.

Moreover, it should be noted that in the modern scientific literature, there is not enough information on the use of grain silage in feeding heifers up to 6 months of age. This indicates the need for further comprehensive research in this scientific direction. All this determines the relevance of the problem under study.

Purpose of the Study: Nowadays, it is of great scientific and practical interest to feed young cattle in the post-milk period with grain silage instead of corn. Based on this, the research aimed to study the effectiveness of feeding replacement heifers with grain silage and its effect on productive performance.

In connection with these, the following tasks were solved:

1. To study the growth rate of replacement heifers of 4-6 months of age with grain silage in the diet
2. To give an economic assessment of the grain silage use in feeding heifers

Materials and Methods

To solve the set tasks in the conditions of a peasant farm enterprise "Zincheko V.D." in the Kemerovo region, a scientific and economic experiment was carried out according to the presented scheme of the experiment **(Figure 1)**.

Heifers of the Black-and-White breed were selected for the study. The age of the experimental young cattle was four months. Two groups were formed based on pairs - analogs: control and experimental (5 heads each).

The efficiency of using grain silage in feeding heifers was studied to reduce livestock products cost. As a substitute for plant food with a low nutritional value (corn silage), the calves of the experimental group included food with a higher nutrient content - vetch-barley grain silage (35% of the diet's nutritional value).

The experiment lasted 90 days. The conditions of keeping the experimental animals were the same. Heifers were weighed monthly to study the animals' growth rate.

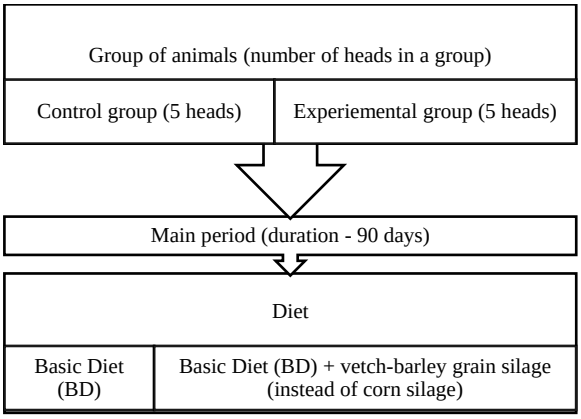

Figure 1. Scheme of the Experiment

The study results were processed by biometric methods to determine the reliability level according to the Student's criterion with the software package Microsoft Excel 2010. The levels of reliability were determined: * p <0.05; ** p <0.01; *** p <0.001.

Results and Discussion

When conducting the scientific and economic experiment, the effectiveness of using grain silage in feeding heifers of 4-6 months of age was studied.

Particular attention to the complete nutrition of experimental animals was paid to the diet balance for raw protein and metabolic energy.

The most important factors in feeding young cattles are the maximum increase in their appetite and the consumption of dry matter of feed ration. The variety and good quality of the fodder contribute to the improvement of the taste and their acceptability by the animals.

Samples of fodder (corn silage, grain silage) were taken for complete zoochemical analysis to determine the chemical composition at the beginning of the experiment. The results of the chemical study of feed are shown in **Figure 2**.

