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Original Article

Introduction of the Modern Methods of Assessing the Breeding Value of Cows in the Selection of Dairy Cattle in the Republic of Kazakhstan

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Abstract

On the genetic improvement of animals, the need for decision-making takes place at the strategic, tactical, and operational levels. At the strategic level, this means defining a breeding goal, selecting a breeding system (selection or crossbreeding), as well as crossbreeding patterns, breeds, and lines. The current study aimed to analyze the breeding and genetic parameters of the dairy cattle in the Republic of Kazakhstan and introduce modern methods for assessing the breeding value of domestic and imported breeds of dairy cows. Research data were collected from primary zootechnical and breeding accounting (from the information and analytical system [IAS]), as well as experimental studies, visual assessment, measurements, and control milking of animals. In addition, biochemical studies of milk were conducted in this study. All animals were in the same conditions of feeding. The average milk yield per cow was 5,712±97 kg, with an average fat content of 3.83±0.02%, protein content of 3.28±0.01%, with the content of 339.6±54 thousand somatic cells. However, these data are obtained based on quarterly quality indicators of milk (fat content, protein, and the number of somatic cells), which raises doubts about the reliability of the results. It was found that the average index of the total estimated breeding value (EBV) for all breeds was 81. Among all breeds, the highest EBV was estimated at 84 in the Holstein cows (imported to the country).

Keywords: Breeding process management system, Control milking, Exterior, Index estimation of breeding value, Milk yield for lactation

1. Introduction

In the dairy cattle breeding in the Republic of Kazakhstan (RK), the rate of development is primarily determined by the productivity of livestock. According to the agency for the RK statistics, as of January 1, 2018, the average milk yield in the RK does not exceed 2,300 kg per 1 cow, the gross milk production was just over 5.0 million tons, and 89% of this amount was produced by small farms. This production provides only 331 kg of whole milk per capita, with a norm of 405 kg. The dairy cattle industry, as well as animal husbandry in general, requires constant monitoring of existing systems for managing selection processes (1, 2). The modern dairy cattle breeding in RK, the main task of animal sciences and practice to further intensify the industry, aimed at increasing the genetic potential of the productive qualities of domestic breeds of animals and the degree of its implementation (3, 4).

The development of molecular biology, population genetics, and biotechnology, development and implementation of large-scale breeding, and the use of computer programs for analyzing breeding information have enriched the arsenal of tools for studying biological patterns and managing animal inheritance and breed formation processes (5, 6). However, it does not mean that individual selection methods have lost their significance. A detailed study of intra-breed structures will allow us to assess the breed's gene pool and give a theoretical justification for its qualitative improvement, avoid the "breeding plateau", and maintain the necessary level of variability of traits while increasing the productivity of herds (7).

The theoretical basis of modern breeding is population genetics, which is established based on the combinative variability of traits and knowledge of the laws of their inheritance. Over the past decades, significant potential has been accumulated in this area, the use of which allows us to work in the right direction, predict the effect of breeding programs, and model them with an accurate calculation of the average for the cows of the same age in the whole breed (8).

Assessment of the genetic and breeding value of the livestock using the genomic breeding program is a suitable and promising alternative for this purpose. Genomic selection, while cost-effective and leading to 50% genetic improvement, can be calculated for one-year-old calves and increase selection pressure (9). In animal breeding, genomic assessment means the combined use of genotypic information at the level of DNA sequence, along with phenotypic information that can be used to classify animals and select the desired individuals without the need for a long time to reveal the phenotypic function. In genomic selection, each of the markers enters the model as a random or quantitative factor, and the corrective value of individuals is estimated from the total corrective value of the markers. The purpose of the genomic selection is the simultaneous use of genotypic data at the level of DNA sequence with phenotypic data so that animals can be evaluated, and the optimal animals can be selected without the need to spend a lot of time and money (10, 11).

It should be noted that genomic studies are an improved method of selecting young gobies, the reliability of which is confirmed by subsequent assessment of the offspring. Since 2009, genomic assessment has become the official assessment system in the United States and Canada, and since August 2011, in Germany and Austria. The only difference from the current estimate is that the confidence indicators reflect additional accuracy of the genomic data (12-14).

The use of the marker genes is particularly relevant for assessing traits the phenotypic manifestation of which occurs relatively late or is restricted by gender, as well as traits the manifestation of which is strongly influenced by non-genetic factors (e.g., environmental factors) (15, 16).

