

Characterization of High-Producing Cows by their Immunogenetic Status

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Abstract— The selection of high-producing cows into the group of cows carrying bull calves is of great importance for successful breeding as for a single farm, as for the industry in the whole region. Present work analyses the productivity of the cattle herd in Sverdlovsk region. It was established that the percentage of cows with the yield of more than 7.0 tons of milk per lactation constantly increases. For instance, in 2015, the percentage of such cows was 41.4%, while by 2017 it increased up to 54.2%. Considering generally increased milk yield, the farms have cows with record breaking yields. The absolute champion of 2017 is cow Snegurka 5242 which yield amounted to 17,120 kg of milk per one lactation with the mass fraction of fat of 3.90%, mass fraction of protein of 3.25% and nutritional yield (fat + proteins) of 1223 kg. The analysis of the high-producing cow genotype has demonstrated that the animals with I2D'E'3G'O' allele are characterized by the highest productivity. In the group of selected 2919 cows with the productivity of more than 10.0 tons of milk, 77 species have the yield of more than 11515 kg of milk regarding the maximum lactation. The most highly productive animals can have G2I2Y2E'3Q' allele, 180 animals (6.2%) in the whole group. The determination of the alleles characterizing the immuno-genetic status of high-producing cows allows defining the potential productivity of the offspring and, using this data as the basis, carrying out early estimation of animal productivity aimed at their selection into the group of cows carrying bull calves.

Keywords— cow, milk yield, lactation, milk, fat, protein

I. JUSTIFICATION OF THE STUDY

The main purpose of cattle breeding is the solution of the food problem in the country, i.e. provision of food to people using accessible biological resources. Over the recent years, there has been a substantial increase in milk yield of cattle; however, the deficit of dairy products remains [2–4, 14].

As a result of many-year work by crossing Ural cattle with Holstein species of different selections, a modern Black Pied Ural breed was developed. The animals of the new breed are of a pronounced milk-producing type and can consume and effectively process into milk a large amount of feeds, have strong feet and hooves and well adapted to machine milking [1, 5–9].

Currently, the selection of the best animals for further breeding is of great significance. Noteworthy, the attention should be paid to stock breeding of dairy cattle having larger longevity; a particular attention should be paid to the health of locally acclimated high-producing cows. This work should be performed only on the animals with confirmed origin [10–13, 15].

The *research goal* is to characterize the immunogenetic status of high-producing cows and make further early-age selection of cows carrying breed grading bulls on its basis.

II. INVESTIGATION METHODS

The study involved black pied cattle breed of breeding organizations having score cards of Sverdlovsk region, separate enterprises having high producing animals and immunogenetic laboratory material of Ural Federal Agrarian Scientific Research Centre of the Ural Branch of RAS (Ural Agricultural Research Institute). In general, the data of dairy productivity and immunogenetic inspection of 2919 cows with the milk yield over 305 days of more than 10 tons were analyzed. Demand for energy resources continues to increase worldwide and accounts for 60% of growth since the early 1990s. In the face of stricter environmental requirements, consumers are more likely to use natural gas in general, including LNG. Over the past 25 years, the growth in demand for LNG as an energy carrier has been 2.3% per year.

III. INVESTIGATION RESULTS

The breeding work, aimed at increased cattle milk yield using prominent genetic potential of Holstein breed, as well as improvement of feeding, stock-keeping and milking, constantly increases livestock population with high milk yield per lactation (Table 1, Fig. 1). For example in 2017, in the

breeding en-terprises of Sverdlovsk region, as compared to 2016, the number of cows with the milk yield lower than 5.0 tons has decreased by 1004 heads. At the same time, an appreciable increase in cow population with the productivity of more than 7.0 tons of milk has increased up to 26,156 cows (by 2532 heads).