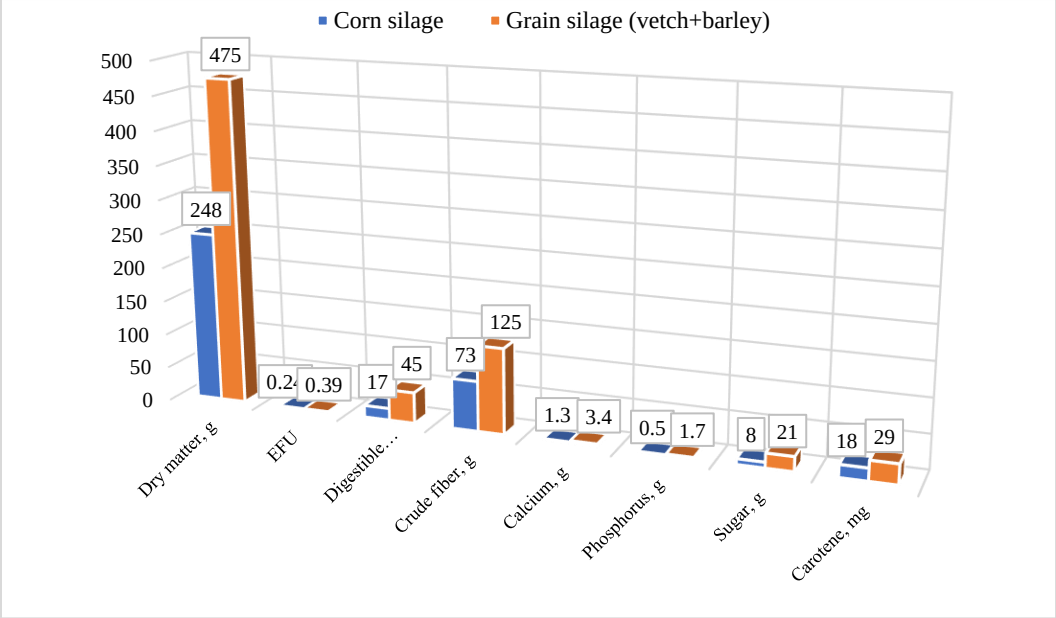

Figure 2. Chemical Composition of Feed

The chemical composition data show that the grain silage used on the farm is characterized by higher fodder characteristics than corn silage, particularly in terms of the content of EFU, digestible protein, calcium, phosphorus, sugar, and carotene. The data obtained on the chemical composition of the investigated feeds made it possible to optimize the diets for experimental animals **(Figure 3)**.

During the research, the diets were compiled for the growing experimental stock. The diets were balanced in essential nutrients according to existing feeding standards. The main difference between the groups was in the composition of the diet. So, instead of corn silage, the animals of the experimental groups fed grain silage from a mixture of grain fodder plants **(Figure 3)**.

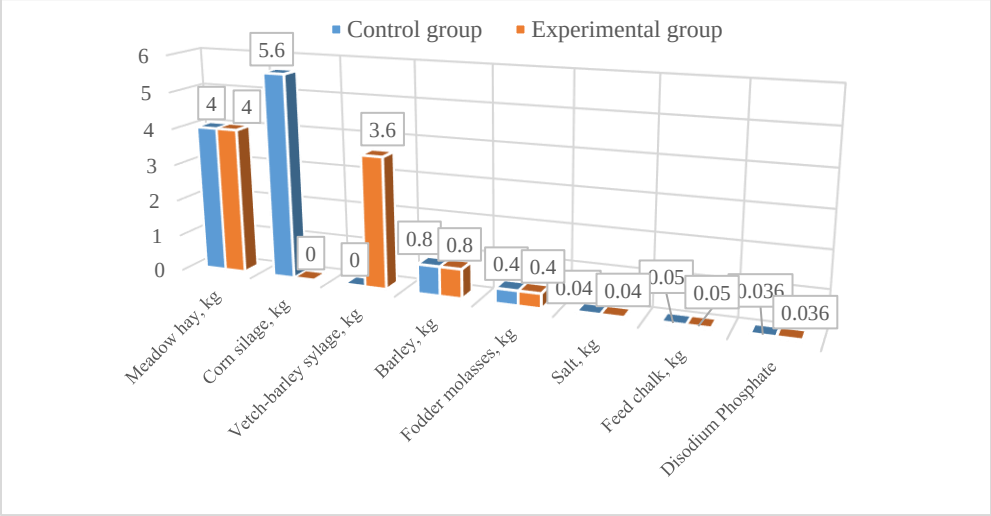

Figure 3. Composition of Diets for Experimental Young Cattle over the Experiment Period (according to the Actual Consumption)

Using grain silage in the diet of animals in the experimental group made it possible to optimize its basic nutrients. The ration was optimized for energy feed units (ECU), dry matter, digestible protein, and crude fiber.

The amount of phosphorus in the diets was balanced by including feed disodium phosphate in the amount of 36.0 grams per head. Calcium optimization was carried out at the expense of main feed and feed chalk in 50.0 grams per head.