Due to the significant variability of environmental conditions and non-additive inheritance of milk productivity, according to some researchers, the productivity of ancestors is not a reliable criterion for the value of their offspring. One of the ways to improve the accuracy of the cow assessment is to consider as many environmental factors as possible, fluctuations in milk productivity by lactation, heritability, standard deviations, and repeatability (17-19).

Practically, an index estimation of the breeding value of the cattle is applied using information and analytical systems (IAS) that allow getting an objective view of the individual animals and herds as a whole (20). Modern information technologies enable remote selection. Economic and research analysis is performed at a suitable quality level using collected data and modern analytical tools. The use of this new tool significantly improved the quality of recorded information (21, 22).

Currently, a clear priority is to increase the economic efficiency of production and improve its quality characteristics by enhancing the breeding qualities of animals and the rational use of genetic resources. To overcome this problem, the main role is played by optimizing the overall system of the breeding work at the level of breeds and populations of animals. Programs of the breeding work in dairy cattle breeding are based on three components, namely the assessment of breeding qualities of animals, the formation of breeding groups, and their intensive use in the reproduction system of the genetic material of the selected population (23).

In the animal industry, research has shown that the accuracy of genomic assessment is more than 80% for production traits and more than 70% for fertility and longevity traits (24). On the other hand, genomic selection reduces the generation gap, and due to its ability to evaluate more livestock, it increases the rate of genetic improvement and saves a high percentage on breeding costs. Therefore, with genomic evaluation, it is possible to achieve this in the short term by applying breeding programs to animal populations with desirable genetic resources. This study aimed to estimate the hereditary and economic value of the studied herds to use new genomic evaluation tools.

2. Materials and Methods

In this study, the information of breeding flocks of Holstein, Alatau, Simmental, Red steppe, as well as Blak-and-White breeds were obtained through experimental observation, ocular evaluation, measurement of studied traits, and control of milking of livestock. In addition, the biochemical properties of milk were studied. In this experiment, the animals used were subjected to the same nutritional and maintenance conditions. Milk production records were collected monthly and categorized based on the daily milk production per milking and milking technology in the field. From a special graduated container (called milk meter) with a capacity of 10 ml, which had an accuracy of 0.01 ml, a sample of milk from three places of buckets (top, middle, and bottom of the bucket) was used and measured.

For biochemical studies in the laboratories of research organizations (RO), the amount of fat, protein, lactose, casein, free fatty acids, urea, and freezing depression were determined by MilkoScan (FOSS Electric, Conveyor 4000), and the number of somatic cells was counted by Fossomatic 5000 (FOOS).

Breeding values were calculated using data collected by farmers on the farm, including herd test data, weighing data, body condition scores, and "non-production characteristics" scores. The breeding value of the dairy cows was estimated based on the collected data related to productive indices (milk yield, milk fat, protein, and body cell number), as well as the results of the linear evaluation of the animals' appearance. The productive index was obtained from the total information, and the value of breeding was estimated according to the method developed by the employees of the limited liability company "Kazakhstan Scientific Research Institute in Animal Husbandry and Forage Production" (25).

To improve the breeding value and develop a system for managing the selection process in dairy cattle breeding within the framework of the segmentation, targeting, and positioning, the study was started on the formation of the groups of first-calvers from different regions of Kazakhstan. A total of 2,107 cows were selected from seven regions.

2.1. Statiscital Analysis

The collected data were stored and processed in Excel and analyzed through statistical methods proposed by Nei (26).

3. Results

In the dairy cattle industry, it is accepted that farms, which breed the livestock of the listed breeds, as well as RO, are involved in the breeding process. In addition, there are laboratories for determining the quality of milk and IAS. Regional agricultural departments subordinate to MA RK should manage the entire breeding process which is shown schematically in figure 1.