TABLE I. DYNAMICS OF COW DISTRIBUTION IN BREEDING ORGANIZATIONS OF SVERDLOVSK REGION IN TERMS OF MILK YIELD PER FINISHED LACTATION (HEADS/%)

Year	Cows	Cows with yield [kg]						
		<3000	3001-4000	4001-5000	5001-7000	> 7001	> 7001 with mass fraction of fat > 4%	> 7001 with mass fraction of protein > 3 %
2015	56051	982	2882	7383	21569	23235	6271	19389
	100	1.8	5.1	13.2	38.5	41.4	11.2	41.1
2016	47177	240	1475	4338	17500	23624	6172	21898
	100	0.5	3.1	9.2	37.1	50.1	13.1	46.4
2017	48215	110	971	3968	17010	26156	7268	23919
	100	0.3	2.0	8.2	35.3	54.2	15.1	49.6

The trend of dairy products consumption testifies the increased interest of people to milk containing decreased fat content and increased content of protein. The analysis of stock data testifies that in breeding herds of Sverdlovsk region, there is an increase of the population of cows with the yield of more than 7.0 tons of milk and mass fraction of protein of at least 3.0%. Over the last three years, the number of such animals increased by 4530 heads and amounted to 23,919

cows, which is 49.6% of total population of cows in the herd [1–3].

Considering the general increase of milk production and quality, a special attention should be paid to the selection of cows for the breeding nucleus; this is essential for successful breeding. This group conditionally includes most valuable animals that substantially exceed average indicators across the herd.

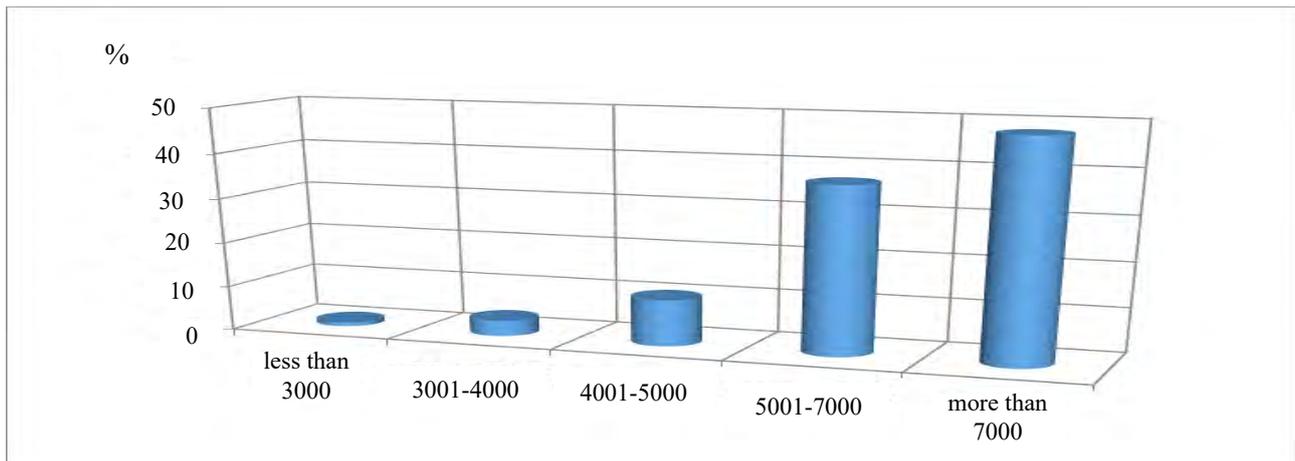


Fig. 1. Average data on distribution of cows in terms of milk yield (2015–2017) in %

s

The analysis of stock cards shows that the number of highly productive cows constantly increases. Table 2 presents the data on the productivity of the most valuable cows of Sverdlovsk region having the milk yield of at least 15.0 tons over 305 days of lactation.

The absolute champion in the list is cow Snegurka 5242 that belongs to Closed Joint-Stock Company Agrofirma Patrushi. Snegurka 5242 over 3 lactations has produced 17,120 kg of milk with the mass fraction of fat of 3.9%, mass fraction of protein of 3.25% and nutritional yield (fat + protein) of 1223 kg.

One more cow to mention is Lolita 2382. It is both high-producing cow and champion in terms of milk yield per fifth lactation. Over the usage time, Lolita 2382 has produced 59.7 tons of milk, three heifer calves and two bull calves.

High-producing cows are the breed's gold reserves and require particular attention in terms of management, feeding and stockkeeping. However, zoo-logic and veterinary experts can get real productivity indicators of the animals only at the age of at least 2.5 years. Thus, the estimation of prospective productivity is rational to be made at the earliest age possible.

One of these methods can be the discovery of alleles (genotype) connected with high productivity and determination of the immunogenetic status of a young animal. In this connection, the immunogenetic status of high-producing cows of Sverdlovsk region was determined (Table 3). The table contains data from the largest datasets.

