Assessment of the use of genetic resources of the black-and-white breed in dairy cattle breeding in the Novgorod region

E G Emelyanov and S L Botvinova
Yaroslav-the-Wise Novgorod State University, 41, ul. B. St. Petersburgskaya, Veliky Novgorod, Russian Federation
E-mail: evemelyanov@yandex.ru

Abstract. The article gives an assessment of the quality of sires used to increase the genetic resources of black-and-white cattle raised on the farms of the Novgorod region.

1. Introduction
Over the past few decades, significant changes have taken place in the world dairy farming [1, 2]. Dairy productivity of cows in developed countries has doubled. The recognized leader is Israel’s dairy cattle. In this Middle Eastern country, the average milk yield per cow exceeds 12000 kg of milk. [3] In the USA, one of the leading countries of the world, the milk yield of dairy cows is approaching 9500 kg. The increase in the genetic potential of herds in these countries was achieved through the use of the seed of outstanding sires, which represent the elite of the world gene pool, as well as the development of computer programs for the selection of these improvement bulls to the corresponding breed stock.

Consequently, when creating the genetic potential of cattle productivity, the most important is the use of bulls that have the appropriate hereditary properties to improve the quality of the offspring. This is confirmed by studies of a number of scientists [4, 5] who found that individual selection of mothers of bulls, fathers of bulls and fathers of cows provides 76-95% of the entire selection efficiency. Accordingly, the genetic changes that can be achieved through breeding are almost entirely determined by the selected sires. Therefore, the main genetic reserves for the further improvement of dairy cattle are sires, obtained from the best representatives of the breed gene pool. Only careful selection and assessment of sires according to their ability to transfer desirable economically useful traits will provide positive dynamics of selection and breeding work [6]. In this regard, it is necessary to assess the potential of sires, taking into account their selection and genetic characteristics, age, keeping, feeding, operating conditions, longevity, preservation of reproductive health, improvement of the quality of sperm production, index and widespread nowadays genomic selection, which is reflected in numerous Russian and international research works [7, 8, 9, 10, 11].

Therefore, a whole system of measures for breeding work has been developed and is being implemented in Russia, a number of pilot projects have been launched to create a dairy cattle breeding base. As a result, the problem of the genetic progress of the productive properties in dairy cattle populations is successfully solved in a number of regions [12], where worthy results have been achieved in the best herds. Thus, for example, in the Leningrad region, the “Rabititsy” and “Gomontovo” breeding enterprises stand out among the leaders in the black-and-white breed, there over 13000 kg of milk from a cow were obtained in 2018.
However, the genetic potential of sires formed by breeders in farms of other regions is used by 40-50%, at best. One of these regions is the Novgorod region, its dairy cattle breeding is the subject of this research.

2. Materials and methods
The research purpose was to analyze the efficiency of using the genetic potential of sires in the region’s farms engaged in breeding black-and-white dairy cattle.

The studies were carried out in the period from 2017 to 2019. The data on 15 sires of black-and-white and Holstein breeds, the categories assigned to them, indicators of milk productivity of their mothers and mothers of fathers were studied, the data of primary zootechnic and breed registration, grading of livestock for the study period were studied. The research results were processed on a computer using generally accepted methods.

3. Research results and discussion
Over the past three years, from 2017 to 2019, the dairy farms of the Novgorod region have used sperm products of 15 sires of black-and-white and 16 sires of Holstein breeds (tables 1, 2) according to the linear-group selection system, in which representatives of one line work in a particular herd no more than two years, avoiding spontaneous inbreeding.

Estimating the genetic potential of sires according to the productivity of their maternal ancestors, we understand that these estimations are not accurate enough, since the level of influence of bulls is better determined by the quality of the offspring and with the methods mentioned in the introduction, but historically it is accepted that the preliminary characteristics of sires are given according to their mothers’ characteristics.

Analysis of table 1 showed that the genetic potential of sires of the black-and-white breed is diverse and rather high. The average milk yield of mothers of black-and-white bulls varied in the range of 8809 – 12060 kg of milk for 305 days of lactation, the average content of mass fraction of fat in milk, expressed as a percentage, varied within 3.81 – 4.62%, and the average milk yield of mothers of fathers was within the range 8643–14914 kg with mass fraction of fat 3.69 – 5.00%. Half of the bulls were rated as milk yield improvers and five as milk mass fraction of fat improvers.

