The influence of reproductive functions on productivity of cows of various live weight

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Abstract. In Sverdlovsk region Holsteinized black-and-white cattle of the Ural type are used for milk production. Animals of this type feature high productivity indices, however, the breeding stock encountered decrease in the productive longevity. The first-calves showed an increase in milk yield per lactation, along with an increase in their live weight up to 624 kg. The difference in milk yield was significant in favor of cows with a live weight of 600-624 kg. in comparison with the groups of cows with a live weight below 575 kg at P≤0.05-P≤0.01. Among the cows of the third lactation the highest milk yield was obtained from the cows with the highest live weight - 625 kg and more - 10122 ± 118.59 kg. All animals feature an excess over the optimal duration of service period by 19-83 days, i.e. by 23.8-103.8%. The average duration of the lactation period for first-calves is 140 ± 4.69 days, for the full-aged cows - 149 ± 3.98 days. The coefficient of reproductive capacity is 0.85 on average. The positive relationship between milk yield per lactation period and the duration of the service period is confirmed. No general pattern for correlation of live weight and duration of service period.

1. Introduction
Milk provides people with full-fledged essential nutrients and is well digested by human body. The increase in cow productivity is inseparably linked to the improvement of milk quality, which has a significant impact on the quality of finished dairy products [8-16]. In recent years to produce milk in our country the dairy cattle of domestic and foreign selection is used; the core livestock of the cattle is represented by black-and-white and Holstein breeds. Since the end of the 70s of the last century the domestic black-and-white cattle has been systematically improved everywhere by admixing the blood (genetic material) of the world’s best dairy breed – the Holstein. In result of such selection and breeding work in individual regions of the country large groups of dairy cattle were created with a high proportion of Holstein breed blood, which features biological and economically useful parameters depending on the breeding zone and breed resources used for cross-breeding [12-16]. In Sverdlovsk region Holstein purebred bulls with high productive qualities according to their maternal ancestors were used to
inseminate the breeding stock of the black-and-white cows of the Ural offspring breed. In 2002 a new Ural type of black-and-white breed was officially registered. The animals of this type are large-bodied and feature high productivity indices [17-27]. When breeding them, dairy farming practices encountered the problem of decreasing of the reproductive functions among the breeding stock. Assessment of the correlation of the productive qualities of cows with their reproduction rates depending on an animal’s age is relevant and has practical importance.

The aim of the research to study the correlation of productive and reproductive qualities depending on the age of cows.

2. Materials and method
The research was implemented in one of the breeding farms-multipliers for breeding black-and-white cattle of the Ural type. The cows of the first and third lactation were divided into groups according to their live weight: less than 550 kg, 550-574 kg, 575-599 kg, 600-624 kg and more than 625 kg. Data and records of zootechnical and breeding information from Seleks database were used for analysis. Milk productivity was taken into account by control milking once a month, as well as by milk quality parameters: mass fraction of fat (MFF) and mass fraction of protein (MFP) in milk. These parameters per every cow were checked monthly in a dairy laboratory of OJSC “Uralplemcenter” of Sverdlovsk region. The correlation coefficients of milk yield for 305 days for lactations were calculated to study the problem of decreasing of the reproductive functions among the breeding stock. The correlation of the productive qualities of cows with their reproduction rates depending on an animal’s age is relevant and has practical importance.

The animals at P≤0.05 in comparison with the cows with a lower weight.

3. Results
During selection and breeding work with a herd, in order to increase its efficiency, the use of selection characteristics in selection and their relationship with each other is important. The farm has the herd of Holstenized black-and-white cattle of the Ural type with a high genetic potential for milk productivity. In 2019 on average 8.215 kg of milk was received from each of 1.100 cows, MFF and MFP in milk was equal to 4.25 and 3.07%, respectively.

The milk productivity of first-calves and cows increases together with an increase in live weight (table 1).

| Live weight, kg | 1st lactation | 2nd lactation |
|----------------|--------------|--------------|
|                | Milk yield, kg | MFF, % | MFP, % | Milk yield, kg | MFF, % | MFP, % |
| Up to 550      | 8017±1073.17  | 4.19±0.159 | 3.09±0.021 | 7680±329.02  | 4.11±0.053 | 3.14±0.025 |
| 550-574        | 8542±259.65   | 4.22±0.068 | 3.10±0.017 | 9309±397.44  | 4.18±0.050 | 3.13±0.022 |
| 575-599        | 9273±137.70   | 4.12±0.036 | 3.09±0.008 | 9429±199.30  | 4.05±0.026 | 3.10±0.008 |
| 600-624        | 9426±93.01    | 4.13±0.025 | 3.10±0.008 | 9669±136.92  | 4.04±0.017 | 3.09±0.009 |
| More than 625  | 9207±257.73   | 4.38±0.062 | 3.06±0.024 | 10122±118.59 | 4.06±0.022 | 3.08±0.007 |

