

# Breeding and productive qualities of Ayrshire cattle

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**Abstract.** In the current conditions of livestock development in the country, dairy cattle breeding requires animals having not only high genetic potential, but also characterized by a high level of milk production. The purpose is to study the breeding and productive qualities of Ayrshire cattle bred in the conditions of the Republic of Mari El. The research was carried out at CJSC Mariiskoye in the Republic of Mari El. The test subject is Ayrshire dairy cattle. Currently, Ayrshire cattle bred on the farm are purebred and have an elite-record class. The herd is young, the average age of the cows is 3.4 calvings. On average, one cow produces 6,876 kg of milk per lactation with a milk fat content (MFC) of 4.5% and a milk protein content (MPC) of 3.34%. The level of cow's milk production exceeds the requirements of the class 1 standard for milk yield by 76.5%, for MFC by 3.4%, and for the amount of milk fat by 26.2%. The cows significantly exceed the established standard for live weight by 12–20% and have an excellent exterior for dairy cattle. Currently, in the herd, there are animals belonging to 5 lines. The cows of the Urho Errant and O.R. Lichting lines yielded more than the average for the herd (7,017 kg and 6,930 kg, respectively). The cows of the S.B. Commander line were giving milk with high fat content and the cows of the Sniperum SRB line were giving milk with high protein content. In the herd, the production is ensured by daughters from 19 bulls.

## 1 Introduction

The current situation in the world significantly affects the state of development and operation of all production areas, including dairy farming, which is one of the most significant sectors of the agroindustrial complex not only in Russia, but also worldwide. Globally, the Russian Federation ranks 10th in terms of cow's milk production, slightly behind the Republic of Belarus and China. In this regard, the state program for the

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development of dairy cattle breeding for 2017–2025 was approved, the main goal of which was to increase the performance of the industry [1,2,3].

The main way to improve dairy farming in Russia at this stage is its further intensification, implemented by increasing the breeding and productive qualities of animals [4,5].

In the current conditions for the development of livestock farming in the country, dairy cattle breeding requires highly productive animals, adapted for long-term use and capable of showing a high level of milk production throughout their lives. In order to effectively solve these issues, first of all, it is necessary to qualitatively transform herds and breeds of cattle [6].

In Russia, the Ayrshire breed is one of the best in terms of milk yield, as well as milk fat and protein content. According to valuation data for 2021, the highest level of milk production of 9,360 kg, MFC of 4.24%, and MPC of 3.35% among Ayrshire cattle was noted in the livestock of the Budogoshch Agricultural Production Cooperative, Leningrad region [7].

The characteristics of the Russian Ayrshire breed are determined by the history of its origin and the selection techniques used. The Ayrshire breed was officially registered in 1826; it was bred in County Ayr in Scotland. The breed was formed by complex reproductive crossing of local cattle with Scandinavian animals and the further infusion of blood from Dutch, Shorthorn, Tizewater, Jersey, Alderney, Hereford and Highland cattle. Ayrshires were first brought to Russia in 1850. Then, Ayrshire cattle were selected separately in each region, largely because of this, very isolated and unique herds were formed over many years [8].

For dairy production, the efficacy of dairy cattle breeding depends on the possibility of using valuable breeding material. Today, facilities of the agroindustrial complex have ample opportunities to select sires from various companies. In their studies, N.I. Abramova, G. S. Vlasova, and L. N. Bogoradova revealed a significant superiority in milk yield for mothers of bulls of import selection over domestic ones. However, the implementation of the genetic potential for milk yield turned out to be higher in the daughters of bulls of domestic selection. In this regard, the authors believe that breeding material should be evaluated annually [9,10].

Some authors think that breeding Ayrshire cattle can be quite profitable. At the same time, when selecting Ayrshires, it is necessary to clearly develop a strategy for breeding, select individuals that meet the target standards and objectives of agricultural enterprises [11,12].

Purpose: to study the breeding and productive qualities of Ayrshire cattle bred in the conditions of the Republic of Mari El.

## **2 Materials and Methods**

The research was carried out at CJSC Mariiskoye in the Republic of Mari El in 2017–2021. The test subject are Ayrshire dairy cattle ( $n=128$  heads). Research material is breeding cow records (2-Mol form).

