Assessment of the economically beneficial traits of mature cows of Holsteinized black-motley breed

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Abstract. Holstein is one of the most widespread dairy breeds in the world. In Russia, the most popular is black-motley breed, which has been improved over the past four decades through crossbreeding with the best world Holstein breed. The study aimed to investigate the productive traits of young replacement cows and cows of different years of birth of Holsteinized black-motley cattle of the Ural type. An increased intensity of rearing of young replacement animals was found to reduce the age of first fruitful insemination, to increase productivity, namely milk yield per lactation, and to reduce the length of the productive life of cows. Intensive rearing of young replacement animals has reduced the age of fruitful insemination by 5.7 months over seven years, particularly in the last 2 years, relative to the indicators observed in 2012. With age, the cow productivity changes insignificantly and remains at sufficiently high level. The study revealed that the genetic potential of the parents and intensive rearing of young replacement animals provide a steady increase in milk production of first-calf heifers. However, productivity of cows in subsequent lactations either remains stable or decreases. Productivity of cows increases in second (2013–2015) and third (2012) lactations and then starts to decline. With age, the length of the lactation service period reduces by 5.2–34.9 days, which is primarily due to synchronization of reproductive cycles with an economically viable waiting period implemented on commercial farms. Reproductive cycle synchronization has been implemented in the region since 2015, which immediately reduced the length of the cow service period.

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 improved 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]. The dynamics of economically beneficial traits of Holsteinized mature cows used in breeding farms in Sverdlovsk region is of interest to assess the selection and breeding level [21–23]. Assessment of economically beneficial traits of Holsteinized mature cows of black-motley breed is of practical relevance, especially in conditions of increased pedigree index in Holsteinized cattle and reduced productive life of cows.

The study aimed to assess economically beneficial traits of Holsteinized mature cows of black-motley breed.

2. Materials and methods
Studies were conducted in breeding reproducers in Sverdlovsk region. Replacement heifers were studied with respect to rearing periods depending on the year of birth. The traits of young replacement animals were assessed by weight gain parameters (live weight by periods and average daily weight gain), the age of first insemination and first fruitful insemination. The study analyzed productivity of cows that reached physiological maturity, which were used for 3 or more lactations. The cow productivity was estimated with regard to milk yield per lactation using the method of control milking once a month. The analysis employed data from zootechnical and breeding records, and the SELEX database.

3. Results
Commercial farms are engaged in breeding of highly productive Holsteinized black-motley cattle of the Ural type with a high pedigree index in the Holstein breed. The farms have shown sufficiently stable economic activities over the past five years. A large percentage of heifers introduced reduces the length of the productive life of cows, which on farms attains 2.1–2.4 lactations. Figure 1 shows distribution of cows by lactations.

Large percentage of young cows can be observed in lactations 1 and 2 and attains 70.1%, of which 41.9% are first-calf heifers. The percentage of mature cows is hence only 29.9%, which does not allow for evaluation of traits of descendants of cows and formation of families to ensure continuity of generations. Productive life and milk production efficiency are found to decrease.

![Figure 1. Distribution of cows by lactation number.](image)

An important trend in breeding on any farm is rearing of young replacement animals. Figure 2 shows the dynamics of development of young replacement animals by years of birth.
Analysis of data on dynamics of the live weight by year of birth shows that birth weight has changed over the years from 29.8 kg to 31.9 kg. However, the homogeneity of the breeding stock, including the live weight of the cows, made even these minor fluctuations valid at low degree of reliability ($P \leq 0.05$). Similar data were obtained for live weights of 6-, 10- and 12-month animals in the year range from 2012 to 2016. In 2017 and 2018, the live weight of replacement heifers was observed to increase compared to previous years. The intensity of rearing of young replacement animals has reduced the age of fruitful insemination by 5.7 months over seven years, especially in the last 2 years, relative to the indicators observed in 2012. It should be noted that differences were found both in the live weight at first insemination and first fruitful insemination, and in age (figures 3 and 4). In all years except 2018, these parameters increased from first insemination to first fruitful insemination. In 2018, the age of first fruitful insemination decreased by 0.5 months.