The diets of the heifers were developed, taking into account their live weight and the planned gain during the rearing period according to the feeding norms (Kalashnikov *et al*., 2003). The diets for young cattle in terms of basic nutrients were calculated to obtain an average daily gain of 650-700 g at 90-180 days of age.

The calves of the control group received the main diet consisting of meadow hay, corn silage and concentrated fodder (barley powder), fodder molasses.

The heifers of the experimental group received grain silage from a mixture of grain fodder crops instead of corn silage. Grain silage was prepared without threshing in the phase of milky - wax and wax ripeness of grain.

The study of feed eatability showed that the diet's main feed consumption in the experimental groups was different during the experiment. This factor influenced the structure of the consumed rations **(Figure 4)**.

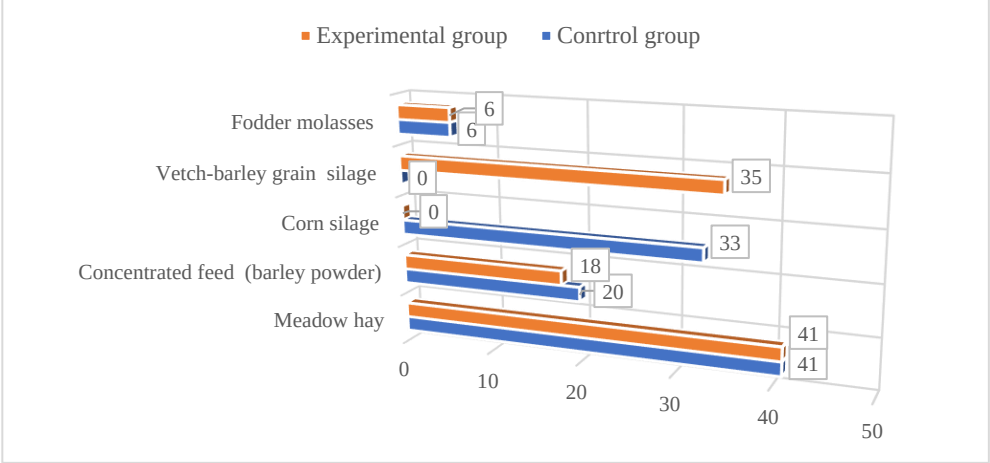

Figure 4. Structure of Diets for Young Stock, % by Nutritional Value

In the experimental groups, according to the diet structure, meadow hay was its basis (41.0%). The share of grain silage in the experimental group was 35.0%, corn silage was not fed. On average, the percentage of concentrated feed in both groups was about 20.0%.

Different diet structures of the experimental livestock led to further growth rates of the experimental animals.

When setting up the experiment, the heifers had the same live weight; however, by the end of 6 months of age, with changing the

diet structure, the live weight of the heifers in the experimental group at the end of the experiment was higher than in the control group. When setting up for the investigation, the animals of the experimental group had an average live weight of 87.7±2.5 kg, and that of the control group - 88.3±2.2 kg.

The experienced livestock of heifers was by 0.6 kilograms inferior to their peers from the control group. The difference in live weight between the experimental animals was 0.7%.

At the end of the experiment, the live weight of animals in the control group averaged 142.5±3.4 kg, and calves from the experimental group 149.8±3.7 kg. At the end of the investigation, calves from the control group were inferior to heifers from the experimental group in live weight by 7.3 kg or 5.12% (Student's t-test value: 1.45. Differences are not statistically significant (p=0.189600).

The obtained data on changes in the live weight of the black-and-white heifers depending on the type of feeding used are presented in **Figures 5 and 6.**

The experiment results indicate an absolute increase in the group of experimental calves (62.1±2.1 kg); however, in their peers from the control group, this indicator was noted at the level of 54.2±1.9 kg. The absolute increase in the experimental group was significantly higher by 14.6% or 7.9±0.4 kg ($p<0.05$) than in the control group (Student's t-test value: 2.79. The differences are statistically significant (p=0.026924).

According to the study results, it was revealed that the average daily gain in the experimental group was 690.0±32.1 g. In the control group, this indicator was noted at the level of 602.2±28.4 g. It was found that the heifers from the experimental group did not significantly exceed their peers in average daily gain. The difference was 87.8±3.1 g or 14.6% (Student's t-test value: 2.05. Differences are not statistically significant (p=0.079702).