The study of the genetic potential of sires (GPS) was carried out by analyzing the performance of maternal ancestors using the following formula:

$$GPS=(2M+MM+FM)/4,$$

where: M is the maternal performance,

MM is the mother's maternal performance,

FM is the father's maternal performance.

### 3 Results and Discussion

Ayrshire cattle were brought to CJSC Mariiskoye in September 2005. Heifers of the Ayrshire breed came from the Smena poultry breeding farm, organization of the scientific services, Sergiyev Posad District of the Moscow region. They belonged to 6 genealogical lines: Riihiviidan Urho Errant 13093, Uttero Romeo 15710, O.R. Lichting 120135, S.B. Commander 393145, Dick 768, and Sniperum SRB 63640.

Currently, CJSC Mariiskoye is a breeding reproducer for breeding Ayrshire cattle.

The enterprise has 166 Ayrshire breed animals, including 80 cows. All Ayrshire cattle bred on the farm are purebred and have the highest elite-record class. The herd is relatively young, the average age of the cows is 3.4 calvings. On average, during 305 days of lactation, one cow produces 6,876 kg of milk with a fat content of 4.5% and a protein content of 3.34%. It should be noted that the cow's milk yield increases with age. If in first-calf heifers the milk yield was 6,300 kg, then in full-aged cows it was higher by 822 kg or 13%. However, the opposite trend was observed for the milk fat content. First-calf heifers turned out to have more milk fat compared to adult cows. The fat content in their milk was higher by 0.19%.

When examining the level of cow's milk production over the past five years, an improved performance of Ayrshire cows was noted. Thus, in 2017, on average, each cow produced 6,825 kg of milk with a fat content of 4.1% and a protein content of 3.14% (Table 1). By 2021, these figures increased and amounted to 6,876 kg, 4.5%, 3.34%, respectively. The increase is especially observed in the fat and protein content, which raised by 9.8% and 6.4%, respectively. This allows us to obtain 309.4 kg of milk fat and 229.7 kg of milk protein from one cow in 2021. It should be noted that the level of milk production of cows bred in the conditions of the republic was higher than in a number of regions of the Russian Federation [8].

**Table 1** Characteristics of cows in terms of milk production for 305 days of lactation

| Year | Total, heads | Yield of milk, kg | Milk fat |       | Milk protein |       |
|------|--------------|-------------------|----------|-------|--------------|-------|
|      |              |                   | %        | kg    | %            | kg    |
| 2017 | 66           | 6,825             | 4.10     | 279.8 | 3.14         | 214.3 |
| 2018 | 47           | 6,872             | 4.12     | 283.1 | 3.20         | 219.9 |
| 2019 | 62           | 6,873             | 4.53     | 311.3 | 3.16         | 217.2 |
| 2020 | 61           | 6,873             | 4.49     | 308.6 | 3.18         | 218.6 |
| 2021 | 72           | 6,876             | 4.50     | 309.4 | 3.34         | 229.7 |

Selecting and breeding Ayrshire cattle on the farm is aimed at increasing milk yield and increasing the milk fat and protein content. The best cow in the herd is No. 845, which, for 305 days of the last completed lactation, produced 8,797 kg of milk with a fat and protein content of 4.46% and 3.32%. Her father was Animate 108572401. The second daughter of this bull, cow No. 8529, for her 2nd lactation, produced 8,734 kg of milk with a fat and protein content of 4.68% and 3.32%.

The list of record holders includes two more daughters of Animate 108572401, among them first-calf No. 8820 with a milk yield of 8,255 kg, a milk fat content of 4.35% and a milk protein content of 3.3%.

Among the record holders, there are 3 daughters of the bull Jelic Oblique 7407843, their milk yield varied from 8,109 kg to 8,427 kg with the fat content of 4.28–4.29% and the protein content of 3.3–3.34%.

Thus, Ayrshire cattle on the farm have a high level of milk production, which exceeds the requirements of the class 1 standard. Thus, on average, a milk yield of full-aged cows in the herd was 176.5% of the standard requirement, the fat content was 103.4%, and the amount of milk fat was 226.2%.