The calculation of the average daily weight gain showed that every year, starting from 2014, it insignificantly increases from 741 g to 892 g, or by 151 g (20.4%). In the period from birth to first fruitful insemination, the average daily weight gain was 8–108 g relative to the year of birth. The highest average daily gain rates were recorded for replacement heifers born in 2018.
Next, we evaluated milk production of cows depending on the birth year. The analysis of productivity and preservation of cows in the herd was performed for animals with completed three or more lactations; therefore, we did not consider the productivity of cows born in 2016 and later. It was found that with age milk production of cows varies insignificantly and remains at sufficiently high level. The studies showed that the genetic potential of the parents and the intensity of rearing young replacement animals allow steady increase in milk production of heifers, which is not found in subsequent lactations, when it either remains stable or decreases. Milk production of cows grows in lactations 2 (2013–2015) and 3 (2012), and then it starts to decline (figure 5). These changes can be due to the reduced time of first insemination and intensity of using animals.

**Figure 4.** Age of first insemination, months.

**Figure 5.** Dynamics of milk production of cows that have reached physiological maturity.
Despite rather high live weight of heifers at first fruitful insemination, they do not exhibit adequate body condition, which ultimately affects the length of the productive life. The survival rate reduces every year; thus, among animals with the completed second lactation, 78.7 percent of animals born in 2012 and only 56.4 percent born in 2014 were found to survive. A similar tendency was observed for subsequent lactations: lactation 3 – 48.4 % of survived animals born in 2012 and 36.0 % of those born in 2014; lactation 4 – 26.4 % of survived animals born in 2012 and 12.2 % of those born in 2015.

Crossbreeding of domestic dairy cattle with the Holstein breed led to a decreased reproductive performance of crossbreeds throughout the country. One of the reproductive characteristics of a cow is the length of the service period. There is still no consensus on the optimal length of the service period among scientists and practitioners. We found that the increased lactation age reduces the length of the service period (Figure 6), which is primarily due to synchronization of reproductive cycles with an economically reasonable waiting period. Sex cycle synchronization has been introduced in agricultural enterprises of the region since 2015, which immediately reduced the length of the service period for cows. The length of the service period tends to decrease with age. Depending on the year of birth and lactation number, the values vary from 29.9 to 70.4 days and from 5.2 to 34.9 days, respectively, relative to the factors. In our opinion, a significant difference in the length of the service period depending on the year of birth is associated with veterinary and preventive measures taken to increase the reproductive performance of cows. Different values of the length of the service period depending on lactation are contradictory, since they show both upward and downward trends.

Thus, it can be concluded that an increased intensity of rearing of young replacement animals reduces the age of first fruitful insemination, increases productivity, namely milk yield per lactation, and reduces the length of the productive life of cows. The reduced service period is due to synchronization of sexual cycles implemented.

4. Discussion
Analysis of the dynamics of economically beneficial traits of heifers and mature cows of Holsteinized black-motley cattle of the Ural type showed that intensive rearing of young animals has reduced the age of fruitful insemination by 5.7 months over seven years, particularly in the last 2 years, relative to the indicators observed in 2012. The milk yield per lactation 1 increases annually, which indicates a high level of breeding efficiency and improved gene pool of cows and their genetic productivity potential. The length of the service period tends to decrease with age, and with regard to the year of birth and the lactation number, it varies from 29.9 to 70.4 days and from 5.2 to 34.9 days, respectively, relative to the
factors. Similar studies conducted by V.S. Mymrin, O.G. Loretts, I.V. Tkachenko, V.F. Gridin, S.L. Gridina, S.L. Gridina, V.F. Gridin, and O.I. Leshonok showed identical results.

5. Conclusion
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.

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