Black-and-White Cow Herd Consolidation Ways by Breeding Traits

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Abstract. In the context of large-scale selection and the widespread use of methods of initial genomic evaluation of stud bulls, a careful selection of breeding pairs is of particular importance when it is necessary to consolidate animals in dairy herds according to the traits of conformation, body composition and dairy type intensity. The method of linear evaluation of physique features, adopted in Russia, coincides with the standard method system approved by the ICAR in the main approaches and characteristics. According to the results of a linear evaluation of bulls used in a herd of black-and-white cattle, it was found that the average score on the main parameters of the conformation for technologically significant traits (dairy type intensity, the condition of the animal's limbs) has been within 5.00...5.90 (points). At the same time, the traits that characterize the main parameters of the udder of cows, depth and breadth measurements, need to be improved. Based on the results of evaluating the prepotent properties of the bulls by linear traits, the optimal structure of the dairy herd has been determined, in accordance with the presence of the main lines in the Holstein breed.

1. Introduction

Breeding and use of black-and-white cows play an important role in the development of the dairy business in Russia, since this dairy cattle has valuable phenotypic and productive traits. In the practice of breeding black-and-white cattle, when selecting breeding pairs, Holstein bulls which rightfully belong to the best cultured dairy breeds in the world are most often used, which, however, leads to a narrowing of genotypic diversity in dairy herds [1, 2]. The widespread application of the principles of large-scale breeding in combination with genomic evaluation of stud bulls is initially encouraging in terms of breeding acceleration, but at the same time increases the importance of evaluating cows-daughters on their own productivity, conformation and body composition, since the existing accuracy of genomic evaluation does not always allow making an unambiguous choice of bulls in order to obtain the desired dairy type of the progeny [3, 4]. Evaluation of the body composition of animals is of particular importance at the present time, since the features of phenotypic traits of cows, as shown by numerous studies, affect economically useful and productive traits, which ultimately affects their breeding value and production use direction [5, 6]. Determination of the body type and productivity direction has made it possible to carry out selective improvement of animals by a targeted selection of breeding pairs. Despite the relatively low efficiency of breeding activities in carrying out artificial selection based on the evaluation of phenotypic traits, the use of the ocular estimate method has made it possible to optimize the feed-gain relationship and preserve especially valuable productive traits in the breed genotype, such as the strength of body composition and milk productivity [7–9]. In order to study the ways of improving
and consolidating the linear traits of breeding animals in a herd of black-and-white cows, we have evaluated the linear parts of the body and the quality of raw milk.

2. Research methods

The work has been carried out in a herd of black-and-white breed cattle in the South of Russia, in Stavropol Krai with livestock of 1275 cows with milk production indicators of about 7.8–8.0 thousand kg of milk with a milk fat content of 3.70 % and a protein content of 3.16 %, which meets the regulatory requirements for highly productive cows of the black-and-white breed. The dairy herd has been mainly represented by animals of the main lines: Reflection Sovering, as well as Vis Back Ideal, Montvik Chieftain and Pabst Governor. The evaluation of the dairy qualities of the cows has been carried out with the participation of control assistant service specialists who, together with specialists from the zootechnic farm service, participated in control milking of the cows. Samples of raw milk have been preserved with bronopol (trade name “Microtabs”) and delivered cold (+6 °C) to Stavropol State Agrarian University Laboratory for Selection Control of Milk Quality, accredited in accordance with GOST ISO/IEC 17025–2019. Determination of physical-chemical parameters of milk has been carried out by an instrumental express-method using an infrared analyzer MilkoScan Mars (Foss Company, Denmark). Linear evaluation of cow constitution has been carried out on a 9-point scale in accordance with national and international requirements (ICAR) [1, 2, 6]. The primary data have been subjected to statistical-mathematical processing using the Excel spreadsheet processor. Differences between the indicators have been considered significant at p <0.05.

3. Results

The research results have shown that the animals are characterized, in general, by a good strength of body composition and productive longevity which averaged about 3 lactations. The average annual milk productivity in the case of first-calf cows of the indicated lines of the black-and-white breed is 7.5–7.9 thousand kg of milk. Throughout the year, the amount of fat in the milk was in the range of 3.94–4.07%, the amount of protein in the milk, respectively, varied in the range of 3.33–3.42%. The linear evaluation of the body parts of the animals has shown that the main parameters of the conformation for technologically significant traits (dairy type intensity, the condition of the animal's limbs) have been within the range of 5.00...5.90 (points). It has been recognized as a promising direction of breeding to select breeding pairs to improve body composition strength and udder quality, which coincides with the opinion of I. Litvinov and S. Tyapugin (2004).

The analysis of the results of the linear evaluation of the first-calf cows (figure 1) shows that, in general, the herd of cows is characterized as production orientated, since the average evaluation for the studied characteristics is in the range of 4.5–5.5 points. At the same time, traits with a score of more than 5 points generally reflect the characteristic traits of Holstein dairy cattle: high growth, intensive dairy traits (udder depth) and a dairy type of body composition (metatarsal bone thickness).

At the same time, some parameters, evaluated at the level of 5 points, can be recognized as technological qualities that need to be paid attention to during the next selection of a breeding pair of evaluated first-calf cows, these are parameters such as udder condition (dug parameters, ligament), leg condition (hock, location), milkiness characteristic (rib angularity), chest characteristic (breast depth) and calving ability (sacrum length).