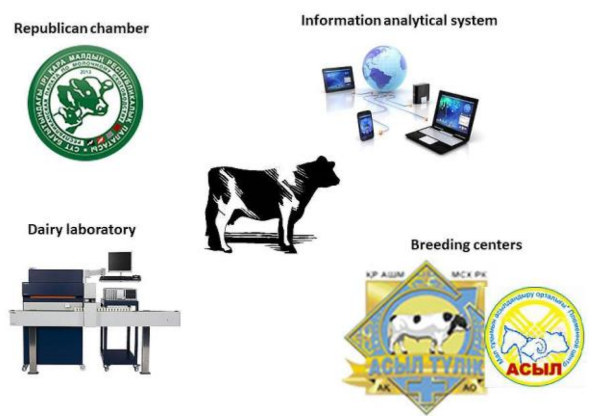

Figure 1. Schematic of the breeding process

According to the results of the group formation, it was found that the milk productivity of the mothers during the lactation of the formed groups has significant fluctuations (3,413 to 9,611 kg); however, the productivity of the mothers of their fathers was much higher (5,000 to 14,850 kg), which determines the genetic potential of the formed groups. Data on the productivity indicators of the cows of the formed groups and their ancestors were entered into the IAS program. The results of the lactation of the cows are shown in table 1. The highest milk production was recorded in Holstein (6,380 kg), and the lowest milk production was recorded in Alatau (5,259 kg). Simmental showed the highest amount of fat (3.96%) and protein (3.37%). Most of the somatic cells also belonged to Alatau (756).

As can be observed in table 1, the average milk yield per cow was 5,712±97 kg, with an average fat content of 3.83±0.02%, protein content of 3.28±0.01%, and the content of 339.6±54 thousand somatic cells. However, these data are obtained based on quarterly quality indicators of milk (fat content, protein, and the number of somatic cells), which raises doubts about the reliability of the results. To obtain valid data, monthly visits were made to experimental farms in different parts of the RK to control the milking of cows by sampling milk and determining its quality *in vitro*. The analysis of the productivity data based on complete data (complete lactation of cows) by downloading them from the IAS program is presented in table 2.

Table 1. Productive indicators of the formed groups by breed

Breed	**Productivity of the cows over a complete lactation**							
	Milk yield, kg		**Fat, %**		**Protein, %**		**Somatic cells, th.**	
	$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v
Alatau (n=534)	5,259±71	28	3.84±0.02	12	3.28±0.01	10	756.0±67	207
Simmental (n=796)	5,654±60	32	3.96±0.01	10	3.37±0.01	7	356.9±20	156
Black-and-white (n=812)	5,548±63	32	3.74±0.01	9	3.24±0.01	7	240.6±15	173
Holstein (n=505)	6,380±67	36	3.80±0.01	11	3.24±0.01	8	217.6±11	176
For 305 days of lactation	5,712±97		3.83±0.02		3.28±0.01		339.6±54	

Table 2. Dairy productivity of the cows based on different breeds

Breed	**n**	**Milk yield, l**		**Fat, %**		**Protein, %**		**Somatic cells**	
		$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v	$\bar{X} \pm m_{\bar{x}}$	C_v
Alatau	220	5,100±273	33	3.78±0.05	8.4	3.22±0.05	8.6	648.0±94	87
Holstein	2,671	5,794±93	37	3.72±0.02	15.6	3.17±0.02	14.7	285.2±8.9	75
Black-and-White	674	4,348±166	44	3.72±0.04	12.9	3.05±0.05	20.4	336.5±46	131
Simmental	403	3,812±207	48	3.91±0.05	9.2	3.23±0.05	14.7	378.5±38	71
Red steppe	23	3,756±571	41	3.53±0.13	9.6	2.84±0.11	10.9	530.7±195	73
Total/on average	3,991	5,300±130	41	3.74±0.03	14.1	3.16±0.03	15.3	324.7±24	85

According to table 2, it is found that the average productivity of 3,991 cows is 5,300±130 kg (milk), and the most productive cow breed is Holstein. Moreover, the productivity rates of this breed were 694; 1,446; 1,982; and 2,038 kg more than those of Alatau, Black-and-White, Simmental, and Red steppe, respectively. The highest fat content was observed in the Simmental breed (3.91±0.05), which were 0.13, 0.19, and 0.38 higher than those in Alatao, Black-and-White, and Holstein, respectively.

Furthermore, the highest amount of protein belonged to the Simmental breed (3.23±0.05%), followed by Alatau (3.22±0.05%), Holstein (3.17±0.02%), Black-and-White (3.05±0.05), and Red steppe breeds (2.84±0.11).

Milk productivity data of the cows were analyzed based on the lactation age. Indicators of the milk productivity of the Alatau breed are presented in table 3.

According to table 3, milk productivity is characterized by an increase from 4,844 to 5,679 and 5,458 kg in the second and third lactations, respectively. A gradual decrease from 4,716 to 4,017 kg was observed in the fourth and fifth lactations. This breed is characterized by a constant level of milk yield, which confirms its high-stress resistance. On average, during all lactations, the cows of this breed weighed 5,123±275.4 kg. It should be noted that the number of somatic cells increases with age in the cows of this breed.

