The use of inbreeding in dairy cattle breeding

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Abstract. In cattle breeding during breeding season, great importance is attached to the selection of male and female pairs. The purpose of the work is to assess the effect of inbreeding on the milk production of cows of different genotypes. It was found that the main number of animals in the herd was obtained using remote inbreeding, which is 83.8%. The use of related mating led to a decrease in the age of the first calving by 0.3 months, a lactation period by 0.4, and a slight increase in milk yield by 78 kg with a decrease in the mass fraction of fat by 0.01% and protein by 0.02%, relative to outbred cows. A significant change in the productive longevity of animals obtained by outbred breeding and the use of a moderate level of inbreeding (P≤0.05) was noted. The effect of blood on Holstein breed on the productive qualities of cows was also established. An increase in blood level to 75-91% led to an increase in milk yield and qualitative indicators of productivity. Thus, the average milk yield in the group increased by 566 kg or 9.4%, while increasing the mass fraction of fat by 0.04% and protein by 0.04%. The best indicators of productivity within the genotype groups were established with a remote level of inbreeding and a genotype of Holstein breed 91-97% blood. In the future, when developing a breeding plan, it is necessary to take into account the fact that the best quality indicators of productivity, namely the mass fraction of fat and the mass fraction of protein are higher in cows with a genotype from 76 to 91% and a moderate level of inbreeding - 3.97% and 3.08%.

1. Introduction
Cattle breeding is the most important livestock industry, to the development of which great attention all over the world is paid. Dairy cattle breeding is one of the leading livestock industries in the world, including in the Russian Federation. This industry solves the most important world problem - the provision of food, primarily dairy and meat products. Up to 97% of all milk is received from cattle.

Milk and products obtained as a result of its processing make up a significant part of the diet of people, providing them with protein, milk fat, calcium, vitamins and other substances necessary for life [1-7]. During its production, there is a focus on improving the quality, which is crucial for processing into dairy products [8-14]. There are several methods of breeding animals, including purebred. In cattle breeding during breeding season, great importance is attached to the selection of male and female pairs. These individuals can be both related to each other, and may not be related to each other. The mating of related males and females is called inbreeding, and the offspring obtained from this mating is called inbred [14-16]. This selection leads to an increase in the frequency of homozygous genotypes in descendants and a decrease in the frequency of heterozygous genotypes. In livestock practice, various types of inbreeding are used: incest (father and daughter, mother and son, brother and sister); breeding
in close relationship (half-brother - half-sister, grandmother - grandson, granddaughter-grandfather), as well as moderate and remote relation [17-18]. However, mating of related animals is often accompanied by undesirable features in inbred offspring, as it is often accompanied by a decrease in its viability, fertility, and birth of freak animals or stillbirths, which is called inbred depression. The closer the relationship between the mating individuals is the more expressed inbred depression is. Despite this, the method is used to consolidate the desirable qualities of a valuable animal, which is inbreeding [19]. Widely used in dairy cattle breeding, Holsteinization led to an increase in the number of inbred animals in herds [20-23]. In some agricultural enterprises, the main amount of up to 98% of cows was obtained by remote or moderate levels of inbreeding. Evaluation of the effectiveness of inbreeding in dairy cattle breeding in the conditions of the Sverdlovsk region is relevant and of practical importance.

The purpose of the study is to assess the effect of inbreeding on the milk production of cows of different genotypes.

2. Materials and method
The study included all the cows from the bred livestock farm of the Sverdlovsk region, which completed lactation. They were divided into 4 groups depending on the level of blood relationship (group 1 - blood less than 75%; group 2 - from 75 to 91%; group 3 - from 91 to 97% and group 4 - 97% and more) by Holstein breed and level of inbreeding (outbred; remote inbreeding; moderate inbreeding and close inbreeding). Milk productivity was evaluated by the control milking method, the mass fraction of fat and protein in milk in the control samples of each cow was determined once a month during lactation. The milk coefficient, the amount of milk fat and milk protein for lactation and for the period of use and life-long milk yield were calculated.

3. Results
Milk productivity is the main breeding trait by which it is possible not only to conduct selection, but also to evaluate the effectiveness of breeding in the herd. Table 1 presents data on the milk production of cows, depending on the genotype (blood content of the improving breed) and the level of inbreeding.

