The effect of age on milk productivity and reproductive qualities of dairy cows

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Abstract. The article presents data on the age dynamics of changes in the level of dairy productivity of cows. As a result of the research, the increase in milk yield and the increase amount of milk fat and protein with age of animals was established. The age dependence of qualitative indicators of milk production wasn’t revealed. It was noted that the level of milk productivity of cows in all age periods was higher than the requirements of the first class standard of black-motley breed. An average positive correlation was found between age and milk yield. It was revealed that the productivity of cows is largely determined by their linear affiliation. When analyzing the age-related changes in the reproductive capacity of cows was revealed that the duration of the service period decreases with the age of the animals. When analyzing the age-related changes in the reproductive capacity of cows was revealed that the duration of the service-period decreases with the age of the animals. The duration period between the calves of the average for the cows was optimal, while its reduction with age was observed. It’s noted that as the age of cows increases, the number of inseminations for fertilization increases.

1. Introduction
It is known that milk productivity can be increased by the growth of cattle stock and milk cow productivity. To increase milk productivity and improve its quality a well-timed and constant development of cattle stock is needed. To achieve this goal, it is necessary to use a complex of indexes for cattle estimation. This estimation allows determining the most productive cows for further breeding and productive use. But it is impossible to select milk cattle without taking into account factors influencing the quality and quantity of the product. According to some data [1–7], the level of milk productivity and qualitative milk content depend on the following factors: some cattle breed, feeding and animal welfare, age, reproductive qualities, cows’ individual features, their health condition and milking management. According to some authors [8, 9], milk yield dependent on the age of cows may be different. It is possible to manage the character of age related productivity.

The cows’ reproductive function is formed under the influence of the environmental factors and depends on the genotype. The following factors influence it: the age of physiological ripeness, impregnation capacity, length of physiological periods, age, etc. Reproductive capacity of cows together with their milk productivity determines the efficiency of their use [9–11].
2. Experimental research
In view of these facts, the objective of the research is to study the correlation between the age and milk productivity of cows. The research has been done in the Productive Cooperative of Kolkhoz Iskra, Kuzhener region of the Republic of Mari El.

To achieve this goal, the following tasks were solved:

- to analyse the age structure of the dairy herd;
- to study the dependence of age on the productivity of cows;
- to consider the age-related dynamics of the yield depending on their linear belonging;
- to analyse age-related changes of the cows’ reproductive qualities.

3. Results and considerations
The dairy herd of the Productive Cooperative of Kolkhoz Iskra includes 600 animals – it is young; the cows’ average age during three years, in 2014-2016 did not change, with calving records 2.2. According to the research, the largest proportion – 52.4 % of the total number of cows belongs to first-calf cows. There are cows in the herd having 7 and more lactations – 0.3 % or 2 heads of livestock. 15.5 % – the cows of the second lactation, 11.5 – the third, 9.7 – the fourth, 4.9 – the fifth, 5.8 % – the sixth ones (figure 1).

Such a quick rotation of the livestock will allow to some extent increasing the indexes of the herd’s productivity but it will be impossible to compensate all the expenses invested in its growth. According to this, the task of the research was to study the influence of the age on the productivity of cows.

The dairy herd of the Productive Cooperative of Kolkhoz Iskra is characterized by the following indexes of dairy productivity: dairy abundance – 4351 kg, weight percentage of fat content – 3.77 %, proteins – 3.22 %, butterfat – 163.2 kg, proteins – 139.8 kg. All the indexes characterizing the herd’s dairy productivity correspond to the requirements of the first class standard of the black-and white breed and in the majority of cases exceed them.

According to the authors [9, 10], dairy productivity is growing together with the animal age, then stabilizes at a maximum level and is decreasing with aging. As our research shows, milk yields were growing together with the animal age and reached their maximum – 5973 kg at the age of the sixth lactation. The yield’s growth at that period equaled 58 %.
The productivity during the sixth lactation was statistically higher – the difference between the first and the sixth lactation was 2183 kg (P<0.001) (table 1).

The dependence of changes in weight percentage of fat content on the age has not been observed. This index was changing from 3.73 % (at the age of the 3-4, 6 lactations) to 3.81 % (at the age of the 7 lactation and higher).