Table 1. Productive indicators of maternal ancestors of black-and-white sires bred in the Novgorod region.

| No | Name, No of Bull | Date and place of birth | Father’s category | Mother | Father’s Mother |
|----|------------------|-------------------------|-------------------|--------|-----------------|
|    |                  |                         | Milk yield, kg    | MFF, % | Milk yield, kg  | MFF, % |
| 1  | Balzam 600206    | 01.12.04 BR             | A3B3              | 10662  | 3.85            | 10269  | 4.62 |
| 2  | Bar 600282       | 24.03.07 BR             | A3B2              | 10467  | 4.62            | 12836  | 4.50 |
| 3  | Batist 600207    | 24.01.05 BR             | A3                | 10881  | 4.17            | 10269  | 4.62 |
| 4  | Bogdan 600173    | 13.08.03 BR             | A2B3              | 11187  | 4.29            | 11018  | 4.77 |
| 5  | Velikan 427      | 03.09.10 RF             | no                | 9640   | 4.07            | 10245  | 4.04 |
| 6  | Dozor 456       | 09.11.11 RF             | no                | 9612   | 3.83            | 9554   | 4.01 |
| 7  | Zimnyak 608     | 27.01.06 RF             | no                | 8809   | 4.14            | 11054  | 3.97 |
| 8  | Lenok 3019      | 21.11.08 RF             | A1                | 11054  | 3.83            | 15741  | 4.00 |
| 9  | Mylord 417      | 23.12.12 RF             | no                | 11818  | 4.25            | 13244  | 4.40 |
| 10 | Nektar 215      | 08.12.10 RF             | neutral           | 11119  | 3.93            | 10171  | 3.69 |
| 11 | Ovod 600198     | 20.06.04 BR             | A3B2              | 11218  | 4.37            | 9833   | 3.89 |
| 12 | Oliver 600239   | 03.01.06 BR             | no                | 10150  | 3.94            | 11733  | 4.23 |
| 13 | Orlenk 600140   | 20.10.01 BR             | A3B3              | 9588   | 4.25            | 9263   | 3.90 |
| 14 | Perets 31       | 01.12.11 RF             | A1                | 11236  | 3.97            | 14914  | 4.01 |
| 15 | Rebus 101476    | 04.02.07 RF             | A2                | 9757   | 4.17            | 8643   | 4.12 |
An analysis of table 2 showed that the average milk yield of mothers of Holstein sires varied from 9298 kg to 15696 kg of milk, the average content of mass fraction of fat in milk varied within 3.82 – 5.47%, and that of fathers’ mothers from 10991 kg to 18030 kg of milk yield, and within 3.20 – 5.03% by mass fraction of fat. It should be noted that about 75% of Holstein bulls are rated as milk yield improvers.

Table 2. Productive indicators of maternal ancestors of Holstein sires bred in the Novgorod region.

| No | Name, No of Bull | Line         | Date and place of birth | Father’s category | Mother | Milk yield, kg | MFF, % | Father’s Mother | Milk yield, kg | MFF, % |
|----|------------------|--------------|-------------------------|-------------------|--------|----------------|--------|-----------------|----------------|--------|
| 1  | Bayan 1104       | R.Severing   | 09.08.07 RF             | A                 |        | 11110          | 3.92   | 13957           | 3.70           |
| 2  | Grohot 959       | Vis. Ideal   | 11.05.04 RF             | A                 |        | 12019          | 3.83   | 14444           | 4.96           |
| 3  | Depp m48624144   | M. Chieftana | 19.08.05 GER            | A                 |        | 13111          | 4.17   | 15994           | 5.03           |
| 4  | Zh.Duk m11087771 | Yes.Ideal    | 26.12.10 Can            | -                 |        | 14661          | 4.40   | 13375           | 4.44           |
| 5  | Krit m107522503  | R.Severing   | 13.03.12 Can            | -                 |        | 15696          | 4.50   | 14189           | 3.20           |
| 6  | Legion m48632097 | M. Chieftana | 15.07.05 GER            | A                 |        | 10459          | 4.91   | 13455           | 3.95           |
| 7  | Linke m51269814  | R.Severing   | 03.08.07 GER            | A                 |        | 12421          | 4.66   | 18030           | 3.75           |
| 8  | Mokko m50406668  | M. Chieftana | 10.07.06 GER            | A                 |        | 12572          | 4.75   | 12367           | 3.87           |
| 9  | Slay m51248686   | M. Chieftana | 13.11.07 GER            | -                 |        | 11002          | 3.75   | 11102           | 4.29           |
| 10 | Terry m50445289  | R.Severing   | 29.03.00 GER            | A                 |        | 11917          | 4.24   | 18030           | 3.75           |
| 11 | Tron 10156       | Vis. Ideal   | 07.07.08 RF             | -                 |        | 10293          | 3.82   | 13161           | 4.35           |
| 12 | Esse m48934890   | R.Severing   | 27.07.06 GER            | A                 |        | 12148          | 4.12   | 10991           | 3.90           |
| 13 | Nils 2928        | R.Severing   | 14.12.10 HOL            | A                 |        | 10313          | 4.32   | 12976           | 3.60           |
| 14 | Marsel 8198      | R.Severing   | 25.03.13 RF             | A                 |        | 13743          | 3.94   | 13858           | 3.90           |
| 15 | Orlan 3376       | Vis. Ideal   | 27.10.05 HOL            | A                 | A2B3   | 10886          | 5.47   | 12610           | 4.25           |
| 16 | Strelets 5427    | R.Severing   | 25.02.09 HOL            | A                 |        | 9298           | 5.07   | 11669           | 4.58           |

