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Contemporary trends in the formation of economically-beneficial qualities in productive animals

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Abstract*—This paper covers the contemporary trends in the formation of economically-beneficial qualities in productive animals. Researchers assessed the breeding and productive traits of animals and established the reproduction characteristics of the breeding stock and stud bulls: the inseminating ability and return into heat after calving, return to the state for re-insemination, physiological manifestations of sexual heat, calving ease, direct and indirect health indicators as well as performance. Genomic testing allowed excluding the animals-carriers of genetic anomalies and haplotypes associated with fertility from the breeding process. To improve the quality of milk and the immune resistance in the breeding of stud bulls research team based on the indices of different caseins: α, β, k. The use of genetically evaluated stud bulls in the Sverdlovsk region had a significant impact on milk productivity: milk yield from 2011 through 2018 increased from 5502 to 7448 kg of milk per cow. Genomic breeding allowed predicting the functional breeding parameters, such as the duration of the productive period, calving ease, fertility, the somatic cells count. It was established that the dairy cows descended from bulls, whose semen had been imported, did not have advantages over dairy cows, descended from semen of bulls 'Uralplemcentr' in terms of nutrients in milk. Certainty in the approaches of the abovementioned organization is based on the genome-wide assay, absence of genetic anomalies and haplotypes with negative impact on fertility, assay-based conclusions that the genome has economically-beneficial qualities that are necessary for increasing the economic profit of the dairy cows descended from abovementioned bulls. Over the course of 2-2.5 lactations it is not feasible to evaluate the cow by genotype. Cases, in which mothers are culled from the herd before calving, and their cow daughters start to lactate, lead to genetic stagnation. Increase in milk yield in production herds is related to the increase of expenses on feed components of artificial origin. This again leads to a rapid deterioration of the body of cows and even earlier culling. Without tackling the issues related to breed (or intra-breed) zoning, creation of genetically isolated groups of animals of the main breeds - the further development of the domestic dairy farming is not possible.

Keywords—economically-beneficial qualities, cattle, genomic evaluation, breeding, reproducible characteristics.

I. INTRODUCTION

Economically-beneficial qualities are quantitative and qualitative characteristics of productivity, having a polygenic basis, defining the goals and economic efficiency of breeding of agricultural animals. These characteristics represent the result of complex interaction of genetic factors and conditions of the external environment [1, 2]

The basis of dairy and meat cattle breeding efficiency is the breeding aimed at the improvement of economically-beneficial qualities, which are of decisive importance for the economy of the economic sector. The most important characteristics are the productive indicators: milk yield, quantitative values of its chemical composition, in particular the content of the mass fraction of fat and protein. In meat cattle breeding these indicators include: the increase of live weight during fattening, milking capacity of cows, which is determined by the live weight of a calf at weaning, the yield of meat at slaughter, the ratio of the boneless meat, bones, tendons and other indicators of meat productivity [3-5].

Presently, in addition to the productive the functional indicators become important. Researchers have established the reproduction characteristics of the breeding stock and stud bulls: the inseminating ability and return into heat after calving, return to the state for re-insemination, physiological manifestations of sexual heat, calving ease, direct (hoof health, resistivity to mastitis) and indirect (appearance, somatic cells count in milk) health indicators as well as operational qualities (temper, milk output rate).

For each individual trait, genetic improvement after breeding, depends on a number of factors. The outcome of the breeding process depends on the accuracy of breeding (hereditability), its intensity and presence of genetic variability in herds and the time span between calvings.

To that end, the consistent work on the estimation of pedigree and productive animals' qualities/traits becomes the essential component of efficiency [6].

II. IMPROVING THE GENETIC POTENTIAL OF DAIRY CATTLE BREEDS

The combination of economically-beneficial qualities is equal to a genetic potential of an animal, which can be considered as the sum of productive indicators, indicators of health and reproduction. The presence of a specific set of breeding features in the genotype, under optimal feeding and living conditions, yields economic result, i.e. the profitability of agricultural companies.

It is known that the degree of manifestation of a genetic potential depends on conditions of external environment. The most important environmental factors include: breeding technology and the quality of raising of replacement young cows, physiological value and calorific value of the feed, the living conditions of the stock and especially the microclimate in the livestock facilities.

Presently, due to the reduction of the cows' productive period, the intensity of their breeding in herds became minimal. Typically, during life a cow gives birth to 1 to 1.5 daughter cows, which provides only the replacements to the herd. A case, where almost all replacement heifers are introduced into the herd leads to the genetic progress suspension, given that there is no breeding, i.e. selection.

Consequently, the role of the stud bulls, which became the main source of genetic progress in each individual herd, and in the population as a whole, sharply increases. Artificial insemination technology features allow for very tough selection of bulls for insemination companies.

The basic criterion for selection of young bulls should be planning in selection for achievement of purposes of selection, strict selection requirements and maintenance of epizootic safety of semen production.