A slightly different picture is observed in the study of milk productivity in the context of lactation in the Holstein cows (Table 4).

As can be observed in table 4, the milk productivity of the Holstein cows increased up to the fifth lactation, without declines, which is typical for this dairy breed. The nature of the flow of the milk productivity of Black-and-White cows (Table 5) has a peculiar specificity.

Table 3. Indicators of the milk productivity and quality of the Alatau breed milk

Age in lactation	Number, animals	Milk yield, kg		Fat, %		Protein, %		Somatic cells, th/cm^3	
		$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v
1st lactation	62	4,844±189	30.8	3.74±0.04	8.6	3.19±0.03	8.6	542.2±57	83.1
2nd lactation	58	5,679±221	29.7	3.77±0.04	8.5	3.22±0.03	8.1	490.6±57	89.3
3rd lactation	36	5,458±313	34.4	3.76±0.04	6.8	3.22±0.04	7.3	802.0±155	116.2
4th lactation	34	4,716±275	34.0	3.79±0.05	8.3	3.23±0.05	8.6	785.3±89	66.2
5th lactation	12	4,017±641	55.3	3.93±0.11	10.0	3.29±0.10	10.3	673.6±181	93.2
6th lactation	14	4,421±468	39.7	3.92±0.12	11.8	3.20±0.11	12.8	1,045±206	74.0
Total/on average	216	5,077±275.4	33.6	3.78±0.05	8.5	3.21±0.05	8.6	649.8±95	87.6

Table 4. Indicators of the milk productivity and composition of the Holstein breed milk

Age in lactation	Number, animals	Milk yield, kg		Fat, %		Protein, %		Somatic cells, th/cm^3	
		$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v
1st lactation	722	5,280±67.6	34.4	3.73±0.02	14.9	3.18±0.02	13.5	302.2±7.3	65.2
2nd lactation	583	5,502±85.4	37.5	3.78±0.02	11.6	3.22±0.02	12.5	274.2±5.3	47.0
3rd lactation	356	5,598±98.1	33.1	3.76±0.02	9.2	3.21±0.01	8.7	313.4±14.9	89.6
4th lactation	158	5,650±159.3	35.4	3.74±0.04	12.6	3.21±0.03	11.7	297.2±16.4	69.3
5th lactation	91	6,139±213.1	33.1	3.79±0.03	8.8	3.25±0.03	7.9	256.7±15.4	57.3
6th lactation	50	5,648±281.6	35.3	3.73±0.05	9.5	3.25±0.03	8.7	287.3±18.3	44.5
Total/on average	1960	5,479±93.3	35.1	3.75±0.02	12.3	3.20±0.02	11.8	293.0±9.5	63.7

Table 5. Indicators of the milk productivity and composition of the Black-and-White breed milk

Age in lactation	Number, animals	Milk yield, kg	Fat, %		Protein, %		Somatic cells, th/cm^3		
		$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v
1st lactation	117	4,936±231	50.7	3.65±0.05	15.3	3.05±0.05	19.5	444.1±101.7	247.8
2nd lactation	121	4,692±191	44.9	3.77±0.03	9.5	2.97±0.06	23.3	293.5±26.6	99.9
3rd lactation	108	4,811±157	34.1	3.75±0.04	10.1	3.14±0.05	18.0	408.1±64.5	164.3
4th lactation	68	4,493±174	32.0	3.81±0.03	6.4	2.97±0.10	26.5	289.1±27.2	77.7
5th lactation	54	3,989±180	33.3	3.85±0.03	5.2	3.23±0.04	8.8	241.7±8.9	26.9
6th lactation	22	4,391±243	26.0	3.84±0.07	8.5	3.21±0.05	6.9	722.3±273.0	177.3
Total/on average	490	4,658±192	40.0	3.75±0.04	10.1	3.07±0.06	19.3	367.7±62.1	141.7

Therefore, from the first lactation, when the maximum milk production was 4,936±231 kg, it gradually decreased to the fifth lactation (3,989±180 kg), where the lowest productivity occurred. This showed an increase in the reaction of this breed to the stress of environmental factors. Nevertheless, the average milk production rates for the entire lactation period were 4,671; 190; and 190 kg. This means that this breed had good potential for milk production. When working with this breed, it is necessary to strengthen the selection of milk productivity and composition of milk.