From the data shown in the table above it is obvious that the first-calves showed increase in milk yield per lactation period along with increase in their live weight up to 624 kg. The difference in milk yield was significant in favor of cows with a live weight of 600-624 kg in comparison with the groups of cows with a live weight below 575 kg at P≤0.05-P≤0.01. With its increase to 625 kg and more the slight decrease in the milk yield was observed among the first-calves, but the difference was insignificant. Among the cows of the third lactation the highest milk yield was obtained from the cows with the highest live weight - 625 kg and more - 10122 ± 118.59 kg. The difference is significant in favor of these animals at P≤0.05-P≤0.01 in comparison with the cows with a lower weight.
Regular changes in the quality indices of milk were reliably established. With increasing milk yield the MFF in milk decreased. Since changes in milk yield were accompanied by increase in live weight of both first-calves and cows, it is possible to talk about the dependence of the absolute values of MFF and MFP in milk on live weight and lactation. The first-calves had higher MFF content in milk, while the full-aged cows had a higher MFP content in their milk. The highest value for mass fraction of fat in milk (MFF) was found in the milk of the first-calves with a live weight of 625 kg or more. This was most likely due to the individual peculiarities of the cows that happened to be included into this group. They also had the lowest values for the mass fraction of protein in their milk.

The milk productivity of cows is related to their reproductive functions, since the physiology of milk production and milk discharge begins after calving. One of the parameter of the cows’ reproductive functions is the service period - the period from calving to fertile mating. The duration of the service period with good reproductive qualities should not exceed 80 days. The first-calves and the full-aged cows in our studies showed long service period (figure 1).

![Figure 1. The duration of the service period for the first-calves and the cows, days.](image)

The diagram above clearly shows that all animals showed excess of optimal duration of the service period by 19-83 days, or by 23.8-103.8%. The average values for the first-calves are equal to 140 ± 4.69 days, for the full-aged cows – 149 ± 3.98 days.

The coefficient of reproductive capacity (CRC) in the first-calves and the full-aged cows turned out to be less than 1, which indicates tension and problems with reproduction function in the breeding stock (figure 2).
The coefficient of reproductive capacity varies from 0.95 (1 lactation, live weight 550-574 kg) to 0.81 (1 lactation, live weight 625 kg and more and 3 lactation, live weight 550-574 kg). CRC decrease below 0.95 indicates the presence of significant problems with reproductive functions in the brood herd, which reduces the profitability of milk production and shortens the period of productive use of the cows.

It is considered that the duration of the service period affects the productivity of cows, in particular: milk yield per lactation. Calculation of coefficients of the correlation between these features showed the data below (figure 3).

Our research confirms a positive relationship between milk yield per lactation and the duration of the service period. In first-calves it varies from high positive to low negative in animals weighing 550-574 and 625 kg or more. In the all groups of full-aged cows this value is medium and low positive. This allows us to say that the elongation of the service period is accompanied by increase in milk yield per lactation.

As a result of this research, a positive tendency of increasing milk yield in dependence from the live weight of the breeding stock was established; therefore the correlation between the live weight and the duration of the service period in first-calves and full-aged cows is of practical interest (figure 4).
Figure 4. Coefficients of correlation between the live weight and the duration of the service period.

No general pattern of correlation between live weight and the duration of the service period has been established. The coefficients of correlation had both medium positive value (0.22, body weight below 550 kg, 3 lactation) and medium negative value (-0.53, body weight 550-574 kg, 1 lactation). In other groups these coefficients values were not defined at all, or were very low (both positive and negative). Thus, the live weight of first-calves and cows does not affect the duration of the service period and related milk yield per lactation.

4. Discussion
The correlation of economically useful traits among themselves is important during breeding activities in the farm in order to increase the breeding value of cows. The results of the research have confirmed the correlation between the duration of service period and milk yield per lactation. Reproduction problems are observed in the breeding stock herd, as proved by low fertility rate. The similar researches were conducted by N. V. Bogolyubova, V. P. Korotky, A. S. Zenkin, V. A. Ryzhov, N. P. Buryakov [23, 24], Mymin V. and Lorett O. [21], O. V. Gorelik, O. E. Lihodeevskaya, N. N. Zezin, M. Ya. Sevostyanov and O. I. Leshonok [25-26].

5. Conclusion
The increase in live weight of heifers and cows leads to absolute increase in milk yield. Milk yield of full-aged cows, starting from a live weight of 550 kg, exceeds the milk yield of the first-calves. There is a positive correlation between increase in milk yield and the duration of the service period. The problems with reproduction of the breeding stock were revealed.

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