Assessment of the impact of the inbreeding level on productive traits and length of the productive life of cows

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Abstract. Dairy cattle breeding employs both heterogeneous and homogeneous selection. The impact of the inbreeding level on productive traits and length of the productive life of cows is assessed. It is found that despite an insignificant increase in milk yield of inbred animals (by 93–378 kg, depending on the inbreeding level, and on average by 73 kg per the inbred animals group), their milk quality, namely mass content of fat and protein, is found to decrease, and the live weight is revealed to significantly increase (P≤0.05). Herd cows are superior in terms of the requirements of the standard for black-motley breed by 2500–2947 kg in groups (on average by 2624 kg) in milk yield and by 0.31% in the fat content in milk. For the Holstein breed, these results are insignificantly lower and amount to 1500–1924 kg (an average of 1624 kg) for milk yield. Inbred cows with moderate levels of inbreeding and outbred animals yielded the greatest amount of milk and nutrients due to an increased length of productive life. With age, milk production of cows virtually does not change and remains at a sufficiently high level. Closely related crossbreeding and an increased pedigree index in the Holstein breed increase the milk yield and the length of productive life by 0.2–0.4 lactation. Inbred cows with a moderate degree of inbreeding remain superior to outbred cows in life-long productivity.

1. Introduction
Uninterrupted and sustainable supply of high-quality food products, including milk, is the key to health of the nation and food security of any country. An increased output of high-quality milk and dairy products is one of the vital tasks in the development of livestock production worldwide, which is becoming crucial due to both the global growth of the population, in particular in our country, and the need to satisfy humanity’s food demands. In this regard, the development of this industry is of great economic relevance [1–7]. Increase in cow productivity is inseparably linked with improvement of the milk quality, which has a significant impact on the quality of finished dairy products [8–18]. All over the world, dairy breeds are used for milk production, including related breeds such as black-motley, Holstein and Dutch, which differ in economically beneficial traits depending on climatic and ecological, and feed conditions of the breeding zone, and the breed gen pool [19–20]. However, since these are related breeds, bulls of the Holstein breed of foreign selection are used in dairy herds. In herds of Holstein black-motley breed of the Ural type in Sverdlovsk region, up to 98% of cows are descendants...
of the bull of foreign selection [21–23]. Assessment of the impact of the bull on the growth of heifer daughters is of practical relevance, especially in conditions of increased pedigree in the Holstein breed.

The aim of the study was to assess the impact of the bull on productive traits of heifer daughters.

2. Materials and methods
The study included cows that completed first lactation and were sired by the bulls Gavano, Emen and Def; Dae-Su and Stoker, which had more than 15 daughters on the breeding farm engaged in breeding of Holsteinized black-motley cattle of the Ural type in Sverdlovsk region.

The cows were divided into 5 groups depending on their belonging to the bull: group 1 – daughters of the bull Emen; group 2 – daughters of the bull Def; group 3 – daughters of the bull Gavano; group 4 – daughters of the bull Stoker; group 5 – daughters of the bull Dae-Su.

The study used data from zootechnical and breeding records of the SELEX database.

The calculated parameters included the coefficient of milk yielding capacity, the milk fat and protein content per lactation and over the period of use, and milk yield over the entire productive period.

3. Results
The commercial farm is engaged in rearing of highly productive, Holsteinized black-motley cattle of the Ural type. Over the past seven years, daughters of 109 bulls have been used and continue to be used in the herd. In terms of the number of daughters in the herd, the bulls can be divided into four groups: group 1 – the number of daughters exceeds 200 heads; group 2 – the number of daughters ranges from 50 to 200 heads; group 3 – the number of daughters is up to 50; group 4 – daughters dropped out of the herd.

The bulls whose daughters showed the lowest percentage of culling and amounted to at least 15 heads in the herd are of particular interest. The percentage distribution among these bulls was as follows: Gavano (74.1% of survived daughters), Emen (51.3%), Def (88.1%), Dae-Su (84.1%), and Stoker (100.0%).