The received data indicate a higher level of organization of breeding work with sires of the Holstein breed; consequently, a high genetic potential of bulls was obtained due to strict selection.

The indicators of milk production and productivity of dairy cattle in the farms of the Novgorod region (table 3) reflect the annual decrease in the volumes produced with a slight increase in the productivity of cows, but a significant decrease in the total number of livestock.
It should be noted that more than 37% of milk is produced in five breeding reproducers where 28% of cows are concentrated and the decline in livestock is practically stopped here. In breeding reproducers, milk yields are higher than the regional average by 1600 kg, with a higher content of mass fraction of fat and mass fraction of protein in milk. Considering the effectiveness of using the genetic potential of sires in breeding reproducers, it is worth mentioning “Peredolskoe” LLC, where in 2019 they received a yield of more than 8000 kg of milk per cow with mass fraction of fat 3.70% from 68 first-calf heifers. In “Ermolinskoe” JSC, some of the first-calf heifers milked more than 6500 kg of milk with mass fraction of fat more than 3.8%, and at “Novgorodskiy Bacon” LLC from 25 first-calf heifers they received almost 6000 kg of milk with mass fraction of fat 3.9%.

Thus, the specialists of these farms aim at the skillful practical use of the advantages created by the breeders in the form of high-class improvement bulls that can significantly increase the genetic potential of these dairy herds.

Table 3. Milk production in the farms of the Novgorod region during the period under study.

| Indicator                  | Average in the region | Data from breeding reproducers |
|----------------------------|-----------------------|--------------------------------|
|                            | 2017  | 2018  | 2019  | 2017  | 2018  | 2019  |
| Heads of cows              | 9234  | 8886  | 7736  | 2970  | 2116  | 2161  |
| Milk yield, kg             | 4479  | 4517  | 4847  | 6015  | 6484  | 6451  |
| Mass fraction of fat, %    | 3.67  | 3.77  | 3.72  | 3.85  | 3.89  | 3.89  |
| Mass fraction of protein, %| 3.12  | 3.07  | 3.05  | 3.02  | 3.10  | 3.11  |

In 41 milk production farms of the Novgorod region, the situation is much worse. However, among the farms there are leaders, producing over 5000 kg of milk per cow per year, for example, according to the data for 2019, “Russia” APC (5300 kg), “Borovichanin” LLC (5666 kg), “RDS-Agro” LLC (6294 kg), “Reshayuschii” LLC (6776 kg), “BK VN–d” LLC (7400 kg). These farms belong to a group of 24 farms using artificial insemination.

Another group of 17 farms of the region does not use artificial insemination at all, milking from 1500 to 3000 kg per cow per year. They use bulls which they raised themselves or traded in other farms. This group includes farms with a productivity of 2000 to 4000 kg of milk per cow per year. The main problem of low productivity is the low level of appropriate keeping and feeding of animals, which are part of the concept of low “production culture”. Obviously, these farms have difficulties in terms of effective management of the dairy herd, as they do not follow the well-known rules that are taught to the first year students. The essence of these rules is that low-yield animals spend up to two-thirds of the nutritional value of the diet on maintaining life, whereas high-yield animals spend a quarter less. Therefore, if you want to manage the dairy industry effectively, you should increase productivity. In addition, sires are better at realizing their potential with high-yield cows. The higher the productivity of the cows, the more efficiently a sire transfers his potential to the offspring. Therefore, if you want to effectively use a sire, you should increase the productivity.

These farms obviously have no prospects for the effective development of the dairy industry without the use of artificial insemination of dairy cattle. But the number of such enterprises, unfortunately, is increasing, and in the last 5 years, the amount of artificial insemination at dairy farms has decreased from 85 to 71%.

4. Conclusion

1. The analysis of the conducted studies shows that during artificial insemination of black-and-white dairy cattle in the farms of the Novgorod region, the seed of sires with a high genetic potential is used, which makes it possible to achieve an average herd productivity of up to 8000 kg of milk per cow.
2. The realization of the genetic potential transmitted to the offspring from sires depends on the level of the production culture, which includes many parameters, but the main ones are the level of feeding and maintenance of dairy cattle and the personnel providing this culture.

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