Productivity Potential of Ayrshire Cattle and Its Implementation in Conditions of Agro-Volok LLC, Novgorod Region

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Abstract. Dairy cattle breeding continues to be the leading field of agriculture. Along with the productivity growth of animals, milk production and profitability, it is of great importance to improve quality, reduce to minimum mechanical and bacterial contamination, improve technological properties, as well as reduce losses in the course of production, primary processing and temporary storage. In the course of a particular study it was shown that the modernization of domestic breeds, the improvement of their productive and technological characteristics on the basis of the use of the gene pool of the best world breeds are of fundamental importance for cattle breeding intensification. The Finnish Ayrshire cattle, along with the Holstein, Dutch, American Swiss, Angler and other breeds of global importance, play an important role in the program for breeding new highly productive dairy types and breeds in our country. The relevance of research carried out in this direction is also confirmed by the fact that the Ayrshire breed is generally recognized as the most selected for a number of economically useful and technological characteristics of the dairy breed. It is distinguished by abundant milk content in combination with high fat and milk content, almost excellent technological properties of the udder, high payment for feed by products, that is, it has the qualities that are required from animals in the conditions of a complex intensification of the industry. As a result of the study it was found that the positive effect of selection for milk yield and mass fat content (MDZh) in milk allows improving breed and productive qualities of cows through the selection of breeding stock and increase productive parameters for milk yield and its quality.

1. Introduction
Primarily, selective and breeding work in the dairy cattle breeding is aimed at increasing livestock productivity. The use of animals with a high genetic potential is the main way to achieve this goal but for this populations should be bred which are capable to increase yields and quality of milk.

In Russia cattle of the Ayrshire breed are widespread since their feature is the ability to persistently maintain necessary genetic qualities and high parameters of milk productivity [2, 9].

Based on the methods of transferring genetic information to descendants, four main breeding groups are distinguished: fathers of bulls – 40–45%, fathers of cows – 17–20%, mothers of bulls 30–35%, mothers of cows 6–8%.

Pedigree work in the conditions of the agricultural enterprise Agro-Volok LLC in Novgorod region is a number of measures aimed at improving productive and breeding qualities of Ayrshire cows. These measures include:
– a correct choice of methods and techniques of breeding;
– purposeful selection of animals for mating;
– selection of the most valuable animals;
– creation of the best conditions for keeping and feeding animals during all periods of economic use [4, 10].

A successful pedigree work requires the correct organization of zoo-technical accounting.

The Seleks. Molochny Skot RTs Plinor Program is used which makes the work of a livestock breeder easier and significantly saves working time.

The Seleks. Molochny Skot Program has a number of very important functions:
1. All primary accounting is entered into the database. It includes the data of control milking, calving, mating, insemination, cow pregnancy and other parameters. When entering these measures a card (2-Mol) is automatically compiled, each time with the latest parameters.
   This reduces the costs of manual labor, saves working time and forms unified information about an animal obtained from a livestock breeder, veterinarian and technician for artificial insemination.
2. There occurs an opportunity to manage the herd based on keeping individual records.
3. Management of selective and breeding work in the herd.
4. Automatic formation of valuation of cattle and its analysis.

In breeding farms individual selection is used for targeted selective work. When conducting it, a clear knowledge of the pedigree of animals is required. [1].

2. Objects and methods of research
The research object is livestock of the Ayrshire cattle in the conditions of the Agro-Volok LLC of the Novgorod region.

The selection effect was determined by milk yield and milk fat content and calculated using the generally accepted Sd formula (selection differential).

3. Results and discussion
Evaluation of breeding bulls for the quality of the offspring is the main breeding measure to determine the true genetic value of breeders. One of the factors significantly affecting the genetic progress is the accuracy of evaluation of breeding traits. It is very important to organize the inspection of bulls in such a way that the information received accurately reflects their breeding value.

It is possible to evaluate the genetic merits of sires with a high degree of accuracy and achieve the maximum increase in genetic progress if the required number of daughters is raised and evaluated in different herds [5, 8].

The genealogical structure of the Agro-Volok LLC herd is represented by eight lines, the main lines are King Erant, Yuttero Romeo, Toosilan Brahma. The genealogical structure of the breeding stock according to the lineage is presented in table 1.

In recent years, purebred Ayrshire bulls of domestic and Finnish origin have worked in the herd. They left offspring in the herd, and now this fact determines the herd genealogical structure [3, 7].

Genealogical affiliation is of great importance when breeding and working with lines and families. So, in the farm herd the targeted selective breeding work is performed with the Ayrshire breed of cattle. Improvement of the cattle genetic potential takes place due to the bull selection.

As a result of the analysis of cow milk productivity at the Agro-Volok LLC under optimal conditions of keeping and feeding, we can observe an increase in milk yield by 1983 kg (3092 kg to 5075 kg of milk) and in milk fat content by 10.9% in the period from 2010 to 2020 (table 2).
### Table 1. Genealogical structure of broodstock according to lineage.

