Index of economic and useful characteristics of red-and-white cattle breed depending on the breed of the used breeding bulls

N G Ryzhova, I M Volohov and A G Anashkin
All Russian research institute of animal breeding, Lesnye Poliany, Pushkin district, Moscow region, 141212, Russia

E-mail: natagemplem@yandex.ru

Abstract. The article deals with influence of pedigree of breeding bulls on indexes of economic and useful signs of red-and-white cattle breed. The degree of realization of the genetic potential for milk productivity in the descendants of red-and-white cattle breed bulls is almost 20% higher than in cows obtained from Holstein producers, with minimal differences in the indicators of average productivity of heifers. The duration of economic use of cows and the yield of milk for 1 day of life is significantly higher than that of cows obtained from Holstein bulls. In the total variance of traits, the breed of the breeding bulls affects the indicators of milk productivity by no more than 6.3%, and the reproduction quality by no more than 4.2%.

1. Introduction
The red-and-white cattle breed in Russia takes the fourth place after the Holstein, Kholmogorsky and Simmental breeds, the second in productivity among domestic breeds of dairy productivity (the fifth among all dairy breeds bred in the Russian Federation) [1] and this breed is one of the most dynamically developing breeds in Russia [2-5].

Currently, animal breeding programs are based on the provisions of population genetics, which is connected with selection and genetic parameters of productivity. Genetic parameters of selection are mathematically based selection indicators that determine and specify the genetic value of animal selection and the characteristics for which it is conducted. The genetic parameters of animal breeding include: variability, heritability, repeatability, correlation of traits, and etc.

The study of variability and heritability, the main economic and useful features and their relationship to a particular herd or breed allows you to choose such methods of selection and selection that will increase the productivity of animals with each generation. That is why out case is to determine the selection and genetic parameters of economically useful traits of red-and-white cattle breed animals in order to improve their breeding and productive qualities, as well as to determine the impact on them of the breed belonging to breeding bulls.

2. Materials for the study and methods of research
The selection and genetic parameters of the main economic and useful traits were calculated based on the “SELEX” database for red-and-white cattle breed in 52 farms of the Russian Federation. Indicators of milk productivity of reproductive qualities in retired cows were studied as economic and useful features. The level of genetic potential was determined taking into consideration the productivity...
indicators of female ancestors. The index of the breeding bull (IB) was calculated using Kravchenko’s [6] formula of (1):

\[ IB = \frac{2M + MM + MB}{4} \tag{1} \]

The formula identifies M as a productivity of a cow that calved a breeding bull, MM – a productivity of a cow that calved a cow that calved a breeding bull, MB – a productivity of a cow that calved an adult bull, which bred a breeding bull.

The expected genetic potential (GP) of a cow was calculated using the formula (2):

\[ GP = \frac{IB + M}{2} \tag{2} \]

The formula identifies IB is the bull’s index for the corresponding indicator, M – maximum productivity of an adult cow.

The degree of realization of the genetic potential (RGP) was determined by the formula (3):

\[ RGP = \frac{\text{actual productivity}}{\text{expected productivity}} \times 100\% \tag{3} \]

The results of experimental studies were processed in the Microsoft Excel 2017 editor. The reliability of derived results was determined by Student-Fischer test, and the influence of factors on the studied characteristics was determined using a variance analysis.

3. Research result

The program for breeding red-and-white cattle breed [7] allows the use of the Holstein breed gene pool as an improving breed, and in some farms, reverse crossing with Simmental bulls was used to improve the individual qualities of cattle.

The analysis of the database “SELEX” represents the statistics that over the last 10 years the population of the studied animals were used 916 bulls- as a percentage of the heifers of these bulls – 51.4% of heifers of Holstein bulls, 36.1% – heifers red-and-white breed cattle bulls, and 12.5% of the heifers of Simmental bulls. The highest productivity was shown by cows obtained from Holstein bulls-5773 kg of milk for 305 days of lactation, which is significantly 378 kg more than the descendants of Simmental bulls.