At the same time, some parameters have been determined with an evaluation below 5 points, which makes it possible to select bulls with necessary prepotent abilities to improve the following linear parts of the animal body: several characteristics of the sacrum (angle of inclination and width), several traits of the spatial characteristics of the udder (dug location; height, width, strength of attachment of the udder to the cow's body), some characteristics of the limbs (the angle of inclination at the hooves and the appearance of the hind legs) as well as chest width.
Researches of many authors have come to the conclusion that it is necessary to develop a model linear profile of a cow for the herd to carry out effective breeding work, in accordance with which the consolidation of traits should be planned [9, 10]. Using the example of the herd under study, a recommendation can be made to improve the following linear body parts of the cows: to improve the score by 2–3 points — chest characteristics (angularity of the ribs, depth and width), limb condition (parameters of the hoof horn and hind legs; hock), udder characteristics (width and height of attachment, support ligament, dug location). To a lesser extent, the growth parameters and fatness of animals need to be improved; it is desirable to increase the score by 1.2–1.5 units.

Analysis of the results of the linear evaluation of first-calf cows to characterize the stud bulls for the transmission of prepotent traits to their peer daughters has shown (figure 2) that all the studied bulls have turned out to be neutral or impairments in terms of the main conformation traits that require improvement: limb condition (angle of inclination of the hooves), several parameters of the udder (attachment state, width and height features), sacrum inclination angle. At the same time, some traits are at the level of neutral and weakly positive influence: supportive ligament, the length of the anterior dugs of the bulls Lancelot, Eden and Marcelus. All bulls are improvers, basically, in terms of two main characteristics: height, thickness of the metatarsal bone.
Analysis of histograms of the linear evaluation of the cows of I and II lactation suggests a positive direction of the selection progress in the herd (figure 3), while visually showing the similarity of graphic outlines that reflect the scoring of individual traits of the animal's conformation. Mathematical analysis has shown a high degree of correlation between the graphs of the histograms, the correlation dependence is the following: $r = 0.75$, which allows us to conclude that the selection improvement of the herd of black-and-white cattle is homogeneous.

A more pronounced stabilization of the conformation traits of second lactation cows should be noted, which in general can characterize the herd as approaching the desired production model. When selecting breeding pairs in the herd, as a rule, bulls with positive prepotent abilities are selected, the coefficient is not lower than 1.5 in terms of the following parameters: sacrum state (angle of inclination and width), udder parameters (dug location, the height and degree of attachment of the udder), limb condition (hoof inclination angle, hind legs), chest parameters (chest width).

Figure 2. Results of linear evaluation of the stud bulls.
Figure 3. Results of linear evaluation of the cows of I and II lactation, $r = +0.75$.

For the rest of the parameters, a stabilizing selection can be applied to preserve the existing linear body parts: several udder parameters (location and length of the dugs, ligament and depth of the udder), milk quality intensity and growth characteristics.

To maintain genetic diversity in the herd and based on the results of the linear evaluation, a conclusion has been made about the recommended genealogical structure of the herd (table 1).

Table 1. Recommended genealogical structure of the black-and-white herd.

| Stud bull line                  | Names and numbers of sons of the bulls | Share of cows in the herd, % |
|---------------------------------|----------------------------------------|-------------------------------|
| Reflection Sovering No.198998   | Blister No.831453                      | 13–15                         |
|                                 | Corey No.64541632                      | 9–10                          |
|                                 | Marcelus No.136057831                  | 3–5                           |
|                                 | Solaris No.61492131                    | 11–12                         |
|                                 | Hitman No 713416352                    | 10–11                         |
| **Total in the line**           |                                        | **49–50**                     |
| Montvik Chieftain No.95679      | Horatio No.78987165                    | 5–7                           |
|                                 | Eden No.78466893                       | 12–13                         |
| **Total in the line**           |                                        | **17–19**                     |
| Vis Back Idial No.1013415       | Lancelot No.19437                     | 7–9                           |
|                                 | Shotman No.740902934                   | 10–12                         |
| **Total in the line**           |                                        | **18–20**                     |
| Pabst Governer No.882933        | Elsinore No.1731                      | 14–16                         |
| **In all lines**                |                                        | **100**                       |

At the same time, taking into account the productive qualities, it is advisable to maintain the largest number of breeding stock of the Reflection Sovering line no. 198998 — about 50% of the total number of first-calf cows. The rest of the lines can be represented at the level of 14–20%.
4. Conclusion

Evaluation of the stud bulls according to the linear conformation traits of their daughters (Figure 3) allows us to trace in more detail individual prepotent abilities of the stud bulls of the Holstein breed. In the conditions of the herd under study, these bulls, obviously, do not fully demonstrate their potential for improving the conformation of first-calf daughters, which should be a subject for consideration by farm breeders, as shown by L. M. Khmel'niy (2005). The selection of breeding pairs in a particular dairy herd must be made on the basis of the results of a linear evaluation of first-calf cows – to determine the conformation, constitution traits that need stabilization and improvement, as shown in the studies of I. Litvinov, S. Tyapugin (2004), E. Martynova and Y. Devyatova (2004). Achievement of the desired phenotype of model breeding and technological traits of a cow for a particular dairy herd will occur depending on the prepotent abilities of bulls-improvers according to the outlined indicators (1.5–2.0) and taking into account the inheritance coefficients of the corresponding traits (0.11–0.40) for 2–4 generations [11].

The main direction of improving the economically useful and breeding traits of black-and-white dairy cattle should be the use of individual selection of breeding pairs with the prepotent ability of stud bulls to improve the traits in relation to the condition of the limbs and udder quality of at least 1.5–2.0 points, which will allow consolidating the herds by the strength of the body composition by 20–25% and will create conditions for the stabilization of milk yield during a lactation period.

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