In total, 8658 cows were selected for the analysis with the yield of at least 10.0 tons of milk per lactation. Among them, 2919 cows have immuno-genetic origin assessment (Table 3).

TABLE II. HIGH-PRODUCING CHAMPION COWS OF SVERDLOVSK REGION

Nickname	Lactation	Milk yield [kg]	Mass fraction of fat [%]	Mass fraction of protein [%]	Nutritional yield [kg]
<i>CJSC Agrofirma Patrusha</i>					
Snegurka 5242	3	17120	3.90	3.25	1223
Rodina 6384	2	16682	3.93	3.27	1201
Yavlina 4898	3	16525	3.97	3.28	1198
Basma 2120	2	16267	3.97	3.32	1185
Silva 3552	4	16025	4.04	3.26	1170
Lolita 2382	5	15628	4.02	3.24	1135
Riga 6608	2	15270	4.04	3.32	1124
Madonna 4644	3	15391	3.98	3.28	1118
Firma 5494	3	15526	3.97	3.23	1117
<i>OJSC Sverdlovskaya pitsefabrika</i>					
Maranta 8599	2	16329	4.05	3.23	1189
<i>LLC Nekrasovo</i>					
122448	3	16121	3.83	3.17	1128

TABLE III. CHARACTERIZATION OF HIGH-PRODUCING COWS BY THE IMMUNOGENETIC STATUS

Number of cows	First lactation			Maximum lactation			
	Milk yield [kg]	Mass fraction of fat [%]	Mass fraction of protein [%]	Time of usage	Milk yield [kg]	Mass fraction of fat [%]	Mass fraction of protein [%]
Total across the set							
2919	8870	3.89	3.16	2.6	11226	3.93	3.22
<i>G₂I₂Y₂E₃Q'</i> genotype							
180	8983	3.90	3.17	2.4	11251	3.92	3.22
<i>G₂Y₂E₃Q'</i> genotype							
135	9131	3.89	3.16	2.3	11117	3.94	3.22
<i>G₂Y₂D'E₃G'O'Q'</i> genotype							
83	9352	3.90	3.19	2.3	11380	3.92	3.23
<i>I₂D'E₃G'O'</i> genotype							
77	9270	3.90	3.19	2.3	11515	3.92	3.21
<i>B₂G₂O₁Y₂D'E₃Q'</i> genotype							
76	8722	3.92	3.15	2.7	11052	3.99	3.20
<i>B₂I₂O₁B'</i> genotype							
73	8735	3.89	3.16	2.6	11066	3.94	3.19
<i>I₂</i> genotype							
67	8436	3.90	3.17	2.7	11027	3.98	3.22
<i>G₂Y₂A₂E₃Q'</i> genotype							
51	8942	3.89	3.18	2.6	10907	3.91	3.22

The analysis of data in Table 3 demonstrates that the largest group (180 heads) includes animals with *G₂I₂Y₂E₃Q'*

genotype. The cows in this group per the first lactation have milk yield of 8983 kg with the mass fraction of fat of 3.90% and mass fraction of protein of 3.17%; the maximum lactation yield-ed 11,251 kg, 3.92% and 3.22%, respectively.

The largest yield, both over the first and maximum lactation, was demonstrated by the animals with I2D'E'3G'O' genotype. These cows yielded over the first lactation 9270 kg of milk with fats of 3.90% and protein of 3.19%; the maximum lactation yielded 11,515 kg, 3.92% and 3.21%, respectively.

Along with high production, an important factor of dairy cattle breeding efficacy is the time of livestock usage. The analysis of Table 3 says that the high-producing cows are used at enterprises for 2.6 lactations on average. However, animals with I2 genotype are productive for 2.7. lactations, while cows with genotypes G2Y2E'3Q'; G2Y2D'E'3G'O'Q' and I2D'E'3G'O' for only 2.3 lactations.

IV. CONCLUSION

Thus, the breeding work at agricultural enterprises of Sverdlovsk region is at high level, which is confirmed by the management of 48.2% of cows with the yield of more than 7000 kilograms of milk per single lactation with the increase in the milk yield up to 17,120 kg. The identified interconnections of the immunogenetic status of cows with their productivity allow determining the possible high productivity of offspring at early stages. The most productive group of cows are animals with I2D'E'3G'O' genotype.

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