| Line code       | Father bull stock number | Nickname | Total breeding stock, heads | Including, heads |
|-----------------|--------------------------|----------|-----------------------------|-----------------|
|                 |                          |          |                             | cows            |
|                 |                          |          |                             | all ages         |
|                 |                          |          |                             | of which first |
|                 |                          |          |                             | calving         |
|                 |                          |          |                             | all ages         |
| Don Zhuan       | 726                      | Arkan    | 7                           | 7               |
| Riihividan Urho | 3343                     | Pizhon   | 8                           | 8               |
| Errant          |                          |          |                             | -               |
| Riihividan Urho | 453                      | Bentli   | 14                          | -               |
| Errant          |                          |          |                             | 14              |
| King Erant      | 10343                    | Furor    | 65                          | 45              |
| King Erant      | 901                      | Vertti   | 46                          | 46              |
| Toosilan Brahma | 669                      | Umar     | 52                          | 52              |
| Juttero Romeo   | 404                      | Zavitok  | 31                          | 31              |
| Juttero Romeo   | 10365                    | Safiyan  | 99                          | 62              |
| Other lines     | 174233                   | Sonet    | 8                           | 8               |
| Other lines     | 5167                     | Sanni    | 11                          | 11              |
| Other lines 768 | 408                      | Usko     | 30                          | 30              |
| Other lines 63640 | 10351                  | Admiral  | 71                          | 71              |
| Other lines     | 174233                   |          |                             | 10              |

### Table 2. Cow characteristic by milk productivity.

| year | livestock, head | milk yield for 1 forage cow, kg | mass fraction of fat, % | milk fat, kg |
|------|----------------|---------------------------------|-------------------------|-------------|
| 2010 | 500            | 3092                            | 3.85                    | 119.0       |
| 2011 | 450            | 2755                            | 3.87                    | 106.6       |
| 2012 | 355            | 4040                            | 3.94                    | 159.2       |
| 2013 | 356            | 4337                            | 3.96                    | 171.7       |
| 2014 | 357            | 4859                            | 4.10                    | 199.2       |
| 2015 | 370            | 5187                            | 4.10                    | 212.7       |
| 2016 | 371            | 5018                            | 4.15                    | 208.2       |
| 2017 | 371            | 4813                            | 4.20                    | 202.1       |
| 2018 | 371            | 4901                            | 4.25                    | 208.3       |
| 2019 | 371            | 4870                            | 4.26                    | 207.5       |
| 2020 | 371            | 5075                            | 4.27                    | 216.7       |
| Change (+; -) | -                  | + 1983                          | + 0.42                 | + 97.7      |

Due to the use of the best sires and improved feeding, the high stable milk productivity was achieved. Long-term use of highly productive animals is the most important condition for an effective selection work in dairy cattle breeding. But in practice, in recent years, we observe a sharp reduction of the duration of economic use.

Thus, the analysis of selective and genetic characteristics of Ayrshire cattle will allow increasing milk productivity and implementing the genetic potential at the level of genealogic lines, herds and the breed in general.
4. Conclusion
Selection by origin suggests that descendants inherit the best qualities of parents, including high productivity. Correlation positive coefficients are the evidence of traits inherited by daughters from mothers, granddaughters from grandmothers along maternal and parental lines of pedigree [6, 11].

Selective differential (Sd) was calculated using the difference between the productivity of breeding cows and the average herd productivity.

In the Agro-Volok LLC, the calculated coefficient of heritability of productive qualities of daughters is equal to 0.35 by the yield, and to 0.38 by the milk fat content. Average yield of the herd is 5075 kg, that of breeding cows is 5700 kg, mass fat content in the milk of cows of the whole population is 4.27%, that of breeding cows is 4.41%. The time of generation change is 5 years.

The expected selection effect on the generation is determined by the formula:

\[ SE = \frac{Sd \times h^2}{i} \]

where:  
SE is a selection effect,  
Sd is a selection differential,  
h\(^2\) is trait heritability,  
i – is the time of generation change.

With the existing reproduction system of the herd in the Agro-Volok LLC about 80% of the best cows are selected for the breeding core, therefore:

1. Calculation of the difference between the average milk yield of cows in the breeding core and the average milk yield of the herd showed that 

\[ Sd = 625 \text{ kg} \]

Calculation of the milk yield selection effect showed that 

\[ SE = \frac{625 \times 0.35}{5} = 43.75 \text{ kg per year} \]

2. Calculation of the difference between the average MDZh (mass fat content) in the milk of the breeding core cows and the average MDZh (mass fat content) of the herd showed that Sd = 0.14 %.

Calculation of the selection effect based on the MDZh (mass fat content) in milk showed that 

\[ SE = \frac{0.14 \times 0.38}{5} = 0.01 \% \text{ per year} \]

From the data obtained it follows that the selection positive effect based on milk yield and milk fat content will improve breeding and productive qualities of cows through the selection of breeding stock and increase production parameters for milk yield and milk quality (table 3).

As can be seen from Table 3, due to the selection of the breeding stock, the milk yield of cows for the period from 2021 to 2025 will increase by 172 kg, and the mass fraction of fat by 0.04%, respectively.

Clear knowledge in this field is required to successfully breed, and develop the genetic potential of highly productive breeding animals under specific conditions. The genetic potential of animals is a basis for selection effect provided optimal conditions of feeding and keeping are implemented. This fact should be taken into account when developing breeding programs for cattle.
Table 3. Change in productivity parameters of cows due to selection of breeding stock according to the forecast until 2025.

| year | total for the herd | milk yield for 1 forage cow, kg | MDZh (mass fat content), % | milk fat, kg |
|------|--------------------|-------------------------------|---------------------------|-------------|
| 2021 | 371                | 5118                          | 4.28                      | 219.0       |
| 2022 | 371                | 5161                          | 4.29                      | 221.4       |
| 2023 | 371                | 5204                          | 4.30                      | 223.7       |
| 2024 | 371                | 5247                          | 4.31                      | 226.1       |
| 2025 | 371                | 5290                          | 4.32                      | 228.5       |
| Change (+, -) | - | + 172 | + 0.04 | + 9.5 |

To implement and improve the genetic potential of dairy productivity of Ayrshire cows in farms of the Novgorod region is possible due to targeted breeding of bulls with a high genetic value provided they are optimally fed and kept.

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