In the case of the Simmental breed, the performance dynamics of the curved valve are shown in table 6.

Milk production of this breed increased from 3,917±138 kg in the first lactation to 4,035±220kg in the second lactation. On the same day, decreasing (3,334±200 kg) and increasing (4,391±302 kg) of milk production were observed in the third and fourth lactations, respectively. From the fifth lactation onwards, a decrease in the lactation rate of this breed was recorded.

Figure 2 illustrates the results of the linear assessment of the cows of Alatau, Simmental, Black-and-White, and Holstein breeds.

Table 6. Indicators of the milk productivity and composition of the Simmental breed milk

Age in lactation	Number, animals	Milk yield, kg		Fat, %		Protein, %		Somatic cells, th/cm^3	
		$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v
1st lactation	134	3,917±138	40	3.96±0.02	5.4	3.30±0.03	9.9	387±17.1	50.9
2nd lactation	100	4,035±220	54	3.88±0.03	7.8	3.18±0.05	16.2	352±18.2	51.7
3rd lactation	68	3,334±200	49	3.80±0.07	15.7	3.22±0.08	20.3	329±17.1	42.7
4th lactation	56	4,391±302	51	3.91±0.04	7.6	2.97±0.09	21.4	418±82.7	148.0
5th lactation	21	3,058±329	49	3.81±0.12	14.2	3.31±0.06	8.6	513±197.4	176.2
6th lactation	23	2,879±246	41	4.23±0.16	17.7	3.64±0.06	8.4	365.4±51.5	67.6
Total/on average	402	3,809±208.0	47	3.91±0.05	9.2	3.23±0.05	14.7	378.7±37.9	70.8