The relative gain, showing the true growth rate, in the experimental group was 70.8±1.7% and was also higher than in control by 15.31% ($p<0.01$), where this indicator was 61.4±1.5% (Student's t-test value: 4.15. Differences are statistically significant (p=0.004316).

The gross gain in heifers of the experimental group was 39.5 kg more than the one in heifers of the control group.

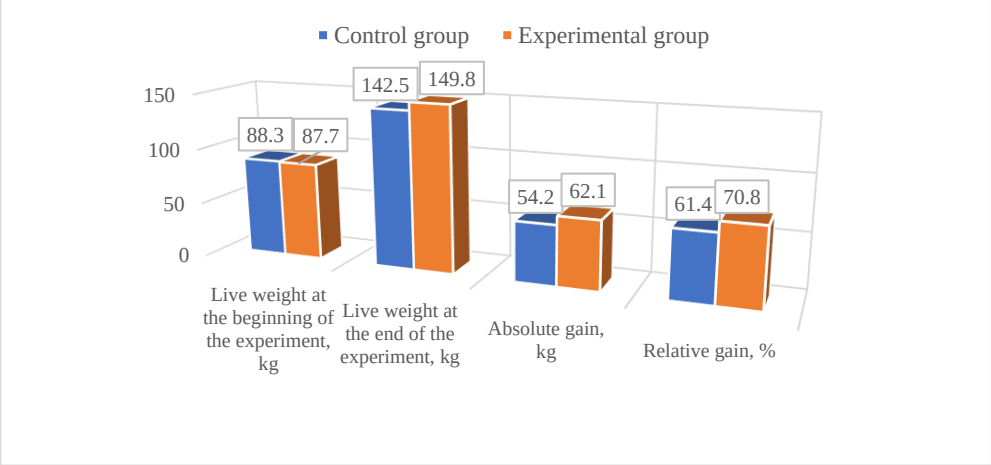

Figure 5. Change in Live Weight Gains of Heifers over the Experiment Period

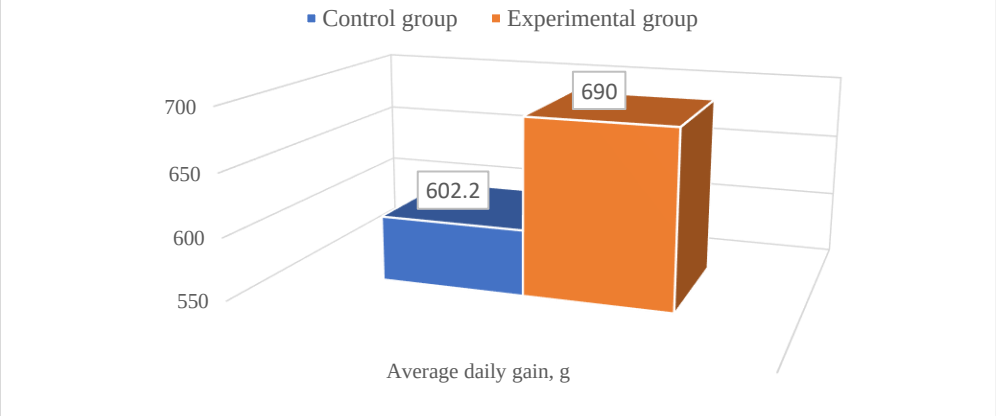

Figure 6. Change in Average Daily Gains in Live Weight of Heifers over the Experiment Period, g

Based on the conducted experiment, it was found that the use of vetch-barley grain in the feeding ration of heifers of the Black-and-White breed had a positive effect on the economic indicators of their rearing.

The main feed consumption differed for the groups in the experimental work; this was reflected in the diets' structure and cost. Production costs for raising heifers in the experimental group were higher by 1,681.0 rubles than for heifers in the control group **(Figure 7)**. The price of 1 kg of products sold amounted to 195.0 rubles. The highest growth energy in the animals of the experimental group made it possible to obtain 39.5 kg of additional products, which ensured a greater profit of 41,738.0 rubles from the experimental group. The economic effect in the experimental group was 5924.0 rubles per head - 1184.8 rubles.