Table 1 Milk productivity of cows according to their age.

| Indexes                          | M   | m  | Cv.% |
|----------------------------------|-----|----|------|
| The 1st lactation (n=314)        |     |    |      |
| 305 lactation days, kg           | 3760| 124.3| 14.4 |
| The fat mass fraction            | 3.78| 0.02| 2.7  |
| Fat content in milk, kg          | 141.9| 4.9 | 15.2 |
| The protein mass fraction        | 3.23| 0.01| 2    |
| Milk proteins, kg                | 121.4| 4.2 | 15.2 |
| The 2nd lactation (n=93)         |     |    |      |
| 305 lactation days, kg           | 3785| 83.5| 8.8  |
| The fat mass fraction            | 3.78| 0.02| 2    |
| Fat content in milk, kg          | 143.1| 3.1 | 8.6  |
| The protein mass fraction        | 3.24| 0.03| 3.7  |
| Milk proteins, kg                | 122.8| 2.2 | 7.2  |
| The 3rd lactation (n=69)         |     |    |      |
| 305 lactation days, kg           | 4254| 141.5| 18.5 |
| The fat mass fraction            | 3.73| 0.02| 2.7  |
| Fat content in milk, kg          | 159| 5.3 | 18.4 |
| The protein mass fraction        | 3.18| 0.02| 2.7  |
| Milk proteins, kg                | 135.3| 4.8 | 19.7 |
| The 4th lactation (n=58)         |     |    |      |
| 305 lactation days, kg           | 4568| 126.4| 19   |
| The fat mass fraction            | 3.73| 0.01| 2.6  |
| Fat content in milk, kg          | 168.4| 4.8 | 19.4 |
| The protein mass fraction        | 3.24| 0.02| 4.4  |
| Milk proteins, kg                | 147.7| 4.1 | 18.8 |
| The 5th lactation (n=29)         |     |    |      |
| 305 lactation days, kg           | 4575| 149.6| 19.1 |
| The fat mass fraction            | 3.76| 0.02| 3.1  |
| Fat content in milk, kg          | 172.2| 5.8 | 19.6 |
| The protein mass fraction        | 3.2| 0.01| 2.4  |
| Milk proteins, kg                | 146.6| 4.9 | 19.7 |
| The 6th lactation (n=35)         |     |    |      |
| 305 lactation days, kg           | 5943| 357.6| 15.9 |
| The fat mass fraction            | 3.73| 0.03| 2    |
| Fat content in milk, kg          | 221| 13.2| 15.8 |
| The protein mass fraction        | 3.17| 0.04| 2.9  |
| Milk proteins, kg                | 188.5| 11.9| 16.7 |
| The 7th lactation (n=2)          |     |    |      |
| 305 lactation days, kg           | 3469| 125.5| 5.1  |
| The fat mass fraction            | 3.81| 0.02| 0.7  |
| Fat content in milk, kg          | 131.9| 4.2 | 4.5  |
| The protein mass fraction        | 3.42| 0.1 | 4    |
| Milk proteins, kg                | 118.2| 1   | 1.2  |
All this influenced such index as fat content. Fat content in milk as well as milk yields were growing together with the age of cows up to the 6 lactation when it reached its maximum meaning of 221 kg. In addition, it should be mentioned that the difference in this index between the cows of the 6 lactation and the animals of the other groups was valid and amounted respectively in the cows at the age of 1, 2, 3, 4, 5 and 7 lactations: 79.1 kg (P≤0.001), 77.9 kg (P≤0.001), 62 kg (P≤0.001), 52.6 kg (P≤0.001), 48.8 kg (P≤0.001) and 89.1 kg (P≤0.001).

The second qualitative index of milk – weight percentage of proteins with the maximum level of 3.42 % belonged to the cows of higher ages (7 lactations and older). The dependence of the age on the weight percentage of proteins in milk has not been observed, index of correlation is negligibly small (r=0.01).

The amount of milk proteins as well as the amount of fat trended upward together with the age of cows to the 7 lactation and higher. This index increased from the 1 to the 6 lactation in 67.1 kg (P≤0.001). As a result, the average positive dependence between the age of the cows and the amount of proteins has been observed. The index of correlation amounts to 0.32.

The variability of the majority of indexes under research was changing over wide range. The yield index of variation was changing from 5.1 % to 19.1 %, the amount of fat in milk – from 4.5 % to 19.6 %, proteins – from 1.2 % to 19.7 %. Variability of weight percentage of fat content in accordance with the age was changing from 0.7 % to 2.7 %; proteins – from 2 % to 4.4 %.