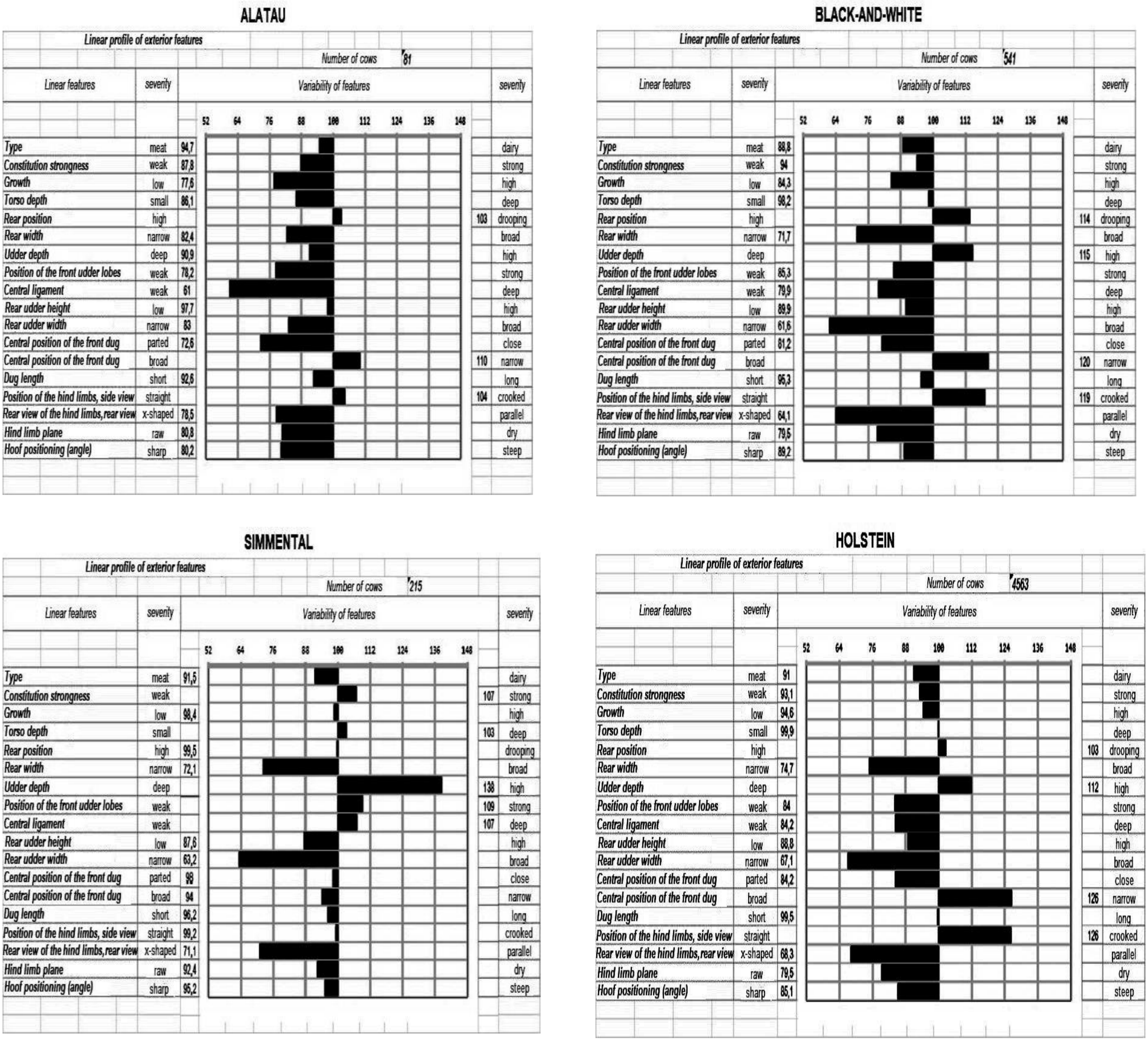

Figure 2. Linear estimation and profile of the first-calvers of Alatau, Simmental, Black-and-White, and Holstein breeds

As can be observed in the linear profile of the animals in Figure 2, domestic cows have optimal scores for the parameters of the species and limb indicators; however, the udder parameters differ sharply, which determines the direction of further selection work with domestic cows. It is necessary to conduct a corrective selection of the studied bulls considering these disadvantages.

The calculation of the cow estimated breeding value is presented in table 7.

From the data in table 7, it is found that the average indicator of the general estimated breeding value (EBV) for all breeds was 81±0.3. The best index of the milk productivity (100±0.2) was in the Holstein breed, and the lowest (98±0.5) was in the Black-and-White breed. In the index of the udder health evaluation, the values of 100±0.01 and 99.4±0.30 were assigned to Holstein and Black-and-White breeds, respectively. After calculating the general EBV, it was found that

Holstein with 84±0.3 and Simmental with 75±0.3 had the highest and lowest values, respectively. Based on the analysis of the research results, a recommendation on the scientific and methodological bases of the organization of the selection process management system in dairy cattle breeding has been developed as follows (Figure 3):

1. Organizations should be created (e.g., service centers) and would have their laboratory for determining the qualitative indicators of milk (milk yield, milk fat, protein, and the number of somatic cells), followed by the staff of grader-classifiers eligible to conduct a linear assessment of the exterior cows.

2. This organization (or service center) as a service would take monthly samples of milk from the cows of economic entities, determine its quality, and conduct a linear assessment of the cows of the first calving two times a year. Afterward, the data on productivity and exterior indicators would automatically be sent to the IAS program through the AWS grader and laboratories.

Table 7. Results of the calculation of the indices of cow breeding value by breed

Breed	Number, animals	Index of milk productivity		Index of udder health		General estimated breeding value	
		$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v	$\bar{X}\pm m_{\bar{x}}$	C_v
Holstein	1,960	100±0.2	7.6	100±0.01	0.4	84±0.3	15.7
Black-and-White	490	98±0.5	11.0	99.4±0.30	7.9	77±0.5	14.1
Alatau	216	100±0.5	7.7	100±0.04	0.6	75±0.4	7.8
Simmental	402	100±0.5	9.6	100±0.02	0.5	75±0.3	7.7
Total/on average	3,091	99.7±0.3	8.4	99±0.10	1.6	81±0.3	13.8