The study revealed that the number of daughters in the herd and the percentage of survived daughters depend on the duration and intensity of use of the bull in the herd rather than on the duration of productive use of daughters. Thus, the bulls Emen and Stoker were used for two years, and other bulls were used for one year. This affected the number of daughters in the herd and the duration of their use (figure 1).

Figure 1 shows the highest survival rate for daughters of the bull Stoker followed by the group of the bull Def, but it should be noted that these groups comprise a small number of animals.
Figure 1. Rotation of bull’s daughters in the herd.

To assess the effect of the length of lactation period on the productivity of cows, we have thoroughly analyzed data on the milk yield per lactation in daughters of Holstein bulls used on the farm.

Daughters of the bull Gavano exhibited the highest milk yield followed by daughters of the bull Dae-Su. It should be noted that the milk yield over the entire lactation period and over 305 days of lactation in all the studied animals ranged from 7300 to 9000 kg, which indicates high potential for productivity in cows of this herd. The milk yield over 305 days of lactation ranged from 7305.9 (bull Emen) to 8062.8 kg (bull Gavano). Due to the fact that the length of lactation period is more than 305 days, the amount of milk yield per lactation in daughters of the bulls Emen, Gavano and Dae-Su was higher than that produced by daughters of the bulls Def and Stoker.

Daughters of the bulls Emen, Gavano and Dae-Su showed a longer lactation period than that accepted in domestic technology of milk production, that is, more than 305 days. The difference is 26–41 days on average for the groups of daughters and 24–59 days for the maximum lactation, which can be clearly seen in the diagram (figure 2).
As a result, the milk yield over the entire lactation period increased by 622–905 days, which is primarily due to the high average daily milk yield of cows and their genetic potential for productivity. It was found that even in the last days of lactation activity, daughters of these bulls exhibited high average daily milk yields (figure 3).

It should be noted that lactation activity of daughters of the bulls Dae-Su and Gavano differed from the generally accepted one. These cows showed higher average daily milk yield per lactation compared to the average daily milk yield over 305 days of lactation.

Average daily milk yields by daughters of bulls Emen, Gavano and Dae-Su at the end of the lactation period exceeding 305 days were also high and amounted to 19.4–27.0 kg.

The nutritive and biological value of milk as a food product depends on the qualitative characteristics of milk, which to some extent determine the efficiency of milk production.

Differences in milk yield over the entire lactation period and over 305 days of lactation, as well as in milk fat and protein content, depend on the bull. The highest fat content (HFC) was noted in the milk of daughters of the bull Def, and the highest protein content (HPC) was observed in the milk of daughters of the bulls Gavano and Stoker (figure 4).
The difference in HFC and HPC content in milk, depending on the length of the lactation period, was not established. The yield of milk fat and protein was more affected by milk yield per lactation and milk yield over 305 days of lactation (figure 5).

The amount of milk fat and protein increased significantly as the length of lactation period grew up. The difference in milk fat ranged from 25.2 to 36.9 kg, and in milk protein – from 20.4 to 29.9 kg.

High coefficients of lactation stability were noted for all the groups of bulls' daughters (figure 6).
Thus, we can conclude that daughters of Holstein bulls used on the farm exhibit high genetic potential.

4. Discussion
The highest indicators of milk production were found in daughters of the bull Gavano, followed by daughters of the bull Dae-Su. It should be noted that the milk yield over the entire lactation period and over 305 days of lactation in all the animals studied ranged from 7300 to 9000 kg, which indicates a high potential of cows in this herd. The lactation stability coefficients were found to be sufficiently high in all the groups of bulls’ daughters and ranged from 101.4±0.79% (bull Emen) to 109.3±.97% (bull Stoker), followed by daughters of the bull Def. Similar studies were carried out by V Mymrin, O Loretts, I Tkachenko, V Gridin, S Gridina, and O Leshonok.

5. Conclusion
Overall, breeding in the herd is carried out at a sufficiently high level. According to economically beneficial traits, the breeding stock is homogeneous and uniform, which contributes to the efficiency of production and milk yield on commercial farms that employ industrial production technology. All daughters of the bulls studied exhibited high productivity performance.

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