It should be mentioned that all the indexes of milk productivity in all age periods, excluding the cows of the 7 lactation and older, exceeded the requirements of the first class standard of the black-and white breed. Thus, the yield in the first lactation exceeded the requirements of the first class standard by 510 kg, weight percentage of fat content – by 0.18 %, fat content – by 24.9 %; productivity of animals in the 2 lactation was higher than the requirements of the standard by 185 kg, 0.18 %, 13.5 kg correspondingly.

Full-grown cows (3-6 lactations) had the yield by 254-1943 kg higher than the requirements of the standard, fat content in milk higher by 0.13-0.18 %, the amount of milk fat – by 15-77 kg higher.

During the analysis of the dependence of the age of cows and their productivity it has been observed that their productivity in the herd in a greater degree is determined by their linear belonging (figure 2).

![Figure 2. Age dynamics of milk yields depending on the cows’ linear belonging.](image)

The research results show that common biological regularities in changes of milk productivity although exist in both groups but have differences in age. Thus, the peak of milk productivity in both
groups is observed in the 6 lactation. But in Vis Back Ideal 1013415 group the yield is growing gradually, from lactation to lactation, but in the Reflection Sovereign 198998 the yield is growing up to the 3 lactation, then to the 4 one the productivity is going down followed by the increase in productivity together with the age.

Analysing the age changes of the cows’ reproductive qualities in the Productive Cooperative of Kolkhoz Iskra it was discovered that the length of the service period is going down together with the age of animals. Thus, the longest service period – 95.2 days was registered in the cows of the 2 lactation, in first-calf cows – 92.6 days, in other age periods its length was going down by 2-6 days from lactation to lactation. In addition, the length of the service periods of young cows was higher than optimal meanings (60-80 days) (table 2).

Table 2. Reproductive qualities of cows depending on their age.

| Age in lactations | n   | Service period, days M±m | Calving interval, days M±m | Conception rate M±m | Cv, % |
|-------------------|-----|--------------------------|--------------------------|---------------------|-------|
| 1                 | 314 | 92.6±9.6 | 372.0±9.2 | 10.8 | 1.11±0.04 | 17.0 |
| 2                 | 93  | 95.2±11.8 | 376.9±10.8 | 11.1 | 2.00±0.19 | 33.9 |
| 3                 | 69  | 89.5±4.5 | 371.2±4.2 | 6.3  | 1.77±0.11 | 33.8 |
| 4                 | 58  | 84.5±5.5 | 358.0±3.6 | 6.8  | 1.77±0.10 | 40.6 |
| 5                 | 29  | 78.4±3.8 | 355.4±3.7 | 6.1  | 1.77±0.12 | 39.9 |
| 6                 | 35  | 76.1±5.3 | 357.4±5.2 | 4.4  | 2.00±0.07 | 11.1 |
| 7 and higher      | 2   | 74.0±2.3 | 357.0±19.7 | 7.8  | 2.00±0.00 | 7.8  |
| Herd average      | 600 | 85.7±2.6 | 364±2.2  | 7.4  | 1.7±39.4 | 39.4 |

The research has observed a small negative connection between the age of the animals and the length of the service period (r= - 0.1).

Calving interval as an integrated index of reproduction is determined by the service period length and pregnancy length. An optimal calving period must not be longer than 365 days. The rising of this index is biologically unreasonable and economically unprofitable. It is connected with the fact that during a year it is recommended to have one calf per one cow to make the milk production in the cooperative profitable. According to the research, the calving interval in the Productive Cooperative of Kolkhoz Iskra was optimal and amounted to 364 days. The calving interval was shortening together with the age. It has been found that young cows at the age of the 1-2 lactations had the longest calving interval: 372 and 376.9 days correspondingly. In further age periods the shortening of calving interval to 355.4 days in the cows of the 5 lactation has been observed. The difference between the calving interval 372 and 376.9 days was changing over wide range. Thus, the service period variability index changed from 20.9 % to 48 % and of the calving interval – from 4.4 % to 11.1 %.
4. Summary
In conclusion, the research of the correlation between reproductive functions and the age of cows indicated that their productivity is growing together with their age, and their linear belonging influences their productivity in different age periods. It has also been observed that indexes characterizing reproductive qualities of cows have age differences.

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