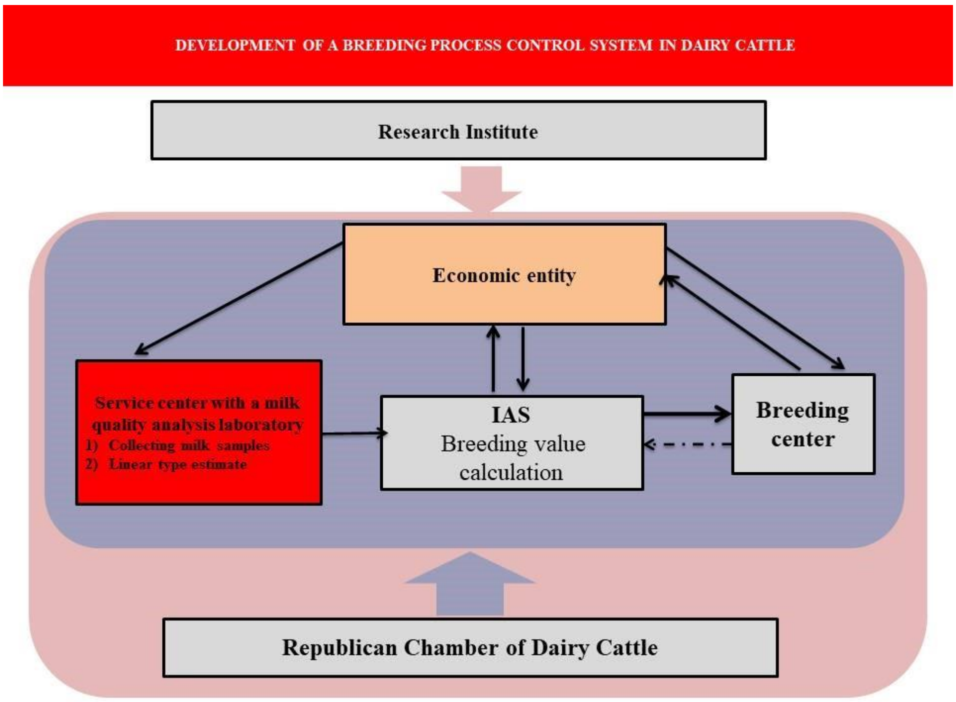

Figure 3. Scheme of the selection process management system in the dairy cattle breeding

3. IAS automatically calculates the EBV for each cow.
4. Breeding centers, according to the EBV data, should develop a plan for custom mating, having previously concluded agreements with economic entities regarding the guaranteed purchase of gobies obtained from custom mating for their further cultivation.
5. After the gobies are born from customized pairing, up to 2-6 months of age, breeding centers should conduct their genomic analysis. When obtaining a high estimated breeding value, breeding centers buy these gobies, raise them, and assess their productivity and the quality of offspring in the future. Therefore, the breeding centers fill the seed bank with the gene pool of the domestic breeding animals.
6. The entire selection process should be conducted under the scientific and methodological guidance of RO. Control for the entire selection process should be carried out by the Republican Chamber for the breeding of dairy cattle.
7. If this recommendation is observed, all the subjects of the selection process will be closely interconnected in one system, as shown in the scheme, and the selection process will acquire the necessary dynamics.

4. Discussion

In the RK, the Republican Chamber was established for the breeding of the dairy cows, and the five breeds included Alatau, Aulieata, Black-and-White, Red steppe, Simmental breeds of domestic selection, as well as Holstein. The selection process management system should group the producing cows to select the productive cows for custom mating. On the other hand, it is necessary to prepare an appropriate scientific program to perform effective mating to obtain fathers with high genetic capacity, and genomic evaluation should also be performed.

When the collected information is entered into the IAS, the breeding value of the animals is automatically calculated, and the genomic rank is determined. Animals that are known to have superior genetic genes are considered in breeding programs. One of the reasons for the low efficiency of dairy cattle breeding in Kazakhstan is the use of low-genetic livestock. Laws passed in Kazakhstan in recent years have created real prerequisites for the preservation of livestock gene pools (27).

Somatic cells were in the normal range. It was also found that the diversity of all traits (milk function, fat and protein content in milk, and the number of body cells) was very high and was most likely determined by the heterogeneity of traits. Therefore, by choosing, some steps can be taken to increase production.

The duration of the economic use of cows is one of the important indicators in the system of the reproduction of the herd as a complex production process that includes a complex of organizational and economic, zoo veterinary, and technological measures. Productivity and reproductive abilities of animals are the most important components of the economy for which selection should be carried out (27-29).

The integrated valuation method in RK is based on the outdated principles of point scaling of economic and individual values. There is still no agreement between scientists and breeders on the possibility of using some selection principles. There is also no scientific justification for determining the values of the coefficients used to construct the linear exterior of animals. In countries with developed livestock breeding, the selection process is closely linked to management. The RO of the RK has developed a method for index estimation of breeding value of milk cows. Farmers do not pay due attention to the linear assessment of the exterior of cows. One of the most acute problems in the breeding of cattle is the lack of study on bulls selection. The situation is complicated by the low organization of breeding work with herds of dairy cattle. The method is embedded in the IAS program, which is based on data on milk productivity and the exterior.