Table 1. Milk production of cows.

| Inbreeding rate       | Heads | Age of calving, months | Average age in lactation | Milk yield, kg | Mass fraction of fat, % | Mass fraction of protein, % |
|-----------------------|-------|------------------------|--------------------------|----------------|-------------------------|-----------------------------|
| Blood count up to 75 %|       |                        |                          |                |                         |                             |
| Outbred               | 11    | 25.9±0.20              | 3.09±0.1                 | 5679±127.7     | 3.92±0.006              | 3.02±0.002                  |
| Remote                | 5     | 23.2±0.20              | 2.4±0.2                  | 6685±175.3     | 3.91±0.004              | 3.02±0.003                  |
| Herd average          | 16    | 24.6±0.20              | 2.75±0.3                 | 5993±133.7     | 3.92±0.003              | 3.02±0.002                  |
| Blood type from 75 to 91%|      |                        |                          |                |                         |                             |
| Outbred               | 5     | 25.2±0.8               | 4.6±0.4                  | 6093±231.3     | 3.92±0.004              | 3.07±0.003                  |
| Remote                | 39    | 25.2±0.7               | 4.4±0.2                  | 6614±157.3     | 3.95±0.004              | 3.06±0.003                  |
| Moderate              | 7     | 25.6±0.5               | 4.7±0.3                  | 6530±185.7     | 3.97±0.004              | 3.08±0.003                  |
| Close                 | 1     | 34±0.0                 | 2.0±0.0                  | 6947±0.0       | 4.43±0.0                | 3.16±0.0                    |
| Herd average          | 52    | 25.4±0.6               | 4.4±0.3                  | 6559±192.7     | 3.96±0.004              | 3.06±0.003                  |
| Blood type from 91 to 97%|      |                        |                          |                |                         |                             |
| Outbred               | 8     | 24.1±0.25              | 3.38±0.7                 | 6299±125.6     | 3.93±0.005              | 3.07±0.004                  |
| Remote                | 203   | 24.7±0.5               | 2.7±0.3                  | 6710±156.8     | 3.87±0.006              | 3.04±0.004                  |
| Moderate              | 20    | 24.6±0.4               | 3.8±0.3                  | 6282±143.9     | 3.84±0.004              | 3.05±0.002                  |
| Herd average          | 231   | 24.7±0.35              | 2.8±0.3                  | 6659±133.7     | 3.87±0.005              | 3.05±0.002                  |
| Blood type from 97% and more|    |                        |                          |                |                         |                             |
| Outbred               | 7     | 24.6±0.4               | 2.0±0.4                  | 6878±123.9     | 3.94±0.005              | 3.08±0.003                  |
| Remote                | 208   | 24.7±0.3               | 2.38±0.2                 | 6584±257.8     | 3.94±0.006              | 3.06±0.002                  |
| Moderate              | 29    | 24.3±0.2               | 2.62±0.3                 | 6643±276.5     | 3.94±0.006              | 3.05±0.002                  |
| Herd average          | 244   | 24.6±0.3               | 2.4±0.3                  | 6599±246.9     | 3.94±0.006              | 3.06±0.004                  |
The use of related mating led to a decrease in the age of the first calving by 0.3 months, a lactation period by 0.4, and a slight increase in milk yield by 78 kg with a decrease in the mass fraction of fat by 0.01% and protein by 0.02%, relative to outbred cows. It should be noted that outbred cows tend to have a higher content of milk fat and milk protein compared with the average herd, but their milk yield was lower by 73 kg or 1.1%.

As a result of studies, the effect of blood in Holstein cows on their productive qualities was identified. An increase in blood level to 75-91% led to an increase in milk yield and qualitative indicators of productivity. Thus, the average milk yield in the group increased by 500 kg, compared with the genotype of 75-91% blood pressure for Holstein breed, but to a decrease in quality indicators relative to cows of the above group by 0.02-0.09% for fat and 0.01-0.02% protein.

The best indicators of productivity within the genotype groups were established with a remote level of inbreeding and a genotype of Holstein breed 91-97% blood. The milk yield for lactation in this group was 6,710 kg, which is 25–126 kg more than in other groups of cows obtained by the method of remote inbreeding. In the future, when developing a breeding plan, it is necessary to take into account the fact that the best quality indicators of productivity, namely the mass fraction of fat and the mass fraction of protein are higher in milk of cows with a genotype from 76 to 91% and a moderate level of inbreeding - 3.97% and 3.08%, respectively.

A significant change in the productive longevity of cows obtained by outbred breeding and by the use of moderate inbreeding (P≤0.05) is noted.

4. Discussion
The use of related mating led to a decrease in the age of the first calving by 0.3 months, a lactation period by 0.4, and a slight increase in milk yield by 78 kg with a decrease in the mass fraction of fat by 0.01% and protein by 0.02%, relative to outbred cows. Outbred cows tend to have a higher content of milk fat and milk protein, compared with the average herd, but their milk yield was 73 kg or 1.1% lower. The duration of productive longevity is higher in outbred and inbred cows with a moderate level of inbreeding. Similar data were obtained in researches of V.S. Mymrin, O.G. Loretts [7], I.V. Tkachenko, V.F. Gridin and S.L. Gridina [10].

5. Conclusions
Thus, the level of inbreeding in a herd of Holstein black and white cattle with a high level of Holsteinization does not significantly affect the productive qualities of cows, while there is a positive tendency to increase the quality of milk in outbred cows and the duration of productive longevity when using inbreeding. The profitability of milk production and, accordingly, the work of an agricultural enterprise should be evaluated not only by the productivity of animals, namely milk yield for lactation, but also by the duration of productive longevity.
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