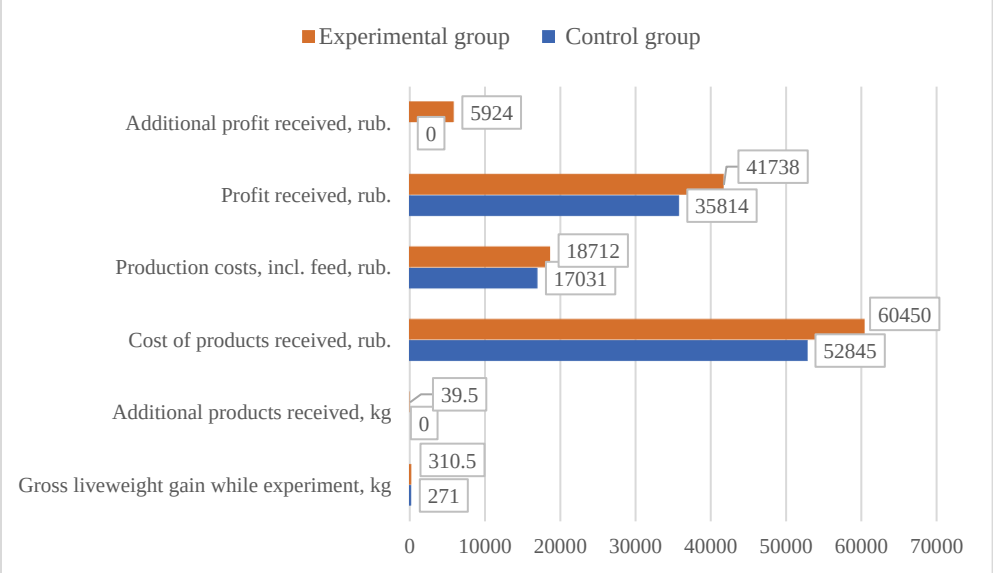

Figure 7. Economic Efficiency of Using Grain Silage in Feeding Young Stock

The most important economic indicator of any production is the cost of production. Suppose the costs associated with the production of a particular type of product are very high and do not pay off. In that case, the output of this type of product will not be profitable for the enterprise, that is, unprofitable. The use of vetch-barley grain in feeding young cattle of the Black-and-White breed had a positive effect on the productive indicators of the livestock and the economic indicators of cultivation.

Studies have found that feeding heifers at the age of 4-6 months with grain silage instead of corn silage led to an increase in their live weight. The absolute and relative gains in live weight significantly increased. The inclusion of grain silage in the diet of young cattle instead of corn silage in nutritional value was accompanied by a decrease in the cost of heifers' growing. The change in the diet composition of the experimental group of heifers contributed to optimal nutritional saturation, particularly in terms of the content of metabolic energy, crude and digestible protein, sugar, macro and microelements, and vitamins. The data obtained in the study coincide with the investigations of some Russian and foreign scientists, which indicates the advisability of using grain silage made from a vetch-barley mixture in the diets of replacement heifers (Ragimov, 2010; Martin *et al*., 2017; Kanani *et al*., 2019; Erickson *et al*., 2020).

Conclusion

As a result of studies carried out on heifers aged 4-6 months, to study the effectiveness of feeding grain silage on their productivity, it was found that the absolute increase in the experimental group was significantly higher than in the control group - by 14.6% or 7.9±0.4 kg ($p<0.05$). A higher relative increase was found in the experimental group, where it was 70.8±1.7%. When calculating the relative gain between the experimental groups, the difference was 15.31% ($p<0.01$). In terms of average daily gain, the heifers from the experimental group did not significantly exceed the control, and the difference between the groups was 87.8±3.1 g or 14.6%. In the experimental group, the profit was higher than in the control group by 5924.0 rubles, which ensured an economic effect per head in the experimental group - 1184.8 rubles. Thus, based on the results obtained, we can talk about the advisability of including grain silage from a vetch-barley mixture in the diet of young cattle.

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Ethics statement: None

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