According to the preliminary research results, the average milk yield per 1 cow was 5,712±97 kg, with an average fat content of 3.83±0.02%, protein content of 3.28±0.01%, with the content of 339.6±54 thousand somatic cells. Holstein cows (6,380±67 kg) had the highest milk yield. The difference between the milk yield of Holstein and Alatau cows was 1,121 kg (*P*>0.999) (Black-and-White: 832 kg; *P*>0.999 and Simmental 726 kg; *P*>0.999). The variability of traits is stable. It is recommended to start breeding work with the formation of groups of heifers and lactating first-calvers in the first three months, conducting monthly control milking with milk sampling, analyzing its quality in independent dairy laboratories, and entering all data into the IAS program, with a linear assessment of the exterior of cows, as well as the formation of bull-producing groups of cows for the selection of highly productive cows in order to conduct custom mating and obtain bulls with high genetic characteristics, conducting their genomic assessment.

Reliable results of the selection work in dairy cattle breeding were obtained, and based on the results of these studies, recommendations were developed for further development of a system for managing the selection process in dairy cattle breeding with its scheme.

Based on the results of the research:

1. It was found that the milk productivity of mothers during the lactation of the formed groups has significant fluctuations (3,413-9,611 kg); however, the productivity of the mothers of their fathers was much higher (5,000-14,850 kg), which determines the genetic potential of the cows of the formed groups.

2. It was found that the average productivity of the 3,991 cows was 5,300±130 kg, and the most productive breeds were Holstein cows, and their excess productivity rates over the Alatau, Black-and-White, Simmental, and Red steppe were 694 (*P*>0.99); 1,446 (*P*>0.999); 1,982 kg (*P*>0.999); and 2,038 kg (*P*>0.999), respectively.

The highest fat content was measured in the Simmental breed (3.91±0.05%), surpassing Alatau by 0.13% (*P*>0.95), Black-and-White and Holstein by 0.19% (*P*>0.999), and Red steppe by 0.38% (*P*>0.999). In terms of the protein content, Simmental cows exceeded Alatau by 0.01% (the difference is not reliable), Black-and-White by 0.18% (*P*>0.999), Holstein by 0.06%, and Red steppe by 0.39% (*P*>0.999). It was also found that the variability of all traits (milk yield, fat and protein content in milk, and the number of somatic cells) is very high, which is most likely due to the heterogeneity of traits.

3. When studying the productive indicators, depending on age, it was found that the milk productivity of Alatau cows was characterized by an increase (4,844; 5,679; and 5,458 kg) to the second-third lactations and a gradual decrease (4,716-4,017 kg) to the fifth. This breed is characterized by a constant level of milk yield, which confirms its high-stress resistance. On average, during all lactations, the cows of this breed weighed 5,123±275.4 kg. With aging, the number of somatic cells in the cows of this breed increases. A slightly different picture is observed in the study of milk productivity in the context of lactation in Holstein cows, and it increases to the fifth lactation without declines. The nature of the flow of milk productivity of Black-and-White cows has a peculiar specificity. Therefore, starting from the first lactation, when there was a maximum milk yield (4,936±231 kg), there is a gradual decrease to the fifth lactation, where the lowest productivity is established. As for the Simmental breed, the dynamics of the milk yield is curved. Accordingly, when productivity increases to the second lactation (from 3,917 to 4,035 kg), in the third, on the contrary, it decreases (from 4,035 to 3,334 kg), then this sequence is repeated.

4. In domestic cows, the optimal scores corresponded to the parameters of the species and limb indicators; however, the udder parameters differ sharply, which determines the direction of further selection work with domestic cows. It is necessary to conduct a corrective selection of the studied bulls considering these shortcomings.

5. It was found that the average indicator of the general EBV for all breeds was 81. Among all breeds, the highest EBV level was determined at 84 in the Holstein cows. The EBV level of the cows of other breeds does not show a significant difference among them.

Authors' Contribution

Study concept and design: S. A.
Acquisition of data: L. B.
Analysis and interpretation of data: R. K.
Drafting of the manuscript: A. B.
Critical revision of the manuscript for important intellectual content: S. A.
Statistical analysis: S. A.
Administrative, technical, and material support: S. A.

Ethics

The present study was approved by the Ethics Committee of the Kazakh Scientific Research Institute of Animal Breeding and Feed Production, Almaty, the Republic of Kazakhstan under the project number (No:2020-7894-5487).

Conflict of Interest

The authors declare that they have no conflict of interest.

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