Breeder's work in contemporary conditions requires rethinking approaches to consolidate the bulls and attach them to breeding cows in herds. Selection of stud bulls based on the productivity of mothers as it once was is not allowed. Bulls should be selected for breeding value of the proband. Therefore, scoring of the bulls has now become a top priority. Modern methods and tools available to the breeders allow evaluation of young bulls by genotype, i.e., posterity quality, with the use of methods of proof of origin, the evaluation of breeding indicators of milk quality, including somatic cells count, linear exterior assessment etc. The main disadvantage of these techniques is that they require a significant amount of time to carry out. The complete scoring of a stud bull requires 5-6 years from its birth. During this period, occurs a change of at least 2 generations of mother cows. Bull semen, even having the highest score, is not in demand due to the above reasons [7-9].

In other countries, the evaluation method based on genomic indices is used. These are the mathematical predictive data, which allow, with a certain probability, to assume the presence in the genome of a stud bull the desirable economically-beneficial qualities, which it can pass on a female line to the descendants. The first bulls estimated by genome were the bulls imported to Russia in 2009 to 'Uralplemcentr'. Analysis made after the evaluation of the productivity of these bulls' daughters and genomic projections indicated a high correlation, approximately 60-65 percent.

Furthermore, genomic testing allows excluding the animals-carriers of genetic anomalies and haplotypes associated with fertility from the breeding process. To improve the quality of milk and the immune resistance in the breeding of stud bulls researchers used the indices of different caseins: α, β, k.

It became a common practice to test by locus Bola RB3, which specifies the degree of animal resistance to cattle leukemia and overall resistance to the effects of pathological factors.

We cannot simply apply the foreign indexes of the breeding value to the population of domestic (Russian) cattle breeds. Our country is distinguished for its natural diversity. Depending on the specific conditions, many generations of breeders worked to establish such type of animals, which suits the needs of the economy of each region. Each individual group of cattle population, even formed in the process of interbreeding of genetically similar species is unique in terms of inner structure. There are very significant differences in phenotypic evaluation of animals, which are bred in different regions of the country.

The use of genetically evaluated stud bulls in the Sverdlovsk region had a significant impact on milk productivity: milk yield from 2011 through 2018 increased from 5502 to 7448 kg of milk per dairy cow. Of utmost importance is that genomic breeding allowed predicting the functional breeding parameters, such as the duration of the productive period, calving ease, fertility, the somatic cells count etc.

TABLE I. GENETIC STUDIES OF THE MAIN STUD BULLS OF OAO 'URALPLEMCENTR'

Breed, line	**Bulls certified**	**Of which classified as elite record class**	**LPI**	**Research study on genetic anomalies**						**Mother cow productivity**		
				BLAD	***CVM***	***BY***	***HH1 HH3 HH4***	***HCD***	***DUMPS***	***Milk yield, kg***	***Fat in dry matter, %***	***Protein in dry matter, %***
Holstein	56	56	2502	56	56	56	56	56	56	12721	4.06	3.33
of which: B. Ideal	29	29	2530	29	29	29	29	29	29	13027	4.12	3.29
R. Sovering	25	25	2506	25	25	25	25	25	25	12506	4.01	3.38
M. Chieftain	2	2	1894	2	2	2	2	2	2	10982	3.73	3.22
Black-and-White	14	14	1898	14	14	14	14	14	14	11384	4.03	3.20
of which: B. Ideal	4	4	1945	4	4	4	4	4	4	11836	3.93	3.17
R. Sovering	9	9	1883	9	9	9	9	9	9	11317	4.07	3.22
M. Chieftain	1	1	-	1	1	1	1	1	1	10177	4.00	3,00
Total	70	70	-	70	70	70	70	70	70	12454	4.05	3.31

The scientific community of livestock breeders in Russia should make efforts to develop genomic indices for domestic cattle breeds, considering all peculiarities of regional development.

To improve the target economically-beneficial traits in cattle, it is necessary to create country's own, domestic base for the breeding of elite bulls. This, in turn, requires the country's food supply security. Application of contemporary breeding methods in the formation of stud bulls' herd at 'Uralplemcentr' resulted in high efficiency.

TABLE II. PRODUCTIVITY OF THE BULLS' DAUGHTERS OF DIFFERENT ORIGIN, IN THE SVERDLOVSK REGION

Animals	Animals N	Milk yield, kg	Fat in dry matter,%	Fat in dry matter,kg	Protein in dry matter, %	Protein in dry matter,kg	Nutrients, kg
Bulls 'Uralplemcentr' (PJSC Ural Breeding Center)	607	8579	4.0	346.7	3.25	278.8	625.5
Imported	659	9179	3.79	348.1	3.02	277.7	625.8

Comparison of milk productivity results, made in one of the agricultural companies of the region, indicated that daughters descended from bulls, whose semen was imported, did not have any advantages as compared to the cows descended from bulls of 'Uralplemcentr' in terms of nutrients. This major indicator determines the final price of milk.