Table 1. Average milk productivity of red-and-white breed cattle cows depending on the male bovine animal (M ± m).

| Index                                      | 1-Holstein breed (n=11921) | 2-Red-and-white breed (n=8373) | 3-Simmental breed (n=2905) | 4-In average (n=23199) |
|--------------------------------------------|-----------------------------|--------------------------------|---------------------------|------------------------|
| Milk yield for 305 days of lactation, kg   | 5773±11.2±3.4***            | 5395±11.5±3.3***                | 4909±17                   | 5528±8.2±3.3***        |
| Fat content in milk, %                    | 3.93±0.02±2.4***            | 3.87±0.02                      | 3.97±0.04±1.4***          | 3.91±0.01±2.0***       |
| Protein content in milk, %                | 3.14±0.01±2.3***            | 3.11±0.01±2.3***               | 3.05±0.02                | 3.12±0.01±2.0***       |
| Amount of milk fat, kg                    | 227±0.5±2.3***              | 208±0.4±2.3***                 | 195±0.7                  | 216±0.3±2.3***         |
| Amount of milk protein, kg                | 182±0.4±2.3***              | 168±0.4±2.3***                 | 150±0.5                  | 173±0.3±2.3***         |
| Duration of use, lactation                | 2.7±0.02                    | 3.3±0.02±2.3***                | 4.0±0.04±1.4***          | 3.1±0.01±2.3***        |
| Maximum milk yield, kg                    | 640±14.1±2.4***             | 612±14.5±3.3***                | 574±20                   | 622±9.4±3.3***         |
| Milk yield for 1 day of life, kg          | 7.1±0.03                    | 7.2±0.03±2.2                   | 7.1±0.04                 | 7.1±0.02               |

Here and further: * – P<0.05; ** – P<0.01; *** – P<0.001.

However, the milk yield for 1 day of life was higher by cows received from red-and-white cattle breed bulls, and the duration of economic use of cows received from Holstein producers was
significantly lower than from red-and-white cattle breed and Simmental adult bulls (by 0.6-1.3 lactations). Despite the higher genetic potential for milk productivity of cows obtained from Holstein producers, they did not realize their potential as well – the degree of its realization was only 83.2%, while the genetic potential for milk production was fully realized in cows descended from other bulls (102-106%) (table 2).

Table 2. Degree of realization of the genetic potential of red-and-white cattle breed cows by milk yield depending on the male bovine animal breed (M±m).

| Index                                      | 1-Holstein breed (n=11589) | 2-Red-and-white breed (n=8277) | 3-Simmental breed (n=2874) | 4-In average (n=22749) |
|--------------------------------------------|----------------------------|---------------------------------|---------------------------|------------------------|
| Adult bull's index of milk yield, kg       | 11181±18                   | 8325±15                         | 8622±31                   | 981±15                 |
|                                           | 1.2,3,4***                 |                                 | 2.2**                     | 4.2,3***               |
| Maximum milk yield of cow, kg              | 6189±15                    | 5746±15                         | 5616±31                   | 5976±11                |
|                                           | 1.2,3,4***                 | 2.3***                         |                           | 4.2,3***               |
| Expected milk yield, kg                    | 8124±17                    | 6397±17                         | 6004±36                   | 7235±13                |
|                                           | 1.2,3,4***                 | 2.3***                         |                           | 4.2,4***               |
| Actual milk yield, kg                      | 6404±14                    | 6127±14                         | 5743±20                   | 6221±9                 |
|                                           | 1.2,3,4***                 | 2.3***                         |                           | 4.2,3***               |
| The degree of implementation of productivity, % | 83.2±0.26                 | 102.2±0.40                      | 106.6±0.74                | 93.0±0.23              |
|                                           | 2.1,3,4***                 | 3.1,2,4***                     |                           | 4.1***                 |

The highest percentage of fat content was in the milk of cows, descendants of Simmental bulls (3.97%***), although the genetic potential for fat content in the milk of female ancestors, Simmental producers (4.12%) were much inferior to Holstein bulls (4.35%). However, the degree of genetic potential realization in Simmental bull flows was higher (99.5%*** than in Holstein bulls (95.2%***). But the percentage of protein in milk was higher in the descendants of Holstein producers (3.14%), although the genetic potential of protein-milk production Simmental bulls (3.97%) were better than Holstein bulls (3.51%).