High lactation performance of cows is associated with great physiological stress on the whole organism, so they must be well developed, capable of eating large amounts of feed and processing it into milk.

The standard for live weight of Ayrshire first-calf heifers is 450 kg, and third-calf cows should weigh 520 kg. During the reporting period, the cows on the farm significantly exceeded the established standard for live weight. Thus, in 2021, first-calf heifers had a live weight of 540 kg, exceeding the requirements of the class 1 standard by 20%.

The weight of the second-calf cows was 577 kg and exceeded the standard by 12%. Full-aged cows had a live weight of 88 kg or 17% higher than the standard.

The Ayrshires bred on the farm are quite large. These Ayrshire cows have an excellent exterior for dairy cattle: light bone structure, deep chest, a graceful carriage of the head, proportional body size and thin skin. The back is wide and straight. The hooves are strong and correctly positioned. The average height of cows is 133 cm. The animals have the relatively long bodies. The breast is moderately voluminous, up to 68 cm deep and 41 cm wide, chest girth behind the shoulder blades is 187 cm. The sacrum is straight, the width in hips is 52 cm. Animals have strong limbs, metacarpus girth is 18 cm.

Currently, in the herd, there are animals belonging to 5 lines of Ayrshire cattle: R. Urho Errant 13093, S.B. Commander 174233, O.R. Lighting 120135, Dick 768, and Sniperum SRB 63640.

The largest line is O.R. Lighting 120135, which contains 52 heads or 40.6% of the livestock, including 23 cows and 29 heifers. In second place in terms of head count is the Sniperum SRB 63640 line, which contains 29 animals (22.7%).

The proportion of R. Urho Errant 13093 and S.B. Commander 174233 line animals in the herd was 17.2% and 18.8%, respectively.

The study of the lactation performance of cows depending on their lineage showed no significant differences among animals of different lines (Table 2).

**Table 2.** Lactation performance of cows depending on their lineage

| Line                  | n  | yield of milk,kg |       |      | milk fat, % |      |      | milk protein, % |      |      |
|-----------------------|----|------------------|-------|------|-------------|------|------|-----------------|------|------|
|                       |    | M                | m     | Cv,% | M           | m    | Cv,% | M               | m    | Cv,% |
| R. Urho Errant 13093  | 22 | 7,017            | 141.1 | 9.4  | 4.45        | 0.06 | 6.4  | 3.34            | 0.01 | 0.8  |
| S.B. Commander 174233 | 24 | 6,640            | 204.3 | 14.1 | 4.55        | 0.05 | 4.8  | 3.34            | 0.01 | 1.2  |
| O.R. Lighting 120135  | 23 | 6,930            | 219.4 | 14.9 | 4.53        | 0.05 | 5.0  | 3.33            | 0.01 | 1.2  |
| Sniperum SRB 63640    | 10 | 6,867            | 451.2 | 16.1 | 4.43        | 0.11 | 6.3  | 3.36            | 0.02 | 1.7  |
| Average for the herd  | 72 | 6,878            | 105.8 | 13.3 | 4.50        | 0.03 | 5.4  | 3.34            | 0.01 | 1.1  |

The milk yield of the Urho Errant and O.R. Lighting line cows was above the average level for the herd and amounted to 7,017 kg and 6,930 kg, respectively. Cows of the S.B. Commander line were giving milk with high fat content, mass fraction of fat was

4.55%. The best protein content of 3.36% was noted in the milk of the Sniperum SRB line cows.

The coefficient of variation in milk yield, reflecting the degree of variability of this parameter, was not high in Ayrshire cows and varied from 9.4% to 16.1%; in the fat and protein content, this value varied from 4.8% to 6.4% and from 0.8% to 1.7%, respectively. This suggests that within the lines the animals are very similar in productive qualities.

The formation of dairy herds on breeding farms occurs, among other things, under the influence of the sires used. Depending on the diversity of bulls selected and the intensity of their use, the herd acquires a certain genetic and phenotypic homogeneity, which affects the productive and breeding qualities of the animals.