III. THE CONTEMPORARY STANCE OF A BREEDING ENTERPRISE

The key goal in the development of dairy farming in our country is to achieve food supply security standards outlined in the related doctrine - 80% of feed consumed to be produced domestically. Recent years' statistical data indicated that the measures taken have made it possible to stabilize milk production. It is now the time to go ahead. Moreover, as the president Vladimir Putin outlined, another important goal is to increase the life expectancy of the Russian citizens. Without scientifically grounded medical norms on the consumption of dairy products, it will not be possible to achieve the abovementioned goal. Since milk is the only full-fledged product, which contains all nutrients required for humans in all periods of life. For kids and teenagers - to form a healthy body, for young and adults - to maintain vitality, and for the elderly - to stay in high spirits and maintain optimism. Therefore, despite the rampant anti-dairy campaign, milk consumption will increase. It is also important that the companies, which came to the Russian market with the assertion that 'milk-containing' products are equal to natural milk, never mention that in the so-called developed countries, consumption of natural milk and natural dairy products ranges from 300 to 390 kg per an inhabitant, and in the US citizens consume more than 400 kg. Milk consumption in Russia is currently 233.4 kg, whereas the normal reference value is 325 kg.

Not all groups in the Russian society are developing at the same pace. Market relations have divided people according to the principle of material wealth: high-, medium- and low-income individuals. Given these realities, dairy farming should also specialize. Natural milk can be of at least three types: industrial, organic and functional. Industrial milk is produced on large farms and agrarian complexes. Cows are in the harsh process conditions at large dairy enterprises without any outdoor runs; feed additives, synthetic vitamins, immunostimulative drugs and hormones are added to the feed - these are the conditions in commercial dairy production. Organic milk is produced on relatively small farms. Here, cows feed on natural fodder and are walking outdoors in summer. Functional is the milk with specific characteristics, for instance, containing a high amount of iodine, selenium or other microelements, depending on the geochemical province. Functional milk can be obtained not only by introducing certain additives to the animals' diet, but also by taking advantage of genetic features. For one, there is a considerable difference in the impact on the human body of milk containing different proteins of ß-casein. Type A2 is suitable for people with digestive problems – individuals, who have difficulty in consumption of type A1 milk. Milk for different applications and for various groups of population should be represented on the market. To tackle this challenge, we must change milk production technologies and apply new genetics. Everything, or almost everything, is clear on how to tackle the process challenges in the production of different kinds of dairy products, whereas the conduct of genetic modifications in the new generations of cows requires profound conceptualization. Primarily, it is necessary to assess the consequences of the wholesale Holstein-based breeding; Holstein breed still holds a leading position in the breeding of all domestic dairy cattle breeds. With efforts of foreign companies, which supply bulls' semen from abroad not considering the climatic conditions of our large country, a true genetic expansionist activity is taking place. Most of the farms breed the same genetic line of bulls, homozygosis increases. The consequence of such activity is the shortening of the productive period of cows and impossibility of selective breeding. The very notion of 'breeding' entails two fundamental principles: classification and selection. The classification process is possible only if an animal was scored in terms commercially-beneficial traits. Over the course of 2-2.5 lactations it is not feasible to evaluate the cow by genotype. Cases, in which mothers are culled from the herd before calving, and their cow daughters start to lactate lead to genetic stagnation. Increase in milk yield in commercial herds is related to the increase of expenses on artificial feed components. This again leads to the rapid deterioration of a cow body and even earlier culling. The key proof point of semen importers is the assumption that in the USA, Israel and other countries the duration of cows' productive period is 1.5 – 1.7 lactations. It may be acceptable in these countries, but it is not unacceptable for Russian conditions. Without tackling the issues related to breed (or intra-breed) zoning, creation of genetically isolated groups of animals of the main breeds further development of the domestic dairy farming is not possible. We must look ahead and create conditions for the interregional exchange of genetic material - this will increase the sustainability of the industry. In the field work at OAO 'Uralplemcentr' these and

other issues were taken into account. Under the aegis of the Coordinational and Methodical Council on the improvement of Black-and-white cattle of the Urals region researchers establish the basis of new domestic cattle genetic lines. Embryo transplantation method will allow for new types of cows, which will fully meet the needs of agricultural companies. These cows will be mothers of stud bulls, which are required to meet the challenges of breeding. Stud bulls are the main link in the creation of new types of animals and breeding of bulls, their scoring are the most important challenge for the experts. Each type of a stud bull is unique, and we should gather all data available in the contemporary science about these types.

IV. CONCLUSION

Comparison of milk productivity results, made in one of the agricultural companies of the region, indicated that cow daughters descended from bulls, whose semen was imported, did not have any advantages as compared to the cows descended from bulls at 'Uralplemcentr' in terms of nutrients. This major indicator determines the final price of milk.

Certainty in the approaches of abovementioned company is based on the genome-wide assay, absence of genetic anomalies and haplotypes with negative impact on fertility, assay-based conclusions that the genome has economically-beneficial qualities that are necessary for increasing the economic profit from the cow daughters descended from abovementioned bulls. This is our professional stance.

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