The descendants of Simmental bulls performed worse than the descendants of other breeds in realizing their genetic potential (82.1%), while the cows obtained from Holstein bulls showed significantly higher results (93.8%).

Only cows obtained from red-and-white breed cattle bulls had a significant positive correlation of milk yield for 305 days of lactation and the duration of economic use (+0.14***), while the descendants of other bulls had a negative relationship (-0.04 P≤0.05...0.001). The correlation coefficient of maximum milk yield and duration of economic use is almost 2 times higher in cows obtained from red-and-white cattle breed bulls (+0.45*** than from other adult bull (+0.26***...+0.9***). In all cows, regardless of the origin of the adult bull, with increasing age of economic use, the average content of fat and protein in milk decreased - these indicators are especially interrelated in Simmental descendants for fat (-0.29**), while for protein, the relationship was weak (-0.01...0.12***).

Indexes of reproductive qualities of cows, depending on the adult bull’s breed also changed significantly. Cows which were born from Holstein producers were the first to be inseminated (19.2 months), which is significantly 1.7 months earlier (P≤0.001) than animals from red-and-white cattle breed and 2.2 months earlier (P≤0.001) than descendants of Simmental bulls. The difference in the length of the service period and the calving interval was insignificant between the groups – 10-13 days but these indicators were better in Simmental descendants and worse in Holstein. The descendants of the studied breeds did not differ in the duration of the dry period (table 3).
bulls of their own red white cattle breed bulls is 0.6 lactation higher, and the milk yield for 1 day of life is significantly 100 g. average productivity of heifers. Moreover, the duration of this stage of development of the breed is not always justified, because the degree of realization of the genetic potential in breeding red and white cattle breed bulls, while in the descendants of Simmentals, the correlation of these indicators was the value for fat +0.20*** and -0.17*** for protein. An increase in the duration of the service period in cows of all groups leads to a decrease in milk yield for 1 day of life and a decrease in the duration of economic use (-0.18...-0.25***).

The variance analysis showed that in the total variance of traits, the breed of the father’s cows affects the indicators of milk productivity by no more than 6.3***, and the reproductive quality by no more than 4.2%***.

4. Conclusions
The research has represented that the use of Holstein potential in breeding red-and-white cattle breed at this stage of development of the breed is not always justified, because the degree of realization of the genetic potential for milk productivity in descendants of red-and-white cattle breed bulls is almost 20% higher than in cows obtained from Holstein breeding bull, with minimal differences in the indicators of average productivity of heifers. Moreover, the duration of economic use of cows obtained from red-and-white cattle breed bulls is 0.6 lactation higher, and the milk yield for 1 day of life is significantly 100 g. higher than that of cows obtained from Holstein bulls. Therefore, it is necessary to increase the number of their own red-and-white cattle breed bulls, rather than continue to import and use Holstein breeding bulls.

References
[1] Dunin I M et al. 2018 Yearbook on Breeding Work in Dairy Cattle Breeding in the Farms of the Russian Federation (Lesnye Poliyan, Moscow region: FGBNU VNIIplem)
[2] Dunin I M et al. 2019 Genefund of dairy cattle breeds of domestic selection: preservation and use perspectives 5 1
[3] Dunin I M, Adjibecov K K and Lozovaya G S 2011 Perspectives of breeding the Red and White breed cattle in the Russian Federation Zootekhniya 12 2-4
[4] Dunin I M, Balcanov A I and Rhyzhova N G 2010 Red-and-White Cattle Breed of Dairy Cattle in Russia (Lesnye Poliyan, Moscow region: FGBNU VNIIplem)
[5] Dunin I M, Adjibecov K K and Prochorenko D G 2003 The Way of Improvement Red-particoloured Cattle Zootekhniya 4 2-4
[6] Kravchenko N A and Vinnichuk D T 1965 Prepotency and methods of its measurement (Kiev: Urozhaj)
[7] Dunin I M et al. 2012 Program of selection of red-and-white breeds of dairy cattle for 2012-2020 (Lesnye Poliyan, Moscow region: FGBNU VNIIplem)