In the Ayrshire cattle herd, the production is ensured by daughters from 19 sires. Of them, seven bulls are recorded in various volumes of state breeding animals books. Seven sires were evaluated in Canada and have high breeding value indices with a LPI from +1752 for Cheliot to +2878 for Bigtime. Eight bulls were evaluated in Russia, of which five have A<sub>1</sub>, three A<sub>3</sub> and one B<sub>2</sub> category (Table 3).

**Table 3.** List of sires whose daughters lactate in the herd

| The Bull's Nickname and Number | Mark and Number GKPG | Breeding value | Category                      | Parent Index bull |        |        |
|--------------------------------|----------------------|----------------|-------------------------------|-------------------|--------|--------|
|                                |                      |                |                               | milk yield, kg    | MFC, % | MPC, % |
| Khural 2629                    | ME-79                |                | A <sub>3</sub>                | 10,870            | 4.31   | -      |
| Pocker 200                     | ME-76                |                | A <sub>3</sub>                | 7,479             | 4.73   | -      |
| D. Oblique 7407843             | -                    |                | A <sub>1</sub>                | 10,183            | 3.97   | 3.40   |
| Showstar 103495571             | -                    |                | A <sub>1</sub>                | 11,758            | 4.20   | 3.30   |
| Sunny 5167                     | ME-88                |                | n                             | 10,030            | 4.37   | 3.30   |
| Venus 5165                     | ME-84                |                | A <sub>3</sub> B <sub>2</sub> | 11,816            | 4.63   | -      |
| Sale 45583                     | ME-92                |                | A <sub>1</sub>                | 11,298            | 4.73   | 3.37   |
| Volan 106202505                | ME-101               |                | A <sub>1</sub>                | 13,517            | 4.53   | -      |
| Glamor 45588                   | ME-98                |                | -                             | 11,296            | 4.80   | 3.37   |
| Landscape 103846246            | -                    |                | A <sub>1</sub>                | 11,784            | 3.90   | 3.40   |
| Rafting 109670397              | -                    | GLPI+2830      | -                             | 10,572            | 3.83   | 3.23   |
| Zachary 7534892                | -                    | GLPI+2130      | -                             | 9,310             | 4.10   | 3.50   |
| Animate 108572401              | -                    | GLPI+2707      | -                             | 10,148            | 4.30   | 3.60   |
| Revolver 108752413             | -                    | GLPI+2306      | -                             | 9,501             | 4.53   | 3.50   |
| Bigtime 109688487              | -                    | GLPI+2878      | -                             | 9,211             | 4.33   | 3.67   |
| Parchment 106611102            | -                    | GLPI+2616      | -                             | 11,938            | 4.23   | 3.20   |
| Cheliot 109397772              | -                    | GLPI+1752      | -                             | 8,169             | 4.73   | 3.43   |
| ST Clement Edmure 100512750    | -                    | GLPI+2266      | -                             | -                 | -      | -      |

The sires used on the farm were characterized by a high genetic performance potential in terms of milk yield (from 7,479 kg to 13,517 kg), fat content (from 3.83% to 4.8%) and protein content (from 3.2% to 3.67%).

The highest indicators for maternal ancestors were observed in Volan (15,825 kg, milk fat content and milk protein content is 4.6% and 3.6%, respectively), then in Landscape (13,132 kg, MFC and MPC is 3.9% and 3.5%, respectively) and Kellcrest Showstar (milk yield is 12,512 kg, MFC and MPC is 3.8% and 3.2%, respectively). It should be noted that Cheliot's mother, S. Chelo, had a high fat content of 5.1% and a high protein content of

3.5% with a milk yield of 7,890 kg. Venus's mother had the highest protein content of 4.1%.

The study of the milk production showed that the daughters of Landscape had the highest milk yields. On average, during the last completed lactation, each heifer produced 7,895 kg of milk with a fat content of 4.35% and a protein content of 3.35%.

## 4 Conclusion

The studies showed that Ayrshire dairy cattle bred in the conditions of the Republic of Mari El were obtained from highly productive ancestors and are characterized by an exterior that is excellent for dairy cattle. The level of cow's milk production exceeds the requirements of the class 1 standard. Thus, on average, a milk yield of full-aged cows in the herd was 176.5% of the standard requirement, the fat content was 103.4%, and the amount of milk fat was 226.2%.

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